Technical information, setting and handling notes

In the following pages you will find technical notes and background information on the MAPAL clamping technology.

In addition to the HSK-A and HSK-C standards and the various ISO versions, the mounting dimensions for the flange module are also listed. Important technical notes are also provided on the individual clamping systems and clamping methods covered in the catalogue.

The main features of the KS Clamping cartridge include details of clamping force and transferable bending moment. In addition torque transmission, concentricity and repeatable accuracies plus spindle speed limits for the HSK connection are described.

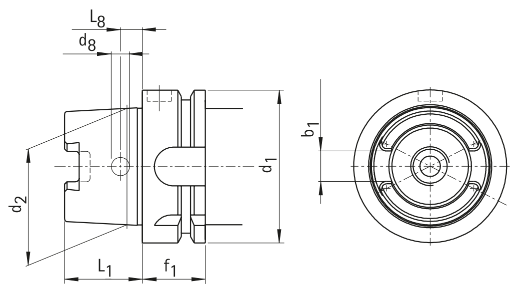
Subject to definition, calculation, effect and limits of balancing, we will also provide information to you the security system to prevent the hollow taper shanks being confused, which stops operating errors when changing tools and is supplied by MAPAL as an option.

Finally we provide you with helpful tips for use in practice with setting and handling notes for fitting and assembling the KS Clamping cartridge and for fitting and alignment of KS adaptor flanges and MAPAL module connections.

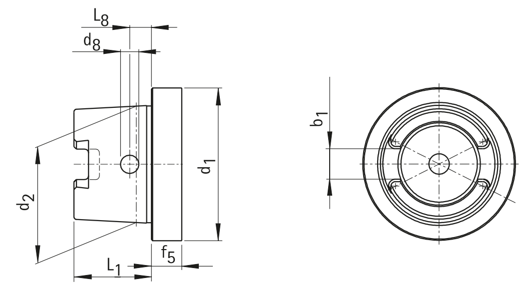
Standards and mounting dimensions

HSK standard

For hollow shanks DIN 69893-1 HSK-A and HSK-C



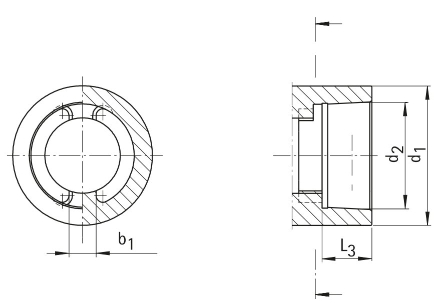
HSK-A for automatic and manual tool change



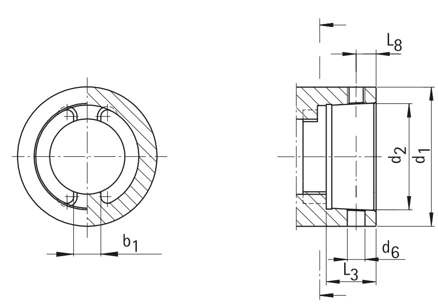
HSK-C for manual tool change

		HSK size					
Nominal size	d_1 h10	32	40	50	63	80	100
Taper diameter	d_2	24,007	30,007	38,009	48,01	60,012	75,013
Shank length	L_1 0/–0,2	16	20	25	32	40	50
Slot width	b_1 +/–0,04	7,05	8,05	10,54	12,54	16,04	20,02
Bore diameter	d_8	4	4,6	6	7,5	8,5	12
Bore spacing	L_8 +/–0,1	5	6	7,5	9	12	15
Flange width HSK-A	f_1 0/–0,1	20	20	26	26	26	29
Flange width HSK-C	f_5	10	10	12,5	12,5	16	16

For adaptors DIN 69093-1 HSK-A and HSK-C



HSK-A for automatic and manual tool change



HSK-C for manual tool change

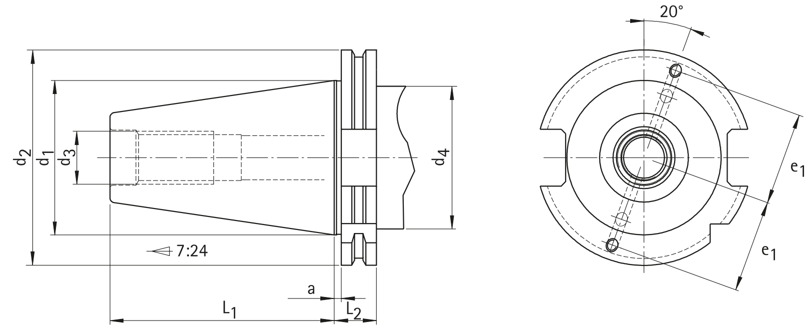
		HSK size					
Nominal size	d_1 min.	32	40	50	63	80	100
Taper diameter	d_2	23,998	29,998	37,998	47,998	59,997	74,997
Depth	L_3 +0,2	11,4	14,4	17,9	22,4	28,4	35,4
Driver width	b_1 +/–0,05	6,8	7,8	10,3	12,3	15,8	19,78

additional with HSK-C

Bore diameter	d_6	4	5	6	8	9	11
Bore spacing	L_8 +/–0,1	5	6	7,5	9	12	15

ISO standard

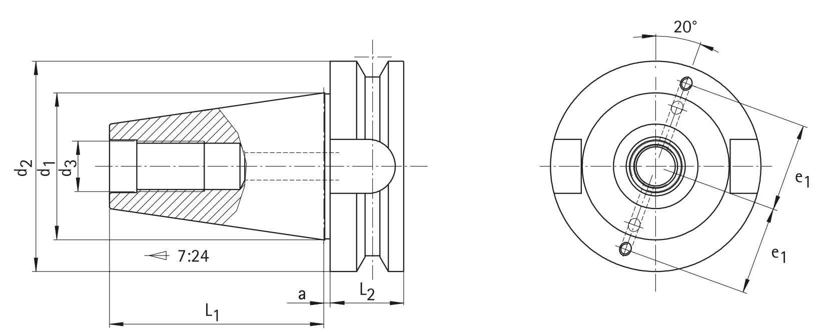
For steep taper shanks DIN 69871



ISO for automatic tool change Form A, Form AD, Form B and version with data carrier

	Steep taper size (ISO)			
	30	40	45	50
a +/–0,1	3,2	3,2	3,2	3,2
d_1	31,75	44,45	57,15	69,85
d_2 0/–0,1	50	63,55	82,55	97,5
d_3	M 12	M 16	M 20	M 24
d_4 max.	45	50	63	80
e_1 +/–0,1	21	27	35	42
L_1 0/–0,3	47,8	68,4	82,7	101,75
L_2 0/–0,1	19,1	19,1	19,1	19,1

For steep taper shanks to BT JIS 6339



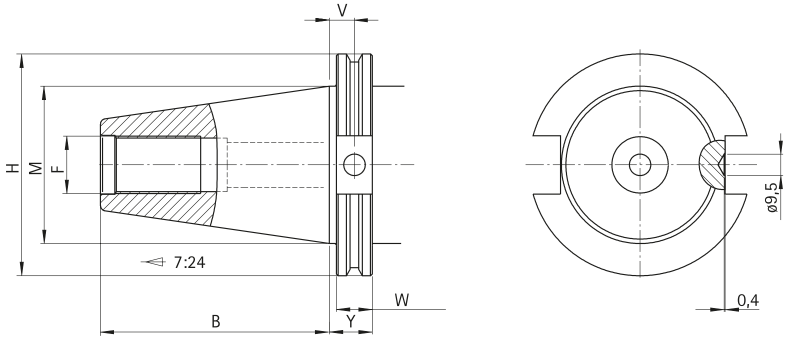
Steep taper for automatic tool change

	Steep taper size (BT)		
	30	40	50
a +/–0,4	2	2	3
d_1	31,75	44,45	69,85
d_2 h8	46	63	100
d_3	M 12	M 16	M 24
e_1 +/–0,1	21	27	42
L_1 +/–0,2	48,4	65,4	101,8
L_2 min.	20	25	35

Standards and mounting dimensions

ISO standard

For ISO shanks with V flange adaptor to ASME B5.50– 1994 (MN633)

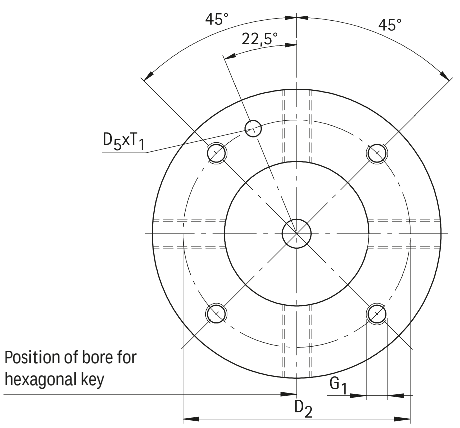


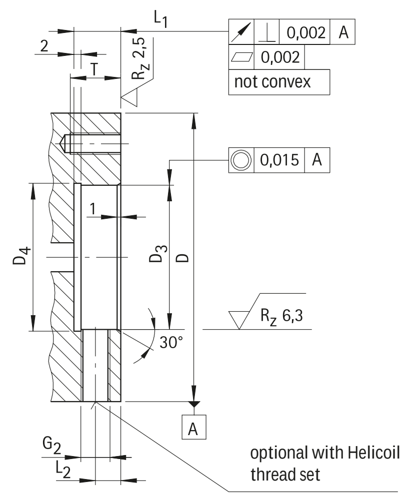
Steep taper for automatic tool change

	Steep taper size			
	30	40	45	50
B +/–0,1	47,65	68,25	82,55	101,60
F UNC–2B	1/2"–13	5/8"–11	3/4"–10	1"–8
H +/–0,5	46,02	63,50	82,55	98,43
M +/–0,13	31,75	44,45	57,15	69,85
V +/–0,25	11,2	11,2	11,2	11,2
W +/–0,05	15,88	15,88	15,88	15,88
Y +/–0,05	19,05	19,05	19,05	19,05

