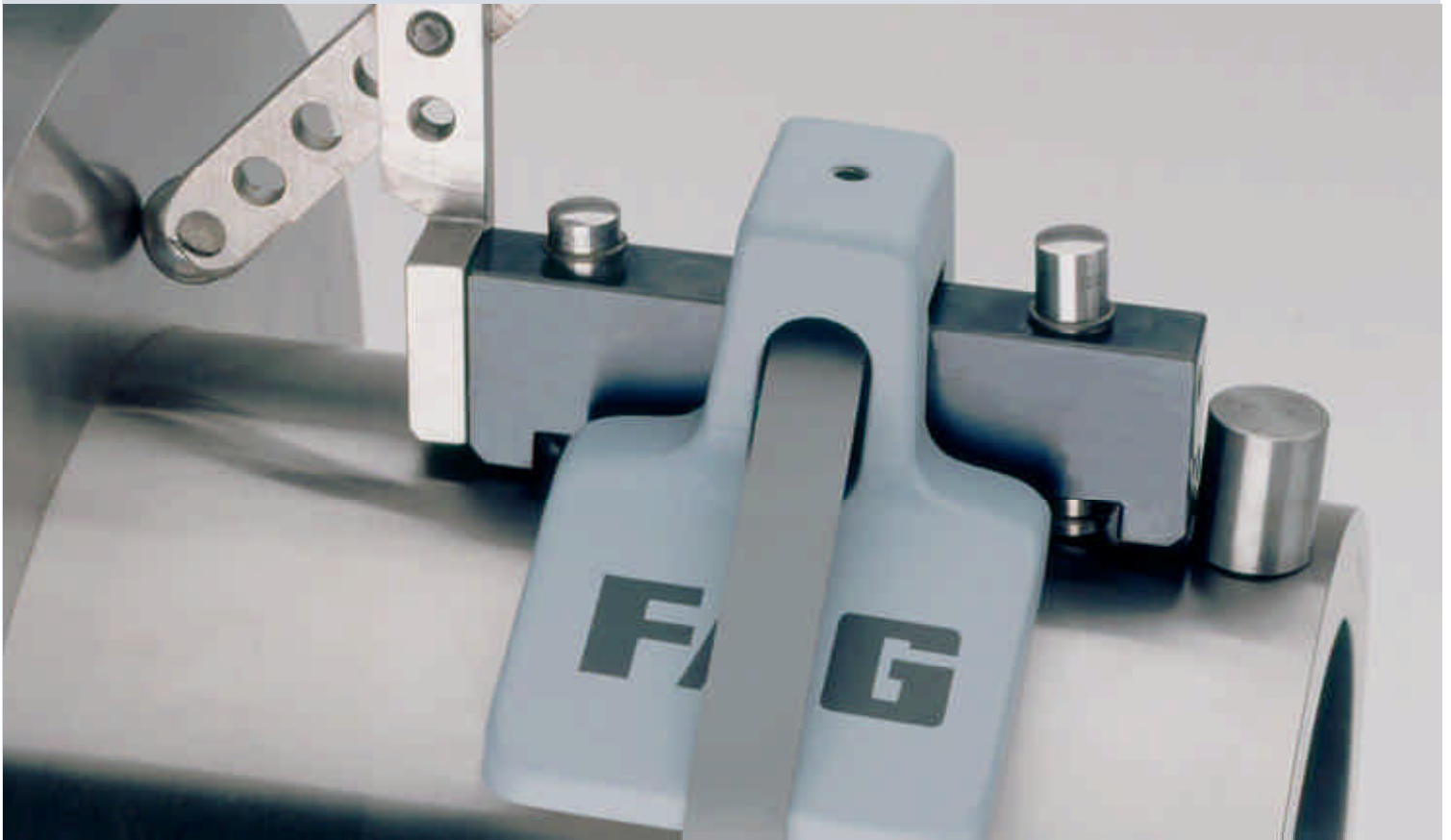


FAG



**Measuring tapered journals with an
FAG taper measuring instrument of series MGK9205;
dimensioning of tapered journals**

Technical Information

A Member of the
Schaeffler Group

Taper measuring instrument MGK9205

Application

Spherical roller bearings with a tapered bore - and multi-row cylindrical roller bearings with a tapered bore - are often mounted directly onto a tapered journal. This offers the main advantage that the journal diameter can be larger. Moreover, mounting and dismounting can be effected simply and quickly, which is very important for many applications, for example in rolling mills.

