

Sphere plate

# KOBA-check

system KK 25

for the periodical monitoring  
of coordinate measuring  
machines



## DELIVERY PROGRAMME AND SERVICE:

- gauge blocks
- gauge block accessories
- step gauge KOBA-step
- ball bar up to 8 m length
- ball cube
- optical scale KOBA-optima
- cylindrical gauges
- feeler gauges
- angle gauge
- sine bars
- precision parts
- spline gauges
- KOBA-calibration service
- DKD-laboratory for gauge blocks

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Made in Germany

The periodic monitoring of hand-operated or computer-controlled coordinate measuring machines is carried out on the basis of calibrated mechanical test pieces. Appropriate selection and combination of various test pieces such as spheres, graduated gauge blocks and sphere plates and their arrangement make it possible to discover the overall measured volume or particular partial measured volumes corresponding to the typical workpiece size and adapt the test to its most important measurement job. The process control is done uniformly in accordance with the nominal data of the test piece. The numeric and graphic evaluation is carried out for each type of test piece with a uniform program and assessed by trained personnel.

Summary characteristic values give an overview of the current level of accuracy and long-term tendencies. In this way the use of coordinate measuring instruments can be optimized and their downtime minimized without high expense.



Fig. 1: **KOBA-check** sphere plate in horizontal construction with insulating handles and probe test unit

To respond to the stiffer requirements for the testing of coordinate measuring instruments, Kolb & Baumann have expanded their supply range (including **KOBA-step**) by adding the **KOBA-check** sphere plate. This incorporates virtually all characteristics required of a test device used to monitor coordinate measuring instruments.

## Characteristics of the KOBA-check sphere plate

### Short-term stability:

- Distortion-free support with ball bearing mountings in prisms on a reinforcement plate
- The arrangement of the ceramic spheres in the neutral plane ensures that no alterations in the gap between given spheres arise when there are positional variations in the measured volume (bowing of the sphere plate) and that their relative position to one another does not change
- Insulating handles and plastic protection to reduce thermal effects
- Rigid underframe and assembly parts guarantee vibrationfree construction

### Long-term stability:

- A special aging procedure guarantees long life with a high degree of dimensional stability
- Symmetrical form ensures no distortion when used at different temperature levels
- Stable construction and purpose-built transport containers virtually exclude the possibility of warping or damage during transport or assembly
- The contact elements are protected against damage by their recessed embedding in the plate body
- The use of ceramic spheres gives the contact elements high resistance to wear

### Contact elements of the sphere plate:

- Fixing of the ceramic spheres in the flexion-neutral-plane
- Stable and deformation-free securing of the spheres
- High dimensional accuracy of the contact element (dimensional variation < 0.3  $\mu\text{m}$ )
- Hardness of the ceramic sphere > 1650 HV

### Contact elements of the probe test unit:

- Ceramic sphere 30 mm in diameter and a sphericity less than 0.15  $\mu\text{m}$
- Ring gauge with a dimensional variation of 0.3  $\mu\text{m}$  (calibrated on request)



Fig. 2: Probe test unit for use in horizontal and vertical position of the ring gauge

### Accessibility of the contact elements:

- The special configuration in the area of the ceramic spheres allows free access to the equatorial area in four sectors and thus a scarining in hemispherical halves around the poles
- The provision of drilled "voids" allows the measurement probe to be aligned at an angle to the plate within certain limits, without a collision occurring
- In vertical operation, contact is possible from both sides of the sphere plate

### Handling:

- Easy to manoeuvre with screw-in insulating handles
- Practical accessories for mounting in various positions
- Drilling out superfluous material reduces weight to a minimum

### Construction:

- Vertical construction with accessories in the direction of the axis planes or the spatial diagonals  
Horizontal construction parallel to the measuring table  
35° angled arrangement with underframe parts

### Calibration:

- Calibration of the KOBA-check sphere plate and probe test unit can be done by the appropriate laboratory in Germany by the PTB or a DKD calibration center, traceable to the official length standard guaranteed

### Time required for monitoring:

- Quick setting up with practical assembly components
- Short tempering time with manipulation using insulating handles
- Determination of the three spatial axes in one measurement cycle when positioning in one diagonal of the measured volume (cf. cover picture)

## Technical Data:

### Spheres:

|                                  |   |
|----------------------------------|---|
| Number of spheres:               | 25                                      |
| Sphere diameter:                 | 22 mm                                   |
| Sphericity:                      | < 0.3 $\mu\text{m}$                     |
| Material:                        | $\text{Al}_2\text{O}_3$                 |
| Hardness:                        | > 1650 HV                               |
| Coefficient of thermal expansion | $a = 5.5 \times 10^{-6} \text{ K}^{-1}$ |