Mounting dimensions for KS flanges

Spindle connection contour for adaptor flange MN5520* and MN5523* to MN5000-14



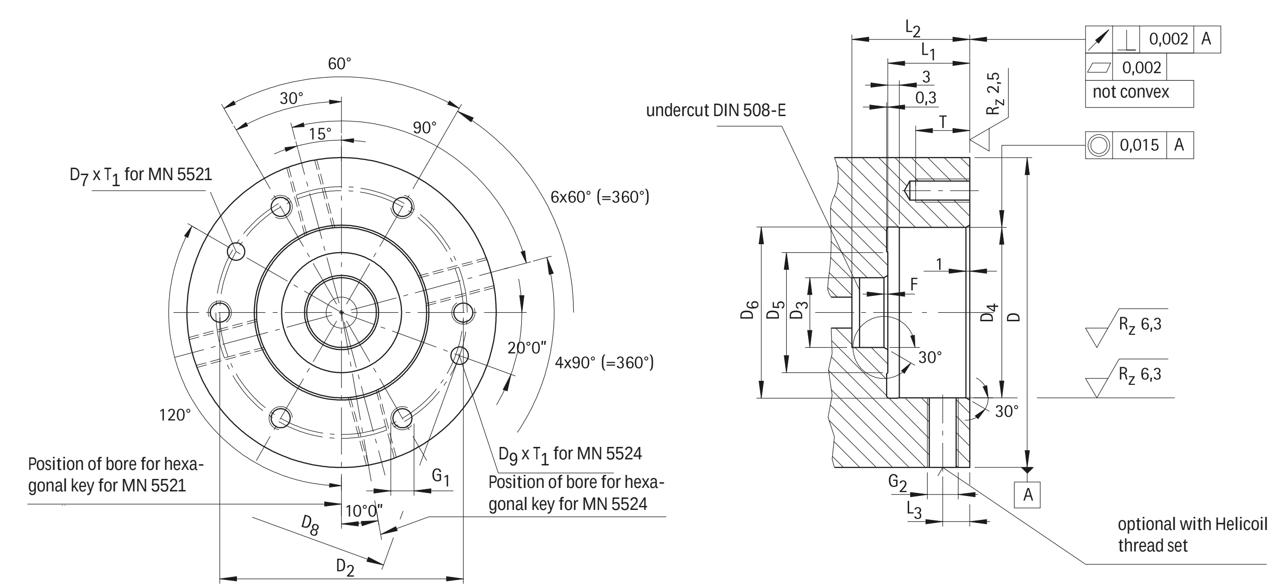


Nominal size module diameter D	32 60	40 70	50 80	63 100	80 117	100 140	125 180	160 210
D_2 +/–0,1	44	53	63	79	96	119	150	185
D_3 F8	30	35	40	50	60	80	100	120
D_4	31	36	41	51	61	81	101	121
D_5	4,5	5,0	5,0	5,0	6,0	6,0	6,0	6,0
L_1	12	12	12	14	14	14	24	37
L_2	7	7	7	8	8	8	8	8
G_1	M5	M6	M6	M8	M8	M10	M12	M12
G_2	M8x1	M8x1	M8x1	M10x1	M10x1	M10x1	M10x1	M10x1
T	11	14	14	15	15	18	25	25
T_1 +0,5	3	3,5	3,5	3,5	4,5	4,5	4,5	4,5

*Because of possible technical modifications we recommend up-to-date production documents be provided if required.

Mounting dimensions for KS flanges

Spindle connection contour for adaptor flange MN5521* and MN5524* to MI5000-12

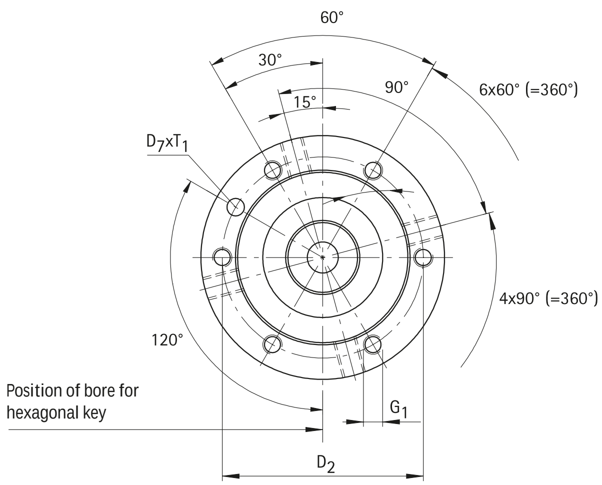


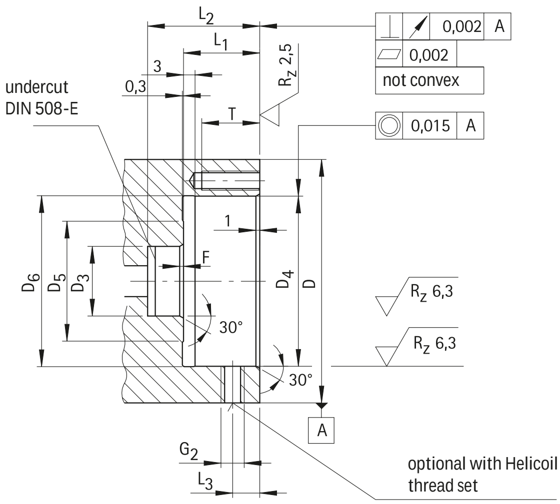
Nominal size module	32	40	50	63	80	100	125	160
diameter D	55	63	80	100	117	140	180	210
D_2 +/–0,1	42	50	63	79	96	119	150	185
D_3 H7	13	15	18	20	23	29	35	35
D_4 F8	28	35	44	56	68	88	112	140
D_5	22	25	31	35	43	55	78	106
D_6 +0,2	28,2	35,2	44,2	56,2	68,2	88,2	112,2	140,2
D_7	4,5	5,0	5,0	5,0	6,0	6,0	6,0	6,0
D_8 +/–0,1	45	52	66	84	101	124	164	194
D_9	4,5	5,0	5,0	5,0	6,0	6,0	6,0	6,0
E	0,4 x 0,2	0,4 x 0,2	0,6 x 0,3	0,6 x 0,3	0,6 x 0,3	0,6 x 0,3	0,6 x 0,3	0,6 x 0,3
L_1 + 0,1	15,2	18,2	21,2	25,2	33,2	43	55	76
L_2 min.	24	27	30,5	35,5	43,5	57	72,5	97,5
L_3	7	7	7	8	8	8	8	8
F	1,0	1,0	1,0	1,5	1,5	1,5	1,5	1,5
G_1	M5	M5	M6	M8	M8	M10	M12	M12
G_2	M4	M5	M8x1	M10x1	M10x1	M10x1	M10x1	M10x1
T	11	14	14	15	15	20	22	22
T_1 +0,5	3	3,5	3,5	3,5	4,5	4,5	4,5	4,5
α	11°	10°	10°	10°	10°	10°	0°	0°

*Because of possible technical modifications we recommend up-to-date production documents be provided if required.

Mounting dimensions for KS flanges

Spindle connection contour for adaptor flange for short spindles MN 5522*

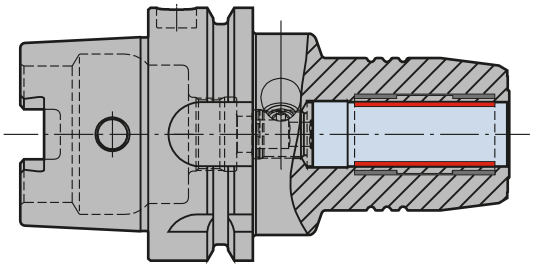




Nominal size module diameter D	32 40	40 50	50 63	63 80
D_2 +/–0,1	33	41	52	66
D_3 H7	13	15	18	20
D_4 F8	28	35	44	56
D_5	22	25	31	35
D_6 + 0,2	28,2	35,2	44,2	56,2
D_7	4,0	4,5	5,0	5,0
E	0,4 x 0,2	0,4 x 0,2	0,6 x 0,3	0,6 x 0,3
L_1 + 0,1	16,2	18,2	19,7	22,2
L_2 min.	25	27	29	32,5
L_3	5,5	6,0	7,0	8,0
F	1,0	1,0	1,0	1,5
G_1	M3	M4	M5	M6
G_2	M4	M5	M6	M8x1
T	10	13	15	16
T_1 + 0,5	3,0	3,5	3,5	3,5

*Because of possible technical modifications we recommend up-to-date production documents be provided if required.

The hydraulic method



When clamping with the hydraulic method constant pressure is built up by means of a tensioning screw and a pressure plunger within a closed chamber system. This pressure is transferred to the tool through the built-in expanding sleeve.

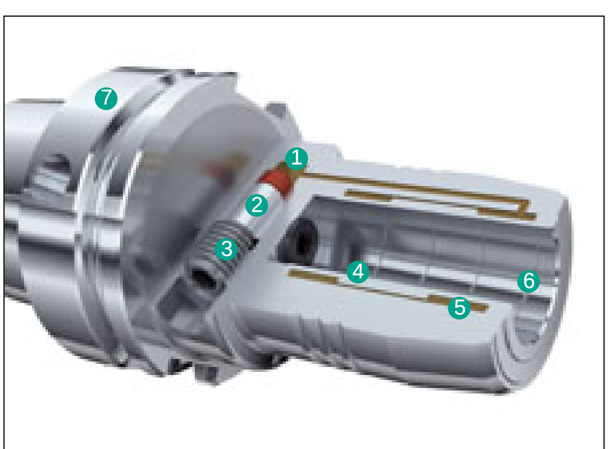
Advantages and use by the customer:

- Longer tool life because of maximum concentricity and repeatable accuracy (< 0.003 mm); this means the cutting edge is evenly applied.
- Improved surface quality on the workpiece; less microscopic fracturing on the tool cutting edge because of excellent vibration damping in the hydraulic system.
- High torque transfer because of diversion of oil, grease and lubricant residue into the groove. This keeps the clamping surface substantially dry.
- Flexible clamping range by using slotted adaptor sleeve with coolant seal (concentricity accuracy of sleeve < 0.002 mm).
- Exact radial or axial length adjustment.
- Suitable for minimal lubrication.

System advantages:

- Easy to use and extremely rapid handling:
  Using a hexagonal key the tool can be clamped concentrically in seconds. No peripheral equipment is needed for clamping and releasing. No additional investment and maintenance costs for external components.
- Closed clamping system:
  No maintenance work and additional costs caused by contamination.
- Extremely high clamping safety:
  No reduction in clamping forces at high spindle speeds.
- Fine balancing:
  All hydraulic chucks are finely balanced as standard for use on HSC machines.