The bearing is pushed onto the journal until it abuts a shaft shoulder or a spacer ring which may also serve as a sealing ring, Figure 2. Before the bearing is mounted, the tapered journal and the shaft shoulder/the spacer ring must be matched to each other in such a way that the axial displacement corresponds to the required bearing clearance reduction. Then, when the bearing is driven onto the journal, it is fitted with the desired bearing clearance, which does not have to be measured. Since the remaining bearing clearance is determined both by the tolerance of the bearing bore and by the production tolerance of the spacer ring, designers usually choose bearings with a larger bearing clearance to avoid getting too small a clearance. Moreover, the bore tolerance must be narrow, and the face at the larger bore diameter must be the reference face. These requirements are met by all FAG bearings with a 1:30 tapered bore.

Sometimes bearings with a 1:30 tapered bore are mounted immediately against a shaft shoulder which is not matched to the journal. In such cases the journal must have a narrower tolerance.

Bearings can also be driven onto a journal without a shaft shoulder until the desired bearing clearance is obtained, which must be measured with a feeler gauge as usual. The standard design of the bearings with a 1:12 tapered bore has a larger bore tolerance than the standard design of the bearings with a 1:30 tapered bore.

Since the reference face of the bearings with a 1:12 tapered bore is situated on the side with the smaller bore diameter, they must be mounted using the latter method.

The position and the taper angle of tapered bearing seats with a diameter of up to ca. 170 mm are usually measured with a taper ring gauge or FAG taper measur-

ing instruments MGK132 or MGK133. For larger shaft journals such ring gauges are very expensive and awkward to handle.

