Original version of the design guide

HOISI PRECISION 凯狮精密 ISO 7312 9830

For	Components			
Spieth clamping sleeve (precision clamping sleeves)	IK 8.12	IL 8.12	IK 55.80	IL 55.80
	IK 10.15	IL 10.15	IK 60.85	IL 60.85
	IK 12.18	IL 12.18	IK 63.88	IL 63.88
	IK 14.20	IL 14.20	IK 65.90	IL 65.90
	IK 15.22	IL 15.22	IK 70.100	IL 70.100
	IK 16.22	IL 16.22	IK 75.105	IL 75.105
	IK 18.25	IL 18.25	IK 80.110	IL 80.110
	IK 20.32	IL 20.32	IK 85.115	IL 85.115
Series	IK 22.35	IL 22.35	IK 90.120	IL 90.120
	IK 25.37	IL 25.37	IK 95.125	IL 95.125
	IK 28.40	IL 28.40	IK 100.130	IL 100.130
	IK 30.42	IL 30.42	IK 110.140	IL 110.140
	IK 32.48	IL 32.48	IK 120.150	IL 120.150
	IK 35.52	IL 35.52	IK 125.155	IL 125.155
	IK 40.56	IL 40.56	IK 130.160	IL 130.160
	IK 45.68	IL 45.68	IK 140.170	IL 140.170
	IK 50.72	IL 50.72	IK 150.180	IL 150.180

The Design Guide is also available for download at www.spieth-me.de. In case of any questions, please contact Spieth-Maschinenelemente GmbH & Co. KG directly.

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Design Guide

IK/IL

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About the design guide for Spieth clamping sleeves

This design guide enables safe and efficient handling of Spieth clamping sleeves and provides valuable information on choice, dimensioning, and assembly of your friction-locked shaft-hub connection.

Notices

This design guide is based on the operating instructions whose recommendations and notices must be followed for dimensioning and design.

Please visit www.spieth-me.de for design guide and operating instructions.

The basic requirement for working safely is compliance with all safety notices. They can be identified by the following symbols:

> Caution!

In addition to the notices in these instructions, local accident prevention guidelines and national health and safety regulations also apply.

Table of Contents

1 Description of Spieth Clamping Sleeves

1.1 Structure

Spieth clamping sleeve

Identifying features
(for original Spieth clamping sleeves)

Spieth logo
Name
Batch number

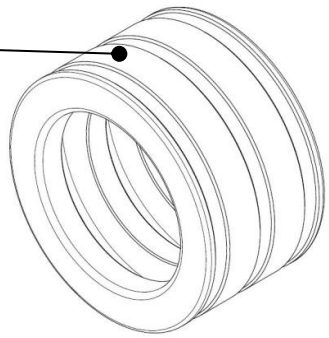

Fig. 1: Schematic representation similar to Spieth IK/IL series clamping sleeves

IK/IL series Spieth clamping sleeves have been designed for use on shafts with h tolerance zone. The clamping sleeve has been designed for external clamping initiation starting from the shaft. In contrast to tapered clamping sleeves, the one-piece cylindrical clamping sleeve has no joints and can therefore achieve a high degree of precision. Using connecting components to initiate axial clamping achieves a uniform lateral contraction thanks to the base body's special geometry. This results in a simple, safe, and rigid centering effect.

1.2 Mode of action

Spieth clamping sleeves are precision clamping sleeves. Due to their design, they provide a maximum of precision, combined with utmost resilience.

Spieth IK/IL series clamping sleeves have been designed as all-purpose precision clamping sleeves. This makes them an ideal solution for applications with a high level of replacements and adjustments.

Despite their compact design they can ensure continuous load transmission and rigid connections together with precise, centering and optimum concentricity for applications with high torques and axial forces.

Fig. 2: Illustration similar to Spieth IK/IL clamping sleeves

Spieth IK/IL series clamping sleeves are classified as friction-locked shaft-hub connections. They have been designed for external clamping initiation starting from the shaft. Axial clamping initiation achieves a uniform lateral contraction thanks to the base body's special geometry. The diaphragms are raised, widening the outer diameter and reducing the inner diameter, to create the required contact with shaft and hub for transmitting torques and axial forces. Thanks to this diaphragm principle, the connection is easy to assemble and quick to undo without the need for applying additional force.