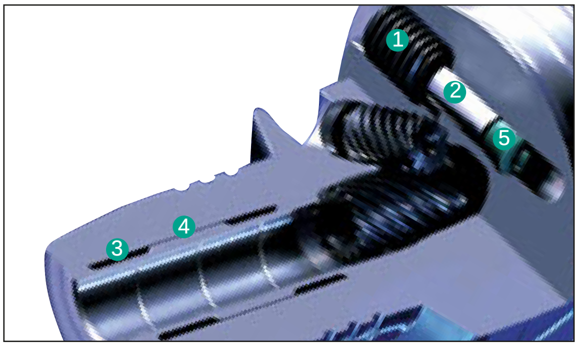
1. Elements of expanding clamping systems



1 **Sealing element:** see page loss in the clamping bore prevented by lip seal.
2 **Pressure plunger:** presses the hydraulic medium into the chamber system.
3 **Tensioning screw:** to activate the piston, can be clamped without using torque wrench.
4 **Expanding sleeve:** clamps the tool shank concentricity by applying the pressure evenly.
5 **Chamber system:** produced through the connection of the expanding sleeve and basic body. Has a damping effect on the tool because of the hydraulic medium and therefore reduces wear.
6 **Groove:** Oil, grease and lubricant residue is diverted into the groove because of the high clamping pressure. The clamping surfaces remain substantially dry and this ensures torque transmission.
7 **Basic body:** MAPAL expanding chucks can be supplied for all current machine connections (HSK-A, HSK-C, ISO, BT and flange module).

The hydraulic method

2. Function principle



1 The tensioning screw is turned as far as the stop with a hexagonal key.
2 The pressure plunger presses the hydraulic medium into the
3 expansion chamber and produces an increase in pressure.
4 The thin walled expansion sleeve pushes evenly against the tool shank. This clamping process first causes the tool shank to be centred and then produces a full, positive clamping effect.
5 The special sealing element ensures an absolute seal and a long tool life.

3. Torque transmission

Please refer to the table for individual torque transmission.

The torques shown apply for shank lengths to DIN 6535 and DIN 1835.

a **Torque transmission** with direct clamping, oiled shank, clamping diameter d_2 = 6 – 32 mm

d_2 [mm]	6	8	10	12	14	16	18	20	25	32
for shank h6 [Nm]	16	23	45	90	110	185	240	330	400	650

b **Torque transmission** measured with adaptor sleeve, oiled shank
Clamping diameter expanding chuck d_2 = 32 mm

d_2 [mm]	6	8	10	12	14	16	18	20	25
for shank h6 Minimum/Maximum [Nm]	36 / 55	46 / 75	82 / 140	120 / 190	140 / 220	200 / 350	260 / 450	280 / 500	400 / 650

Clamping diameter expanding chuck d_2 = 20 mm

d_2 [mm]	3	4	5	6	7	8	9	10	11	12
for shank h6 Minimum/Maximum [Nm]	6 / 10	10 / 15	16 / 25	28 / 50	45 / 68	50 / 80	70 / 100	80 / 120	100 / 150	115 / 175

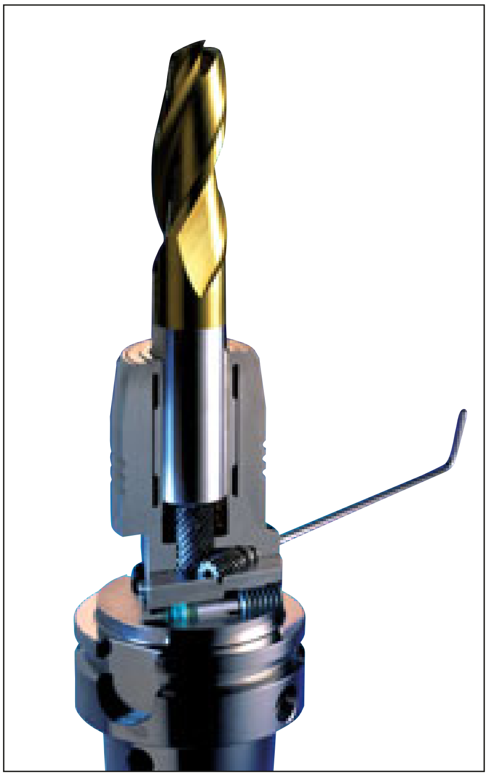
d_2 [mm]	13	14	15	16	17
for shank h6 Minimum/Maximum [Nm]	125 / 180	130 / 190	140 / 200	170 / 240	200 / 250

Clamping diameter expanding chuck d_2 = 12 mm

d_2 [mm]	3	4	5	6	8
for shank h6 Minimum/Maximum [Nm]	4 / 5	5 / 10	7 / 15	12 / 26	15 / 32

The hydraulic method

4. Radial tool length adjustment



In the area of clamping devices with HSK adaptors, MAPAL also supplies hydraulic chucks with radial tool length adjustment. Using this setting method concentricity accuracy is also guaranteed of < 0.003 mm.

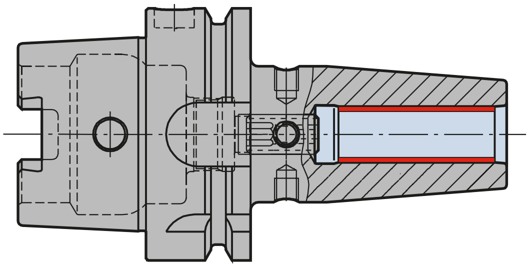
Advantages of radial length adjustment

- high precision length adjustment (µ) by means of adjustment gearing
- no change in position of tool caused by own weight or by axial pressure because of self-locking adjusting screw
- 10 mm adjustment path for all clamping diameters with front and rear stop for adjusting screw
- not affected by dirt
- robust mechanical elements
- coolant seal for up to 100 bar
- no radial change in set screw
- user friendly and reliable in production

Radial length adjustment components:

1 Radial length adjustment activated
2 Ventilation
3 Clamping applied
4 Set screw

The thermal expansion method

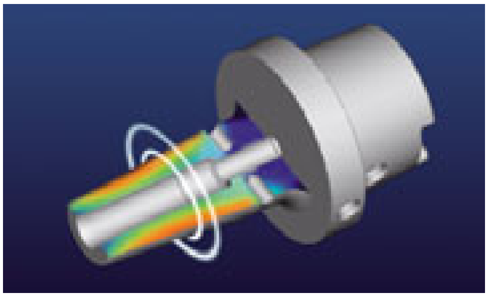


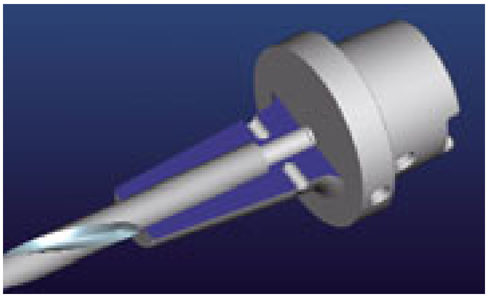
The thermal expansion method uses thermal influences to clamping the tool. An induction coil warms the thermal expanding chuck, the chuck expands and the cold tool shank can be inserted. The thermal expanding chuck is then cooled again, contracts and forms an extremely homogenous unit with the tool.

Advantages and use by customer:

- High flexibility: numerous options for combining thermal expanding chucks and extensions.
- Wide range of applications: high torque transfer and radial rigidity.
- Long tool life: no changes in geometry or structure when heat is applied.
- No maintenance costs: closed system so no contamination.
- High dimensional stability in the workpiece: durable concentricity and repeatable accuracy of < 0.003 mm in the location bore.
- Long tool life and good surface quality: fine balanced as standard.

Function principle





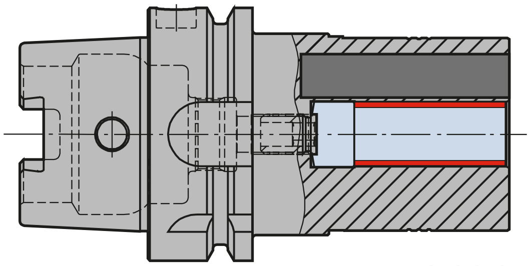
1. Warming the chuck
   The chuck is warmed precisely at the clamping point using the latest induction technology. The clamping diameter expands. An induction coil produces eddy currents which act directly on the chuck and heat precisely at the point where the tool shank is located.

2. Insert the tool shank
   The cold tool shank is inserted into the warmed chuck.

3. Cooling
   The thermally expanded chuck is cooled, the clamping diameter contracts to its original size and clamps the tool. An efficient unit with water-cooled cooling elements produces rapid cooling within 30 seconds. This means that the taper and the data chip are not warmed. Adaptors which can be incorporated in the cooling unit allow extensions and also non-standard thermal expanding chucks to be cooled.

The result:
With the inductive warming system tool change can be carried out within seconds. The shrink-fit chuck, the tool extension where applicable, and tool shank form an homogeneous unit. Carbide and HSS tools can be perfectly clamped. The tool sits in the tool holder with perfect fit and held with maximum clamping force.

The polygon clamping method



With the polygon clamping method the tool shank is shrunk into a polygon which has been “deformed” by using a hydraulic clamping device. The TRIBOS® polygon chucks are produced in a narrow design as TRIBOS-S and a more heavy-duty version as TRIBOS-R. The TRIBOS-S chucks are intended for fine and light machining and for areas of the workpiece which are difficult to reach. TRIBOS-R is for heavy duty, difficult machining operations requiring very high precision.

Advantages and use to the customer:

- Long tool life and production reliability: durable concentricity and repeatable accuracy of < 0.003 mm.
- Short machine stoppage times, fast and easy handling: tool change within 20 seconds.
- Flexible and cost-saving: use of adaptor sleeves (concentricity accuracy < 0.002 mm) allows clamping of several clamping diameters.
- Maximum spindle speeds possible: absolutely rotationally symmetrical construction with basic imbalance of < 4 gmm. Fine balanced as standard for use on HSC machines.
- Durable: no material stress caused by thermal expansion and cooling.
- Totally maintenance free: system has no movable parts and is therefore not mechanically sensitive.
- No material restrictions: clamps carbide and HSS, for shanks with or without clamping flat.
- Flexible location for clamping device: no external power source required.
- Precise axial length adjustment: no axial movements during the clamping process.
- Write/read chips for tool identification system can be used.

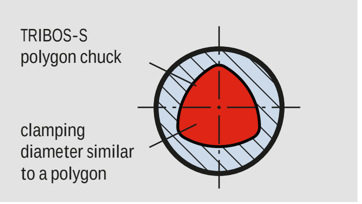
The polygon clamping method

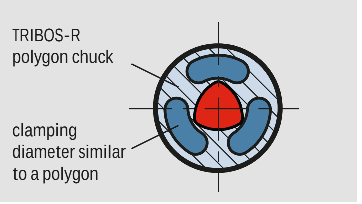
1. Function principle

	TRIBOS-S	TRIBOS-R

1. Special geometry

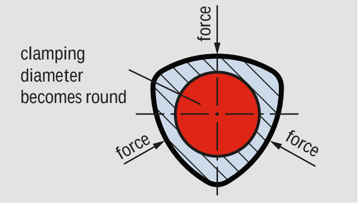
When released, the clamping diameter of the TRIBOS polygon chuck is similar to that of a polygon.

