GÜHRING

Technical Section

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Bright finish

Especially for the machining of wrought and cast aluminium alloys with a high silicon content, un-coated drills offer a very good machining performance. In order to counter adhesive (formation of built-up edges), these tools are optimally suited to this field of application thanks to a special geometry combined with a high surface quality in the point thinning, flute and clearance areas.

Steam tempered/nitrided surface finish

A steam tempered surface finish provides an improved corrosion protection as well as an improved tribological behaviour of the tools thanks to the oxidation of the surface area (approx. 3 to 10 ųm). Nitriding the land is recommended for abrasive applications, it increases the hardness of the surface on the land and therefore improves wear resistance of the tool. However, using hard material / soft material coatings often provide better results, this type of surface treatment is becoming increasingly less important.

TiN-coating

Max. application temperature: <600° C
Colour: Golden yellow
Structure: Single-layer
Hardness: 2300 HV0.05

Introduced by Gühring at the beginning of the 1980's, TiN-coating is applied to HSS and carbide for drilling operations as a cost-efficient general purpose coating.

FIRE/nanoFIRE-coating

Max. application temperature: <800° C
Colour: Violet
Structure: Multi-layer
Hardness: 3300 HV0.05

FIRE and nanoFIRE coatings contain aluminium, titanium and nitrogen. These coatings were introduced towards the end of the 1990's and are a further development of the TiN-coating. They excel thanks to increased hardness and good thermochemical resistance, they are suitable for HSS and carbide.

Raptor-coating

Max. application temperature: < 800°C
Colour: Pale golden
Structure: Multi-layer
Hardness: 3300 HV0.05

The TiN/ TiAlN-multi-layer structure of Raptor is the key component for the good performance when machining steel. Thanks to the additional friction reducing top layer coating, based on zircon, the performance coud now be further extended for steels that tend to adhere during machining (i.e. ferritic, austenitic and Duplex steels).

TiAlN-coating

Max. application temperature: <800° C
Colour: Violet
Structure: Single-layer
Hardness: 3300 HV0.05

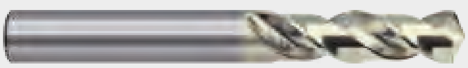
The TiAlN-coating displays similar characteristics to FIRE and nanoFire and with its single-layer structure is mostly applied in the field of micro-precision drills.

nanoA-coating

Max. application temperature: <900° C
Colour: Blue violet
Structure: Multi-layer, nano-structured
Hardness: 3300 HV0.05

TiAlN based nanoA has proven itself in the machining of stainless steels and is suitable for drilling cast iron, nickel based alloys and cobalt chrome alloys. Thanks to its nano-layered structure the fracture growth is delayed. Furthermore, thanks to its adapted composition it possesses a higher thermo-chemical resistance than for example TiAlN.

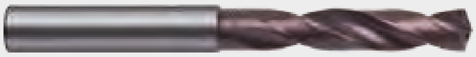
Sirius-coating



Max. application temperature: < 900°C
Colour: Pale golden
Structure: Multi-layer, nano-structured
Hardness: 3400 HV0.05

Sirius, essentially based on AlTiN is especially suitable for the machining of stainless steels. Thanks to the nano-structured designvit displays good hardness and toughness. The zircon containing top layer coating is to largely eliminate chemical reactions with the material and therefore encourage chip evacuation.

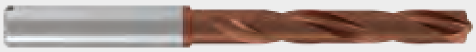
Signum-coating



Max. application temperature: <800° C
Colour: Bronze
Structure: Multi-layered nano-composite
Hardness: 5500 HV0.05

The Signum-coating belongs to the group of Nano-composites. The microstructure features extremely fine TiAlN nano-crystals bedded into a glass-like, high temperature resistant silicon nitride matrix. This results in a high hardness especially making the Signum-coating the first choice for hardened steels and cast materials.

Endurum-coating



Max. application temperature: <800° C
Colour: Copper
Structure: Multi-layered nano-composite
Hardness: 4000 HV0.05

Endurum-coating, another coating of the Nano-composite family, this was specifically designed for the machining of carbon, free-cutting and manganese alloyed steels.

Zenit-coating

Max. application temperature: <700° C
Colour: Pale gold
Structure: Multi-layer, nano-structured
Hardness: 2500 HV0.05

The nano-structured Zenit-coating was specifically optimised for the machining of titanium-alloys. The special structure as well as the composition contribute to a significant reduction of tribochemical wear and therefore make it a true specialist. In parallel it also achieves good results when drilling aluminium cast alloys with moderate silicon content.

Ice-coating

Max. application temperature: <1000° C
Colour: Metallic grey
Structure: Multi-layer
Hardness: 3500 HV0.05

The titanium, aluminium and chrome based Ice-coating specialises in the machining of non-ferrous metals such as, copper alloys, bronze and brass.

Carbo-coating

Max. application temperature: <500° C
Colour: Grey black
Structure: Single-layer
Hardness: 5000 HV0.05

The Carbo-coating is part of the DLC-coating group (DLC – diamond-like-carbon). These carbon coatings possess diamond-like characteristics. The Carbo-coating displays a very high hardness due to its composition of 100% carbon and structure (ta-C). It explains the outstanding performance when drilling non-ferrous metals such as, wrought and cast aluminium alloys (< 12% Si), copper, brass and bronze. In addition, it is suitable for plastics and wood.

Cristall-coating

Max. application temperature: <600° C
Colour: Grey black
Structure: Single-layer
Hardness: 8000 HV0.05

Cristall-coating is a pure crystalline diamond coating that does not lag behind natural diamond in anything. With many interesting physical properties it impresses with its extreme hardness. Therefore, the micro-crystalline Cristall-coating is exceptionally suited for the machining of highly abrasive materials such as, fibre-reinforced plastics, ceramic, graphite and cast aluminium alloys with a high silicon content (> 12%). This coating can only be applied on special carbide grades for technical process reasons.

	Drilling		
	Carbide		HSS
	conventional	MQL	
C-steels, Free-cutting steels, Mn-steels	Endurum Raptor Fire	Endurum Raptor Fire	Fire - -
Steel, low-alloyed	Fire Endurum Raptor	Fire Endurum Raptor	Fire TiN
Steel, alloyed	Fire Signum nanoA	Fire Signum nanoA	Fire TiN
Steel, hardened <55 HRC	Signum Fire TiAlN	Signum Fire TiAlN	- - -
Steel, hardened 55-65 HRC	Signum Fire TiAlN	Signum Fire TiAlN	- - -
Steel, stainless and acid resistant	nanoA Sirius Endurum	nanoA Sirius Endurum	Sirius Fire TiN
Cast iron	Signum Fire nanoA	Signum Fire nanoA	Fire - -
Aluminium wrought alloys	bright Carbo Cristall	bright Carbo Cristall	bright Carbo -
Aluminium cast alloys (< 12% silicon)	bright Zenit Carbo	bright Zenit Carbo	bright Zenit Carbo
Aluminium cast alloys (≥ 12% silicon)	Cristall - -	Cristall - -	- - -
Nickel based alloys (i.e. Inconel)	nanoA Signum Fire	nanoA Signum Fire	Fire - -
Titanium / titanium alloys	Zenit nanoA	Zenit nanoA	Fire -
Copper / bronze / brass	ICE Carbo	ICE Carbo	TiN -
Cobalt chrome alloys	nanoA Signum Fire	nanoA Signum Fire	- - -
Precious metals	nanoA	nanoA	-
Ceramic	Cristall	Cristall	-
Plastics, non-reinforced	Carbo	-	-
Plastics, fibre-reinforced	Cristall Signum	Cristall Signum	- -

Note:

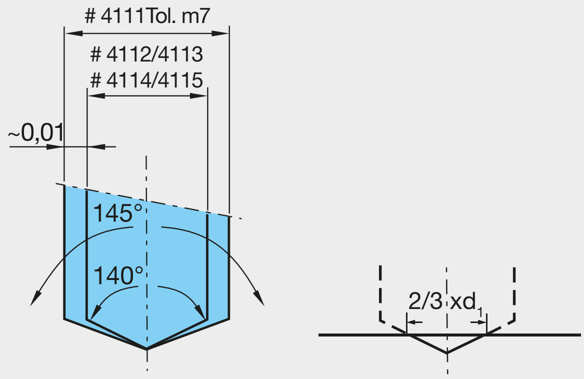
The overview shows the general application recommendations for Gühring coatings. Prioritisation is from top to bottom.

Centring and pilot drilling

Centring and pilot drilling for HT 800

Generally we recommend centring/pilot drilling for HT 800 with drilling depths above 5xD.

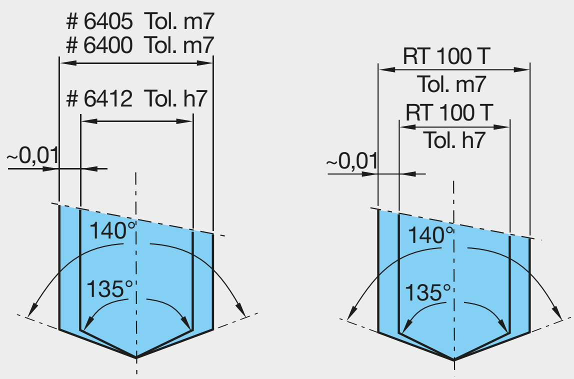
When centring, the drilling diameter should be approximately 2/3 of the hole diameter to be produced.
With pilot drilling we recommend a drilling depth of 1xD. In addition, the point angle as well as the diameter of the pilot drill should be larger than the point angle and the diameter of the following drill.
To ensure this, we recommend the application of the adapted pilot drilling inserts art. no 4111 with 145° point angle and m7 diameter tolerance in an extra short, rigid holder art. no. 4105.



Centring and pilot drilling for solid carbide

When applying solid carbide drills for drilling depths 7xD to 12xD we recommend centring or the production of a pilot hole with a depth of 1xD to 2xD.
With drilling depths larger than 12xD a pilot hole with a depth of 1xD to 2xD is imperative.

With pilot drilling for the Exclusive Line micro-precision drill with 15xD (art. no. 6412) we recommend the application of Exclusive Line micro-precision drill 4xD without internal cooling (art. no. 6400) or 5xD with internal cooling (art. no. 6405), as they are optimally adapted regarding point angle and diameter tolerance.

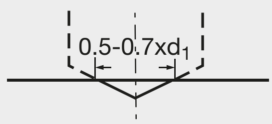


When pilot drilling for deep hole drills eg. type RT100T, a Ratio drill type RT100U with internal cooling, 3xD (e.g. art. no. 2477) can be applied, as it is optimally suited regarding point angle and diameter tolerance.

Centring and pilot drilling for HSS

Centring with drill lengths to DIN 340

When using long series drills (DIN340) in HSS/HSCO, we recommend spot drilling with a spotting diameter of 0.5 to 0.7xD (D = drill diameter). HSS NC spotting drills are optimally suited for this process. Detailed information regarding NC spotting drills can be found in the NC spot drilling section.



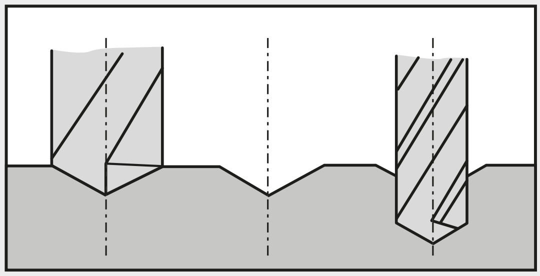
Pilot drilling with drill lengths to DIN 1869

When applying extra length HSS/HSCO drills to DIN 1869 we recommend the production of a pilot hole with a depth of 1xD to 2xD.
Stub drills type GV 120 to DIN 1897 are optimally suited.

NC spotting drills

NC spotting drills

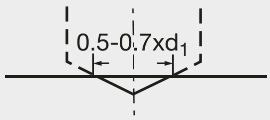
When producing accurately positioned holes, holes with close diameter tolerances, deep holes or generally with unfavourably shaped workpieces (round, rough. etc.) it's recommended to use a NC spotting drill. This ensures the following drill, drills accurately and prevents the drill from running off.
NC spotting drills can also be used to produce chamfers or countersinks (when using a spot drill with a larger diameter than the actual hole) and centring in one operation.



NC spotting drills are designed with a very short flute length and without body clearance to ensure a very rigid design and therefore accurately positioned spotting. Due to the design, NC spot drills are only suitable for spotting, drilling depths must not exceed the length of the point geometry.

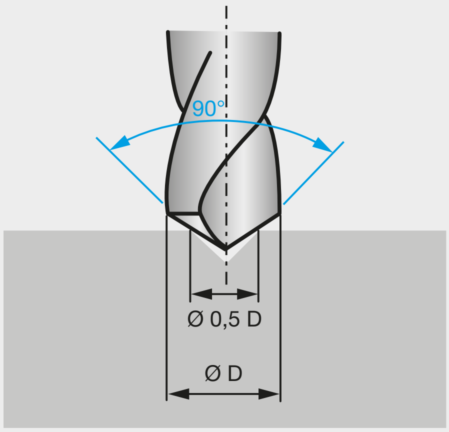
Selecting an NC spotting drill

Ideally, the spotting diameter should be chosen between 0.5 to 0.7xD.



90° NC spotting drills

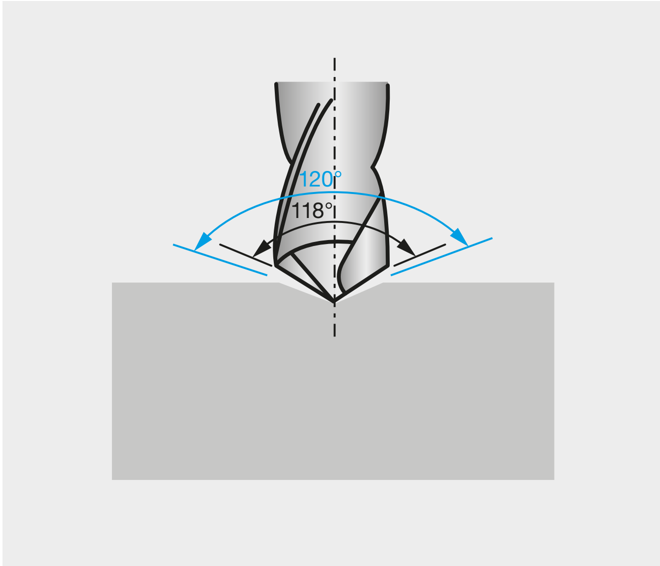
NC spotting drills with a 90° point angle are ideally suited for spotting if the following HSS/HSCO drills have a relatively large chisel edge. This ensures that the following HSS/HSCO drill drills with the cutting lip first and is guided by the most stable points of the cutting edge.
In addition, NC spotting drills with a 90° point angle are used to produce a 90° countersink and centre in one operation if the spotting diameter is larger than the actual hole diameter.



NC spotting drills

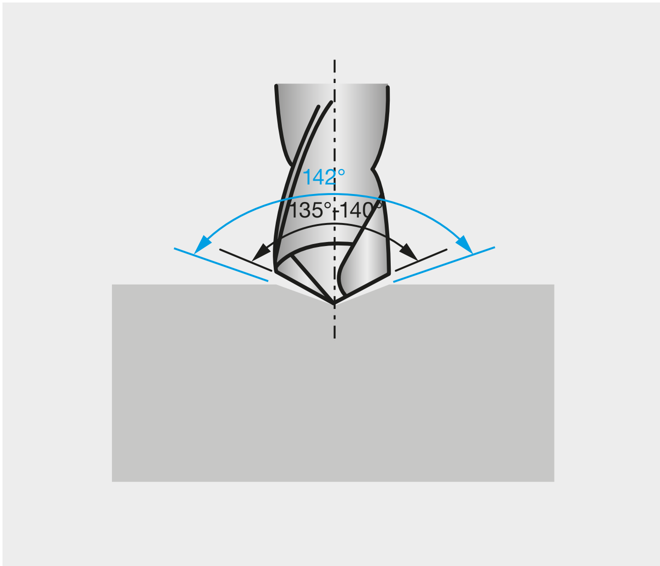
120° NC-spotting drills

NC-spotting drills with a 120° point angle are specially suited for spotting operations if the actual hole is subsequently produced with HSS/HSCO drills with a 118° point angle. This ensures the following HSS/HSCO drill spots with the point first and is well guided.



142° NC-spotting drills

NC-spotting drills with 142° point angle are specially suited for spotting operations if the actual hole is subsequently produced with carbide drills with a 135° - 140° point angle. This ensures the following carbide drill spots with the point first, centers and is well guided. If the cutting corners of the carbide drill meet the material to be machined before the point, there is the risk of corner crumbling with carbide drills.