### Plate body:

|                                  |   |
|----------------------------------|---|
| Material:                        | Gauge steel, protected against corrosion by surface treatment |
| Coefficient of thermal expansion | $a = 11.5 \times 10^{-6} \text{ K}^{-1}$                      |

### Ring gauge:

|                                  |  |
|----------------------------------|--|
| Coefficient of thermal expansion | $a = 11.5 \times 10^{-6} \text{ K}^{-1}$                                   |
| Dimensional variation:           | < 0.5 $\mu\text{m}$<br>< 0.3 $\mu\text{m}$ on request<br>(at extra charge) |

### Probe test sphere:

|                                  |  |
|----------------------------------|--|
| Coefficient of thermal expansion | $a = 11.5 \times 10^{-6} \text{ K}^{-1}$ |
| Dimensional variation:           | < 0.15 $\mu\text{m}$                     |
| Hardness:                        | > 1650 HV                                |

| Order no.:       | 644 000– | 0620       | 0420       | 0320       | 0230       |    |
|------------------|----------|------------|------------|------------|------------|----|
| Dimensions:      |          | 620x620x24 | 420x420x24 | 320x320x24 | 230x230x24 | mm |
| Weight:          |          | 28         | 18         | 11         | 9          | kg |
| Max. sphere gap: |          | 532        | 332        | 240        | 150        | mm |
| No. of spheres:  |          | 25         | 25         | 25         | 9          |    |

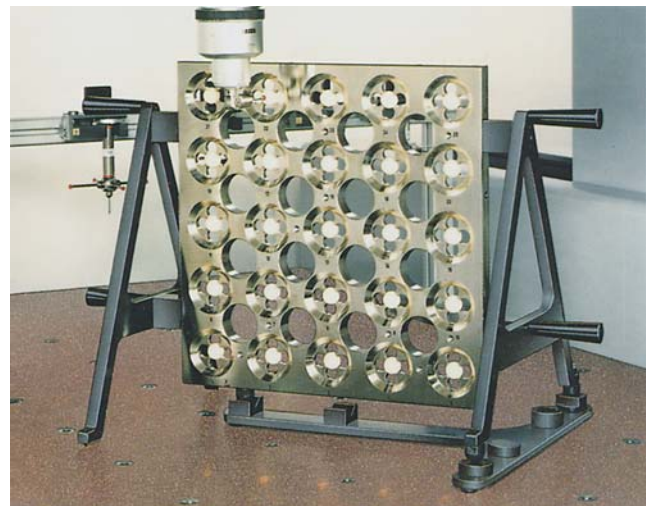


Fig. 3: KOBA-check sphere plate in vertical position with adaptor plate and additional lateral support

## Range supplied:

- 4 standard sizes in square form
- Special sizes and design at customer's request
- Accessories for rigid fixing of the sphere plates on the measuring instrument table, such as
  - Adaptor plate
  - additional lateral support
  - Underframe elements for 35° tilt
- Probe test unit
- Sturdy aluminium type storage case



Fig. 4: KOBA-check 620 sphere plate in use

## **A complete monitoring system: KOBA-check Sphere plate + Probe test unit + GUK-K analysis software**

Complete systems for monitoring dimensional-gauging precisions, consisting of the KOBA-check sphere plate plus the GUK-K software package, provide facilities for verifying and documenting dimensional-gauging precisions of coordinate measuring machines in conjunction with formal equipment acceptance procedures, and with routine equipment performance monitoring. The GUK-K software package provides documentary proof of compliance with proper dimensional-gauging equipment monitoring procedures, as specified under ISO 9000pp thereby establishing a basis for centralized acquisition of dimensional-gauging-precision verification data, as well as for conducting comparisons of the precisions of items of dimensional-gauging equipment from various manufacturers.

Users receive fully documented statements as to whether components checked in preceding verification periods have been correctly gauged, along with projections as to whether components will be correctly gauged over subsequent verification periods. Users are thus able to reliably establish that manufacturing quality control statistics have not been falsified by defective dimensional gauging equipment, and may optimize their fabrication precisions by feeding back the results of dimensional gauging verification runs into their fabrication operations.

### **What is GUK? – What does GUK offer?**

GUK is a registered trade mark of iti GmbH for programmes to monitor accuracy of CMMs using the test standards step gauge or sphere plate, which match the measuring volume of CMM with regard to accuracy and dimension.