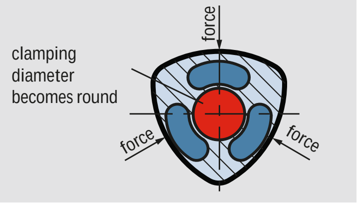




2. Apply pressure

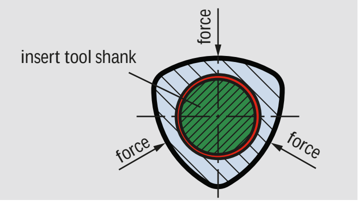
Using the hydraulic clamping device, an exact amount of pressure to the polygon chuck is applied at three points using the clamping display on a pressure gauge. This turns the clamping diameter into a circle.

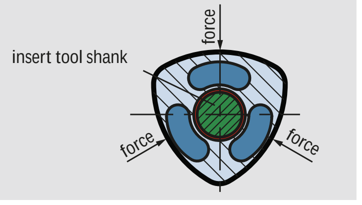




3. Insert tool shank

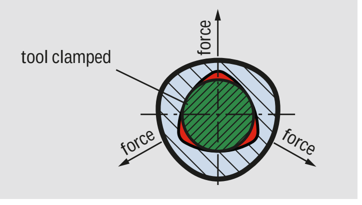
The tool shank of the cutting tool is now inserted into the clamping diameter.

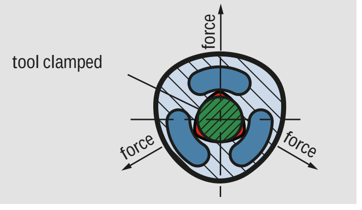




4. Clamp tool

The clamping device is released and the force acting on the polygon chuck released completely. The clamping diameter returns to its original form and the tool shank is clamped. The clamping process is then complete.





2. TRIBOS-S

TRIBOS-S chucks are for fine and light machining. Because of its narrow design, TRIBOS-S is designed for machining workpiece areas which are difficult to reach and where conventional clamping systems cannot be used.
The slim design and low weight also gives the advantage that TRIBOS-S can also be used at high spindle speeds and with high feed rates.

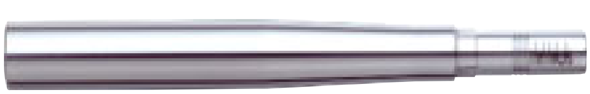
The polygon clamping method

3. TRIBOS-R

For heavy-duty machining to maximum precision the external diameter on TRIBOS-R is reinforced to increase rigidity. To dampen vibrations a special chamber system, filled with vibration-damping, copper alloy inserts, is incorporated which produces better surface finish and longer tool life.
The high rigidity of TRIBOS-R allows the high radial forces to be absorbed which occur in heavy duty cutting. A long tool life and quiet machining process are achieved because of the filling in the hollow chamber with Duroplast around the clamping diameter. TRIBOS-R collets can also be used for high settings and high cutting volumes because of its stability.

4. Use of adaptor sleeves

By using adaptor sleeves different clamping diameters can be clamped with just one tool holder, thus producing cost savings. The radial rigidity is increased and significantly higher clamping forces can be achieved. When connecting to TRIBOS extensions, numerous combination options are possible.



5. Tool extensions (concentricity < 0.003 mm)

The TRIBOS programme also includes tool extensions with which the polygon clamping method can be combined with an extremely wide variety of chucks. The tool extensions are of particular advantage in machining situations where chucks with projecting tool restrictions cannot be used.

The polygon clamping method

6. TRIBOS clamping fiyture

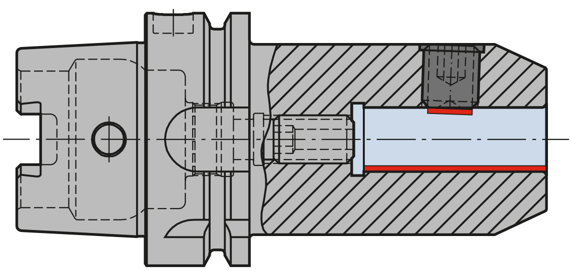
Design:
- Hydraulic clamping fixture
- Hand pump for build-up of clamping pressure
- No external power source required (electrical, air, etc.)

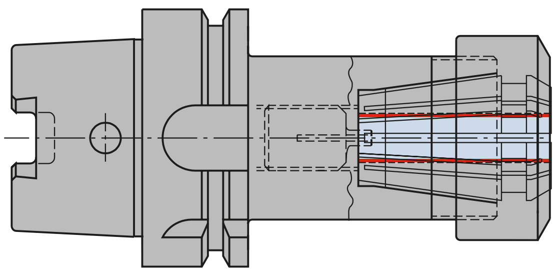
Procedure for clamping and releasing TRIBOS polygon chuck in the clamping fixture:

1. Read off clamping pressure required from the polygon chuck (see label).
2. Insert polygon chuck with the necessary reduction insert into the clamping fixture.
3. Close the outlet valve on the clamping fixture.
4. Using the hand lever produce the required clamping pressure, checking the display on the pressure gauge.
5. Insert or remove tool.

The mechanical chuck method

The low cost version in the world of tool clamping is to use mechanical chucks. These chucks are characterised by their sturdy design and simplicity.





1. Cylindrical holders to DIN 69882-4/-5

MAPAL includes both clamping devices with lateral clamping surfaces and with angled clamping surfaces in their programme. However, because of the effect of clamping force on one side, shortcomings in concentricity have to be accepted.

For HSK-A adaptors chucks with alignment facilities are also available. This version allows for greater demand for concentricity. Using four alignment screws at the clamping bore, concentricity of up to 0.003 mm can be achieved. Chucks with alignment are particularly suitable for brazed fine boring and roughing tools.

In the steep taper area it is advisable to clamp MAPAL NC reamers with angled clamping surfaces using a precision adaptor. These special clamping devices are supplied for steep taper chucks to DIN, BT and ASME standards. These are restricted to 0.003 mm in order to reliably achieve the quality requirements set for MAPAL reaming tools in production.

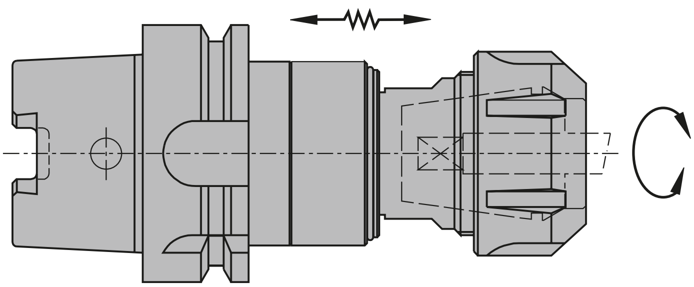
2. Collet holders to DIN 69882-6

The flexible version of the mechanical chuck is the solution which uses collets. By using appropriate collets, a holder can hold tools with cylindrical shanks within a whole clamping diameter range (e.g. clamping range 2 - 20 mm with a single clamping device). For this a collet covers an area of 1 mm in the diameter.

The variability of the collet holders has the disadvantage, however, that, in the context of concentricity, the collet holder has shortcomings when it comes to maximum possible spindle speed and maximum torque transmission.

In addition to conventional collet holders MAPAL also offers chucks with clamping nuts for internal coolant supply. When used with the ER sealing discs, these Hi-Q/ERC clamping nuts also allow previously used collets to be used for tools with internal coolant supply.

The mechanical chuck method



3. Softsynchro® tapping chucks

The synchronisation of the spindle's rotary movement and feed axis allows threads to be produced with tools without length adjustment. In practice, however, synchronisation errors cannot be entirely avoided. The reasons for this are the machine's dynamics and the interplay between spindle and linear drives. Tolerances on the tapping tool also play a role. When using rigid tools these synchronisation errors produce high axial forces and as a result shorter tool life and threads and teeth which are not clean and cannot be gauged.

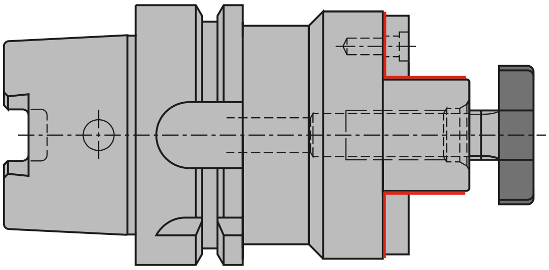
Collet holders of the Softsynchro® type act as an attenuating element between synchronous spindle and tapping tool and allow the synchronous spindle to be used in the best possible way. This produces optimum tool life and surface qualities.

The MAPAL programme includes Softsynchro® tapping chucks with HSK-A adaptors and with cylindrical shank to DIN 1835 B + E.

Advantages and use by the customer:

- Adjustment of differences in pitch between synchronous spindle and tapping tool
- High concentricity
- Firm clamping by means of collets with square holder
- No special shanks required on tool
- High production reliability when producing threads synchronously.

The mechanical chuck method



3. Softsynchro® tapping chucks

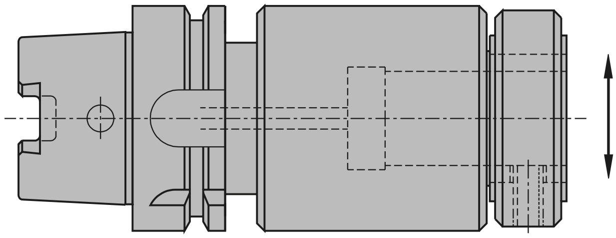
Design features of Softsynchro®
tapping chucks:

- In two parts (chuck shank / tool holder): easy to dismantle, easy maintenance
- Axial force adjustment and torque separate: hardly any effect
- Pre-stressed damping element in plastic: no effect on tool cutting edge from upward axial movement. Axial movement only when pre-stressed level has been exceeded.
- Lengthways movement guided by ball-bearings: little friction caused by rolling, very good response.
- Suitable for up to 50 bar internal coolant: no effect of axial force from coolant pressure so no lengthways movement.

4. Milling cutter arbors to DIN 69882-3

A tried and tested clamping system for holding cutter heads, shell end face milling cutters and single angle shell end mills.

MAPAL floating holders



Simple design, problem-free function

Reamers are used to improve the dimensional accuracy and surface quality of a bore. Because of their design they are supported in the bore by guides. This applies both for multiple bladed reamers and for tools which use the single blade principle.
The coordination of the rough bore with the tool axis is a prerequisite for both tool designs to perform without problems. In many cases this condition is not met. As a result, when machining with several clamping set-ups and frequently with a single tool change, for example, a cycle and positioning error will occur and cause an offset between tool and workpiece.
The MAPAL "Wellach System" floating holder programme has been designed for optimum use of high speed reamers and allows for this axis and angle displacement.