NC spotting drills

90°	120°	142°
		

Coolant pressure and volumes Ratio drills

The illustrated optimum, good and minimum required coolant volume apply only to spiral-fluted Ratio drills type RT 100. In contrast to the pressure, which is a feature of the machine tool; the cooling system fitted to it and also the possibility of leakage, volume does not depend on the machine (fig. 1). The pressure figures given are therefore recommendations which serve only as guidelines. Ratio drills type RT 80 with central coolant duct are subject to different standards (fig. 2). The diagrams shown are for Ratio drills in their most important application, machining of steel.But they are also guidelines for the machining of other materials, primarily because the highest coolant pressures are constantly required for the machining of steel. The effects of cooling using straight-fluted Ratio drills type RT 150 is particularly sensitive and is clearly demonstrated in the examples for particular workpiece materials. For example, the loss in tool life through low pressures when machining grey cast iron is considerably higher than when machining AlSi alloys. But this is only the case when the AlSi alloy is short-chipping! The absolute necessary minimum pressure or good pressure should, when machining cast iron, be generally a little higher than for AlSi machining (figures 3 and 4).

The recommended values are to be used only for drilling depths of up to approx. 5 x D. Deeper holes should be produced with tools having internal coolant ducts, as for example RT 150 GN, otherwise the production of deeper holes (depending on the material) becomes uneconomical.

Required coolant pressures
- optimum pressure
- good pressure
- minimum pressure

Required coolant volumes
- optimum volume
- good volume
- minimum volume

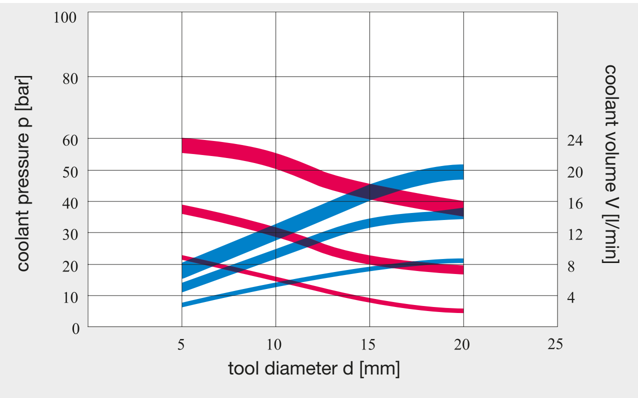


fig. 1:
Required coolant pressures and volumes for RT 100 Ratio drills with internal spiral coolant ducts.

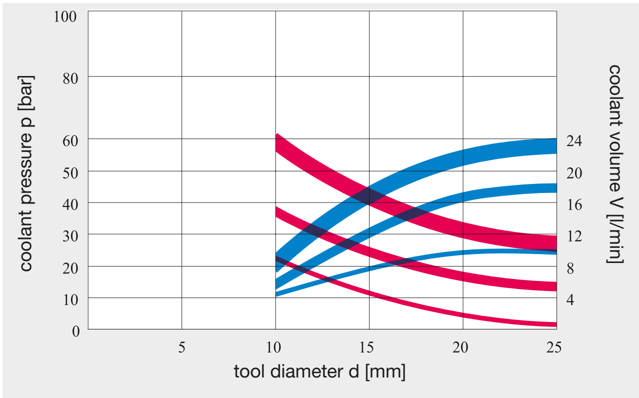


fig. 2:
Required coolant pressures and volumes for RT 80 Ratio drills with central internal coolant duct.

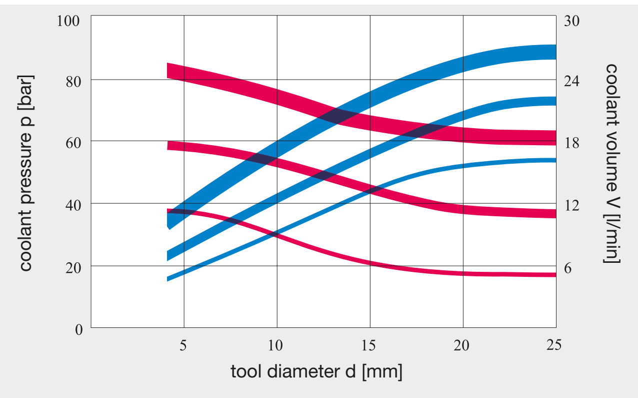


fig. 3:
Required coolant pressures and volumes for straight-fluted Ratio drill type 150 GG when machining cast iron.

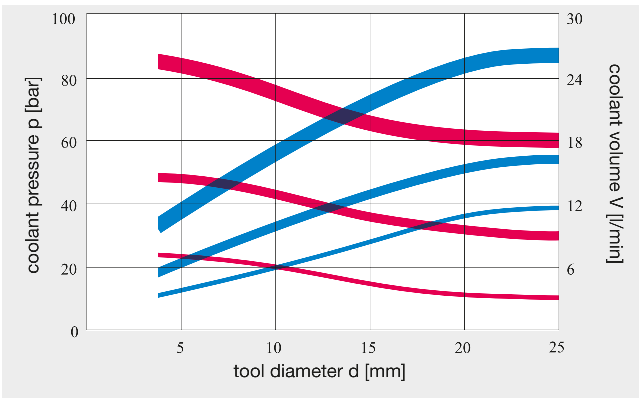


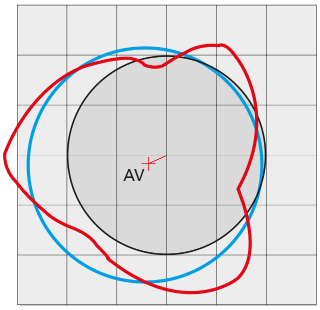
fig. 4:
Required coolant pressures and volumes for straight-fluted Ratio drill type 150 GG when machining AlSi7.

Typical hole quality characteristics

1. in 42CrMo4V, Ø 14.5 mm

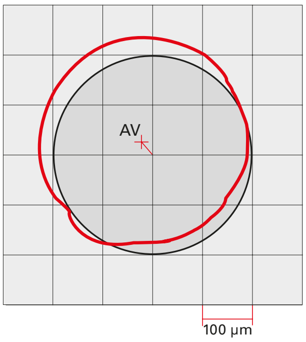
HSS drills, type N
Gühring no. 651 ●

vc = 25 m/min
f = 0.25 mm/rev.
+Rmax = 131.8 µm
-Rmax = -49.1 µm
actual D = 14.566 mm
dRmax = 103.5 µm
AV = 49.2 µm
Ra = 2.6 µm, Rz = 6.8 µm **IT12**



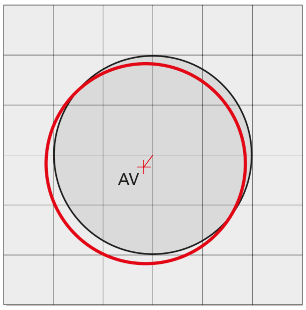
Ratio drills, type RT 80
Gühring no. 1171 ●

vc = 70 m/min
f = 0.25 mm/rev.
+Rmax = 42.7 µm
-Rmax = -29.6 µm
actual D = 14.515 mm
dRmax = 12.9 µm
AV = 35.3 µm
Ra = 1.4 µm, Rz = 4.31 µm **IT9**



Ratio drills, type RT 100
Gühring no. 1181 ●

vc = 70 m/min
f = 0.25 mm/rev.
+Rmax = 26.7 µm
-Rmax = -17.2 µm
actual D = 14.509 mm
dRmax = 5.2 µm
AV = 22.8 µm
Ra = 1.04 µm, Rz = 3.2 µm **IT8**



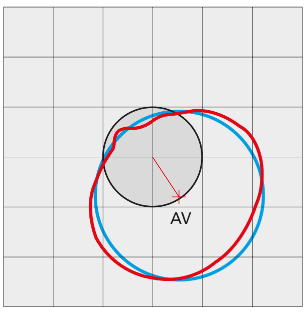
The overall total of the maximum positive and negative deviations is the sum of the total run-out in relation to the black circle as measured on standard instruments (dRmax). The red lines at the hole centres indicate the direction and amplitude of the displacements AV (Axis Shifting) of the produced hole from the true centre point. The parameter showing the largest deviation is decisive for the IT quality class of the hole in relation to the tool diameter.

The black circle in the diagram represents the nominal hole diameter which the tool should ideally produce. The red circle indicates the form actually produced.
The mean value of the radius of the red circle, i.e. the average diameter, is shown by the blue circle. (with our Ratio drills the average diameter is practically identical to the actual diameter produced).

2. in GGG40, Ø 10.0 mm

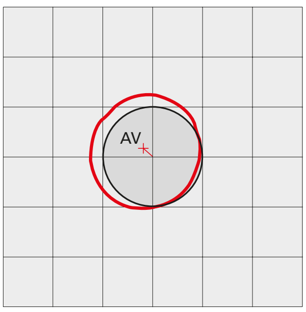
HSS drills, type N
Gühring no. 651 ●

vc = 30 m/min
f = 0.2 mm/rev.
actual D = 10.077 mm
+Rmax = 106 µm
-Rmax = -28 µm
dRmax = 42 µm
AV = 68.5 µm
Ra = 3.7 µm, Rz = 17.2 µm **IT12**



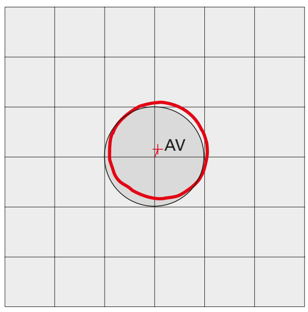
Ratio drills, type RT 100
Gühring no. 1181 ●

vc = 90 m/min
f = 0.3 mm/rev.
actual D = 10.027 mm
+Rmax = 34 µm
-Rmax = -9.2 µm
dRmax = 6.5 µm
AV = 22.5 µm
Ra = 2.2 µm, Rz = 11.5 µm **IT9**

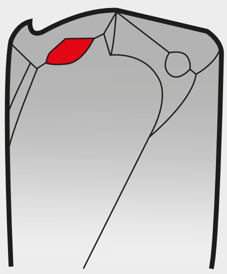
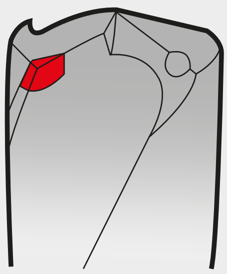
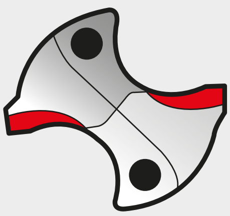
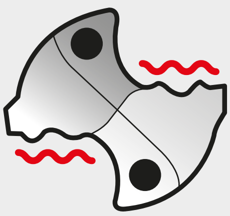


Ratio drills, type RT 150 GG
Gühring no. 768 ○

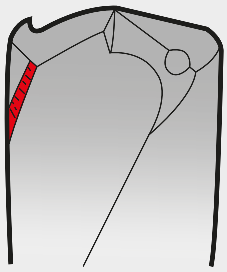
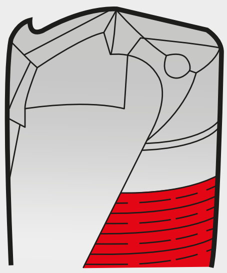
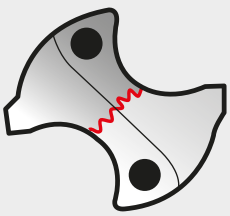
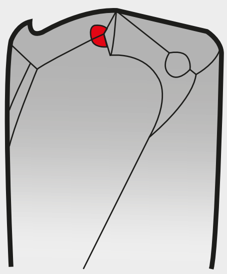
vc = 130 m/min
f = 0.2 mm/rev.
actual D = 9.994 mm
+Rmax = 11.5 µm
-Rmax = -18 µm
dRmax = 5 µm
AV = 14 µm
Ra = 1.99 µm, Rz = 11.2 µm **IT8**



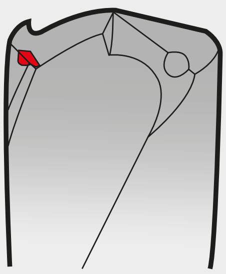
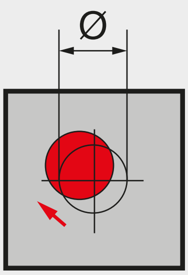
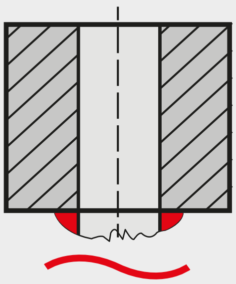
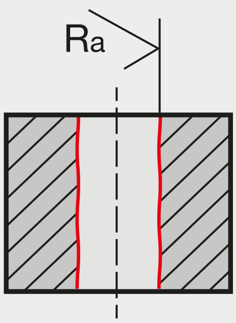
Application/Troubleshooting

Problem	Cause	Remedy
1. Cutting edge build up 	low cutting speed	increase cutting speed
	excessive honing of cutting lip	reduce cutting lip honing
	bright finish cutting lip	have tool coated
2. Crumbling of outer corners 	non rigid conditions, insufficient workpiece clamping	rigid clamping of workpiece
	deviation from concentricity too large	check and correct concentricity if possible
	interrupted cut	reduce feed
3. Heavy wear at flank 	cutting speed too high	reduce cutting speed
	feed too low	increase feed
	clearance angle too small	increase clearance angle
4. Crumbling on cutting lips 	non rigid conditions, insufficient workpiece clamping	rigid clamping of workpiece
	interrupted cut	reduce feed
	max. wear values exceeded	reduce tool change intervals
	incorrect tool type	apply suitable tool)

Application/Troubleshooting

Problem	Cause	Remedy
5. Land wear 	non rigid conditions, insufficient workpiece clamping	rigid clamping of workpiece
	deviation from concentricity too large	check and correct concentricity if possible
	back taper too small	reduce tool change intervals
	incorrect coolant (oil), coolant too weak	increase strength of coolant or use neat oil
6. Scoring on tool body 	non rigid conditions, insufficient workpiece clamping	rigid clamping of workpiece
	deviation from concentricity too large	check and correct concentricity if possible
	interrupted cut	increase back taper
	abrasive workpiece material	increase strength of coolant or use neat oil
7. Heavy chisel edge wear 	cutting speed too low	increase cutting speed
	feed too high	reduce feed
	excessive honing of cutting lip	reduce cutting lip honing
8. Crumbling at intersection, web thinning and cutting lip 	clearance angle too small	increase clearance angle
	excessive honing of cutting lip	reduce cutting lip honing
	incorrect tool type	apply suitable tool

Application/Troubleshooting

Problem	Cause	Remedy
9. Plastic deformation of outer corner 	cutting speed too high	reduce cutting speed
	insufficient coolant volume	increase volume/pressure
	incorrect or no honing at corner	correct honing
10. Misalignment 	non rigid conditions, insufficient workpiece clamping	rigid clamping of workpiece
	deviation from concentricity too large	check and correct concentricity if possible
	spotting area transverse	use milling cutter (2-fluted) for spotting
	chisel edge too large	reduce chisel edge
11. Heavy burring on breakthrough 	feed too high	reduce feed
	max. wear values exceeded	reduce tool change intervals
	excessive honing of cutting lip	reduce cutting lip honing
12. Unsatisfactory surface quality 	non rigid conditions, insufficient workpiece clamping	rigid clamping of workpiece
	deviation from concentricity too large	check and correct concentricity if possible
	insufficient coolant volume	increase volume/pressure

High speed steels

We only produce tools in the highest quality, carefully selected high speed grades. Depending on the alloying component, the tools have specific properties suited to the application case:

Tungsten, molybdenum: Increases the temper resistance and the wear resistance.
Vanadium: Increases the wear resistance.
Cobalt: Increases the wear resistance, increases the thermal hardness.

Gühring description	Type	Field of application, properties
HSS	Conventional high speed steel	Standard tool material for universal applications
HSCO / HSS-E	Cobalt-alloyed high speed steel	Tool material with high thermal hardness for increased demands, especially suitable for higher machining temperatures or unfavourable cooling.
M42 **HSS-E**	8% cobalt-alloyed high speed steel	Tool material with increased thermal resistance and hardness,suitable for machining difficult-to-machine materials.
HSS-E-PM	Powder metallurgically produced cobalt-alloyed high speed steel	Tool material with a very dense and uniform structure. High hardness and thermal resistance, high wear resistance and cutting edge stability.

The most important carbide grades for Gühring tools

The following table lists the most important carbides that are available from Gühring ex-stock for general applications. Further carbide grades are available on request and detailed information can be found at www.guehring-carbide.de

In more than 80% of applications known to Gühring, the results of DK460UF carbide grade tools together with a specially adapted coating could not be surpassed by any other carbide grades, including coated tools. This and the availability of the material ex-stock simplify tool selection immensely. For further information regarding the application of other carbide grades please contact our technical engineers.