The formal verification that a CMM (tested randomly overall or during test with inadequately small test standards also only in a selected partial area at few positions) is adjusted in such a way that it complies with the specifications of the manufacturer under ideal measuring and ambient conditions is not sufficient for us!

The content of this type of test is mainly based on the acceptance verification and at the most is suitable only for verification of orderly execution of installation and service tasks on the machine.

GUK offers the conscientious user, a comprehensive analysis of monitored measurements, for e.g. by evaluation of all measuring point combinations or by mentioning "position deviation" based on the position of the ball No. 1 touched first. This is done in order to make a safe statement about:

- which distance measurement uncertainty
- under present real measuring and ambient conditions
- independent of the position of the measuring location in measuring volume of the measuring machine

is actually achieved. This is precisely the information which the user requires to avoid recourse on account of inaccurate measurements.

Additionally GUK offers (as long as not already done in individual cases during measurement) the selective elimination of temperature effects so that it can be detected to what extent do the deviations come from non-ideal temperature relations or from deviations of the measuring machine itself. With that it is clear, whether, if necessary, a decisive improvement can be made

- by an adjustment on behalf of the manufacturer or
- by improvement of local measuring and ambient conditions.

This reliable information serves as a basis for deciding the introduction of efficient measures of improvement for cost-conscious users.

Naturally, the decisive evaluation algorithms of GUK-system are tested and certified by the Physikalisch-Technische Bundesanstalt in Braunschweig (PTB) to the extent required by the users (for e.g. for sphere plate).

## **Dimensional-gauging-precision verification and monitoring using the GUK-K software package**

Procedures for verifying dimensional-gauging precisions of items of equipment with the Probe test unit and KOBA-check sphere plate (Fig. 19) involve using the equipment's own profiling/gauging software to run a conventional CNC-routine specifically prepared for this purpose. No special operator knowledge or training is required to perform these procedures. Results of verification runs are saved to data-transfer files as they are acquired. Once verification runs have been concluded, the GUK-K software package takes over the results and compares the dimensional-gauging precisions determined to the limiting tolerances specified by the equipment's manufacturer and documents any departures from these specifications in the form of equipment dimensional-gauging-precision protocols and dimensional gauging-error plots. The programme system GUK-K runs under MS-Windows as well as on the computer of the CMM or any external PC, to which measuring values from the CMM can be transferred either online, on a diskette or via network. It is the advantage of using an external PC that several different CMM in a plant can be managed at one place.

### **Dimensional-gauging-precision monitoring protocols**

The protocol (Fig. 20 + Fig. 21) output upon conclusion of dimensional-gauging precision verification runs include all of the data needed for generating and analyzing historical records of dimensional-gauging precision verification runs. Automatic comparisons of nominal dimensions measured using KOBA-check sphere plate with accurate dimensional data taken from their calibration certificates are employed in computing dimensional-gauging errors for output to a printer. The message „CMM ok“ will be output if all dimensional-gauging errors fall within prescribed tolerance bands. Protocols may then be signed by the verifying operator and inserted into the checked item of equipment's file.

### **Conducting analyses of equipment dimensional-gauging performance using dimensional-gauging-error plots in compliance with VDI/VDE 2617, Sheet 5**

Operators may view dimensional-gauging-error plots (Fig. 22) for both current and immediately preceding verification runs onscreen, or may output them to a printer. The protocol states how often measurement deviations are outside of the given tolerance bands.

### **Deviations of precision**

In addition, the deviation of precision from every measurement point in respect to the first measured ball No. 1 can be displayed. This helps in detecting the reasons for striking deviations in measurement.