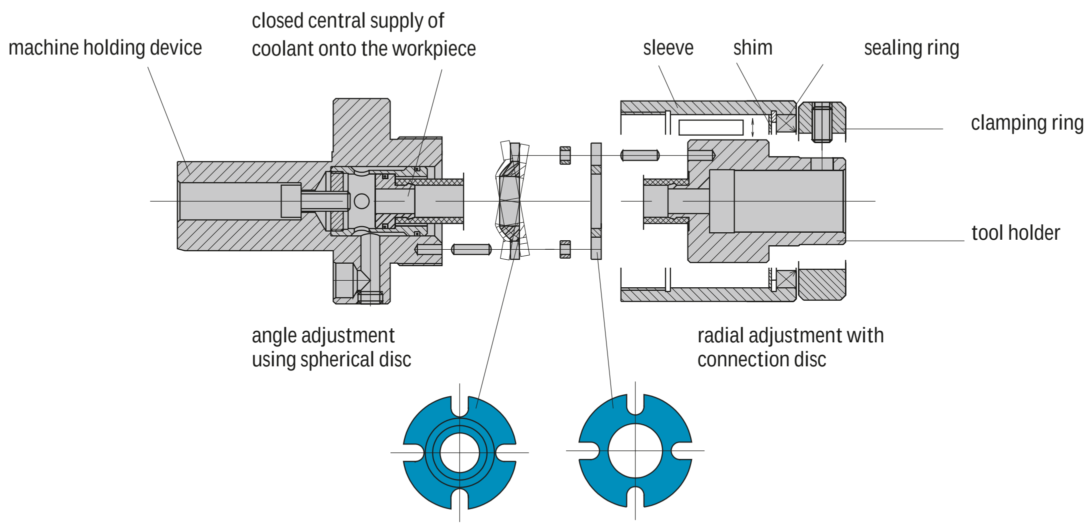
Advantages and use by the customer:

- Long tool life, even at high feed rates, because of trouble-free operation
- Consistent results for batch production
- Less scrap and reworking
- Less space for multi-spindle use because of slim design and small head diameter
- An advantage at high spindle speeds
- No parts subject to wear so no cost-intensive stock of spares required.

MAPAL floating holders

1. Design elements

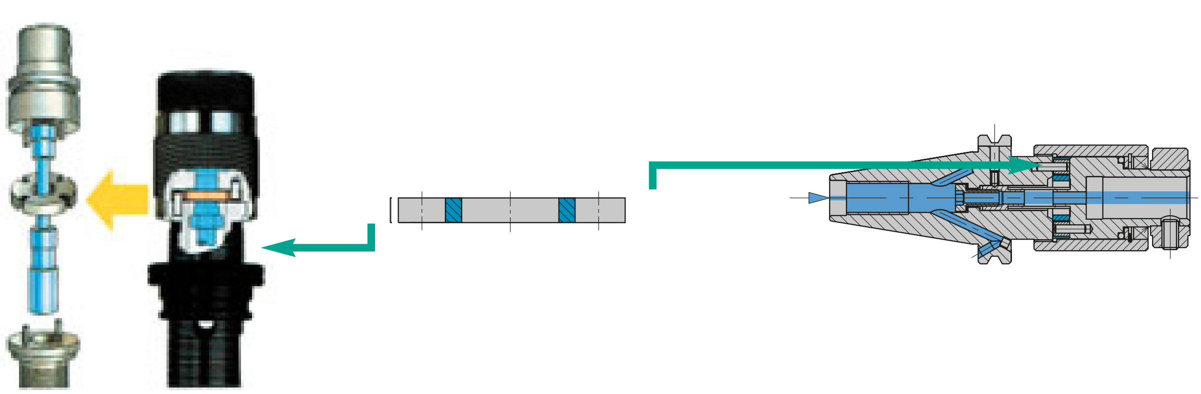
- Sliding surface connection: smooth sliding surfaces transfer the axial feed forces with low pressure on surface.
- Reliable function: even at the feed rates which are normal today and with the high forces these cause.
- Problem-free radial and angular movement of tool holder with long lasting high accuracy.
- Radial and angular adjustment ensured by play incorporated in the design.
- The design advantage of the surface connection is particularly great compared to conventional contact at a specific point.
- Closed, central coolant system (water, oil, air) supplied to the workpiece by means of a flexible, sealed unit which is connected with the holding device and the tool holder.



2. Offset adjustment methods

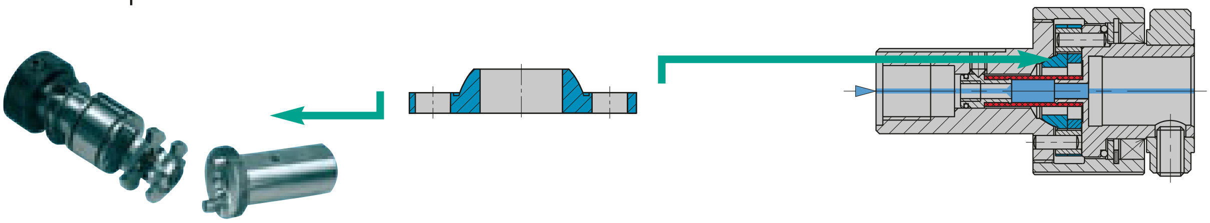
Two different types of floating holders vary in the methods used for offset adjustment:

Type PR has a **sliding surface contact**, with which the axial feed forces are transferred with low surface pressure being applied.

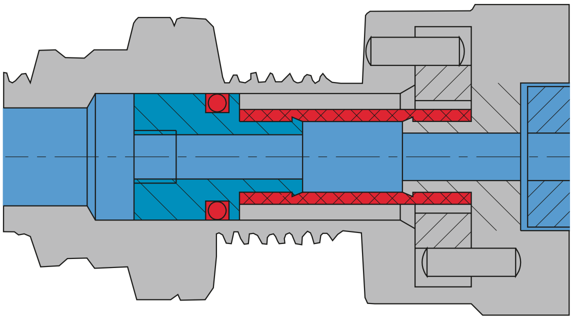


MAPAL floating holders

Type PA has a **second movement plane** with which the angular offset is compensated for with a spherical disc and tapered "dish".

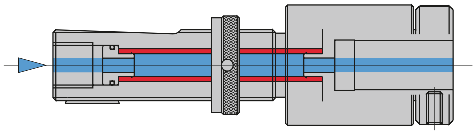


3. Coolant supply

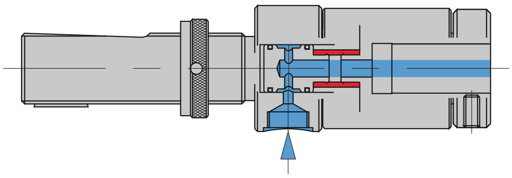


MAPAL floating holders are characterised by a **closed central coolant supply** (water, air, oil) onto the workpiece using a **flexible, sealed unit** which is connected with the machine holding device and the tool holder.

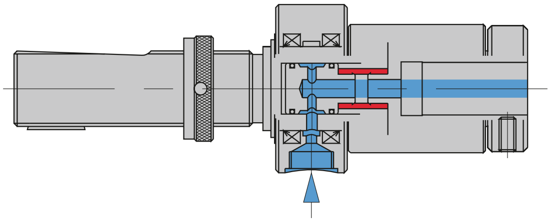
The following three connection versions are available



1. Supply at end of floating holder
   Maximum possible coolant pressure 50 bar. Ref. code KZ.

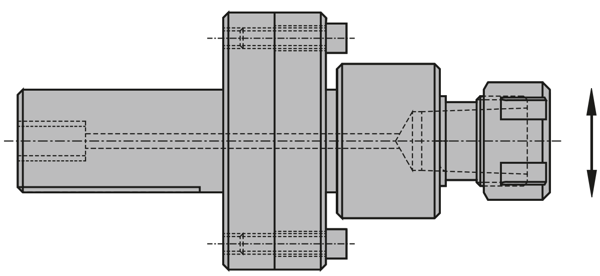


2. Supply through lateral hole
   Maximum possible coolant pressure 50 bar. Ref. code KZB.

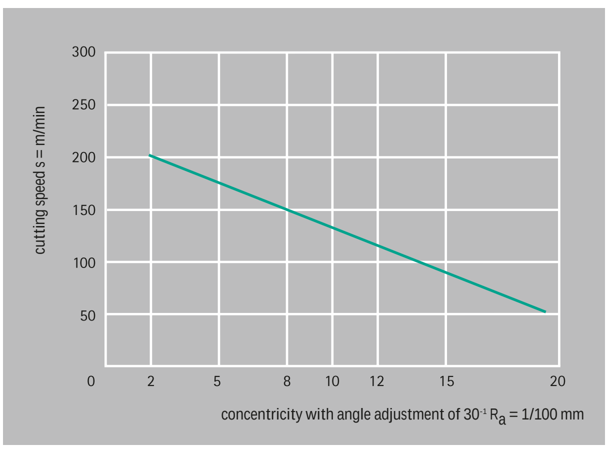


3. Supply through rotating ring
   Maximum possible coolant pressure 30 bar. Ref. code KZD.

MAPAL floating holders
Self-adjusting floating holders

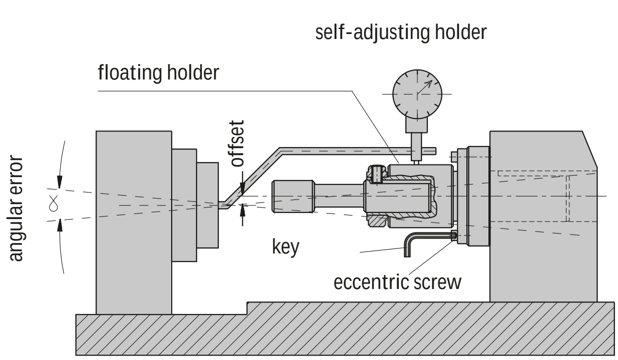


In order to achieve higher machining values and even better machining results, the floating holder can be combined with the MAPAL self-adjusting floating holder. The self-adjusting floating holder reduces the pendulum movement of the floating holder and the radial play is then minimised. The efficiency of the system can be seen from the higher spindle speeds and cutting speeds which extend right up to the HSC range.