Grade	Co-content [M-%]	Tungsten carbide grain size [µm]	Hardness [HV]	ISO classification [ISO 513]	Characteristics
DK460UF K40UF	10	0,6	1620	K20-K40	A carbide grade with wide range of application possibilities. It is applied, mostly coated, for the machining of steel, soft Al alloys, cast iron as well as “super alloys” such as Inconel 718. This grade is the backbone of our carbide production.
DK500UF K44UF	12	0,5	1690	K20-K30	The grade has been especially developed for hard machining. It possesses a higher hardness and deformation tolerance in comparison to DK460UF. Due to the high Co-content, a coated application is strongly recommended.
DK255F	8	0,7	1720	K20	The grade is recommended for hard machining, the machining of high tensile grey cast iron and hard AlSi-alloys. Dry machining is possible. A coated application is preferable.
DK120	6	1,3	1620	K15-K20	The grade is especially suitable for the application with diamond coating.
DK120UF	7	0,7	1850	K05-K10	Ultra fine grain type offering extreme wear resistance, suitable for absolutely rigid machines, preferred for reamers.
K55SF	9	0,2-0,4	1920	K05-K10	For application with high wear resistant materials, s tainless steels, composite materials such as Kevlar and GRP, high speed machining and dry machining.
DK400N	10	0,7	1580	K20-K40	An extremely tough grade for the machining of high heat resistant metals.
DK256EH	10	0,6	1750	K20	The grade is especially suitable for the machining of nickel-based alloys.
K6UF	6	0,6	1870	K05-K10	Ultra fine grain type offering extreme wear resistance. Especially suitable for application with high wear resistant materials, composite materials, GRP and Kevlar.
K5UF	5	0,5	2010	K05-K10	Newly developed extremly hard grade for drilling and reaming. Especially suitable for application with composite materials and GRP.

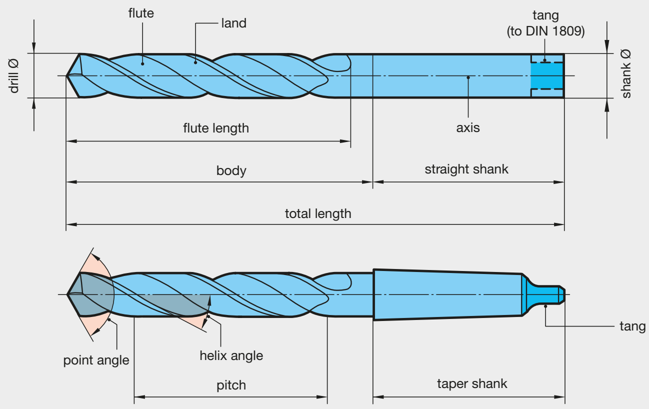
Superhard tool materials

It is not only the extreme hardness of superhard tool materials but also their high heat-resistance which enables highest cutting rates and increased productivity. PCD (Poly-Crystalline Diamond) stands for maximum wear resistance. PCD's main field of application is the machining of aluminium and fibre composites. PcBN (Polycrystalline cubic Boron Nitride) finds application in ferrous materials. To unfold the full potential of these tool materials, the application on the most rigid of machine tools is recommended

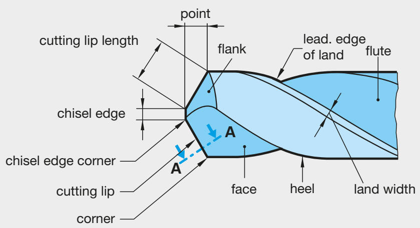
Gühring description	Classification	Range of application	Average grain size	Diamond content
PCD	Fine grain	Aluminium and AlSi-alloys <10%Si, magnesium alloys, brass, copper, bronze, excellent cutting edge quality, high abrasion resistance, excellent surface qualities.	2-4 µm	> 90% PCD
	Medium grain	Universal grade (general finishing applications) AlSi-alloys <14%Si, copper alloys, graphite and graphite composite materials, fibre composite plastics, unsintered ceramic and carbide (<15% binding metal content) excellent resistance, good surface qualities.	5-10 µm	approx. 92% PCD
	Coarse grain	Roughing applications AlSi-alloys >14%Si and other abrasive machining applications, MMC, sintered ceramic and carbide (<15% binding metal content, extreme abrasion resistance, high shock resistance, long tool life with acceptable surface quality.	>25 µm	approx. 94% PCD
	Mixed grain	Abrasive machining applications (i.e.: >14% AlSi-alloys, MMC, fibre composite plastics) highest wear resistance, excellent shock resistance, extreme abrasion resistance with good edge roughness, long tool life with good surface quality.	4 µm+ 25 µm	approx. 95% PCD
PcBN 10..	Low CBN-content with carbide base	For finish machining of case hardened, hardened heat-treatable and tool steels, suitable for continuous and medium to heavily interrupted cutting with ap smaller 0.3 mm. High wear resistance, resistance to impact, temperature resistance, toughness.	<1-4 µm	40-65% CBN
PcBN 20..	High CBN-content with carbide base	For the machining of perlitic grey cast iron (> 45 HRC), PM-steels, chilled cast iron. Application in continuous and interrupted cutting with ap of 0.5-1.5 mm. High wear resistance, resistance to impact.	2-3 µm	70-90% CBN
PcBN 30..	High CBN-content without carbide base	Massive PcBN tool material suitable for roughing operations. Perlitic grey cast iron, hard casting, hardened steels. For application in clamping holders, drilling and boring tools, milling heads with jaw clamping. High wear resistance, resistance to impact.	2-20 µm	70-87% CBN

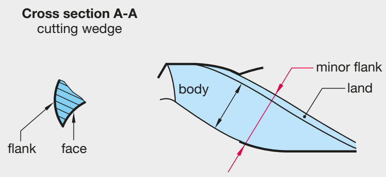
Definitions, dimensions and angles DIN ISO 5419 (extract; edition 06/98)

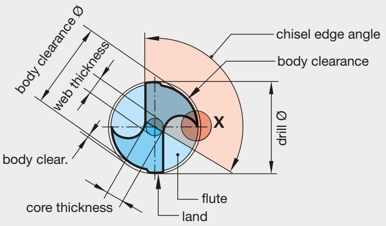
Twist drills with straight/Morse taper shank

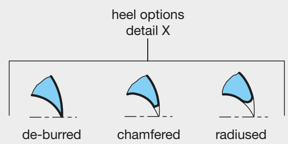


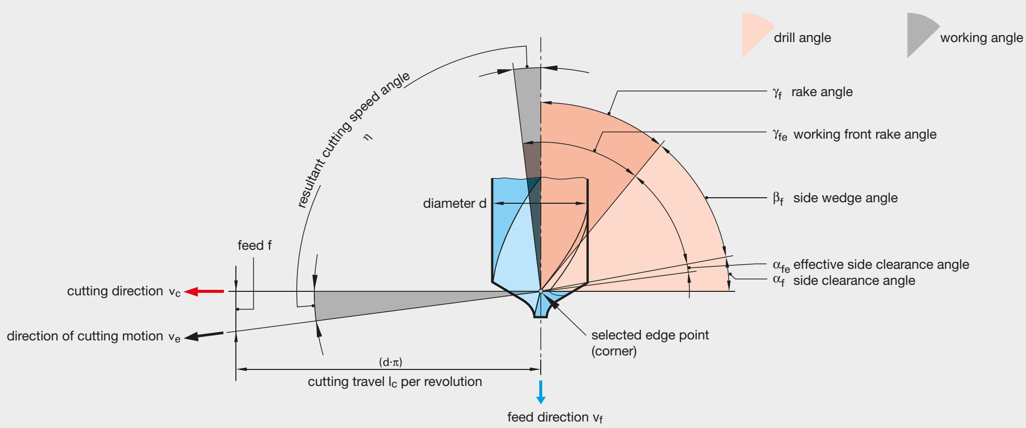
Cutting portion





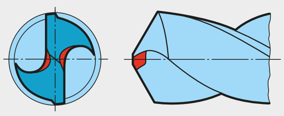




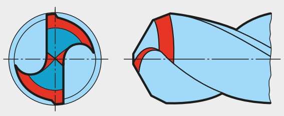


Special point geometry and manufacturing tolerances

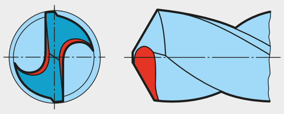
Special point geometry to DIN 1412 (extract; edition 03/01)



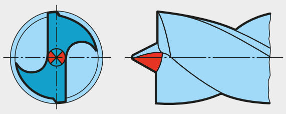
Form A
Thinned chisel edge



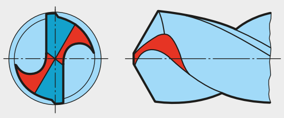
Form D
Point ground for cast iron



Form B
Thinned chisel edge with corrected cutting lips



Form E
Brad point (center point)



Form C
Split point

Twist drill manufacturing tolerances to DIN ISO 286, part 2

diameter (nominal size) up to and incl. mm	tolerance range µm h8	h7
0.38 … 0.60	10	7
0.95	12	8
3.00	14	10
6.00	18	12
10.00	22	15
18.00	27	18
30.00	33	21
50.00	39	25
80.00	46	30
120.00	54	35

* If you need tolerances other than ISO h8 please let us know. Additional charges for closer diameter tolerance see additional charges at the end of chapter Drilling Tools.

Reference to other relevant standards

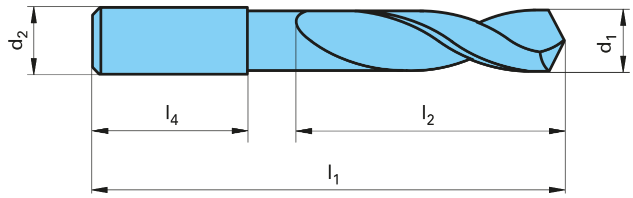
DIN 228	Part 1 machine tapers; Morse tapers and metric tapers, taper shank
DIN 1414-1	Directions for design and use for high speed steel twist drills
DIN 6580	Definitions of the metal-cutting industry; motions and geometry of the cutting process
DIN 6581	Definitions of the metal-cutting industry; Cutting portion reference systems and angles

The standard descriptions above are given with the permission from the German Standards Institute (Deutsches Institut für Normung). The most recent editions of the standard sheets apply and are available in DIN A 4 format from Beuth-Verlag GmbH, D-10787 Berlin.

Carbide twist drills (Ratio drills)

Carbide twist drills (Ratio drills) DIN 6537

Applies to solid carbide twist drills with 2 or 3 cutting edges and straight shank to DIN 6535

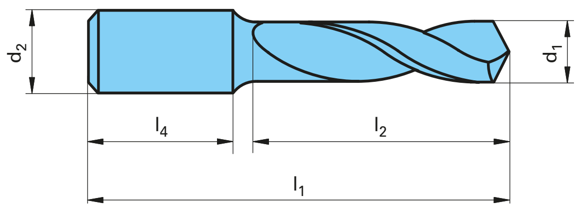


Dimensions in mm

nom. Ø-range up to d1m7	shank Ø d2h6	Ratio drills for 3 x D		Ratio drills for 5 x D		shank length l4
		overall length l1	max. flute length l2	overall length l1	max. flute length l2	
2.9...3.75	6	62	20	66	28	36
4.75	6	66	24	74	36	36
6.00	6	66	28	82	44	36
7.00	8	79	34	91	53	36
8.00	8	79	41	91	53	36
10.00	10	89	47	103	61	40
12.00	12	102	55	118	71	45
14.00	14	107	60	124	77	45
16.00	16	115	65	133	83	48
18.00	18	123	73	143	93	48
20.00	20	131	79	153	101	50

Carbide twist drills (Ratio drills) DIN 6538

Applies to twist drills with brazed carbide tip or head with reinforced straight shank (steel) to DIN 6535. The brazed head can be a part or the complete cutting portion.



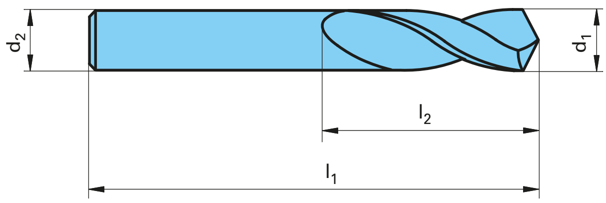
Dimensions in mm

nom. Ø-range up to d1h7	shank Ø d2h6	Ratio drills for 3 x D		Ratio drills for 5 x D		Ratio drills for 7 x D		shank length l4
		overall length l1	max. flute length l2	overall length l1	max. flute length l2	overall length l1	max. flute length l2	
9.5...12.0	16	103	51	127	75	151	99	48
14.0	16	111	59	139	87	167	115	48
16.0	20	122	68	154	100	186	132	50
18.0	20	130	76	166	112	202	148	50
20.0	25	144	84	184	124	224	164	56
22.0	25	153	93	197	137	241	181	56
24.0	25	161	101	209	149	257	197	56
26.0	32	174	110	226	162	278	214	60
28.0	32	182	118	238	174	294	230	60
30.0	32	190	126	250	186	310	246	60

Carbide twist drills (Ratio drills)

Carbide twist drills (Ratio drills) DIN 6539

Applies to solid carbide twist drills with parallel shank, i.e. equal nom. drill and shank diameter.



Dimensions in mm

nom. Ø-range up to (= shank Ø d2) d1	overall length l1	flute length l2
1.90...2.12	38	12
2.36	40	13
2.65	43	14
3.00	46	16
3.35	49	18
3.75	52	20
4.25	55	22
4.75	58	24
5.30	62	26
6.00	66	28
6.70	70	31
7.50	74	34
8.00	79	37
8.50	79	37
9.50	84	40

nom. Ø-range up to (= shank Ø d2) d1	overall length l1	flute length l2
10.00	89	43
10.60	89	43
11.80	95	47
12.00	102	51
13.20	102	51
14.00	107	54
15.00	111	56
16.00	115	58
17.00	119	60
18.00	123	62
19.00	127	64
20.00	131	66

Straight shank twist drills

dia. to (incl.) mm	DIN 338		DIN 339		DIN 340		DIN 1897		DIN 1869 Extra length twist drills, series 1		DIN 1869, series 2		DIN 1869, series 3	
	total length mm	flute length mm	total length mm	flute length mm	total length mm	flute length mm	total length mm	flute length mm	total length mm	flute length mm	total length mm	flute length mm	total length mm	flute length mm
≤ 0.24	19	2.5					19	1.5						
0.30	19	3					19	1.5						
0.38	19	4					19	2						
0.48	20	5			30*	10*	19	2.5						
0.53	22	6			32*	12*	20	3						
0.60	24	7	32*	15*	35*	15*	21	3.5						
0.67	26	8	36*	18*	38*	18*	22	4						
0.75	28	9	39*	20*	42*	21*	23	4.5						
0.85	30	10	42*	22*	46*	25*	24	5						
0.95	32	11	45*	24*	51*	29*	25	5.5						
1.06	34	12	48	26	56	33	26	6						
1.18	36	14	50	28	60	37	28	7						
1.32	38	16	52	30	65	41	30	8						
1.50	40	18	55	33	70	45	32	9						
1.70	43	20	58	35	76	50	34	10	115*	75*				
1.90	46	22	62	38	80	53	36	11	120*	80*				
2.12	49	24	66	41	85	56	38	12	125	85	160*	110*	205*	135*
2.36	53	27	70	44	90	59	40	13	135	90	170*	115*	215*	145*
2.65	57	30	74	47	95	62	43	14	140	95	180*	120*	225*	150*
3.00	61	33	79	51	100	66	46	16	150	100	190	130	240*	160*
3.35	65	36	84	55	106	69	49	18	155	105	200	135	250*	170*
3.75	70	39	91	60	112	73	52	20	165	115	210	145	265	180
4.25	75	43	96	64	119	78	55	22	175	120	220	150	280	190
4.75	80	47	102	69	126	82	58	24	185	125	235	160	295	200
5.30	86	52	108	74	132	87	62	26	195	135	245	170	315	210
6.00	93	57	116	80	139	91	66	28	205	140	260	180	330	225
6.70	101	63	124	86	148	97	70	31	215	150	275	190	350	235
7.50	109	69	133	93	156	102	74	34	225	155	290	200	370	250
8.50	117	75	142	100	165	109	79	37	240	165	305	210	390	265
9.50	125	81	151	107	175	115	84	40	250	175	320	220	410	280
10.60	133	87	162	116	184	121	89	43	265	185	340	235	430	295
11.80	142	94	173	125	195	128	95	47	280*	195*	365*	250*	455*	310*
13.20	151	101	184	134	205	134	102	51	295*	205*	375*	260*	480*	330*
14.00	160	108	194	142	214	140	107	54						
15.00	169	114	202	147	220	144	111	56						
16.00	178	120	211	153	227	149	115	58						
17.00	184	125	218	159	235	154	119	60						
18.00	191	130	226	165	241	158	123	62						
19.00	198	135	234	171	247	162	127	64						
20.00	205	140	242	177	254	166	131	66						
21.20					261	171	136	68						
22.40					268	176	141	70						
23.60					275	180	146	72						
25.00					282	185	151	75						
26.50					290	190	156	78						
28.00					298	195	162	81						
30.00					307	201	168	84						
31.50					316	207	174	87						
33.50							180	90						
35.50							186	93						
37.50							193	96						
40.00							200	100						
42.50							207	104						
45.00							214	108						
47.50							221	112						
50.00							228	116						

Gühring delivers twist drills to Gühring standard up to total length of 1000 mm Gühring no. 242, 243, 244

* Gühring std.