2 Choice for Your Use Case

The values specified in Table 1 apply to exclusively acting maximum transmittable torques and axial forces. The admissible torques and axial forces refer to the recommended tolerances of the connecting components.

They also apply to static and pulsating, alternating, or impact loads, provided the occurring peak forces stay below the specified maximum values. Alternating torsion or rotating bending stress is an exception for friction-locked connections because it may cause fretting corrosion. To avoid complicating the disassembly process, pay attention to the following details:

Admissible strain	For alternating torsion	$\tilde{T}_{zul} \leq 0{,}6\ M_{max}$	[Nm]
	For rotating flex	$\tilde{M}_{b,zul} \leq 0{,}3\ M_{max}$	[Nm]

Please note:

The details about the maximum load capacity of all Spieth products are based on the material's yield strength. The reason for this is that Spieth-Maschinenelemente GmbH & Co. KG only accepts elastic deformation of its products. Plastic deformation can complicate the disassembly process for precision clamping sleeves. With shaft-hub connections from other manufacturers, calculations are often based on tensile strength so a direct comparison of performance data is not possible.

Table 1: Application-relevant data of Spieth clamping sleeves

Bezeichnung	IK			IL			IK/IL
		Transmittable forces			Transmittable forces		Precision
IK/IL	Order-No.	Axial force $F_{ax,max}$ [N]	Torque T_{max} [Nm]	Order-No.	Axial force $F_{ax,max}$ [N]	Torque T_{max} [Nm]	Run-out accuracy [µm] /IT4
8.12	K-12200801	1750	7	K-12400801	3000	12	8
10.15	K-12201001	2200	11	K-12401001	4200	21	8
12.18	K-12201201	2950	18	K-12401201	5900	35	8
14.20	K-12201401	3620	25	K-12401401	6970	49	8
15.22	K-12201501	3840	29	K-12401501	7260	54	8
16.22	K-12201601	4320	35	K-12401601	8050	64	8
18.25	K-12201801	4930	44	K-12401801	8900	80	8
20.32	K-12202001	8240	82	K-12402001	12360	124	8
22.35	K-12202201	8680	95	K-12402201	13020	143	8
25.37	K-12202501	10290	128	K-12402501	15190	190	8
28.40	K-12202801	11570	162	K-12402801	16950	237	8
30.42	K-12203001	12450	187	K-12403001	18110	272	8
32.48	K-12203201	16200	259	K-12403201	24300	389	8

Bezeichnung	IK			IL			IK/IL
		Transmittable forces			Transmittable forces		Precision
IK/IL	Order-No.	Axial force $F_{ax,max}$ [N]	Torque T_{max} [Nm]	Order-No.	Axial force $F_{ax,max}$ [N]	Torque T_{max} [Nm]	Run-out accuracy [µm] /IT4
35.52	K-12203501	17540	307	K-12403501	26140	457	8
40.56	K-12204001	20230	404	K-12404001	29950	599	8
45.68	K-12204501	24590	553	K-12404501	35760	804	8
50.72	K-12205001	27170	679	K-12405001	39520	988	8
55.80	K-12205501	33040	908	K-12405501	47790	1314	8
60.85	K-12206001	36080	1082	K-12406001	51910	1557	nach IT4
63.88	K-12206301	38280	1205	K-12406301	54780	1725	nach IT4
65.90	K-12206501	39940	1298	K-12406501	56870	1848	nach IT4
70.100	K-12207001	48070	1682	K-12407001	67770	2372	nach IT4
75.105	K-12207501	50870	1907	K-12407501	71720	2690	nach IT4
80.110	K-12208001	54620	2185	K-12408001	76650	3065	nach IT4
85.115	K-12208501	57470	2442	K-12408501	80650	3427	nach IT4
90.120	K-12209001	62200	2799	K-12409001	84500	3802	nach IT4
95.125	K-12209501	66100	3139	K-12409501	89500	4251	nach IT4
100.130	K-12210001	69200	3460	K-12410001	93700	4685	nach IT4
110.140	K-12211001	75200	4136	K-12411001	101800	5599	nach IT4
120.150	K-12212001	82500	4950	K-12412001	111200	6672	nach IT4
125.155	K-12212501	85500	5343	K-12412501	115300	7206	nach IT4
130.160	K12213001	88600	5759	K-12413001	119500	7767	nach IT4
140.170	K-12214001	96100	6727	K-12414001	129100	9037	nach IT4
150.180	K-12215001	102300	7672	K-12415001	137520	10314	nach IT4