Effect of radial play on cutting speed

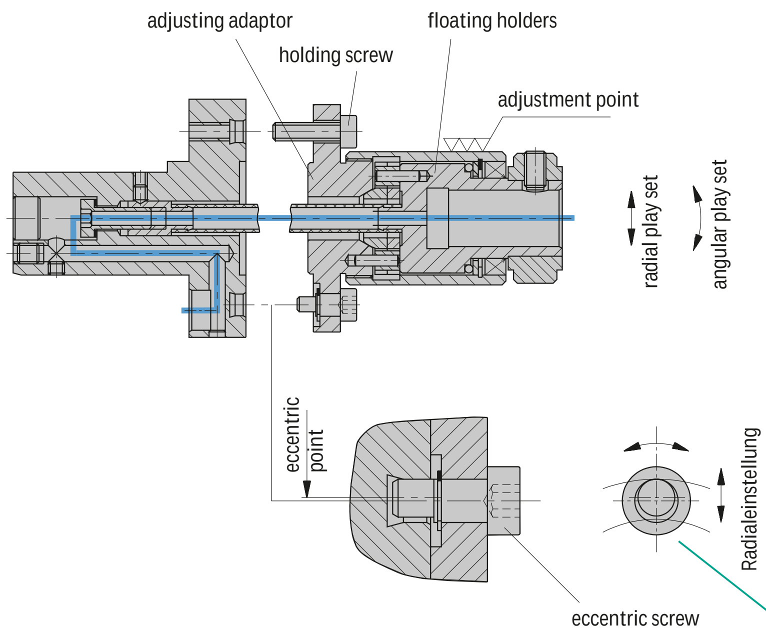
1. Structural diagram of self-adjusting floating holder



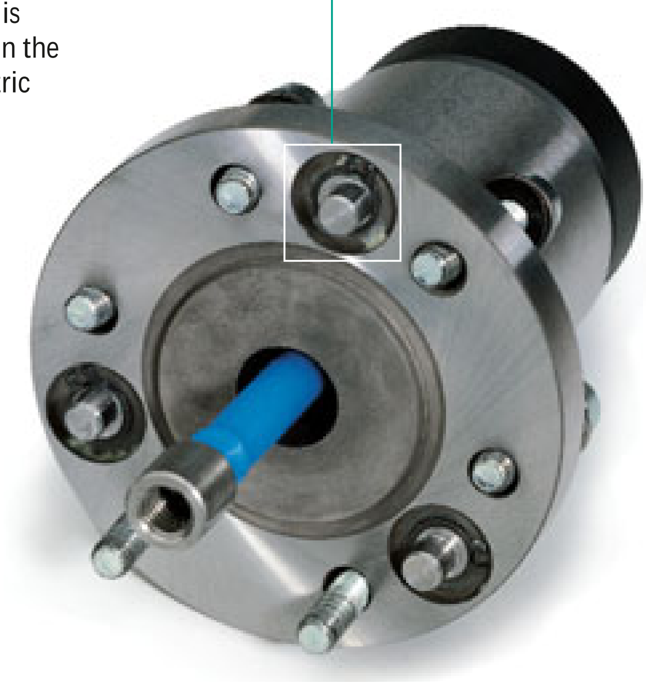
The combination of floating holder and self-adjusting holder also saves long machine stoppage times: instead of having to set up the whole machine, the spindle error can be set easily and directly on the self-adjusting floating holder using easily accessible eccentric screws. The new self-adjusting floating holder is especially suited for use on turning machines (adjusting slide guideways) and multi-spindle machines (adjusting tool holders). In general the MAPAL self-adjusting floating holders can be used wherever manual adjustment of an axial error is needed.

MAPAL floating holders
Self-adjusting floating holders

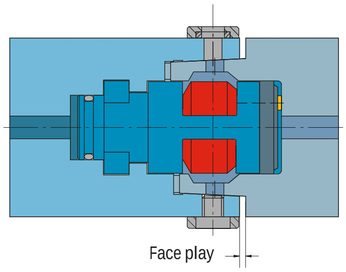
2. Function



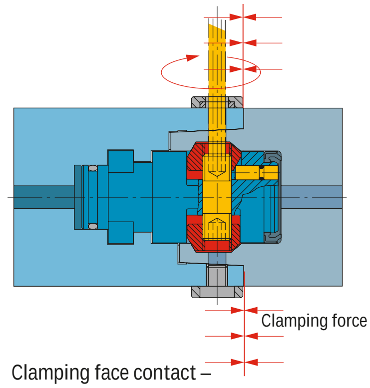
The holders are supplied set to. If the radial play is not sufficient, loosen the holding screw and align the floating holder on the machine using the eccentric screws.



Main features of the KS Clamping cartridge



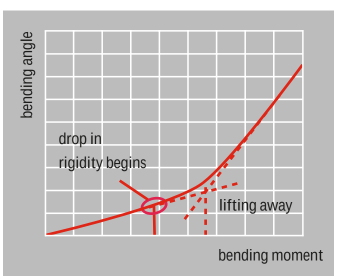
Unclamped face connection – taper connection

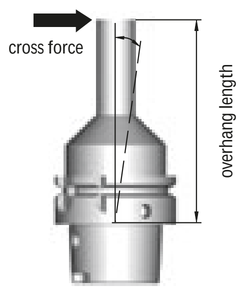


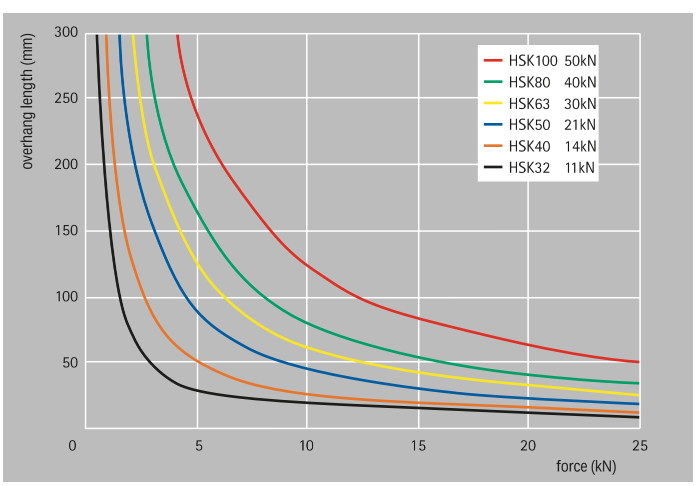
Clamping face contact – taper connection

Clamping force and acceptable bending moments

The pre-stressed HSK connection draws its efficiency from a high clamping force effected on the face connection with force effected simultaneously on the taper shank. The tolerances for the HSK shank and holder lead to excessive forces. The excessive proportion of the clamping force is applied to the face connection and, together with the face connection diameter, this is responsible for absorbing high bending moments.







Permissible bending load for HSK connection when using KS cartridge

Because of the compact design of the clamping mechanism the MAPAL KS clamping system allows higher clamping forces than are recommended under the standard. This produces an extremely high load capacity from the bending moments and a high rigidity in the connection.

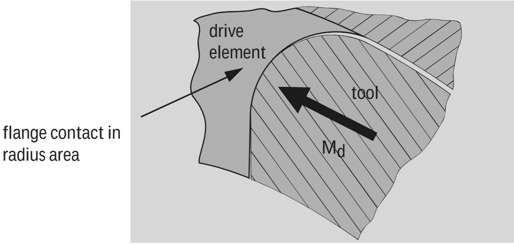
In practical use this means the absorption of higher cutting forces even with large overhangs plus better tool life and therefore maximum productivity. Depending on external stresses, the lower DIN clamping forces may also be sufficient.

Nominal size HSK		32	40	50	63	80	100
Clamping diameter d_2	mm	24	30	38	48	60	75
Shank diameter (DIN 69893)	kN	4,5	6,8	11	18	29	45
Clamping force (MAPAL KS)	kN	11	14	21	30	40	50
Clamping moment	Nm	6	7	15	20	30	50
Lifting moment M_{lift}	Nm	150	260	460	625	1.005	1.400

Clamping force and lifting moment

The values shown in the diagram and the table are the result of extensive trials in research and in practice and provide an orientation for the user. Depending on the application in question, loads beyond this are also possible.

Main features
of the HSK connection



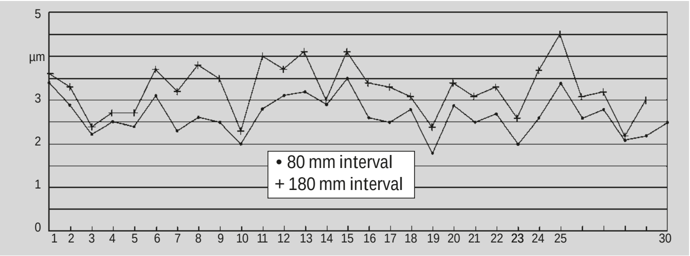
Ideal torque transfer with osculation in radius area

Nominal size HSK		32	40	50	63	80	100
Clamping force	kN	11	15	21	30	38	50
Torque $M_{d,fric}$	Nm	35	57	115	250	450	900
Torque $M_{d,max}$	Nm	275	500	900	1.600	3.300	6.000

Torque transmission

Measurements	HSK 50 chuck			
	1	2	3	4
1	0,002	0,004	0,003	0,004
2	0,005	0,003	0,004	0,004
3	0,003	0,002	0,002	0,003
4	0,001	0,003	0,003	0,002
5	0,002	0,005	0,002	0,003
6	0,001	0,003	0,002	0,002
7	0,004	0,001	0,003	0,001
8	0,004	0,002	0,005	0,005
9	0,003	0,004	0,004	0,004
10	0,005	0,005	0,005	0,004

Concentricity (shown in mm)



Repeatable accuracy measurement with KS chuck (HSK 63)

Nominal size HSK	Spindle speed limit [min^{-1}]
32	50.000
40	42.000
50	30.000
63	24.000
80	20.000
100	16.000

Guideline values for spindle speed limits for HSK connections

Transferable torque

HSK connections transfer both positive and form locking torques. The high clamping force of the MAPAL KS clamping system leads to high friction forces on taper and face and as a result to correspondingly high friction moments.
The form locking torque transfer is characterised by compact drive elements in the holders whose radii osculate exactly and thus allow maximum transferable values.

For tools in 16MnCr5 / 1.7131, the form locking torque transfer allows an extremely high maximum torque ($M_{d, max}$). When using higher quality materials, such as 1.6582 or 1.2343, these values rise dramatically.

Concentricity and repeatable accuracy

The accuracy of the HSK connection is the predominant feature of this standardised connection system. When used with the easy-to-operate KS clamping system, changeover and repeatable accuracies in the high precision range are possible which open up new perspectives for improving quality.

The repeatable accuracy of the HSK connection is $\leq$ 1 µm axially and $\leq$ 3 µm radially.