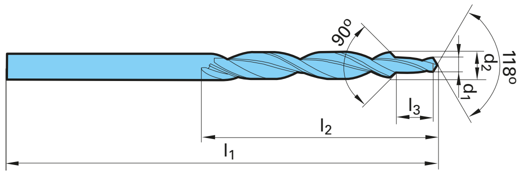
Morse taper twist drills

dia. to (incl.) mm	DIN 345			DIN 346			DIN 341			Bushing drills with oversize taper*			GV/VA-drills* for drilling difficult materials			DIN 1870 Extra length twist drills					
																series 1			series 2		
	total length	flute length	Morse taper	total length	flute length	Morse taper	total length	flute length	Morse taper	total length	flute length	Morse taper	total length	flute length	Morse taper	total length	flute length	Morse taper	total length	flute length	Morse taper
	mm			mm			mm			mm			mm			mm			mm		
2.65	111*	30*	1*																		
3.00	114	33	1																		
3.35	117	36	1																		
3.75	120	39	1																		
4.25	124	43	1				145*	64*	1*												
4.75	128	47	1				150*	69*	1*												
5.30	133	52	1				155	74	1												
6.00	138	57	1				161	80	1												
6.70	144	63	1				167	86	1												
7.50	150	69	1				174	93	1												
8.50	156	75	1				181	100	1				130	49	1	265	165	1	330	210	1
9.50	162	81	1				188	107	1				134	53	1	275	175	1	345	220	1
10.60	168	87	1	185*	87*	2*	197	116	1	214	116	2	138	57	1	285	185	1	360	235	1
11.80	175	94	1	192*	94*	2*	206	125	1	223	125	2	142	61	1	300	195	1	375	250	1
13.20	182	101	1	199	101	2	215	134	1	232	134	2	147	66	1	310	205	1	395	260	1
14.00	189	108	1	206	108	2	223	142	1	240	142	2	168	70	2	325	220	1	410	275	1
15.00	212	114	2	235*	114*	3*	245	147	2	268	147	3	172	74	2	340	220	2	425	275	2
16.00	218	120	2	241*	120*	3*	251	153	2	274	153	3	176	78	2	355	230	2	445	295	2
17.00	223	125	2	246*	125*	3*	257	159	2	280	159	3	179	81	2	355	230	2	445	295	2
18.00	228	130	2	251*	130*	3*	263	165	2	286	165	3	183	85	2	370	245	2	465	310	2
19.00	233	135	2	256	135	3	269	171	2	292	171	3	186	88	2	370	245	2	465	310	2
20.00	238	140	2	261	140	3	275	177	2	298	177	3	212	91	3	385	260	2	490	325	2
21.20	243	145	2	266	145	3	282	184	2	305	184	3	216	95	3	385	260	3	490	325	3
22.40	248	150	2	271	150	3	289	191	2	312	191	3	219	98	3	405	270	3	515	345	3
23.02	253	155	2	276	155	3	296	198	2	319	198	3	222	101	3	405	270	3	515	345	3
23.60	276	155	3	304*	155*	4*	319	198	3	347	198	4	222	101	3	425	270	3	535	345	3
25.00	281	160	3	309*	160*	4*	327	206	3	355	206	4	225	104	3	440	290	3	555	365	3
26.50	286	165	3	314*	165*	4*	335	214	3	363	214	4	256	107	4	440	290	3	555	365	3
28.00	291	170	3	319	170	4	343	222	3	371	222	4	259	110	4	460	305	3	580	385	3
30.00	296	175	3	324	175	4	351	230	3	379	230	4	263	114	4	460	305	3	580	385	3
31.50	301	180	3	329	180	4	360	239	3	388	239	4	266	117	4	480	320	3	610	410	3
31.75	306	185	3	334	185	4	369	248	3	397	248	4	269	120	4	480	320	3	610	410	3
33.50	334	185	4	372*	185*	5*	397	248	4	435	248	5	269	120	4	505	320	4	635	410	4
35.50	339	190	4	377*	190*	5*	406	257	4				272	123	4	530	340	4	665	430	4
37.50	344	195	4	382*	195*	5*	416	267	4				276	127	4	530	340	4	665	430	4
40.00	349	200	4	387*	200*	5*	426	277	4				317	130	5	555	360	4	695	460	4
42.50	354	205	4	392	205	5	436	287	4				320	133	5	555	360	4	695	460	4
45.00	359	210	4	397	210	5	447	298	4				323	136	5	585	385	4	735	490	4
47.50	364	215	4	402	215	5	459	310	4							585	385	4	735	490	4
50.00	369	220	4	407	220	5	470	321	4							605	405	4	765	510	4
50.80	374	225	4	412	225	5	475*	326*	4*												
53.00	412	225	5	479*	225*	6*	513*	326*	5*												
56.00	417	230	5	484*	230*	6*	518*	331*	5*												
60.00	422	235	5	489*	235*	6*	523*	336*	5*												
63.00	427	240	5	494*	240*	6*															
67.00	432	245	5	499	245	6															
71.00	437	250	5	504	250	6															
75.00	442	255	5	509	255	6															
76.50	447	260	5	514	206	6															
80.00	514	260	6																		
85.00	519	265	6																		
90.00	524	270	6																		
95.00	529	275	6																		
100.00	534	280	6																		
106.00	539*	285*	6*																		

Gühring delivers twist drills to Gühring standard up to total length of 1000 mm Gühring no. 293, 298, 299, 563, 564, 565, 566

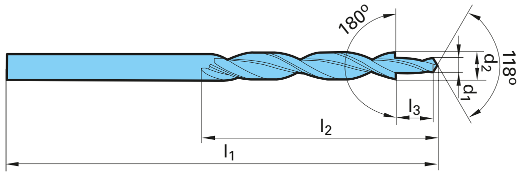
* Gühring std.

Straight shank subland drills, 90° step angle



body Ø d2 h8 mm	step Ø d1 h9 mm	overall length l1 mm	step length l2 mm	step length l3 mm	for thread	range of application
HSS DIN 8378/ Carbide Gühring std.						
3.4	2.5	70	39	8.8	M 3	For tapping size holes to DIN 336 and countersinks in accordance with clearance holes to DIN-ISO 273 (old) and DIN EN 20273 »medial tolerance«.
4.5	3.3	80	47	11.4	M 4	
5.5	4.2	93	57	13.6	M 5	
6.6	5.0	101	63	16.5	M 6	
9.0	6.8	125	81	21.0	M 8	
11.0	8.5	142	94	25.5	M10	
13.5	10.2	160	108	30.0	M12	
DIN 8374 for countersinks, fine tolerance						
6.0	3.2	93	57	9.0	M 3	For clearance holes to DIN-ISO 273 (old). DIN EN 20273 »fine tolerance« and screwhead countersinks form A and B to DIN 74 part 1 (old) »fine tolerance« and screwhead countersinks to DIN 74 form F. For screws to DIN 963 (old) and DIN 964 (old).
8.0	4.3	117	75	11.0	M 4	
10.0	5.3	133	87	13.0	M 5	
11.5	6.4	142	94	15.0	M 6	
15.0	8.4	169	114	19.0	M 8	
19.0	10.5	198	135	23.0	M10	
Gühring std. for countersinks, medial tolerance						
6.6	3.4	101	63	9.0	M 3	For clearance holes to DIN-ISO 273 (old) and screwhead countersinks form A and B to DIN 74 part 1 (old) »medial tolerance«. For screws to DIN 963 (old) and DIN 964 (old).
9.0	4.5	125	81	11.0	M 4	
11.0	5.5	142	94	13.0	M 5	
13.0	6.6	151	101	15.0	M 6	
17.2	9.0	191	130	19.0	M 8	
DIN 8374 for countersinks, medial tolerance						
7.5	3.4	109	69	9.0	M 3	For clearance holes to DIN-ISO 273 (old) and screwhead countersinks form A and B to DIN 74 part 1 (old) »medial tolerance«. For screws to DIN 963 (old) and DIN 964 (old).
9.7	4.5	133	87	11.0	M 4	
12.0	5.5	151	101	13.0	M 5	
14.5	6.6	169	114	15.0	M 6	
19.9	9.0	198	135	19.0	M 8	

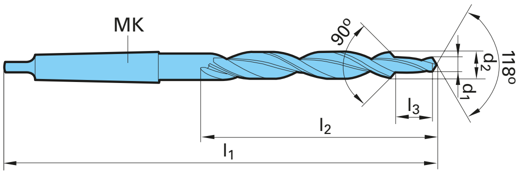
Straight shank subland drills, 180° step angle



body Ø d2 h8 mm	step Ø d1 h9 mm	overall length l1 mm	flute length l2 mm	step length l3 mm	for thread	range of application
			HSS DIN 8376/ Carbide Gühring std.			
6.0**	3.4	93**	57**	9.0	M 3	For clearance holes to DIN-ISO 273 (old), DIN EN 20273 »medial tolerance«, screwhead countersinks to DIN 974-1 and screwhead countersinks form H, J and K to DIN 74 part 2 (old): »medial tolerance«. For screws to DIN 84 (old), 912 (old), 6912, 7513 and DIN 7984.
6.5	3.4	101	63	9.0	M 3	
8.0	4.5	117	75	11.0	M 4	
10.0	5.5	133	87	13.0	M 5	
11.0	6.6	142	94	15.0	M 6	
15.0	9.0	169	114	19.0	M 8	
18.0	11.0	191	130	23.0	M10	
			Gühring std.			
6.0	3.2	93	57	9.0	M 3	For clearance holes to DIN-ISO 273 (old) and screwhead countersinks form H, J and K to DIN 74 part 2 (old): »fine tolerance«. For screws to DIN 84 (old), 912 (old), 6912, 7513 and DIN 7984.
8.0	4.3	117	75	11.0	M 4	
			Gühring std. for countersinks, fine tolerance (old*)			
5.9	3.2	93	57	11.0	M 3	For screws to DIN 84 (old), DIN 912 (old) and DIN 6912. For old type screwhead countersinks form H, J and K to DIN 75 part 2: »fine tolerance«.
7.4	4.3	109	69	13.0	M 4	
9.4	5.3	125	81	16.0	M 5	
10.4	6.4	133	87	19.0	M 6	
13.5	8.4	160	108	22.0	M 8	
16.5	10.5	184	125	25.0	M10	
			Gühring std. for countersinks, medial tolerance (old*)			
8.0	4.8	117	75	13.0	M 3	For screws to DIN 84 (old), DIN 912 (old) and DIN 6912. For old type screwhead countersinks form H, J and K to DIN 75 part 2: »medial tolerance«.
10.0	5.8	133	87	16.0	M 4	
11.0	7.0	142	94	19.0	M 5	
14.5	9.5	169	114	22.0	M 6	
17.5	11.5	191	130	25.0	M 8	

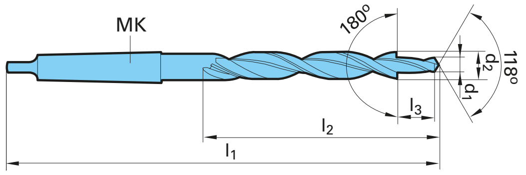
* DIN 75, part 2; ** Gühring std

Morse taper subland drills, 90° step angle



body Ø d2 h8 mm	step Ø d1 h9 mm	overall length l1 mm	flute length l2 mm	Morse taper MK	step length l3 mm	for thread	range of application
Gühring std.							
11.0	5.5	175	94	1	13.0	M 5	For clearance holes to DIN-ISO 273 (old), DIN EN 20273 »medial tolerance«, screwhead countersinks to DIN 74 form F and screwhead countersinks form A and B to DIN 74 part 1 (old) »medial tolerance«. For screws to DIN 963 (old) and DIN 964 (old).
13.0	6.6	182	101	1	15.0	M 6	
17.2	9.0	228	130	2	19.0	M 8	
21.5	11.0	248	150	2	23.0	M10	
26.0	14.0	286	165	3	27.0	M12	
29.0	16.0	296	175	3	31.0	M14	
DIN 8375							
12.0	5.5	182	101	1	13.0	M 5	For clearance holes to DIN-ISO 273 (old), DIN EN 20273 »medial tolerance«, screwhead countersinks to DIN 74 form F and screwhead countersinks form A and B to DIN 74 part 1 (old) »medial tolerance«. For screws to DIN 963 (old) and DIN 964 (old).
14.5	6.6	---	108	1	15.0	M 6	
19.0	9.0	253	135	2	19.0	M 8	
23.0	11.0	248	155	2	23.0	M10	
Gühring std.							
11.5	6.4	175	94	1	15.0	M 6	For clearance holes to DIN-ISO 273 (old) and screwhead countersinks form A and B to DIN 74 part 1 (old) »fine tolerance«. For screws to DIN 963 (old) and DIN 964 (old).
15.0	8.4	212	114	2	19.0	M 8	
19.0	10.5	233	135	2	23.0	M10	
23.0	13.0	253	155	2	27.0	M12	
26.0	15.0	286	165	3	31.0	M14	
30.0	17.0	296	175	3	35.0	M16	
DIN 8379							
9.0	6.8	162	81	1	21.0	M 8	For tapping size holes to DIN 336, DIN EN 20273 »medial tolerance« and countersinks in accordance with clearance holes to DIN-ISO 273 (old).
11.0	8.5	175	94	1	25.5	M10	
13.5	10.2	189	108	1	30.0	M12	
15.5	12.0	218	120	2	34.5	M14	
17.5	14.0	228	130	2	38.5	M16	
20.0	15.5	238	140	2	43.5	M18	
22.0	17.5	248	150	2	47.5	M20	

Morse taper subland drills, 180° step angle



body Ø d2 h8 mm	step Ø d1 h9 mm	overall length l1 mm	flute length l2 mm	Morse taper MK	step length l3 mm	for thread	range of application
HSS DIN 8377/ **Carbide** Gühring std.							
10,0	5,5	168	87	1	13,0	M 5	For clearance holes to DIN-ISO 273 (old), DIN EN 20273 »medial tolerance«, screwhead countersinks to DIN 974-1 and screwhead countersinks form H, J and K to DIN 74 part 2 (old): »medial tolerance«. For screws to DIN 84 (old), 912 (old), 6912, 7513 and DIN 7984.
11,0	6,6	175	94	1	15,0	M 6	
15,0	9,0	212	114	2	19,0	M 8	
18,0	11,0	228	130	2	23,0	M10	
20,0	13,5	238	140	2	27,0	M12	
24,0	15,5	281	160	3	31,0	M14	
26,0	17,5	286	165	3	35,0	M16	
30,0	20,0	296	175	3	39,0	M18	
33,0	22,0	334	185	4	43,0	M20	
Gühring std.							
10,0	5,3	168	87	1	13,0	M 5	For clearance holes to DIN-ISO 273 (old) and screwhead countersinks form H, J and K to DIN 74 part 2 (old): »fine tolerance«. For screws to DIN 84 (old), 912 (old), 6912, 7513 and DIN 7984.
11,0	6,4	175	94	1	15,0	M 6	
15,0	8,4	212	114	2	19,0	M 8	
18,0	10,5	228	130	2	23,0	M10	
20,0	13,0	238	140	2	27,0	M12	
24,0	15,0	281	160	3	31,0	M14	
26,0	17,0	286	165	3	35,0	M16	
Werksnorm für Senkungen, Ausführung fein (alt*)							
9,4	5,3	162	81	1	16,0	M 5	For screws DIN 84 (old), DIN 912 (old) and DIN 6912. For old countersinks form H, J and K to DIN 75 part 2: »fine tolerance«.
10,4	6,4	168	87	1	19,0	M 6	
13,5	8,4	189	108	1	22,0	M 8	
16,5	10,5	223	125	2	25,0	M10	
19,0	13,0	233	135	2	28,0	M12	
23,0	15,0	253	155	2	30,0	M14	
25,0	17,0	281	160	3	33,0	M16	
28,0	19,0	291	170	3	36,0	M18	
31,0	21,0	301	180	3	39,0	M 20	
Werksnorm für Senkungen, Ausführung mittel (alt*)							
10,0	5,8	168	87	1	16,0	M 5	For screws DIN 84 (old), DIN 6912. For old countersinks form H, J and K to DIN 75 part 2: »medial tolerance«.
11,0	7,0	175	94	1	19,0	M 6	
14,5	9,5	212	114	2	22,0	M 8	
17,5	11,5	228	130	2	25,0	M10	
20,0	14,0	238	140	2	28,0	M12	
24,0	16,0	281	160	3	30,0	M14	
26,0	18,0	286	165	3	33,0	M16	
29,0	20,0	296	175	3	36,0	M18	
33,0	23,0	334	185	4	39,0	M20	

inches	mm	inches	mm	inches	mm	inches	mm	MK	inches	mm	for thread	range of application
British Standard												
19/32	15.08	25/64	9.92	8 5/8	219	4 3/4	121	2	3/4	19.05	3/8 inch	For British Standard caphead screws.
21/32	16.67	29/64	11.51	8 3/4	222	4 7/8	124	2	7/8	22.22	7/16 inch	
25/32	19.84	33/64	13.10	9 3/8	238	5 1/2	140	2	1	25.40	1/2 inch	