3 Design of Spieth Clamping sleeves

IK/IL series Spieth clamping sleeves are made of steel with high material strength (approx. 650 N/mm²). The surface is bronzed with grinded functional surfaces.

The run-out accuracy of borehole / outside diameter is 0.008 mm and/or starting from d_2 > 80 mm, a concentricity accuracy as per IT4.

The outer diameter is machined as per ISO tolerance h5, the inner diameter is machined as per ISO tolerance H6.

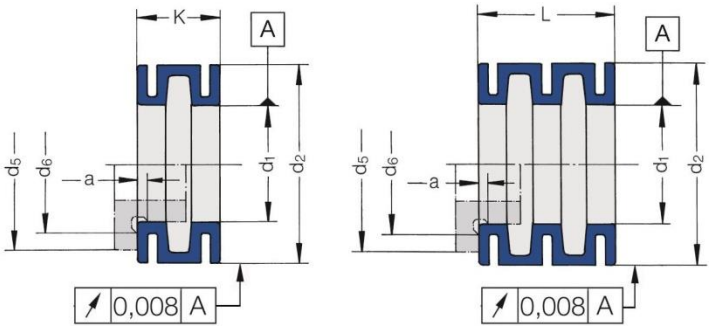

Fig. 3: Sectional view

Caution!

The clamping sleeve is ductile in axial direction; therefore, handle it with care. Initiate clamping only when the functional surfaces of the clamping sleeve are fully covered by the connecting components.

Otherwise, damage such as plastic deformation may occur on the clamping sleeve and render it unusable.

In such a case, Spieth-Maschinenelemente GmbH und Co. KG assumes no liability or warranty.

Table 2: Design data for dimensioning Spieth clamping sleeves

Name	Dimensions			Mass-related properties			
				IK		IL	
IK/IL	Length K/L [mm]	Inner Ø d_1 H6 [mm]	Outer Ø d_2 h5 [mm]	Weight m [kg]	Mass moment of inertia J [Kg cm²]	Weight m [kg]	Mass moment of inertia J [Kg cm²]
8.12	12/19	8	12	0,003	0,089	0,005	0,138
10.15	12/19	10	15	0,005	0,206	0,008	0,314
12.18	12/19	12	18	0,007	0,411	0,010	0,621
14.20	12/19	14	20	0,008	0,593	0,012	0,894
15.22	12/19	15	22	0,010	0,883	0,015	1,330
16.22	12/19	16	22	0,009	0,837	0,014	1,266
18.25	12/19	18	25	0,012	1,373	0,017	2,06
20.32	16/26	20	32	0,029	5,35	0,045	8,29
22.35	16/26	22	35	0,035	7,57	0,053	11,71