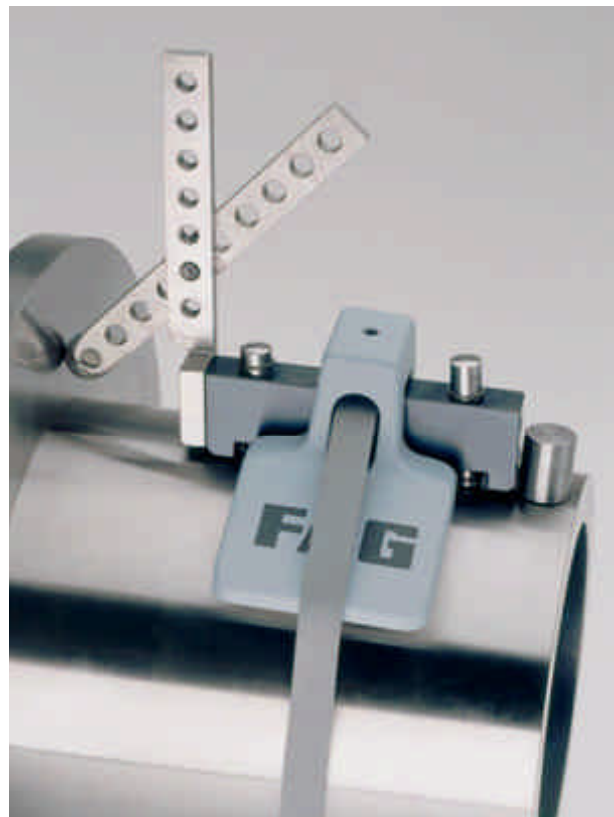


Figure 1: FAG taper measuring instrument MGK9205

Taper measuring instrument MGK9205

Measuring principle

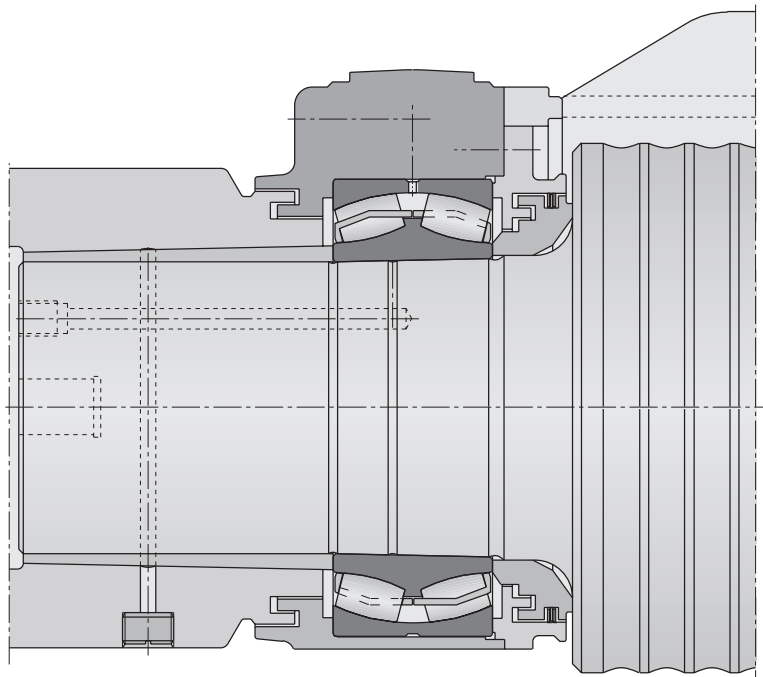


Figure 2: Bearing mounted against a sealing ring

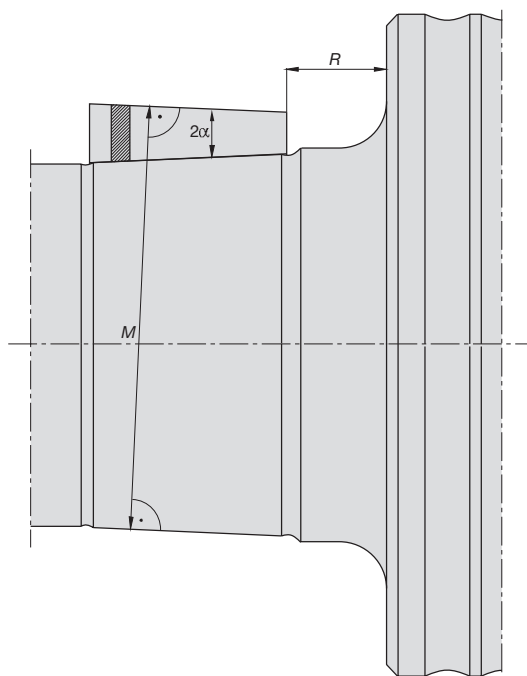


Figure 3: Straight edge

Tapered journals with a large diameter can be measured with a straight edge, Figure 3, whose upper edge and lower edge form an angle, the taper angle of the journal $= 2\alpha$.

If the upper edge of the straight edge is parallel to the generatrix of the journal, which is situated diametrically opposite to the straight edge, i.e. if M has the same magnitude at two measuring points, the taper angle of the journal is o.k. Moreover, the taper must have a certain ratio to a reference face, e.g. to the side face of the roll body. For this reason, if the straight edge has a certain position at the distance R from the reference face, the magnitude of M must be determined by calculation. That is the principle on which the FAG taper measuring instrument of series MGK9205 is based. With this taper measuring instrument, M is measured with an external micrometer and two gauging pins.