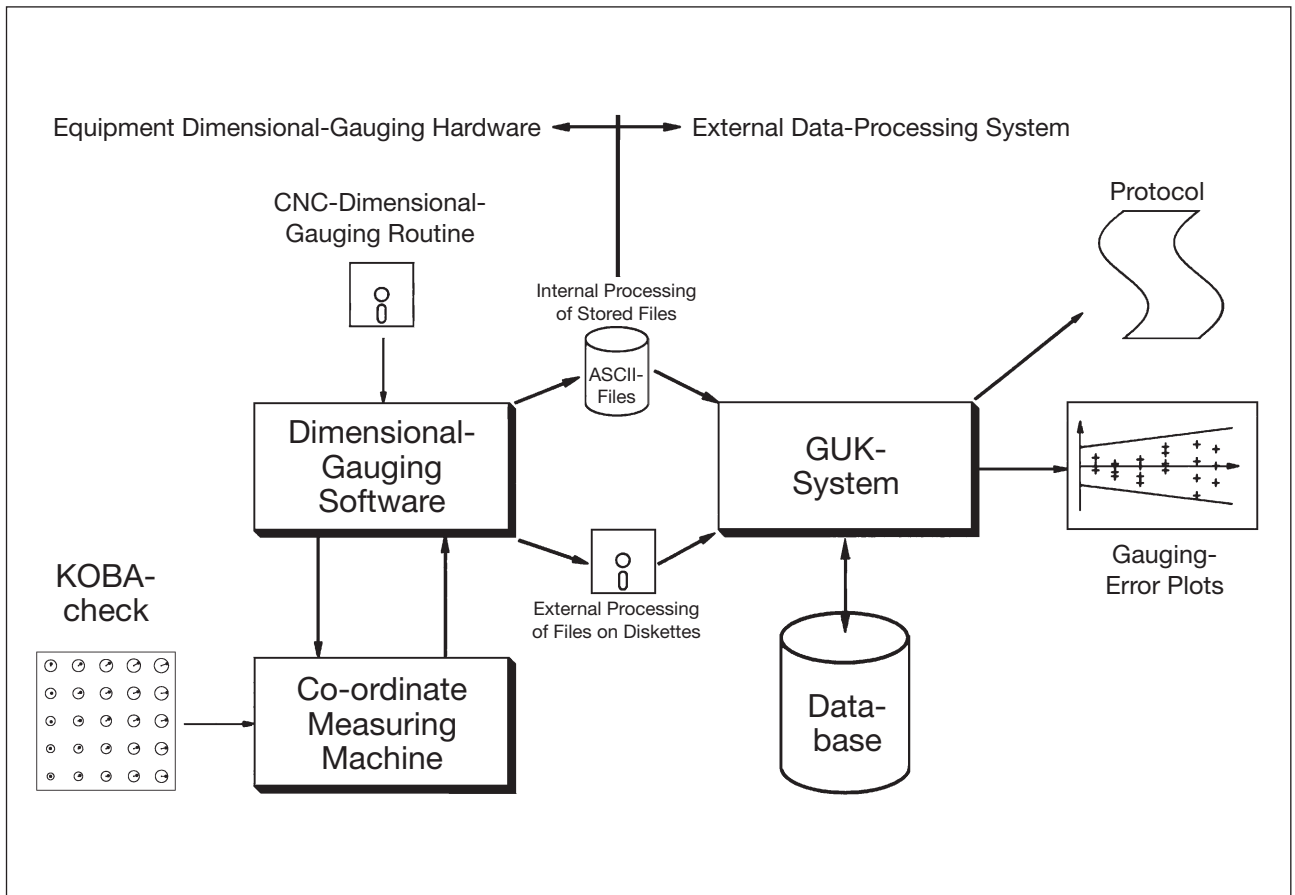


Figure 19: Block schematic of the interfacing of the GUK-K dimensional-gauging-precision monitoring system to a co-ordinate measuring machine.

Protocol for  
Monitoring the accuracy of a CMM by sphere plate  
of 01.10.1997 by iti GmbH ©iti GmbH, Barsbüttel

Instrument: CMM #6 : UMM 550  
Identification No. : 88 614  
Location of CMM : Rheine  
Year of Manufacture : 1990  
Max. range of measurem. : 1200 mm  
Permiss. dev. of distances  
-constant term : 2.30 µm  
-term proport. to dist. : 5.00 µm/1000 mm Distance  
Therm. exp. coeff. scale : 7.80 µm/m K

References: Ring Gauge  
-Identification No. : ITI R 30  
-calibrated Diameter : 30.00150 mm  
-Therm. expans. coeff. : 11.5 µm/m K  
Sphere  
-Identification No. : ITI K 30  
-calibrated Diameter : 29.97675 mm  
-Therm. expans. coeff. : 5.5 µm/m K  
Sphere Plate #6  
-Type : 5x5 22 83  
-Identification No. : 436.03-001  
-Year of Manufacture : 1993  
-Max Test Range : 332 mm x 332 mm  
-Calibration Date : 07.07.1995  
-No. of calib. Certif. : 5,32-95,106 / 3177 PTB 95  
-Therm. expans. coeff. : 11.70 µm/m K

Inspection #3: Date / Time : 01.10.1997 / 21:20  
Auditor : Plath  
Probe diameter : 7.9979 mm  
Temperature of CMM  
-when measuring ring : 21.4 °C  
-when meas. sph. plate : 21.9 °C  
Temperat. of ring gauge : 21.6 °C  
Temperat. of sphere : 21.6 °C  
Temperat. of sph. plate : 22 °C  
Compensat. of temperat. : None

Test scope: Ring Measurement : Executed, see page 2  
Sphere Measurement : Executed, see page 2  
Sph. plate measurement : Executed, see page 2  
and annex if any

.....  
(Date) (Seal / Signatures of Auditor)

Fig. 20: Dimensional-gauging-precision monitoring protocols page 1 (example).