* DIN 75, part 2

Straight shank core drills

diameter up to incl. mm	DIN 344 overall length mm	flute length mm	diameter up to incl. mm	overall length mm	flute length mm
4.25	96*	64*	11.70	173	125
4.75	102*	69*	13.20	184	134
5.30	108	74	14.00	194	142
6.00	116	80	15.00	202	147
6.70	124	86	16.00	211	153
7.50	133	93	17.00	218	159
8.50	142	100	18.00	226	165
9.50	151	107	19.00	234	171
10.60	162	116	20.00	242	177

Shell-core drills

DIN 222 nom. Ø up to incl. mm	overall length mm	nom. Ø of hole mm
35.5	45	13
45.0	50	16
53.0	56	19
63.0	63	22
75.0	71	27
90.0	80	32
101.6	90	40

Taper shank core drills

diameter up to incl. mm	DIN 343			DIN 1864		
	overall length mm	flute length mm	Morse taper	overall length mm	flute length mm	Morse taper
7.50	150*	69*	1*	174*	93*	1*
8.50	156*	75*	1*	181*	100*	1*
9.50	162	81	1	188	107	1
10.60	168	87	1	197	116	1
11.70	175	94	1	206	125	1
13.20	182	101	1	215	134	1
14.00	189	108	1	223	142	1
15.00	212	114	2	245	147	2
16.00	218	120	2	251	153	2
17.00	223	125	2	257	159	2
18.00	228	130	2	263	165	2
19.00	233	135	2	269	171	2
20.00	238	140	2	275	177	2
21.20	243	145	2	282	184	2
22.40	248	150	2	289	191	2
23.60	253	155	2	296	198	2
25.00	281	160	3	327	206	3
26.50	286	165	3	335	214	3
28.00	291	170	3	343	222	3
30.00	296	175	3	351	230	3
31.50	301	180	3	360	239	3
33.50	334	185	4			
35.50	339	190	4			
37.50	344	195	4			
40.00	349	200	4			
42.50	354	205	4			
45.00	359	210	4			
47.50	364	215	4			
50.00	369	220	4			

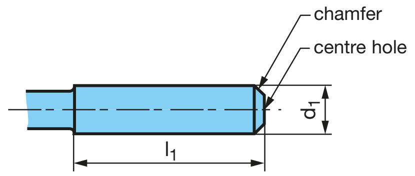
*Gühring std.

Micro-precision drills (total length 25 mm)

DIN 1899 diameter up to incl. mm	shank Ø mm	flute length mm	diameter up to incl. mm	shank Ø mm	flute length mm
from 0.1 . . . 0.12	1.0	0.5	0.67	1.0	4.2
0.15	1.0	0.8	0.75	1.0	4.8
0.19	1.0	1.1	0.79	1.0	5.3
0.24	1.0	1.5	0.85	1.5	5.3
0.30	1.0	1.9	0.95	1.5	6.0
0.38	1.0	2.4	1.06	1.5	6.8
0.48	1.0	3.0	1.18	1.5	7.6
0.53	1.0	3.4	1.32	1.5	8.5
0.60	1.0	3.9	1.45	1.5	9.5

High speed steel straight shanks, DIN 1835-1 (extract)

Form A, plain

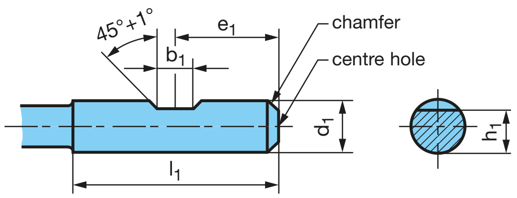


Dimensions in mm

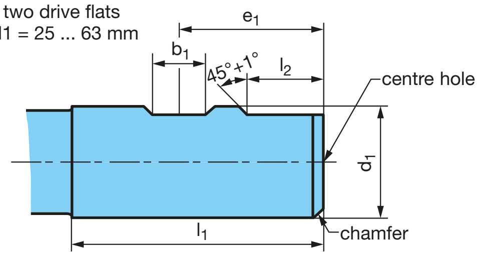
d_1 h8	l_1 +2 0	d_1 h8	l_1 +2 0	d_1 h8	l_1 +2 0
3	28	12	45	50	80
4	28	16	48	63	90
5	28	20	50		
6	36	25	56		
8	36	32	60		
10	40	40	70		

Form B, with drive flat

with one drive flat
for d1 = 6 ... 20 mm



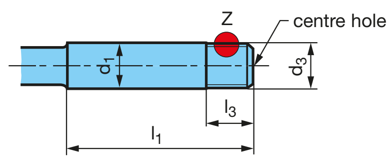
with two drive flats
for d1 = 25 ... 63 mm



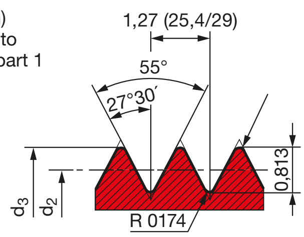
Dimensions in mm

d_1 h6	b_1 +0,05 0	e_1 0 -1	h_1 h13	l_1 +2 0	l_2 +1 0	centre hole form R DIN 332 sect. 1
6	4.2	18	4.8	36	-	1.6x2.5
8	5.5	18	6.6	36	-	1.6x3.35
10	7	20	8.4	40	-	1.6x3.35
12	8	22.5	10.4	45	-	1.6x3.35
16	10	24	14.2	48	-	2.0x4.25
20	11	25	18.2	50	-	2.5x5.3
25	12	32	23	56	17	2.5x5.3
32	14	36	30	60	19	3.15x6.7
40	14	40	38	70	19	3.15x6.7
50	18	45	47.8	80	23	3.15x6.7
63	18	50	60.8	90	23	3.15x6.7

Form D, screwed shank



Detail Z
(cross section)
thread profile to
DIN ISO 228 part 1

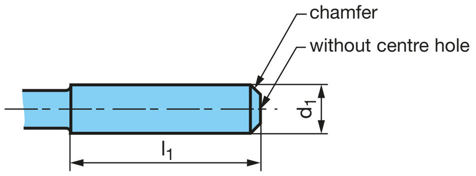


Dimensions in mm

d_1 h8	d_3	d_3 tol. zone	d_2	d_2 tol. zone	l_1 +2 0	l_3 +2 0	centre hole form R DIN 332 sect. 1
6	5.9	0 -0.1	5.087	0 -0.1	36	10	1.6 x 2.5
10	9.9	0 -0.1	9.087	0 -0.1	40	10	1.6 x 3.35
12	11.9	0 -0.1	11.087	0 -0.1	45	10	1.6 x 3.35
16	15.9	0 -0.1	15.087	0 -0.1	48	10	2.0 x 4.25
20	19.9	0 -0.15	19.087	0 -0.15	50	15	2.5 x 5.3
25	24.9	0 -0.15	24.087	0 -0.15	56	15	2.5 x 5.3
32	31.9	0 -0.15	31.087	0 -0.15	60	15	3.15 x 6.7

Carbide straight shanks DIN 6535 for twist drills and end mills

Form HA, plain

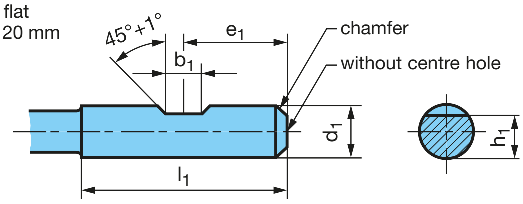


Dimensions in mm

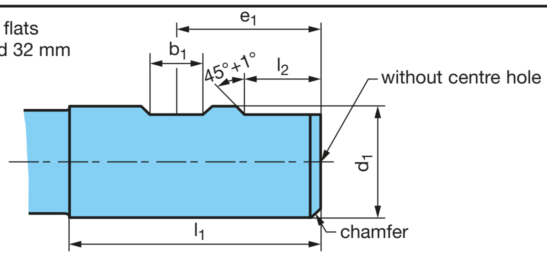
d1 h6	l1 +2 0	d1 h6	l1 +2 0
2	28	14	45
3	28	16	48
4	28	18	48
5	28	20	50
6	36	25	56
8	36	32	60
10	40		
12	45		

Form HB, with drive flat

with **one** drive flat
for d1 = 6 and 20 mm



with **two** drive flats
for d1 = 25 and 32 mm



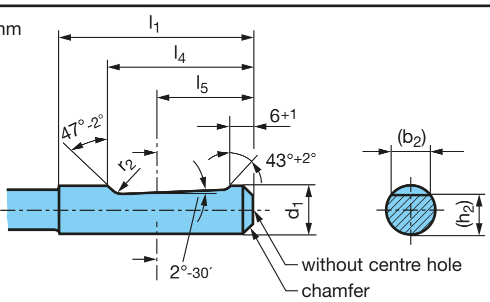
Dimensions in mm

d1 h6	b1 +0,05 0	e1 0 -1	h1 h11	l1 +2 0	l2 +1 0
6	4.2	18	5.1	36	–
8	5.5	18	6.9	36	–
10	7	20	8.5	40	–
12	8	22.5	10.4	45	–
14	8	22.5	12.7	45	–
16	10	24	14.2	48	–
18	10	24	16.2	48	–
20	11	25	18.2	50	–
25	12	32	23	56	17
32	14	36	30	60	19

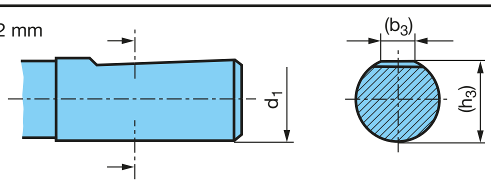
Form HE, with whistle notch flat without coolant ducts*

* Design: Straight shanks to DIN 6335 are available with or without oil feed holes. Applications for various tools, dimensions and position of oil feed holes are fully described within the standard range sections.

for d_1 = 6 to 20 mm



for d_1 = 25 and 32 mm

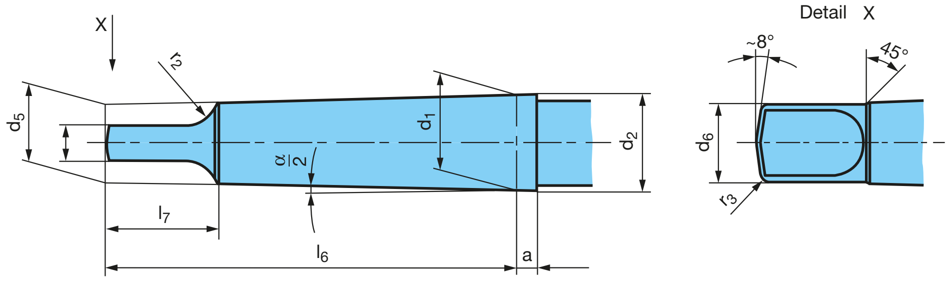


Dimensions in mm

d1 h6	(b2) ≈	(b3)	h2 h11	(h3)	l1 +2 0	l4 0 -1	l5 Dim. nom.	r2 min.
6	4,3	–	5,1	–	36	25	18	1,2
8	5,5	–	6,9	–	36	25	18	1,2
10	7,1	–	8,5	–	40	28	20	1,2
12	8,2	–	10,4	–	45	33	22,5	1,2
14	8,1	–	12,7	–	45	33	22,5	1,2
16	10,1	–	14,2	–	48	36	24	1,6
18	10,8	–	16,2	–	48	36	24	1,6
20	11,4	–	18,2	–	50	38	25	1,6
25	13,6	9,3	23,0	24,1	56	44	32	1,6
32	15,5	9,9	30,0	31,2	60	48	35	1,6

Morse taper shanks DIN 228 part 1 (extract)

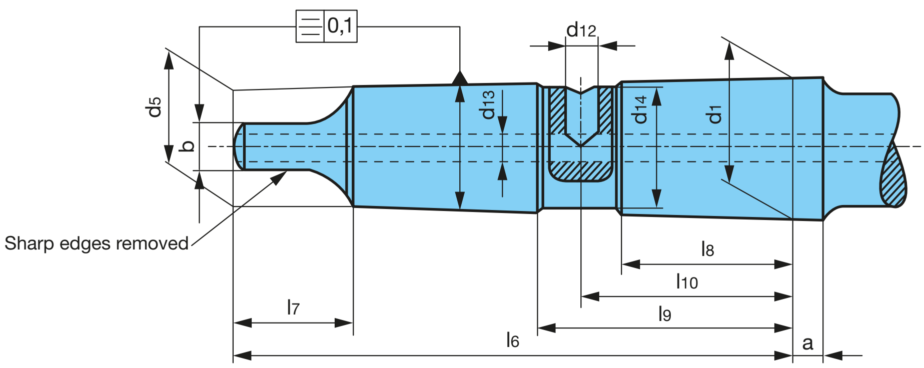
Form B, Morse taper with tang



Dimensions in mm

Shank to DIN 228 form B Size	a	Limiting dimensions	b	d_1	d_2 ≈	d_5 ≈	d_6 max.	l_6 0 -1	l_7 max.	r_2 max.	r_3 ≈	$\frac{\alpha}{2}$
MK 1	3.5	+1.4 0	5.2	12.065	12.2	9.0	8.7	62	13.5	5	1.2	1°25´43´´
MK 2	5.0	+1.4 0	6.3	17.780	18.0	14.0	13.5	75	16	6	1.6	1°25´50´´
MK 3	5.0	+1.7 0	7.9	23.825	24.1	19.1	18.5	94	20	7	2	1°26´16´´
MK 4	6.5	+1.9 0	11.9	31.267	31.6	25.2	24.5	117.5	24	8	2.5	1°29´15´´
MK 5	6.5	+1.9 0	15.9	44.399	44.7	36.5	35.7	149.5	29	10	3	1°30´26´´

Form BK, Morse taper with tang and coolant lubricant delivery



Dimensions in mm

Shank to DIN 228 form BK Size	a ±0.1	Limiting dimen-sions	b h13	d_1	d_5 ≈	d_{12}	d_{13}	d_{14} 0 -0.01	l_6 0 -1	l_7 max.	l_8	l_9	l_{10}
MK 1	3.5	+1.4 0	5.2	12.065	9.0	-	-	-	62	13.5	-	-	-
MK 2	5	+1.4 0	6.3	17.780	14.0	4.2	4.2	15.0	75	16	20	34	27
MK 3	5	+1.7 0	7.9	23.825	19.1	5.0	5.0	21.0	94	20	29	43	36
MK 4	6.5	+1.9 0	11.9	31.267	25.2	6.8	6.8	28.0	117.5	24	39	55	47
MK 5	6.5	+1.9 0	15.9	44.399	36.5	8.5	8.5	40.0	149.5	29	51	69	60