Taper measuring instrument MGK9205

Design

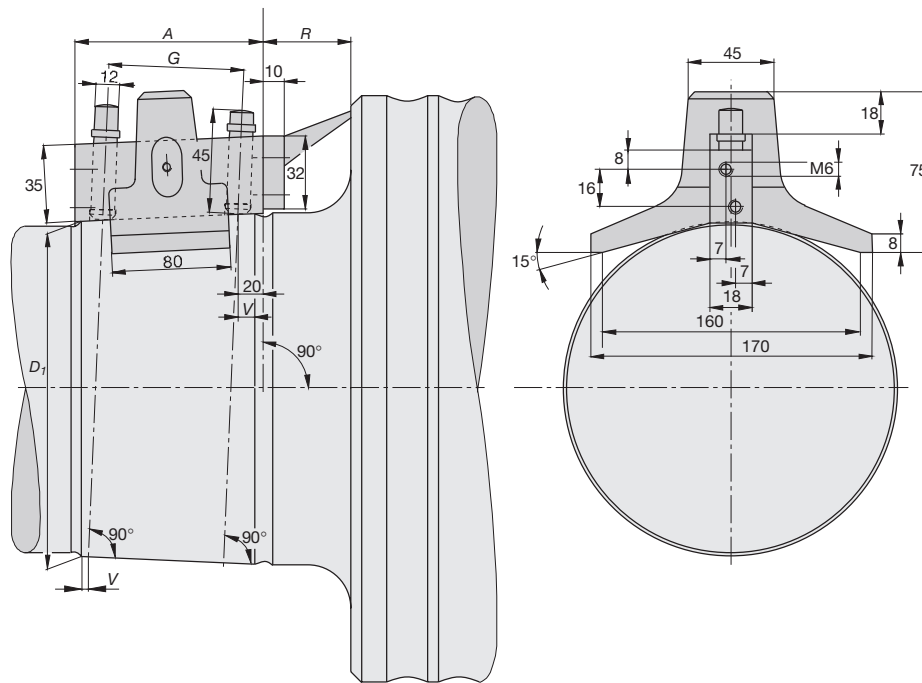


Figure 4: FAG taper measuring instrument of series MGK9205

Taper measuring instrument

The measuring instrument is shown in Figures 1 and 4. The gauging pins are accurately guided in a straight edge which in turn is axially guided on the journal by one or two saddles. The straight edge is held in the saddle by a bolt, which makes it easier to repeatedly conduct measurements during the journal machining process. The distance R between the end face of the straight edge and the reference face of the tapered journal is determined by a spacer that is screwed to the straight edge. To prevent the straight edge from sliding during the measurement, a permanent magnet is placed on the workpiece behind the straight edge, Figure 1. Deliveries of individual taper measuring instruments and complete sets of taper measuring instruments always include two magnets. The scope of delivery also includes straps for fastening the measuring instrument in other positions than on top of the journal, Figure 5. The dimensions of these measuring instruments are shown in Figure 4 and Table 1. Five straight edge sizes are available for 1:30 tapers and 1:12 tapers.



Figure 5: Taper measuring instrument attached to the side of a journal

Taper measuring instrument MGK9205

Design · Dimensioning of the journal

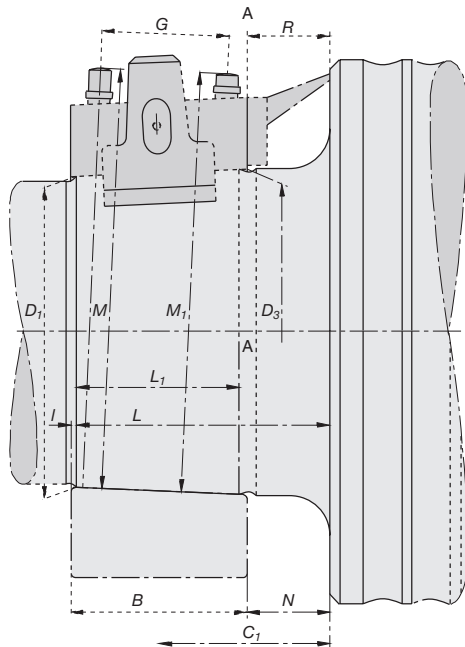


Figure 6: Dimensioning of the journal when using an FAG taper measuring instrument of series MGK9205

A complete set of taper measuring instruments MGK9205.12.SET (taper 1:12) or MGK9205.30.SET (taper 1:30) comprises two saddles and the five straight edges listed in Table 1. In addition, it includes an adjustable spacer which should, however, only be used in exceptional cases as the measuring results obtained with such a spacer do not have the accuracy of results obtained with a fixed spacer. Customers have to make the fixed spacers they need themselves. Their dimensions depend on the dimensions of the roll journal.

Table 1

Measuring instrument designation *	Measuring instrument designation *	A	G	Number of saddles
Taper 1:12	Taper 1:30	mm	mm	
MGK9205.12-50	MGK9205.30-50	90	50	1
MGK9205.12-80	MGK9205.30-80	120	80	1
MGK9205.12-130	MGK9205.30-130	170	130	2
MGK9205.12-210	MGK9205.30-210	250	210	2
MGK9205.12-350	MGK9205.30-350	390	350	2

* Single measuring instruments are delivered without adjustable spacers.

$V \geq 5$ mm for $D_1 \leq 180$ mm
 ≥ 7 mm for $D_1 = (180) - 400$ mm
 ≥ 9 mm for $D_1 > 400$ mm

Dimensioning of the journal

When measuring a tapered journal which is to be checked with an FAG taper measuring instrument of series MGK9205, one starts out with dimension C_1 , Figure 6, which indicates the distance of the centre of a mounted bearing to a reference face. Consequently, the magnitude of L can be determined from

$$L = C_1 + B/2 - l$$

B is the width of the bearing. The value of l can be taken from Table 2 (l shall have the same magnitude as the corner r of the outer ring).

The nominal journal diameter D_1 is obtained from

$$D_1 = d + l/k + T_m + 1.1 \Delta g$$

where

d = Nominal diameter of the bearing bore, mm

$1/k$ = Taper of the bearing bore (1/30 or 1/12)

T_m = Mean tolerance of the bearing bore, taking into account the deviation from the nominal taper, mm (Table 2)

Δg = Mean value of the bearing clearance reduction during mounting which is normally recommended, mm (Table 2)

The factor 1.1 is a mean value which takes into account the ratio of the actual bearing clearance reduction to the interference between inner ring bore and journal after mounting.