Spindle speed limits

The spindle speed limit for the HSK connection is defined by a number of factors. This means that the length of the supporting location taper, the excess between the taper shank and the taper holder, and also the clamping system used, have considerable effect.

For applications at high spindle speeds the spindle speed limit needs to be determined according to conditions. The values shown alongside can be taken as rough guidelines.

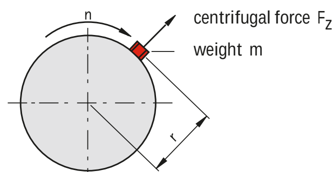
Definition, calculation, effect and limits of balancing

1. Imbalance and calculation of imbalance

Imbalance *U* is a measurement which defines what weight *m* is located on a specific radius *r* to the axis of rotation (see sketch 1). This has the “unmanageability” unit gmm and is calculated with formula A:

$$U = m \cdot r$$

(Formula A)

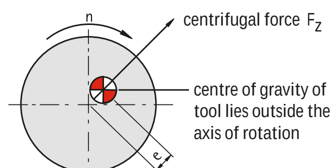


(Sketch 1)

With a rotating cutting tool, the imbalance is normally referred to this weight m_{WZ} and is calculated with an eccentric distortion *e* from its centre of gravity to the axis of rotation:

$$U = m_{WZ} \cdot e$$

(Formula B)



(Sketch 2)

This imbalance is calculated on a balancing device and the weight to be balanced under Formula A automatically adjusted to the radius r on which the material compensation is carried out so that the tool will meet the customer requirement.

The permissible distance e_{zul} is produced from the balancing quality value *G* and the required spindle speed *n* using Formula C:

$$e_{zul} = G \cdot \frac{60}{2 \cdot \pi \cdot n}$$

(Formula C)

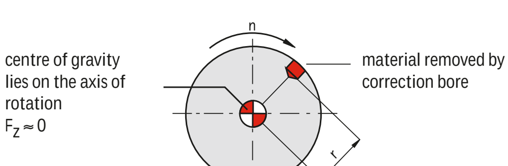
and is a good basis on which to estimate how difficult balancing will be and whether a request for balancing can be effectively carried out.

The permissible residual imbalance m_R from this is produced from

$$m_R = m_{WZ} \cdot \frac{e_{zul}}{r}$$

(Formula D)

As an example, using Formula C for a toolholder with a required balance of G 6.3 and a spindle speed *n* of 10.000 min^{-1}, the permissible distance e_{zul} = 6 µm. For a correction radius *r* = 16 mm, with a tool weight of m_{WZ} = 1 kg, using Formula D the permissible residual imbalance weight m_R is then 380 kg.



(sketch 3)

The imbalance with the rotating spindle produces a centrifugal force F_Z which, if the imbalance is too great, can have a negative effect on the machining process and/or the life of the spindle bearing.

The centrifugal force F_Z develops linearly with the imbalance and quadratically with spindle speed *n* using Formula E:

$$F_Z = U \cdot \omega^2 = U \cdot (2 \cdot \pi \cdot n)^2$$

(Formula E)

To avoid these centrifugal forces, compensating bores and surfaces are normally produced on tool holders and tools, as a result of which the centre of gravity is shifted in the direction of the axis of rotation and the centrifugal force reduced accordingly (see sketch 3)

The balancing quality *G* is calculated from

$$G = e \cdot \omega = \frac{U}{m} \cdot \frac{2 \cdot \pi \cdot n}{60}$$

(Formula F)

2. Balancing limits

The purpose of balancing a tool holder (with tool) must be to ensure sufficient balance for the application in question. This always means a compromise between the technical feasibility and the technical and economic practicalities.

In general a requirement to balance is both unrealistic and also unfeasible if the permissible distance e_{zul} which this produces is less than the radial clamping accuracy for the tool holder used.

For the hollow taper shank (HSK), as the currently most accurate connection, this limit is $e_{min} \geq 2$ µm. With this value, using Formula B for a tool holder with a clamped tool (total weight 1,340 g), this produces a possible, and not influential, imbalance pf 2.68 gmm and, using Formula F at a spindle speed of, for example, 30,000 min^{-1}, the best possible balance of G 6.3.

The same clamping accuracies/inaccuracies which occur with use on the machine tool spindle also apply of course to the balancing device, and as a result a lower residual imbalance and a better balancing quality cannot be reproduced.

The measuring accuracy of balancing devices as used in the tool industry must be taken into account when considering these limits. With a display sensitivity of 0.5 gmm for a high quality balancing device this means a further measuring uncertainty because of the shift in centre of gravity of 0.5 µm and with regard to the balancing quality of ΔG at 30,000 min^{-1} (tool weight 1,340 g).

3. Balancing chucks for cylindrical shanks Form HB and HE

In these chucks standard tools such as drills and milling cutters are used which, because of their clamping surface(s). have an integral imbalance. If the tool holders for these tools are then balanced without taking this imbalance into account, the overall imbalance of the tool is transferred to the unit produced by the tool holder + tool when assembled.

For this reason, to balance the tool holder correctly either a shank must be clamped on or the imbalance in question 'contained' on the screw side. The material for the tool to be held (usually HSS or carbide) is therefore of great significance because of the density specific to this.

If the tool material is either not known or varies, these tool holders can be balanced as a 'fictitious' material whose theoretical density of 11.2 g/mm³ lies exactly between that of steel (7.8 mm³) and carbide (14.6 g/mm). This means the possible deviation for the user from the free choice of tool material normally required is only half as great as if the balancing were to be either for steel or carbide.

With regard to the general balance limits which are generally to be applied for such tool holders, the clamping accuracy of the cylindrical shank in the location bore also needs to be taken into account.

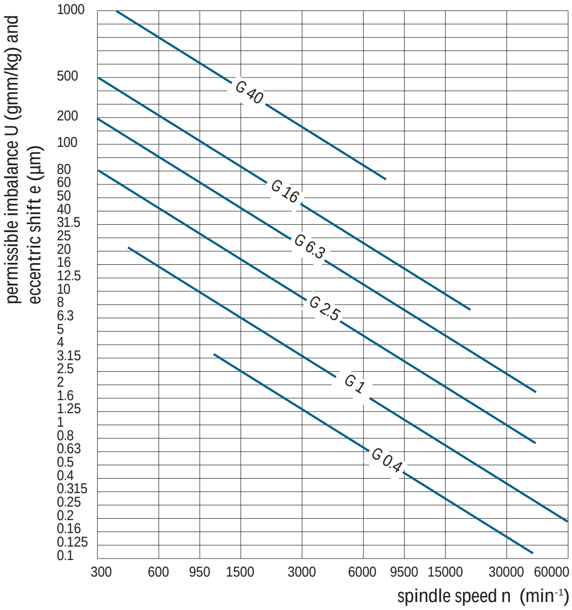
Example
Tool 25 mm ø / 370g
DIN tolerances: bore H5 produces ø tolerance 0/+9 µm
shank h6 produces ø tolerance 0/-13 µm
⟹ maximum radial offset 11 µm

For the whole tool being observed (tool holder + tool = 1.340 g), using Formula F for a spindle speed of 8,000 min^{-1}, a possible drop in the balance quality is produced of Δ G 2.5. The clamping accuracy for the HSK hollow taper shank produces a further uncertainty of Δ G 1.68.

The overall result in the case of these tool holders can only be that requirements below G 6.3 are hardly practicable.

In certain cases it may be necessary to balance tool holder and tool together. Clear limits can only be defined, however, by taking the type of tool, overhang length and machine/spindle design into consideration.

The diagram show below (to DIN/ISO 1940-1) shows, for balance values G on a balancing weight of 1 kg, the permissible standardised residual imbalance *U* and the permissible radial shift in the centre of gravity e in relation to the spindle speed *n*.



4. Formula symbols, units and formula

Symbols	Units	Formula	Description
e	µm	$e = \frac{U}{m_{WZ}}$	eccentric shift
e_{zul}	µm	$e_{zul} = G \cdot \frac{60}{2 \cdot \pi \cdot n}$	permissible distance
F_Z	N	$F_Z = U \cdot \omega^2$	centrifugal force
G	mm/s	$G = e \cdot \omega$	balancing quality
m	g		weight
m_R	g	$m_R = m_{WZ} \cdot \frac{e_{zul}}{r}$	permissible residual imbalance weight
m_{WZ}	g		tool weight
n	min^{-1}		spindle speed
r	mm		radius
U	gmm	$U = m \cdot r = m_{WZ} \cdot e$	imbalance

5. Fine balancing

MAPAL chucks are balanced as standard with at least G6.3 at 3,000 min^{-1}. On request specific clamping devices can also be fine balanced (see relevant notes on table pages)

For this the order numbers have an "F" added.
Example:
Chuck for cylindrical shanks with lateral clamping surface, location shank HSK-A 63, clamping diameter 12 mm.

Order No. with standard balancing G 6.3 at 3,000 min:
MN5083-08-K

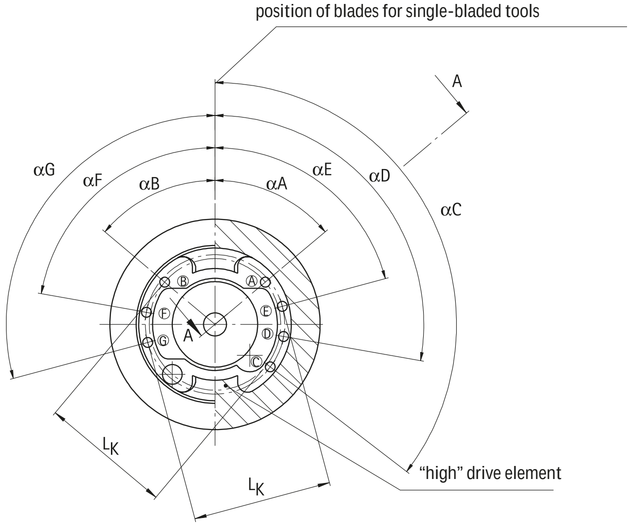
Order No. in fine balanced version:
MN5083-08-KF

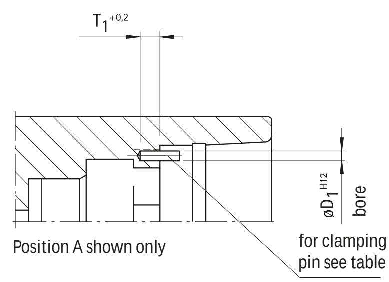
Technical notes

Security system for identifying hollow taper shanks

On special machines multi-spindle boring heads are frequently used. A large number of spindles are often kept In a very tight space. To prevent operator error when changing tools, the DIN 69894 security system has been developed for hollow taper shanks. With this a tool is clearly allocated to a specific spindle by means of additional pins in the tool spindles and slots at the end of the HSK shank.