Page 2 of protocol for  
Monitoring the accuracy of a CMM by sphere plate  
of 01.10.1997 by iti GmbH ©iti GmbH, Barsbüttel

CMM #6, Inspection #3 of 01.10.1997 / 21:20  
Compensat. of temperat. : None

Evaluation: Probe

|                          |          | Span | Numb. exceed. | M-factor |
|--------------------------|----------|------|---------------|----------|
| Ring gauge               | Diameter | 0    | 0             | .54      |
| 3 Measurements / 12 pts. |          |      |               | .12      |
| Sphere                   | Span     | 0    | 0             | .62      |
| 3 Measurements / 17 pts. | Diameter |      |               | .23      |

Position of sphere plate (CMM coordinates)

|            | coordinates of 1. measurement (mm) |            |            |
|------------|------------------------------------|------------|------------|
|            | X                                  | Y          | Z          |
| sphere 1/1 | 66.57860                           | -184.21890 | -345.34390 |
| sphere 1/5 | 66.19500                           | -516.13968 | -345.35090 |
| sphere 5/1 | 398.73389                          | -184.67667 | -345.41120 |

|            | coordinates of control measurement (mm) |            |            |
|------------|---|------------|------------|
|            | X                                       | Y          | Z          |
| sphere 1/1 | 66.57850                                | -184.21960 | -345.34600 |
| sphere 1/5 | 66.19500                                | -516.14038 | -345.35290 |
| sphere 5/1 | 398.73409                               | -184.67687 | -345.41140 |

|            | difference 1. measurement - control measurement (mm) |         |         |
|------------|--|---------|---------|
|            | X  | Y       | Z       |
| sphere 1/1 | .00010   | -.00070 | -.00210 |
| sphere 1/5 | .00000   | -.00070 | -.00200 |
| sphere 5/1 | -.00020  | .00020  | .00020  |

Evaluation: Distance measurement

| Number of Distances | Number of Numb. of exceed. | M-factor |
|---------------------|----------------------------|----------|
| 300                 | 0                          | .93      |

Fig. 21: Dimensional-gauging-precision monitoring protocol page 2 (example).

Annex 'A' of the Protocol for  
Monitoring the accuracy of a CMM by sphere plate  
of 01.10.1997 by iti GmbH ©iti GmbH, Barsbüttel

CMM #6, Inspection #3 of 01.10.1997 / 21:20  
Compensat. of temperat. : None

Evaluation: Distance measurement

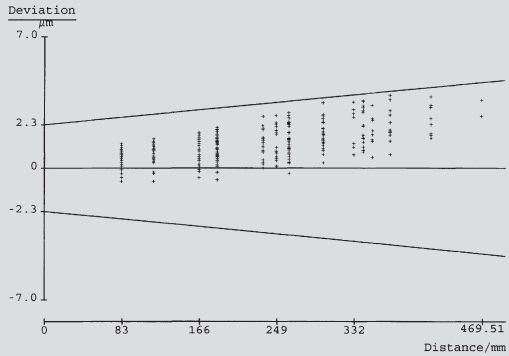


Fig. 22: Evaluation of Distance Measurement

Annex 'B' of the Protocol for  
Monitoring the accuracy of a CMM by sphere plate  
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CMM #6, Inspection #3 of 01.10.1997 / 21:20  
Compensat. of temperat. : None

2D-Pos. deviation

maximal position deviation  
relativ to sphere 1/1 = 4.0 µm

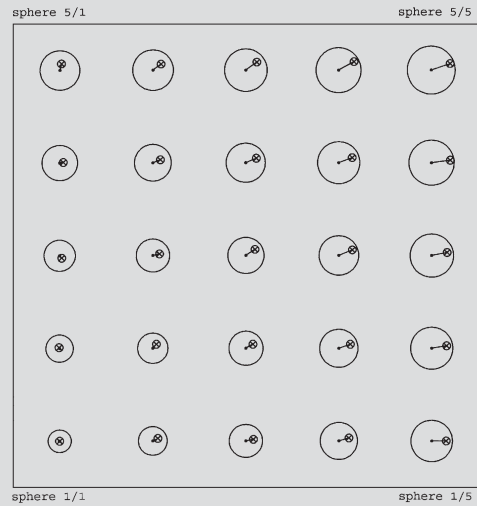


Fig. 23: Evaluation of 2D Pos.-deviation

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