Tolerances core drills

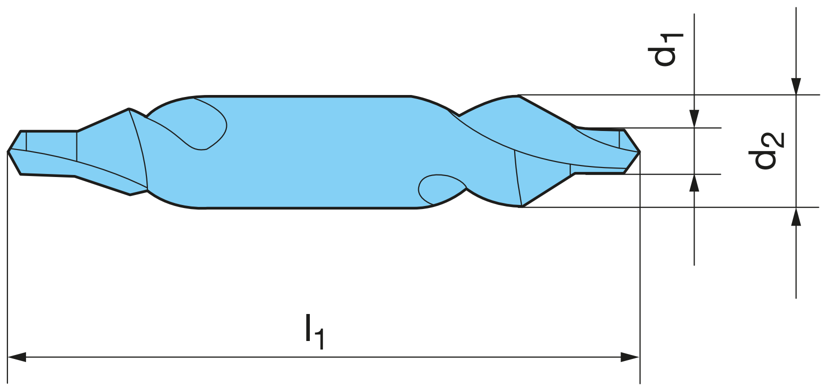
DIN 333	
Ø-range d1 mm	tolerance zones from d1 mm
0,50 – 2,50	0 +0,14
3,15 – 5,00	0 +0,18
6,30 – 10,00	0 +0,22
12,50	0 +0,27

for Gühring nos. 285/286	
Ø-range d1 mm	tolerance zones from d1 mm
1,00 –1,25	0 +0,10
1,60 – 3,15	0 +0,15
3,15 – 10,00	0 +0,20

to B.S. 328	
Ø-range d1 mm	tolerance zones from d1 mm
1,19 – 1,59	0 ±0,05
2,38 – 3,17	0 ±0,07
4,76	0 ±0,07
6,35 – 7,94	0 ±0,12

to B.S. 328	
Ø-range d1 mm	tolerance zones from d1 mm
3,17 – 4,76	-0,020
6,35	-0,025
7,94 – 11,11	-0,050
15,87 – 19,05	-0,050

to ASA	
Ø-range d1 mm	tolerance zones from d1 mm
all	0 + 0,07 mm



Recommended tapping size holes for thread forming

Std. ISO metric threads DIN 13

nom. Ø	pitch P	tapp. size hole Ø	tapp. size hole Ø min.	tapp. size hole Ø max.	core Ø of int. thread 7H* min.	core Ø of int. thread 7H* max.
mm		mm	mm	mm	mm	mm
M 2	0.40	**1.85**	1.84	1.88	1.567	1.679
M 2.2	0.45	**2.00**	2.01	2.05	1.713	1.838
M 2.5	0.45	**2.30**	2.28	2.32	2.013	2.138
M 3	0.50	**2.80**	2.78	2.85	2.459	2.639
M 3.5	0.60	**3.25**	3.23	3.30	2.850	3.050
M 4	0.70	**3.70**	3.68	3.76	3.242	3.466
M 4.5	0.75	**4.20**				
M 5	0.80	**4.65**	4.62	4.71	4.134	4.384
M 6	1.00	**5.55**	5.52	5.62	4.917	5.217
M 7	1.00	**6.55**	6.52	6.62	5.917	6.217
M 8	1.25	**7.40**	7.36	7.47	6.647	6.982
M 9	1.25	**8.40**	8.36	8.47	7.647	7.982
M 10	1.50	**9.30**	9.26	9.38	8.376	8.751
M 11	1.50	**10.30**	10.26	10.38	9.376	9.751
M 12	1.75	**11.20**	11.15	11.29	10.106	10.531
M 14	2.00	**13.10**	13.05	13.20	11.835	12.310
M 16	2.00	**15.10**	15.05	15.20	13.835	14.310
M 18	2.50	**16.90**	16.83	17.02	15.294	15.854
M 20	2.50	**18.90**	18.83	19.02	17.294	17.854
M 22	2.50	**20.90**	20.83	21.02	19.294	19.854
M 24	3.00	**22.70**	22.62	22.80	20.752	21.382
M 27	3.00	**25.70**	25.62	25.80	23.752	24.382
M 30	3.50	**28.50**	28.40	28.60	26.211	26.921
M 33	3.50	**31.50**	31.40	31.60	29.211	29.921
M 36	4.00	**34.30**	34.17	34.40	31.670	32.420
M 39	4.00	**37.30**	37.17	37.40	34.670	35.420
M 42	4.50	**40.10**	39.95	40.20	37.129	37.979

* M 2 up to M 2.5 tapping size hole of int. thread 6H

ISO metric fine threads DIN 13

nom. Ø	x	pitch P	tapp. size hole Ø	tapp. size hole Ø min.	tapp. size hole Ø max.	core Ø of int. thread 7H* min.	core Ø of int. thread 7H* max.
mm			mm	mm	mm	mm	mm
M 2.5	x	0.35	**2.35**	2.35	2.38	2.121	2.221
M 3	x	0.35	**2.85**	2.85	2.88	2.621	2.721
M 4	x	0.35	**3.85**	3.85	3.88	3.621	3.721
M 4	x	0.50	**3.80**	3.78	3.83	3.459	3.639
M 5	x	0.50	**4.80**	4.78	4.83	4.459	4.639
M 5.5	x	0.50	**5.30**	5.28	5.33	4.959	5.139
M 6	x	0.75	**5.65**	5.62	5.70	5.188	5.424
M 7	x	0.75	**6.65**	6.62	6.70	6.188	6.424
M 8	x	0.75	**7.65**	7.62	7.70	7.188	7.424
M 8	x	1.00	**7.55**	7.52	7.62	6.917	7.217
M 9	x	0.75	**8.65**	8.62	8.70	8.188	8.424
M 9	x	1.00	**8.55**	8.52	8.62	7.917	8.217
M 10	x	0.75	**9.65**	9.62	9.70	9.188	9.424
M 10	x	1.00	**9.55**	9.52	9.62	8.917	9.217
M 10	x	1.25	**9.40**	9.36	9.47	8.647	8.982
M 11	x	0.75	**10.65**	10.62	10.70	10.188	10.424
M 11	x	1.00	**10.55**	10.52	10.62	9.917	10.217
M 12	x	1.00	**11.55**	11.52	11.62	10.917	11.217
M 12	x	1.25	**11.40**	11.36	11.47	10.647	10.982
M 12	x	1.50	**11.30**	11.26	11.38	10.376	10.751
M 14	x	1.00	**13.55**	13.52	13.62	12.917	13.217
M 14	x	1.25	**13.40**	13.36	13.47	12.647	12.982
M 14	x	1.50	**13.30**	13.26	13.38	12.376	12.751
M 15	x	1.00	**14.55**	14.52	14.62	13.917	14.217
M 15	x	1.50	**14.30**	14.26	14.38	13.376	13.751
M 16	x	1.00	**15.55**	15.52	15.62	14.917	15.217
M 16	x	1.50	**15.30**	15.26	15.38	14.376	14.751
M 17	x	1.00	**16.55**	16.52	16.62	15.917	16.217
M 17	x	1.50	**16.30**	16.26	16.38	15.376	15.751
M 18	x	1.00	**17.55**	17.52	17.62	16.917	17.217
M 18	x	1.50	**17.30**	17.26	17.38	16.376	16.751
M 18	x	2.00	**17.10**	17.05	17.20	15.835	16.310
M 20	x	1.00	**19.55**	19.52	19.62	18.917	19.217
M 20	x	1.50	**19.30**	19.26	19.38	18.376	19.751
M 24	x	1.00	**23.55**	23.52	23.62	22.917	23.217
M 24	x	1.50	**23.30**	23.26	23.38	22.376	22.751
M 24	x	2.00	**23.10**	23.05	23.20	21.835	22.310
M 27	x	1.50	**26.30**	26.26	26.38	25.376	25.751
M 30	x	1.50	**29.30**	29.26	29.38	28.376	28.751
M 33	x	1.50	**32.30**	32.26	32.38	31.376	31.751
M 36	x	1.50	**35.30**	35.26	35.38	34.376	34.751
M 39	x	1.50	**38.30**	38.26	38.38	37.376	37.751
M 42	x	1.50	**41.30**	41.26	41.38	42.376	42.751

* M 2.5 x 0.35 up to M 4 x 0.35 tapping size hole of int. thread 6H

Tapping size hole diameter tolerance zone for thread forming (to DIN 13, section 50)

Due to the tensile strength it is not necessary to adhere to the tapping size hole diameter tolerance class 6H; tolerance class 7H satisfies the requirement that the flank coverage of external and internal threads should not fall below 0.32 x P.
In addition, formed threads generally possess a higher tensile strength in comparison to cut threads thanks to an uninterrupted grain flow and subsequent work hardening.

UNC threads ASME B1.1

nom. Ø		threads per inch	tapp. size hole Ø	tapp. size hole Ø min.	tapp. size hole Ø max.	core Ø of int. thread min.	core Ø of int. thread max.
			mm	mm	mm	mm	mm
Nr. 1	-	64	**1.68**	1.67	1.70	1.425	1.580
Nr. 2	-	56	**1.98**	1.97	2.01	1.694	1.872
Nr. 3	-	48	**2.28**	2.27	2.32	1.941	2.146
Nr. 4	-	40	**2.55**	2.54	2.59	2.157	2.385
Nr. 5	-	40	**2.90**	2.89	2.94	2.487	2.698
Nr. 6	-	32	**3.15**	3.14	3.19	2.642	2.896
Nr. 8	-	32	**3.80**	3.78	3.82	3.302	3.531
Nr. 10	-	24	**4.35**	4.33	4.39	3.683	3.937
Nr. 12	-	24	**5.00**	4.97	5.03	4.343	4.597
1/4	-	20	**5.75**	5.72	5.80	4.978	5.258
5/16	-	18	**7.30**	7.26	7.37	6.401	6.731
3/8	-	16	**8.80**	8.77	8.88	7.798	8.153
7/16	-	14	**10.30**	10.27	10.37	9.144	9.550
1/2	-	13	**11.80**	11.77	11.88	10.592	11.024
9/16	-	12	**13.30**	13.28	13.39	11.989	12.446
5/8	-	11	**14.80**	14.78	14.90	13.386	13.868
3/4	-	10	**17.90**	17.85	17.97	16.307	16.840
7/8	-	9	**21.00**	20.95	21.10	19.177	19.761
1	-	8	**24.00**	23.95	24.12	21.971	22.606

UNF threads ASME B1.1

nom. Ø		threads per inch	tapp. size hole Ø	tapp. size hole Ø min.	tapp. size hole Ø max.	core Ø of int. thread min.	core Ø of int. thread max.
			mm	mm	mm	mm	mm
Nr. 1	-	72	**1.70**	1.69	1.72	1.473	1.610
Nr. 2	-	64	**2.00**	1.99	2.03	1.755	1.910
Nr. 3	-	56	**2.30**	2.29	2.34	2.024	2.197
Nr. 4	-	48	**2.60**	2.59	2.63	2.271	2.459
Nr. 5	-	44	**2.90**	2.89	2.93	2.550	2.741
Nr. 6	-	40	**3.20**	3.19	3.24	2.819	3.023
Nr. 8	-	36	**3.85**	3.83	3.88	3.404	3.607
Nr. 10	-	32	**4.45**	3.43	4.49	3.962	4.166
Nr. 12	-	28	**5.10**	5.07	5.13	4.496	4.724
1/4	-	28	**5.95**	5.92	5.99	5.359	5.588
5/16	-	24	**7.45**	7.42	7.50	6.782	7.036
3/8	-	24	**9.05**	9.02	9.10	8.838	8.636
7/16	-	20	**10.55**	10.48	10.58	9.728	10.033
1/2	-	20	**12.10**	12.08	12.18	11.328	11.608
9/16	-	18	**13.65**	13.61	13.72	12.751	13.081
5/8	-	18	**15.25**	15.21	15.32	14.351	14.681
3/4	-	16	**18.35**	15.30	18.41	17.323	17.678
7/8	-	14	**21.40**	21.35	21.49	20.269	20.650
1	-	12	**24.45**	24.40	24.54	23.114	23.571

(Whitworth) threads DIN EN ISO 228-1

nom. Ø	threads pro inch	tapp. size hole Ø	tapp. size hole Ø min.	tapp. size hole Ø max.	core Ø of int. thread min.	core Ø of int. thread max.
inch	inch	mm	mm	mm	mm	mm
G 1/16	28	**7.30**	7.28	7.35	6.561	6.843
G 1/8	28	**9.30**	9.28	9.35	8.566	8.848
G 1/4	19	**12.50**	12.48	12.55	11.445	11.890
G 3/8	19	**16.00**	15.98	16.05	14.950	15.395
G 1/2	14	**20.00**	19.98	20.12	18.631	19.172
G 5/8	14	**22.00**	21.98	22.12	20.587	21.128
G 3/4	14	**25.50**	25.48	25.62	24.117	24.658
G 7/8	14	**29.25**	29.23	29.37	27.877	28.418
G 1	11	**32.00**	31.98	32.15	30.291	30.931
G 1 1/4	11	**40.75**	40.70	40.85	38.952	39.592

Tapping size holes for thread cutting

Std. ISO metric threads DIN 13

nom. Ø	pitch P mm	tapping size hole Ø DIN 336 mm	core Ø of int. thread 6H* min. mm	core Ø of int. thread 6H* max. mm
M 1	0.25	**0.75**	0.729	0.785
M 1.1	0.25	**0.85**	0.829	0.885
M 1.2	0.25	**0.95**	0.929	0.985
M 1.4	0.30	**1.10**	1.075	1.142
M 1.6	0.35	**1.25**	1.221	1.321
M 1.8	0.35	**1.45**	1.421	1.521
M 2	0.40	**1.60**	1.567	1.679
M 2.2	0.45	**1.75**	1.713	1.838
M 2.5	0.45	**2.05**	2.013	2.138
M 3	0.50	**2.50**	2.459	2.599
M 3.5	0.60	**2.90**	2.850	3.010
M 4	0.70	**3.30**	3.242	3.422
M 4.5	0.75	**3.70**	3.688	3.878
M 5	0.80	**4.20**	4.134	4.334
M 6	1.00	**5.00**	4.917	5.153
M 7	1.00	**6.00**	5.917	6.153
M 8	1.25	**6.80**	6.647	6.912
M 9	1.25	**7.80**	7.647	7.912
M 10	1.50	**8.50**	8.376	8.676
M 11	1.50	**9.50**	9.376	9.676
M 12	1.75	**10.20**	10.106	10.441
M 14	2.00	**12.00**	11.835	12.210
M 16	2.00	**14.00**	13.835	14.210
M 18	2.50	**15.50**	15.294	15.744
M 20	2.50	**17.50**	17.294	17.744
M 22	2.50	**19.50**	19.294	19.744
M 24	3.00	**21.00**	20.752	21.252
M 27	3.00	**24.00**	23.752	24.252
M 30	3.50	**26.50**	26.211	26.771
M 33	3.50	**29.50**	29.211	29.771
M 36	4.00	**32.00**	31.670	32.270
M 39	4.00	**35.00**	34.670	35.270
M 42	4.50	**37.50**	37.129	37.799
M 45	4.50	**40.50**	40.129	40.799
M 48	5.00	**43.00**	42.587	43.297
M 52	5.00	**47.00**	46.587	47.297
M 56	5.50	**50.50**	50.046	50.796

* M 1.1 up to M 1.4 tapping size hole of int. thread 5H

ISO metric fine threads DIN 13

nom. Ø x pitch P mm	tapping size hole Ø DIN 336 mm	core Ø of int. thread 6H min. mm	core Ø of int. thread 6H max. mm
M 2.5 x 0.35	**2.15**	2.121	2.221
M 3.0 x 0.35	**2.65**	2.621	2.721
M 3.5 x 0.35	**3.15**	3.121	3.221
M 4.0 x 0.50	**3.50**	3.459	3.599
M 4.5 x 0.50	**4.00**	3.959	4.099
M 5.0 x 0.50	**4.50**	4.459	4.599
M 5.5 x 0.50	**5.00**	4.959	5.099
M 6.0 x 0.75	**5.20**	5.188	5.378
M 7.0 x 0.75	**6.20**	6.188	6.378
M 8.0 x 0.50	**7.50**	7.459	7.599
M 8.0 x 0.75	**7.20**	7.188	7.378
M 8.0 x 1.00	**7.00**	6.917	7.153
M 9.0 x 0.75	**8.20**	8.188	8.378
M 9.0 x 1.00	**8.00**	7.917	8.153
M 10 x 0.75	**9.20**	9.188	9.378
M 10 x 1.00	**9.00**	8.917	9.153
M 10 x 1.25	**8.80**	8.647	8.912
M 11 x 0.75	**10.20**	10.188	10.378
M 11 x 1.00	**10.00**	9.917	10.153
M 12 x 1.00	**11.00**	10.917	11.153
M 12 x 1.25	**10.80**	10.647	10.912
M 12 x 1.50	**10.50**	10.376	10.676
M 14 x 1.00	**13.00**	12.917	13.153
M 14 x 1.25	**12.80**	12.647	12.912
M 14 x 1.50	**12.50**	12.376	12.676
M 15 x 1.00	**14.00**	13.917	14.153
M 15 x 1.50	**13.50**	13.376	13.676
M 16 x 1.00	**15.00**	14.917	15.153
M 16 x 1.25	**14.80**	14.647	14.912
M 16 x 1.50	**14.50**	14.376	14.676
M 17 x 1.00	**16.00**	15.917	16.153
M 17 x 1.50	**15.50**	15.376	15.676
M 18 x 1.00	**17.00**	16.917	17.153
M 18 x 1.50	**16.50**	16.376	16.676
M 20 x 1.00	**19.00**	18.917	19.153
M 20 x 1.50	**18.50**	18.376	18.676
M 20 x 2.00	**18.00**	17.835	18.210
M 22 x 1.00	**21.00**	20.917	21.153
M 22 x 1.50	**20.50**	20.376	20.676
M 22 x 2.00	**20.00**	19.835	20.210
M 24 x 1.00	**23.00**	22.917	23.153
M 24 x 1.50	**22.50**	22.376	22.676
M 24 x 2.00	**22.00**	21.835	22.210
M 25 x 1.00	**24.00**	23.917	24.153
M 25 x 1.50	**23.50**	23.376	23.676
M 25 x 2.00	**23.00**	22.835	23.210
M 27 x 1.00	**26.00**	25.917	26.153
M 27 x 1.50	**25.50**	25.376	25.676
M 27 x 2.00	**25.00**	24.835	25.210
M 28 x 1.00	**27.00**	26.917	27.153
M 28 x 1.50	**26.50**	26.376	26.676
M 28 x 2.00	**26.00**	25.835	26.210
M 30 x 1.00	**29.00**	28.917	29.153
M 30 x 1.50	**28.50**	28.376	28.676
M 30 x 2.00	**28.00**	27.835	28.210
M 30 x 3.00	**27.00**	26.752	27.252
M 32 x 1.50	**30.50**	30.376	30.676
M 32 x 2.00	**30.00**	29.835	30.210
M 33 x 1.50	**31.50**	31.376	31.676
M 33 x 2.00	**31.00**	30.835	31.210
M 33 x 3.00	**30.00**	29.752	30.252
M 35 x 1.50	**33.50**	33.376	33.676
M 36 x 1.50	**34.50**	34.376	34.676