After selecting a suitable straight edge (see next section), the diameter D_3 in plane A-A, Figure 6, is determined by calculation; this plane coincides with the end face of the straight edge, which lies on the thicker section of the journal:

$$D_3 = D_1 + (1/k) (L - R)$$

D_3 is used to determine the nominal dimension of M using the following equations

$$M = D_3 - 0.000139 D_3 + 44.346 \text{ (for a 1:30 taper)}$$

$$M = D_3 - 0.000867 D_3 + 43.413 \text{ (for a 1:12 taper)}$$

These two formulas apply only to FAG taper measuring instruments of series MGK9205.

A certain tolerance, which also applies to M , must be left for the machining of the journal. Suitable tolerances are indicated in Table 3.

Taper measuring instrument MGK9205

Selecting a straight edge · Determining the spacer width

If a bearing is to be mounted against a shaft shoulder not matched to the journal, the journal must be machined to the narrower tolerance j_7 .

One must also allow a deviation from the nominal taper angle, i.e. a positive difference of $M_1 - M$. The maximum difference is obtained from $(B/G) \cdot (M_1 - M)$, whose limiting values for roll journals are indicated in Table 3. G is the distance between the two gauging pins, Table 1.

Selecting a straight edge

In order to obtain an accurate measuring result, the distance G between the gauging pins should cover the largest possible part of the taper length L_1 . G must meet the following conditions:

$$G < L_1 - 2V - 0.02 D_1 \text{ (for a 1:30 taper)}$$

$$G < L_1 - 2V - 0.05 D_1 \text{ (for a 1:12 taper)}$$

V is the distance that must be left free at the large and at the small taper diameter to leave room for the gauging pins/micrometer. The recommended minimum values of V are indicated in Table 1.

Determining the spacer width

If the bearing is to be mounted against a spacer (Figure 2), the spacer width must be accurately matched to the journal onto which it is to be mounted.

The nominal spacer width is

$$N = L + l - B$$

(The nominal dimensions of L , l and B must be used).

The actual spacer width for a specific journal is obtained from the following equation:

$$N_e = N + k \Delta M$$

ΔM is the measured positive or negative deviation from the nominal dimension of M .

To ensure that the rings are given the required allowance for regrinding, they must be produced with the larger width

$$N_f = N + k h$$

h is the upper tolerance for M according to Table 3. For a bearing with a bore diameter of 400 mm and a 1:30 taper,

$$N_f = N + 30 \times 0.07 = N + 2.1 \text{ mm.}$$

Table 2

Bearing bore Nominal dimension d		$T_m^*)$		Δg	l
mm Over	To	mm Taper 1:30	Taper 1:12	mm	mm
(100)	120	0.019	0.036	0.06	3
(120)	140	0.023	0.042	0.078	3
(140)	160	0.023	0.042	0.088	4
(160)	180	0.023	0.042	0.095	4
(180)	200	0.027	0.048	0.11	4
(200)	225	0.027	0.048	0.12	4
(225)	250	0.027	0.048	0.13	4
(250)	280	0.031	0.054	0.145	6
(280)	315	0.031	0.054	0.16	6
(315)	355	0.034	0.059	0.18	6
(355)	400	0.034	0.059	0.2	6
(400)	450	0.038	0.064	0.23	8
(450)	500	0.038	0.064	0.245	8
(500)	560	0.042	0.07	0.28	8
(560)	630	0.042	0.07	0.305	10
(630)	710	0.057	0.077	0.35	10
(710)	800	0.057	0.077	0.395	10
(800)	900	0.071	0.086	0.435	10
(900)	1000	0.071	0.086	0.48	10
(1000)	1120	0.086	0.096	0.525	12
(1120)	1250	0.086	0.096	0.57	12
(1250)	1400	0.106	0.106	0.635	15

*) If, in special cases, bearings with a 1:12 taper are to be mounted against a shaft shoulder, they may be produced with a reference face at the larger taper diameter and with the narrower bore tolerance specified for 1:30 tapers. These bearings are available at higher prices and can be ordered under special designations.

Table 3

Bearing bore Nominal dimension d		Abmaß für M		$(B/G) \cdot (M_1 - M)$	
mm over	to	mm upper	lower	mm min.	max.
(100)	120	0.044	-0.043	0	0.022
(120)	180	0.05	-0.05	0	0.025
(180)	250	0.058	-0.057	0	0.029
(250)	315	0.065	-0.065	0	0.032
(315)	400	0.07	-0.07	0	0.036
(400)	500	0.078	-0.077	0	0.04
(500)	630	0.085	-0.085	0	0.043
(630)	800	0.095	-0.095	0	0.047
(800)	1000	0.105	-0.105	0	0.052
(1000)	1250	0.115	-0.115	0	0.058
(1250)	1600	0.13	-0.13	0	0.065

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TI No. WL 80-70 EA