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Name	Dimensions			Mass-related properties			
				IK		IL	
IK/IL	Length K/L [mm]	Inner Ø d_1 H6 [mm]	Outer Ø d_2 h5 [mm]	Weight m [kg]	Mass moment of inertia J [Kg cm²]	Weight m [kg]	Mass moment of inertia J [Kg cm²]
25.37	16/26	25	37	0,035	8,89	0,054	13,73
28.40	16/26	28	40	0,039	11,63	0,059	17,9
30.42	16/26	30	42	0,041	13,74	0,062	21,1
32.48	21/35	32	48	0,076	32,3	0,120	51,4
35.52	21/35	35	52	0,088	43,8	0,138	69,7
40.56	21/35	40	56	0,091	54,9	0,143	87,1
45.68	26/42	45	68	0,183	155,1	0,268	229
50.72	26/42	50	72	0,187	182,8	0,273	269
55.80	31/52	55	80	0,187	182,8	0,410	498
60.85	31/52	60	85	0,279	383	0,440	612
63.88	31/52	63	88	0,290	432	0,458	689
65.90	31/52	65	90	0,298	466	0,470	743
70.100	38/62	70	100	0,482	910	0,705	1349
75.105	38/62	75	105	0,510	1075	0,746	1592
80.110	38/62	80	110	0,538	1259	0,787	1863
85.115	38/62	85	115	0,566	1464	0,828	2164
90.120	38/62	90	120	0,594	1690	0,869	2496
95.125	38/62	95	125	0,623	1938	0,910	2861
100.130	38/62	100	130	0,651	2209	0,952	3260
110.140	38/62	110	140	0,707	2827	1,034	4166
120.150	38/62	120	150	0,764	3550	1,116	5227
125.155	38/62	125	155	0,792	3954	1,157	5820
130.160	38/62	130	160	0,820	4388	1,198	6456
140.170	38/62	140	170	0,876	5349	1,280	7864
150.180	38/62	150	180	0,933	6441	1,362	9464

4 Dimensioning of Clamping Sleeve Connection

The overall rigidity of the connection between hub, clamping sleeve, and shaft is influenced by a large number of parameters. They include not only characteristic material values but also the actual dimensions of the components used. Therefore, connection rigidity and resulting suitable revolution speed for clamping sleeves depend on the individual case.

In case of any questions, please contact Spieth-Maschinenelemente GmbH & Co. KG.

4.1 General

To be able to transmit the maximum admissible torques M_{max} as specified in Table 1, pretension the clamping sleeves with the maximum admissible axial force F_{max} as specified in Table 3. If the clamping force stays below the required value, use Formula 1 to approximate the reduced torque M_{red} that can be transmitted with the given clamping force $F_{geg} < F_{max}$.

To calculate the required clamping force F_{erf} for a transmittable reduced torque $M_{red} < M_{max}$, we can approximate their relationship using Formula 2:

$$M_{red} = \frac{M_{max} \cdot \left(F_{geg} - 0.05 \cdot F_{max}\right)}{0.95 \cdot F_{max}} \; [Nm] \qquad \text{(Formula 1)}$$

$$F_{erf} = \frac{M_{red} \cdot 0.95 \cdot F_{max}}{M_{max}} + 0.05 \cdot F_{max} \; [N] \qquad \text{(Formula 2)}$$

with	M_{red}	[Nm]	Reduced transmittable torque	
	M_{max}	[Nm]	Maximum transmittable torque	(Table value; Table 1)
	F_{geg}	[N]	Given clamping force < F_{max}	
	F_{max}	[N]	Maximum permissible clamping force	(Table value; Table 3)
	F_{erf}	[N]	Required clamping force	

4.2 Automated operation

In automatic mode using, e.g., hydraulic actuation, the system's actual values may deviate from the table values because of a number of different parameters. For this application scenario, we strongly recommend that you verify the force or torque values required. In this application, care must be taken to ensure that the installation is completely free of axial clearance. To prevent fatigue failure and due to fretting corrosion risk, tension the clamping sleeve at a high clock frequency with a max. force of 0.75xF_{max}.

Please see the relevant assembly instructions, available at www.spieth-me.de, for more information on assembly.

4.3 Transmittable forces and torques

The values specified in Table 1 for maximum transmittable torque M_{max} have been established from test series with connecting components made from steel C45 and manufactured in the prescribed surface quality. The values apply for a single/exclusively acting axial force at F_{ax} = 0 N and/or for a single acting torque at M = 0 Nm.

If both torque and axial force act on a clamping sleeve at the same time, use Formula 3 to check whether transmissible torque M_{max} specified in Table 1 is greater than the calculated resultant torque M_r. Resultant torque M_r can be calculated from required torque M_{erf} and required axial force $F_{ax,erf}$.

$$M_{max} \geq M_r = \sqrt{{F_{erf}}^2 + \left(\frac{F_{ax,erf} \cdot d_1}{2000}\right)^2} \; [Nm] \qquad \text{(Formula 3)}$$

with	M_{max}	[Nm]	Maximum transmissible torque	Table value; Table 1
	M_{erf}	[Nm]	Required torque	
	M_r	[Nm]	Resultant torque	
	$F_{ax,erf}$	[N]	Required axial force	
	d_1	[mm]	Shaft diameter	

4.4 Provide functional space and tolerances to be designed

4.4.1 Shaft

The rigidity of the shaft influences the required assembly pretension of the clamping sleeve. All the details about pretensioning processes have been established using a solid shaft. If a hollow shaft is used, the resulting pretension forces may be different.