UNC threads ASME B1.1

nom. Ø	threads pro inch	tapping size hole Ø DIN 336 mm	core Ø of int. thread 2B min. mm	core Ø of int. thread 2B max. mm
Nr. 1 -	64	**1.55**	1.425	1.580
Nr. 2 -	56	**1.85**	1.694	1.872
Nr. 3 -	48	**2.10**	1.941	2.146
Nr. 4 -	40	**2.35**	2.157	2.385
Nr. 5 -	40	**2.65**	2.487	2.698
Nr. 6 -	32	**2.85**	2.642	2.896
Nr. 8 -	32	**3.50**	3.302	3.531
Nr. 10 -	24	**3.90**	3.683	3.937
Nr. 12 -	24	**4.50**	4.343	4.597
1/4 -	20	**5.10**	4.978	5.258
5/16 -	18	**6.60**	6.401	6.731
3/8 -	16	**8.00**	7.798	8.153
7/16 -	14	**9.40**	9.144	9.550
1/2 -	13	**10.80**	10.592	11.024
9/16 -	12	**12.20**	11.989	12.446
5/8 -	11	**13.50**	13.386	13.868
3/4 -	10	**16.50**	16.307	16.840
7/8 -	9	**19.50**	19.177	19.761
1 -	8	**22.25**	21.971	22.606
1 1/8 -	7	**25.00**	24.638	25.349
1 1/4 -	7	**28.00**	27.813	28.524
1 3/8 -	6	**30.75**	30.353	31.115
1 1/2 -	6	**34.00**	33.528	34.290
1 3/4 -	5	**39.50**	38.938	39.802
2 -	4.5	**45.00**	44.679	45.593

MJ threads DIN ISO 5855

nom. Ø x pitch P mm	tapping size hole Ø DIN 336 mm	core Ø of int. thread 5H* min. mm	core Ø of int. thread 5H* max. mm
MJ 3 x 0.50	**2.60**	2.513	2.653
MJ 4 x 0.70	**3.40**	3.318	3.498
MJ 5 x 0.80	**4.30**	4.221	4.421
MJ 6 x 0.50	**5.55**	5.513	5.625
MJ 6 x 0.75	**5.35**	5.269	5.419
MJ 6 x 1.00	**5.10**	5.026	5.216
MJ 8 x 0.50	**7.55**	7.513	7.625
MJ 8 x 0.75	**7.35**	7.269	7.419
MJ 8 x 1.00	**7.10**	7.026	7.216
MJ 8 x 1.25	**6.90**	6.782	6.994
MJ 10 x 1.00	**9.10**	9.026	9.216
MJ 10 x 1.25	**8.90**	8.782	8.994
MJ 10 x 1.50	**8.60**	8.539	8.775
MJ 12 x 1.75	**10.40**	10.295	10.560
MJ 16 x 2.00	**14.20**	14.051	14.351

* MJ3 x 0.50 up to MJ 5 x 0.80 tapping size hole of int. thread 6H

UNJC threads ISO 3161

nom. Ø	threads per inch	tapping size hole Ø DIN 336 mm	core Ø of int. thread 3B min. mm	core Ø of int. thread 3B max. mm
Nr. 6 -	32	**2.85**	2.733	2.939
Nr. 8 -	32	**3.55**	3.393	3.599
Nr. 10 -	24	**4.00**	3.795	4.064
Nr. 12 -	24	**4.60**	4.455	4.704
1/4 -	20	**5.30**	5.113	5.387
5/16 -	18	**6.75**	6.563	6.833
3/8 -	16	**8.20**	7.978	8.255
7/16 -	14	**9.60**	9.346	9.639
1/2 -	13	**11.00**	10.798	11.095
9/16 -	12	**12.40**	12.228	12.482
5/8 -	11	**13.80**	13.627	13.904

UNJF threads ISO 3161

nom. Ø	threads per inch	tapping size hole Ø DIN 336 mm	core Ø of int. thread 3B min. mm	core Ø of int. thread 3B max. mm
Nr. 6 -	40	**3.00**	2.888	3.053
Nr. 8 -	36	**3.60**	3.480	3.663
Nr. 10 -	32	**4.20**	4.054	4.255
Nr. 12 -	28	**4.75**	4.602	4.816
1/4 -	28	**5.60**	5.466	5.662
5/16 -	24	**7.00**	6.906	7.109
3/8 -	24	**8.60**	8.494	8.679
7/16 -	20	**10.00**	9.876	10.084
1/2 -	20	**11.60**	11.463	11.661
9/16 -	18	**13.00**	12.913	13.122
5/8 -	18	**14.60**	14.501	14.702

UNF threads ASME B1.1 nom. Ø	threads per inch	tapping size hole Ø DIN 336 mm	core Ø of int. thread 2B min. mm	max. mm
Nr. 1	72	**1.55**	1.473	1.610
Nr. 2	64	**1.85**	1.755	1.910
Nr. 3	56	**2.15**	2.024	2.197
Nr. 4	48	**2.40**	2.271	2.459
Nr. 5	44	**2.70**	2.550	2.741
Nr. 6	40	**2.95**	2.819	3.023
Nr. 8	36	**3.50**	3.404	3.607
Nr. 10	32	**4.10**	3.962	4.166
Nr. 12	28	**4.60**	4.496	4.724
1/4	28	**5.50**	5.359	5.588
5/16	24	**6.90**	6.782	7.036
3/8	24	**8.50**	8.382	8.636
7/16	20	**9.90**	9.728	10.033
1/2	20	**11.50**	11.328	11.608
9/16	18	**12.90**	12.751	13.081
5/8	18	**14.50**	14.351	14.681
3/4	16	**17.50**	17.323	17.678
7/8	14	**20.40**	20.269	20.650
1	12	**23.25**	23.114	23.571
1 1/8	12	**26.50**	26.289	26.746
1 1/4	12	**29.50**	29.464	29.921
1 3/8	12	**32.75**	32.639	33.096
1 1/2	12	**36.00**	35.814	36.271

BSW (Whitworth) threads BS84 nom. Ø	threads per inch	tapping size hole Ø DIN 336 mm	core Ø of int. thread 2B min. mm	max. mm
W 1/16	60	**1.20**	1.045	1.230
W 3/32	48	**1.80**	1.704	1.912
W 1/8	40	**2.50**	2.362	2.591
W 5/32	32	**3.20**	2.952	3.214
W 3/16	24	**3.60**	3.407	3.745
W 7/32	24	**4.50**	4.201	4.539
W 1/4	20	**5.10**	4.724	5.156
W 5/16	18	**6.50**	6.130	6.590
W 3/8	16	**7.90**	7.492	7.987
W 7/16	14	**9.20**	8.789	9.330
W 1/2	12	**10.50**	9.989	10.591
W 9/16	12	**12.00**	11.577	12.179
W 5/8	11	**13.50**	12.918	13.558
W 3/4	10	**16.25**	15.797	16.483
W 7/8	9	**19.25**	18.611	19.353
W 1	8	**22.00**	21.334	22.147
W 1 1/8	7	**24.50**	23.928	24.832
W 1 1/4	7	**27.75**	27.103	28.007
W 1 3/8	6	**30.50**	29.504	30.528
W 1 1/2	6	**33.50**	32.679	33.703
W 1 5/8	5	**35.50**	34.769	35.963
W 1 3/4	5	**39.00**	37.944	39.138
W 2	4.5	**44.50**	43.571	44.877

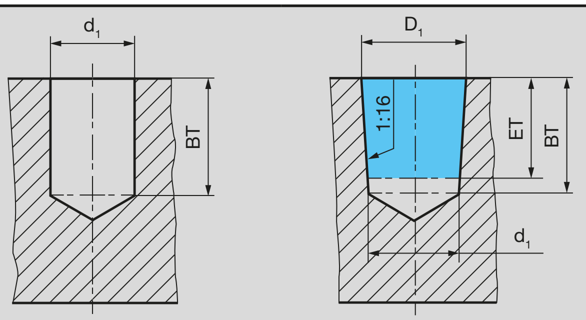
(Whitworth) threads (DIN-ISO 228-1) nom. Ø inch	threads per inch	tapping size hole Ø DIN 336 mm	core Ø of int. thread min. mm	max. mm
G 1/16	28	**6.80**	6.561	6.843
G 1/8	28	**8.80**	8.566	8.848
G 1/4	19	**11.80**	11.445	11.890
G 3/8	19	**15.25**	14.950	15.395
G 1/2	14	**19.00**	18.631	19.172
G 5/8	14	**21.00**	20.587	21.128
G 3/4	14	**24.50**	24.117	24.658
G 7/8	14	**28.25**	27.877	28.418
G 1	11	**30.75**	30.291	30.931
G 1 1/8	11	**35.50**	34.939	35.579
G 1 1/4	11	**39.50**	38.952	39.592
G 1 1/2	11	**45.25**	44.845	45.485
G 1 3/4	11	**51.00**	50.788	51.428
G 2	11	**57.00**	56.656	57.296

Steel armoured conduit threads to DIN 40430 nom. Ø	threads per inch	tapping size hole Ø mm	core Ø of int. thread min. mm	max. mm
Pg 7	20	**11.40**	11.280	11.430
Pg 9	18	**14.00**	13.860	14.010
Pg 11	18	**17.30**	17.260	17.410
Pg 13.5	18	**19.00**	19.060	19.210
Pg 16	18	**21.30**	21.160	21.310
Pg 21	16	**26.90**	26.780	27.030
Pg 29	16	**35.50**	35.480	35.730
Pg 36	16	**45.50**	45.480	45.730
Pg 42	16	**52.50**	52.480	52.730
Pg 48	16	**57.80**	57.780	58.030

NPT ANSI B 2.1
American tapered pipe thread 1:16

Version A (avoid if possible)

Version B



nom. Ø	threads pro inch	tapp. size hole Ø cylindrical (A) d_1	tapp. size hole Ø conical (B) D_1	cutting depth ET mm	cutting depth BT (min) mm
1/16	27	**6.15**	6.39	9.29	10.7
1/8	27	**8.40**	8.74	9.32	10.8
1/4	18	**11.10**	**11.36**	13.52	15.6
3/8	18	**14.30**	**14.80**	13.83	16.0
1/2	14	**17.90**	**18.32**	18.07	20.8
3/4	14	**23.30**	**23.67**	18.55	21.3
1	11.5	**29.00**	**29.69**	22.29	25.6
1 1/4	11.5	**37.70**	**38.45**	22.80	26.1
1 1/2	11.5	**43.70**	**44.52**	22.80	26.1
2	11.5	**55.60**	**56.56**	23.20	26.5
2 1/2	8	**66.30**	**67.62**	31.75	36.3
3	8	**82.30**	**83.52**	33.74	38.5

Metric/metric fine EG-threads (EG M14 x 1.25) for wire thread inserts DIN 8140 nom. Ø	x pitch P mm	tapping size hole Ø DIN 336 mm	core Ø of int. thread min. mm	max. mm
EG M 4	x 0.70	**4.20**	4.152	4.292
EG M 5	x 0.80	**5.25**	5.174	5.334
EG M 6	x 1.00	**6.30**	6.217	6.407
EG M 8	x 1.25	**8.40**	8.271	8.483
EG M10	x 1.50	**10.50**	10.324	10.560
EG M12	x 1.75	**12.50**	12.379	12.644
EG M14	x 1.25	**14.40**	14.271	14.483
EG M16	x 2.00	**16.50**	16.433	16.733

UNC (UNC-STI) EG-threads for wire thread inserts ASME B18.29.1 nom. Ø	threads per inch	tapping size hole Ø mm	core Ø of int. thread min. mm	max. mm
EG Nr. 6	32	**3.80**	3.678	3.879
EG Nr. 8	32	**4.40**	4.338	4.524
EG Nr. 10	24	**5.20**	5.055	5.283
EG Nr. 12	24	**5.80**	5.715	5.944
EG 1/4	20	**6.70**	6.624	6.868
EG 5/16	18	**8.40**	8.242	8.489
EG 3/8	16	**10.00**	9.868	10.127
EG 7/16	14	**11.60**	11.506	11.783
EG 1/2	13	**13.30**	13.122	13.393
EG 9/16	12	**14.90**	14.747	15.032
EG 5/8	11	**16.50**	16.375	16.673

UNF (UNF-STI) EG-threads for wire thread inserts ASME B18.29.1 nom. Ø	threads per inch	tapping size hole Ø mm	core Ø of int. thread min. mm	max. mm
EG Nr. 6	40	**3.70**	3.644	3.818
EG Nr. 8	36	**4.40**	4.321	4.498
EG Nr. 10	32	**5.10**	4.999	5.184
EG Nr. 12	28	**5.70**	5.682	5.809
EG 1/4	28	**6.60**	6.546	6.721
EG 5/16	24	**8.25**	8.166	8.352
EG 3/8	24	**9.80**	9.754	9.931
EG 7/16	20	**11.50**	11.389	11.585
EG 1/2	20	**13.10**	12.974	13.172
EG 9/16	18	**14.70**	14.592	14.798
EG 5/8	18	**16.25**	16.180	16.386

From 1/64 to 11 63/64

Size (inch)	mm	Part of inch (decimal)
-	0.10	0.0039
97	0.15	0.0059
96	0.16	0.0063
95	0.17	0.0067
94	0.18	0.0071
93	0.19	0.0075
92	0.20	0.0079
91	0.21	0.0083
90	0.22	0.0087
89	0.23	0.0091
88	0.24	0.0095
-	0.25	0.0098
87	0.25	0.0100
	0.26	0.0102
86	0.27	0.0105
	0.27	0.0106
85	0.28	0.0110
	0.29	0.0114
84	0.29	0.0115
-	0.30	0.0118
83	0.30	0.0120
82	0.32	0.0125
	0.32	0.0126
81	0.33	0.0130
80	0.34	0.0135
79	0.37	0.0145
1/64	0.40	0.0156
78	0.41	0.0160
77	0.46	0.0180
-	0.50	0.0197
76	0.51	0.0200
75	0.53	0.0210
74	0.57	0.0225
-	0.60	0.0236
73	0.61	0.0240
72	0.64	0.0250
71	0.66	0.0260
-	0.70	0.0276
70	0.71	0.0280
69	0.74	0.0292
-	0.75	0.0295
68	0.79	0.0310
1/32	0.79	0.0313
-	0.80	0.0315
67	0.81	0.0320
66	0.84	0.0330
65	0.89	0.0350
-	0.90	0.0354
64	0.91	0.0360
63	0.94	0.0370
62	0.97	0.0380
61	0.99	0.0390
-	1.00	0.0394
60	1.02	0.0400
59	1.04	0.0410
58	1.07	0.0420
57	1.09	0.0430
56	1.18	0.0465
3/64	1.19	0.0469
	1.20	0.0472
	1.25	0.0492
	1.30	0.0512
55	1.32	0.0520
54	1.40	0.0550
	1.45	0.0571
	1.50	0.0591
53	1.51	0.0595
	1.55	0.0610
1/16	1.59	0.0625
	1.60	0.0630
52	1.61	0.0635
	1.65	0.0650