Security system for tool spindles:

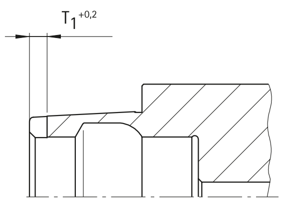


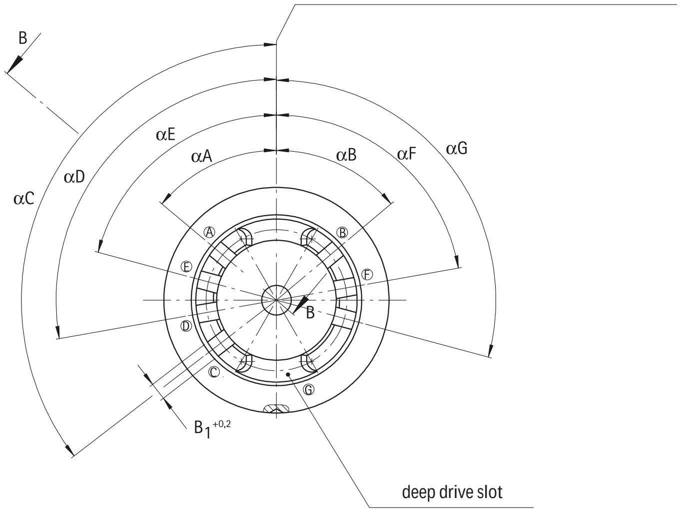


Position / HSK	Ⓐ α A	Ⓑ α B	Ⓒ α C	Ⓓ α D	Ⓔ α E	Ⓕ α F	Ⓖ α G	D_1	T_1	L_K	Clamping pin
32	50°	50°	127,5°	100°	75°	80°	105°	1,5	3	As selected by the manufacturer	DIN 1481-1,5x6
40	52,5°	52,5°	127,5°	100°	75°	80°	105°	2	3		DIN 1481-2x6
50	55°	55°	125°	100°	75°	80°	105°	2,5	3		DIN 1481-2,5x6
63	60°	60°	120°	105°	75°	75°	105°	3,5	4		DIN 1481-3,5x8
80	60°	60°	120°	105°	75°	75°	105°	4,5	5		DIN 1481-4,5x10
100	45°	45°	135°	105°	75°	75°	105°	4,5	7		DIN 1481-4,5x12
125	45°	45°	135°	105°	75°	75°	105°	4,5	7		DIN 1481-4,5x12
160	45°	45°	135°	105°	75°	75°	105°	4,5	7		DIN 1481-4,5x12

☐ = Recommended

Security system for identifying hollow taper shanks:





Position / HSK	Ⓐ αA	Ⓑ αB	Ⓒ αC	Ⓓ αD	Ⓔ αE	Ⓕ αF	Ⓖ αG	D_1	T_1
32	50°	50°	127,5°	100°	75°	80°	105°	2,5	2,5
40	52,5°	52,5°	127,5°	100°	75°	80°	105°	3	2,5
50	55°	55°	125°	100°	75°	80°	105°	3,5	2,5
63	60°	60°	120°	105°	75°	75°	105°	4,5	3,5
80	60°	60°	120°	105°	75°	75°	105°	5,5	4,5
100	45°	45°	135°	105°	75°	75°	105°	5,5	5
125	45°	45°	135°	105°	75°	75°	105°	5,5	5
160	45°	45°	135°	105°	75°	75°	105°	5,5	5

☐ = Recommended

All MAPAL clamping devices and HSK adaptors can be supplied with this security system.
For this the letter "V" is added to the order number. In addition the position is clearly indicated by the appropriate letter.

Order examples:
Hydraulic chuck with security system on the adaptor side in position B for nominal size MN5165-08-KF:
MN5165-08-KFV-B
Collet chucks with security system on the adaptor side in position A and position C for nominal size MN5140-07-K:
MN5140-07-KV-AC

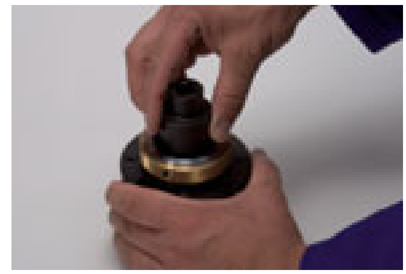
KS Clamping cartridges

1. Direct mounting of KS Clamping cartridge on the spindle, chuck or adaptor

a) Using an assembly key

1. Insert clamping cartridge into the spindle or into the adaptor.

2. Place box spanner on the clamping cartridge.



3. Rotate in clockwise direction until the nose of the cartridge engages on the clamping pin.

b) Using KS wrench

1. Open jaws on wrench by pressing the round button and insert the clamping cartridge.

2. Insert the clamping cartridge into the spindle or adaptor and rotate the wrench clockwise until the nose of the cartridge engages on the clamping pin.

3. With the cartridge is engaged there must be play between the cartridge and pin.

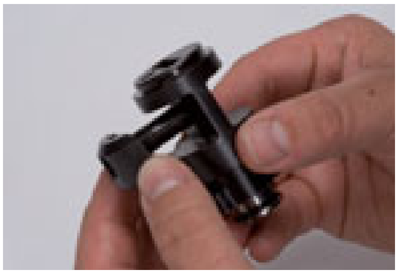
For order references for assembly key see page 149.
For order reference for KS wrench see page 149.

KS Clamping cartridges

2. Fitting the KS Clamping cartridge

1. Clamping jaw seating on basic body, clamping angle on jaws and threaded spindle are lightly greased. Recommended grease: METAFLUX anti-friction metal paste.

2. Screw threaded spindle into the clamping jaw with the ejector angle by approx. one turn.



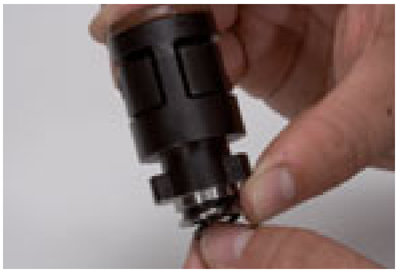
3. Insert clamping jaw with threaded spindle into the basic body from side of the bore for the ejector pin.

4. Also screw second jaw into the threaded spindle by approx. one turn.

5. By turning the threaded spindle with a key both jaws are moved inwards.

6. Check the threaded spindle's seating – this must be exactly central between the jaws.

7. Press on sealing ring with soft sealing lip forwards on the face side.



8. Pull on O-ring.

9. Insert pressure pin into bore.

KS Clamping cartridges

3. Starting torques for clockwise/anti-clockwise screw on KS Clamping cartridge for clamping tool

HSK size	32	40	50	63	80	100
Max. starting torque [Nm]	6	7	15	20	30	50
Key width	3	3	4	5	6	8

4. Notes on using the KS clamping system

In using spindles or adaptors which are fitted with a clamping cartridge and are being used without a tool, a cap should be used in every case. This will protect the system and the user and prevent contamination.

When using tools with low radial stress, e.g. in drilling and reaming operations, it is acceptable to fall below the maximum starting torque by approx. 25 %.

5. Maintenance and care

With every tool change the taper should be cleaned using a taper cleaner.

The Clamping cartridge should be greased again after comparatively long use. The mount of time between applications depends on the frequency of the tool change, the type of operation and the coolant. However, re-greasing should be carried out at least once every six months.

KS adaptor flanges

1. Fitting and aligning the KS adaptor flange with radial alignment


1. Clean taper and faces of adaptor flange and adaptors.


2. Insert adaptor flange. Tighten holding screw to 50 % of the specified starting torque (see table on page 214).


3. Clean taper and face of test arbor or tool.

4. Insert test arbor or tool and secure with gripper screw.


5. Bring the dial indicator into position on the concentricity check point.
With MAPAL tools alignment can also take place on the HSK collar.
Locate the highest measurement point and bring dial indicator to zero.

KS adaptor flanges

6. Roughly align adaptor flange (approx. 0.01 mm). Release the adjusting screw each time this is activated.

7. Set concentricity with adjusting screw. Also release the adjusting screw each time this is activated. Repeat the process until the concentricity error is < 3 µm.

8. Tighten gripper screw over cross and apply starting torque (see table). After the full starting torque has been reached, check radial alignment again and adjust if necessary. Apply adjusting screw lightly.

Radial alignment can also be carried out with measuring probes. For this the probes are positioned on the adaptor flange taper.

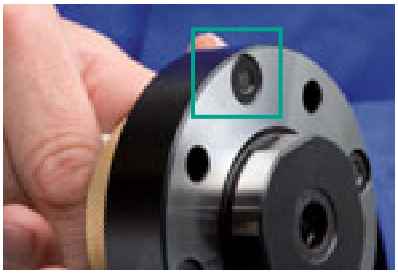
Withdrawal torques

Nominal size	Module diameter	Gripper screw	Starting torque
HSK 32	60	DIN 912 – M5x16 – 12.9	8,7 Nm
HSK 40	70	DIN 912 – M6x20 – 12.9	15 Nm
HSK 50	80	DIN 912 – M6x20 – 12.9	15 Nm
HSK 63	100	DIN 912 – M8x25 – 12.9	36 Nm
HSK 80	117	DIN 912 – M8x25 – 12.9	36 Nm
HSK 100	140	DIN 912 – M10x30 – 12.9	72 Nm

As a basis for the maximum starting torques for cylindrical screws to DIN 912, the general DIN standard for rigidity class 10.9 applies.

MAPAL only uses cylindrical screws to DIN 912 with rigidity class 12.9.

2. Fitting and aligning KS adaptor flanges and MAPAL modular adaptors with radial and angular alignment



1. Clean faces of adaptor flange and adaptor (see page 213). In doing so check that the face of the alignment screw does not protrude beyond the face of the adaptor flange.

2. Insert adaptor flange. Position gripper screw.

3. Clean taper and face of test arbor or tool extremely carefully. Insert test arbor or tool.

4. Bring the dial indicator into position at the concentricity check point. With MAPAL tools alignment can also take place on the HSK collar. Locate the highest measurement point and bring dial indicator to zero.
   For procedure see page 214.

5. For angular alignment the dial indicator is positioned at the uppermost checking point or approx. 100 mm from the connection. Carry out angular alignment using the alignment screws. Do <u>not</u> loosen the alignment screws after this has been done.

6. After the angular alignment has been set to < 3 µm, check the radial alignment at the concentricity checkpoint on the collar again and adjust if necessary. If the radial alignment needs to be adjusted, the angular alignment should be checked again afterwards.