For the shaft, a manufacturing tolerance of h5 (no more than h6 is admissible). For shafts with a tolerance of h6, the transmittable forces may decrease by approx. 10% in a worst case scenario.

In case of doubt, please contact Spieth-Maschinenelemente GmbH & Co. KG.

4.4.2 Hub

For hub boreholes, a manufacturing tolerance of H7 (or H6 for high run-out accuracy requirements and/or hydraulically actuated clamping) applies.

To ensure that hub strain remains within the elastic range, the following recommendations apply for minimum hub wall thickness:

Recommended minimum wall thickness	for steel C45:	0.6 ($d_2 - d_1$)	[mm]
	for AL alloy Minimum material strength F38:	1.0 ($d_2 - d_1$)	[mm]
	for grey iron GG-25 void free cast	1.0 ($d_2 - d_1$)	[mm]

4.4.3 Clamping initiation

Spieth IK/IL series clamping sleeves have been designed for external clamping initiation starting from the shaft (see Fig. 4). For best results regarding the radial run-out, we recommend the functional surfaces of the connecting components used for clamping initiation to be manufactured with an axial run-out accuracy of 0.01 mm and/or as per IT4.

Please also take into account that the clamping force acts on the end faces of the clamping sleeves in the area between diameters $d_{5,max}$ and $d_{6,min}$ (see Fig. 4; see Table 3).

Ensure that the cylindrical borehole and outer surface of the clamping sleeve are fully covered by the connecting components. To facilitate the design of connecting elements, the clamping sleeve can stick out by a maximum of (see Table 3; see Fig. 4).

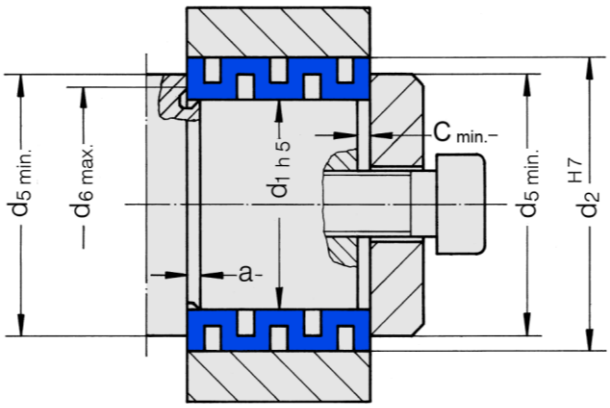

Fig. 4: Sectional view of Spieth IK/IL clamping sleeves

> Caution!
>
> Spieth clamping sleeves require force-controlled clamping. Therefore, ensure that movement in axial direction (= clamping travel) is possible during clamping. The clamping force cannot be applied in relation to the clamping travel. To avoid premature jamming, ensure you have provided a "free" functional travel "C_{min}" > clamping travel (see Table 3).

Machine cylindrical shaft and borehole with a mean roughness depth of Rz = 2.5 … 6.3µm.

> Please note:
>
> For clamping initiation from the housing, use Spieth AK and/or AL series clamping sleeves.

Table 3: Data for assembly and clamping initiation

Name	Clamping initiation			Dimensions for connecting components		
IK/IL	Max. adm. clamping force F_{max} [N]	C_{min}		Max. clamping initiation Ø $d_{5,max}$ [mm]	Min. clamping initiation Ø $d_{6,min}$ [mm]	Max. overhang a [mm]
		IK	IL			
8.12	10000	0.3	0.5	11	9,2	1,5
10.15	11000	0.4	0.6	14	11,2	1,5
12.18	11800	0.4	0.7	17	13,2	1,5
14.20	13400	0.5	0.8	19	15,2	1,5
15.22	13700	0.5	0.8	21	16,2	1,5
16.22	14900	0.5	0.8	21	17,2	1,5
18.25	15900	0.6	0.9	24	19,2	1,5
20.32	20600	0.6	0.9	28	22	1,7
22.35	21700	0.6	0.9	30	24	1,7
25.37	24500	0.7	1.1	33	27	1,7
28.40	26900	0.7	1.1	36	30	1,7
30.42	28300	0.7	1.1	38	32	1,7
32.48	32400	0.8	1.2	40	34	2,2
35.52	34400	0.8	1.2	44	37	2,2
40.56	38900	0.8	1.2	49	42	2,2
45.68	44700	0.8	1.2	55	48	3
50.72	49400	0.8	1.2	60	53	3
55.80	59000	1.0	1.5	65	58	3
60.85	63300	1.0	1.5	70	63	3
63.88	66000	1.0	1.5	73	66	3
65.90	67700	1.0	1.5	75	68	3
70.100	78800	1.0	1.5	82	74	4
75.105	83400	1.0	1.5	87	79	4
80.110	88100	1.1	1.6	92	84	4
85.115	92700	1.1	1.6	97	89	4
90.120	97200	1.1	1.6	102	94	4
95.125	101800	1.2	1.8	107	99	4
100.130	106500	1.3	2.0	112	104	4
110.140	115700	1.4	2.1	122	114	4
120.150	125000	1.4	2.1	132	124	4
125.155	129600	1.4	2.1	137	129	4
130.160	134300	1.5	2.2	142	134	4
140.170	143500	1.5	2.2	152	144	4
150.180	152800	1.5	2.2	162	154	4

5 How to Assemble Spieth Clamping Sleeves

Clamping sleeve and connecting components can be joined without applying great force. This is followed by clamping initiation, where an elastic deformation of the clamping sleeve occurs and the shaft friction-locks with the housing borehole.

> Caution!
>
> Spieth clamping sleeves require force-controlled clamping. The clamping force cannot be applied in relation to the clamping travel. Make sure never to bottom out the connecting component for clamping initiation on the housing as ductile deformation may occur on the clamping sleeve and render it unusable. Furthermore, it is not possible in such a case to guarantee sufficient clamping force.

During this process, the clamping sleeve becomes a few tenths of a millimeter shorter, depending on clamping force, on size of the clamping sleeve, and on actual dimensions of the clamping sleeve and joining parts, dragging the part to be clamped in clamping direction. The occurring axial displacement of the clamped part can amount to up to 0.5 times the clamping travel. If arranged against a shaft collar or similar, the axial thrust creates intense surface contact of the clamped part.

> Please note:
>
> The IK series clamping sleeves are available as low-thrust models; their transmittable torques and axial forces are, however, only up to 0.5 times the values specified in Table 2.

6 Operating Spieth Clamping Sleeves

Spieth clamping sleeves provide a permanently rigid and high-quality shaft-hub connection. Visually inspecting the clamping sleeve in regular intervals means low-maintenance operation of Spieth clamping sleeves.

7 Disassembling Spieth Clamping Sleeves

If handled correctly, Spieth clamping sleeves can be reused several times. Undo the clamping initiation to return the cylindrical clamping sleeve into its original shape.

In case you used a Spieth clamping sleeve to friction-lock a shaft and a hub, due to the adjustments made you can only reconnect these two components after they have been disassembled.

To disassemble, proceed in reverse assembly order.

- 1. Release the clamping force.
- 2. The clamping sleeve relaxes and resumes its original shape. All the parts are once again freely movable. Due to the many possible ways of initiating the clamping force, this description can only be formulated in general terms.

To enable later reuse, clean, preserve, and store Spieth clamping sleeves correctly. If non-original Spieth spare parts are used, Spieth-Maschinenelemente GmbH & Co. KG assumes no liability or warranty.

8 Disposing of Spieth Clamping Sleeves

You can easily reorder Spieth clamping sleeves by entering the component designation imprinted on the clamping sleeve and the batch number.

Spieth clamping sleeves are made of steel. At the end of their operating life, clean metal parts and dispose of them as scrap metal.

> Please note:
>
> For environmental reasons, please comply with applicable statutory regulations and guidelines when disposing of these products.