Size (inch)	mm	Part of inch (decimal)
51	1.70	0.0670
	1.75	0.0689
50	1.78	0.0700
	1.80	0.0709
49	1.85	0.0730
	1.90	0.0748
48	1.93	0.0760
	1.95	0.0768
5/64	1.98	0.0781
47	1.99	0.0785
-	2.00	0.0787
	2.05	0.0807
46	2.06	0.0810
45	2.08	0.0820
	2.15	0.0846
44	2.18	0.0860
43	2.26	0.0890
42	2.37	0.0935
3/32	2.38	0.0938
41	2.44	0.0960
40	2.50	0.0980
39	2.53	0.0995
38	2.58	0.1015
37	2.64	0.1040
36	2.71	0.1065
7/64	2.78	0.1094
35	2.79	0.11
34	2.82	0.111
33	2.87	0.113
	2.90	0.1142
32	2.95	0.116
-	3.00	0.1181
31	3.05	0.12
1/8	3.18	0.125
30	3.26	0.1285
	3.30	0.1299
29	3.45	0.136
	3.50	0.1378
28	3.57	0.1405
9/64	3.57	0.1406
27	3.66	0.144
26	3.73	0.147
	3.75	0.1476
25	3.80	0.1495
24	3.86	0.152
23	3.91	0.154
5/32	3.97	0.1562
22	3.99	0.157
-	4.00	0.1575
21	4.04	0.159
20	4.09	0.161
	4.20	0.1654
19	4.22	0.166
18	4.31	0.1695
11/64	4.37	0.1719
17	4.39	0.173
16	4.50	0.177
15	4.57	0.18
14	4.62	0.182
13	4.70	0.185
3/16	4.76	0.1875
12	4.80	0.189
11	4.85	0.191
10	4.91	0.1935
9	4.98	0.196
-	5.00	0.1968
8	5.05	0.199
7	5.11	0.2010
13/64	5.16	0.2031
6	5.18	0.2040
5	5.22	0.2055
	5.25	0.2067

Size (inch)	mm	Part of inch (decimal)
4	5.31	0.2090
3	5.41	0.213
	5.50	0.2165
7/32	5.56	0.2188
2	5.61	0.221
1	5.79	0.228
A	5.94	0.234
15/64	5.95	0.2344
-	6.00	0.2362
B	6.05	0.238
C	6.15	0.242
D	6.25	0.246
1/4	6.35	0.25
E	6.35	0.25
	6.50	0.2559
F	6.53	0.257
G	6.63	0.261
17/64	6.75	0.2656
	6.75	0.2657
H	6.76	0.266
I	6.91	0.272
-	7.00	0.2756
J	7.04	0.2772
K	7.14	0.281
9/32	7.14	0.2812
L	7.37	0.29
M	7.49	0.2949
	7.50	0.2953
19/64	7.54	0.2969
N	7.67	0.3020
	7.75	0.3051
5/16	7.94	0.3125
-	8.00	0.315
O	8.03	0.316
P	8.20	0.323
21/64	8.33	0.3281
Q	8.43	0.332
	8.50	0.3346
R	8.61	0.339
11/32	8.73	0.3438
	8.75	0.3445
S	8.84	0.348
-	9.00	0.3543
T	9.09	0.358
23/64	9.13	0.3594
U	9.35	0.368
	9.50	0.374
3/8	9.53	0.375
V	9.56	0.377
W	9.80	0.386
25/64	9.92	0.3906
-	10.00	0.3937
X	10.08	0.397
Y	10.26	0.4040
13/32	10.32	0.4062
Z	10.49	0.413
	10.50	0.4134
27/64	10.72	0.4219
-	11.00	0.4331
7/16	11.11	0.4375
	11.50	0.4528
29/64	11.51	0.4531
15/32	11.91	0.4688
-	12.00	0.4724
31/64	12.30	0.4844
	12.50	0.4921
1/2	12.70	0.50
-	13.00	0.5118
33/64	13.10	0.5156
17/32	13.49	0.5312
	13.50	0.5315
35/64	13.89	0.5469

Size (inch)	mm	Part of inch (decimal)
-	14.00	0.5512
9/16	14.29	0.5625
	14.50	0.5709
37/64	14.68	0.5781
-	15.00	0.5906
19/32	15.08	0.5938
39/64	15.48	0.6094
	15.50	0.6102
5/8	15.88	0.625
-	16.00	0.6299
41/64	16.27	0.6406
	16.50	0.6496
21/32	16.67	0.6562
-	17.00	0.6693
43/64	17.07	0.6719
11/16	17.46	0.6875
	17.50	0.689
45/64	17.86	0.7031
-	18.00	0.7087
23/32	18.26	0.7188
	18.50	0.7283
47/64	18.65	0.7344
-	19.00	0.748
3/4	19.05	0.75
49/64	19.45	0.7656
	19.50	0.7677
25/32	19.84	0.7812
-	20.00	0.7874
51/64	20.24	0.7969
	20.50	0.8071
13/16	20.64	0.8125
-	21.00	0.8268
53/64	21.03	0.8281
27/32	21.43	0.8438
	21.50	0.8465
55/64	21.84	0.8594
-	22.00	0.8661
7/8	22.23	0.875
	22.50	0.8858
57/64	22.62	0.8906
-	23.00	0.9055
29/32	23.02	0.9062
59/64	23.42	0.9219
	23.50	0.9252
15/16	23.81	0.9375
-	24.00	0.9449
61/64	24.21	0.9531
	24.50	0.9646
31/32	24.61	0.9688
-	25.00	0.9843
63/64	25.00	0.9844
1	25.40	1.00

1 inch = 25.400 0 mm, see DIN 4890 (issue 2/75)

The new material abbreviations (selection)

mat. nos.	abbreviation old	abbreviation new
0.6010	GG10	EN-GJL-100
0.6020	GG20	EN-GJL-200
0.6025	GG25	EN-GJL-250
0.6035	GG35	EN-GJL-350
0.7050	GGG50	EN-GJS-500-7
0.7070	GGG70	EN-GJS-700-2
0.8035	GTW35	EN-GJMW-350-4
0.8155	GTS55	EN-GJMB-550-4
0.8170	GTS70	EN-GJMB-700-2
1.0022	St 01Z	–
1.0035	St 33	S185
1.0039	St 37 -2	S235JRH
1.0044	St 44 -2	S275JR
1.0050	St 50 -2	E295
1.0060	St 60 -2	E335
1.0070	St 70 –2	E360
1.0114	St 37 –3U	S235J0
1.0226	St 02Z	DX51D
1.0242	StE 250 -2Z	S250GD
1.0244	StE 280 -2Z	S280GD
1.0250	StE 320 -3Z	S320GD
1.0301	C 10	–
1.0302	C 10 Pb	–
1.0306	St 06 Z	DX54D
1.0312	St 15	DC05 [Fe P05]
1.0319	RRStE 210.7	L210GA
1.0322	–	DX56D
1.0330	St 12 [St 2]	DC01 [Fe P01]
1.0333	USt 13	–
1.0338	St 14 [St 4]	DC04 [Fe P04]
1.0345	H I	P235GH
1.0347	RRSt 13 [RRSt 3]	DC03 [Fe P03]
1.0348	UH I	P195GH
1.0350	St 03Z	DX52D
1.0355	St 05Z	DX53D
1.0356	TTSt 35 N	P215NL
1.0358	St 05 Z	–
1.0401	C 15	–
1.0402	C 22	C22
1.0403	C 15 Pb	–
1.0406	C 25	C25
1.0419	St 52.0	L355
1.0424	St 45.8 (ersetzt)	P265
1.0424	St 42.8 (ersetzt)	P265
1.0425	H2	P265GH
1.0429	StE 290.7 TM	L290MB
1.0457	StE 240.7	L245NB
1.0459	RRStE 240.7	L245GA
1.0461	StE 255	S255N
1.0473	19 Mn 6	P355GH
1.0481	17 Mn 4	P295GH
1.0484	StE 290.7	L290NB
1.0486	StE 285	P275N
1.0501	C 35	C35
1.0503	C 45	C45
1.0505	StE 315	P315N
1.0511	C 40	C40
1.0528	C 30	C30
1.0529	StE 350 -3Z	S350GD
1.0535	C 55	C55
1.0539	StE 355N	S355NH
1.0540	C 50	C50
1.0547	St 52 –3U	S355J0H
1.0582	StE 360.7	L360NB
1.0601	C 60	C60
1.0710	15 S 10	–
1.0715	9 SMn 28	11SMn30
1.0718	9 SMnPb 28	11SMnPb30
1.0721	10 S 20	10S20
1.0722	10 S Pb 20	10SPb20
1.0726	35 S 20	35S20
1.0727	45 S 20	46S20

mat. nos.	abbreviation old	abbreviation new
1.0728	60 S 20	–
1.0736	9 SMn 36	11SMn37
1.0737	9 SMnPb 36	11SMnPb37
1.0756	35 SPb 20	35SPb20
1.0757	45 SPb 20	46SPb20
1.0760	–	38SMn26
1.0761	–	38SMnPb26
1.0762	–	44SMn28
1.0763	–	44SMnPb28
1.0873	–	DC06 [Fe P06]
1.1103	EStE 255	S255NL1
1.1105	EStE 315	S315NL1
1.1121	Ck 10	C10E
1.1141	Ck15	C15E
1.1151	Ck 22	C22E
1.1158	Ck 25	C25E
1.1170	28 Mn 6	28Mn6
1.1178	Ck 30	C30E
1.1181	Ck 35	C35E
1.1186	Ck 40	C40E
1.1191	Ck 45	C45E
1.1203	Ck 55	C55E
1.1206	Ck 50	C50E
1.1221	Ck 60	C60E
1.1241	Cm 50	C50R
1.1750	C 75 W	C75W
1.2067	102 Cr 6	102Cr6
1.2080	–	X210Cr12
1.2083	–	X42Cr13
1.2419	–	105WCr6
1.2767	–	X45NiCrMo4
1.3243	S6-5-2-5	S 6-5-2-5
1.3343	S6-5-2	S 6-5-2
1.3344	S6-5-3	S 6-5-3
1.4000	X6Cr 13	X6Cr13
1.4002	X6CrAl 13	X6CrAl13
1.4003	X2Cr 11	X2CrNi12
1.4005	–	X12CrS13
1.4006	X10Cr 13	X12Cr13
1.4016	X6Cr 17	X6Cr17
1.4021	X20Cr 13	X20Cr13
1.4028	X30Cr 13	X30Cr13
1.4031	X38Cr 13	X38Cr13
1.4034	X46Cr 13	X46Cr13
1.4037	X65Cr13	X65Cr13
1.4057	X20CrNi 17 2	X17CrNi16-2
1.4104	X12CrMoS 17	X14CrMoS17
1.4105	X4CrMoS 18	X6CrMoS17
1.4109	X65CrMo 14	X70CrMo15
1.4110	X55CrMo 14	X55CrMo14
1.4112	X90CrMoV 18	X90CrMoV18
1.4113	X6CrMo 17 1	X6CrMo17-1
1.4116	X45CrMoV 15	X50CrMoV15
1.4120	X20CrMo 13	X20CrMo13
1.4122	X35CrMo 17	X39CrMo17-1
1.4125	X105CrMo 17	X105CrMo17
1.4301	X5CrNi 18 10	X5CrNi18-10
1.4303	X5CrNi 18 12	X4CrNi18-12
1.4305	X10CrNiS 18 9	X8CrNiS18-9
1.4306	X2CrNi 19 11	X2CrNi19-11
1.4310	X12CrNi 17 7	X10CrNi18-8
1.4311	X2CrNiN 18 10	X2CrNiN18-10
1.4313	X4CrNi 13 4	X3CrNiMo13-4
1.4318	X2CrNiN 18 7	X2CrNiN18-7
1.4335	X1CrNi 25 21	X1CrNi25-21
1.4361	X1CrNiSi 18 15	X1CrNiSi18-15-4
1.4362	X2CrNiN 23 4	X2CrNiN23-4
1.4401	X5CrNiMo 17 12 2	X5CrNiMo17-12-2
1.4404	X2CrNiMo 17 13 2	X2CrNiMo17-12-2
1.4410	X10CrNiMo 18 9	X2CrNiMoN25-7-4
1.4418	X4CrNiMo 16 5	X4CrNiMo16-5-1
1.4435	X2CrNiMo 18 14 3	X2CrNiMo18-14-3

mat. nos.	abbreviation old	abbreviation new
1.4436	X5CrNiMo 17 13 3	X3CrNiMo17-13-3
1.4438	X2CrNiMo 18 16 4	X2CrNiMo18-15-4
1.4460	X4CrNiMo 27 5 2	X3CrNiMoN27-5-2
1.4462	X2CrNiMoN 22 5 3	X2CrNiMoN22-5-3
1.4509	X6CrTiNb 18	X2CrTiNb18
1.4510	X6CrTi 17	X3CrTi17
1.4511	X6CrNb 17	X3CrNb17
1.4512	X6CrTi 12	X2CrTi12
1.4520	X1CrTi 15	X2CrTi17
1.4521	X2CrMoTi 18 2	X2CrMoTi18-2
1.4522	X2CrMoNb 18 2	X2CrMoNb18-2
1.4532	X7CrNiMoAl 15 7	X8CrNiMoAl15-7-2
1.4541	X6CrNiTi18 10	X6CrNiTi18-10
1.4542	X5CrNiCuNb 17 4	X5CrNiCuNb16-4
1.4550	X6CrNiNb 18 10	X6CrNiNb18-10
1.4558	X2NiCrAlTi 32 20	X2NiCrAlTi32-20
1.4567	X3CrNiCu 18 9 X	X3CrNiCu18-9-4
1.4568	X7CrNiAl 17 7	X7CrNiAl17-7
1.4571	–	X6CrNiMoTi17-12-2
1.4577	X3CrNiMoTi 25 25	X3CrNiMoTi25-25
1.4592	X1CrMoTi 29 4	X2CrMoTi29-4
1.4713	X10CrAl 7	X10CrAlSi7
1.4724	X10CrAl 13	X10CrAlSi13
1.4742	X10CrAl 18	X10CrAlSi18
1.4762	X10CrAl 24	X10CrAlSi25
1.4821	X20CrNiSi 25 4	X20CrNiSi25-4
1.4828	X15CrNiSi 20 12	X15CrNiSi20-12
1.4833	X7CrNi 23 14	X7CrNi23-12
1.4841	X15CrNiSi 25 20	X15CrNiSi25-21
1.4845	X12CrNi 25 21	X12CrNi25-21
1.4864	X12NiCrSi 36 16	X12NiCrSi35-16
1.4878	X12CrNiTi18 9	X10CrNiTi18-10
1.4903	–	X10CrMoVNb9-1
1.5026	55 Si 7	55Si7
1.5131	50 MnSi 4	50MnSi4
1.5415	15 Mo 3	16Mo3
1.5530	21 MnB 5	20MnB5
1.5531	30 MnB 5	30MnB5
1.5532	38 MnB 5	38MnB5
1.5637	10 Ni 14	12Ni14
1.5662	–	X11CrMo5+I
1.5680	–	X12Ni5
1.5710	36 NiCr 6	36NiCr6
1.5715	–	16NiCrS4
1.5752	14 NiCr 14	15NiCr13
1.6210	15 MnNi 6 3	15MnNi6-3
1.6211	16 MnNi 6 3	16MnNi6-3
1.6310	20 MnMoNi 5 5	20MnMoNi5-5
1.6311	20 MnMoNi 4 5	20MnMoNi4-5
1.6341	11 NiMoV 5 3	11NiMoV5-3
1.6368	15 NiCuMoNb 5	15NiCuMoNb5
1.6511	36 CrNiMo 4	36CrNiMo4
1.6523	21 NiCrMo 2	21NiCrMo2-2
1.6526	21 NiCrMoS 2	21NiCrMoS2-2
1.6580	30 CrNiMo 8	30CrNiMo8
1.6582	34 CrNiMo 6	34CrNiMo6
1.6587	17 CrNiMo 6	18CrNiMo7-6
1.7003	38 Cr 2	38Cr2
1.7006	46 Cr 2	46Cr2
1.7016	17 Cr 3	17Cr3
1.7023	38 CrS 2	38CrS2
1.7025	46 CrS 2	46CrS2
1.7030	28 Cr 4	28Cr4
1.7033	34 Cr 4	34Cr4
1.7034	37 Cr 4	37Cr4
1.7035	41 Cr 4	41Cr4
1.7036	28 CrS 4	28CrS4
1.7037	34 CrS 4	34CrS4
1.7038	37 CrS 4	37CrS4
1.7039	41 CrS 4	41CrS4
1.7131	16 MnCr 5	16MnCr5
1.7139	16 MnCrS 5	16MnCrS5

mat. nos.	abbreviation old	abbreviation new
1.7043	–	38Cr4
1.7147	20 MnCr 5	20MnCr5
1.7149	20 MnCrS 5	20MnCrS5
1.7176	55 Cr 3	55Cr3
1.7182	27 MnCrB 5 2	27MnCrB5-2
1.7185	33 MnCrB 5 2	33MnCrB5-2
1.7189	39 MnCrB 6 2	39MnCrB6-2
1.7213	25 CrMoS 4	25CrMoS4
1.7218	25 CrMo 4	25CrMo4
1.7219	–	26CrMo4-2
1.7220	34 CrMo 4	34CrMo4
1.7225	42 CrMo 4	42CrMo4
1.7226	34 CrMoS 4	34CrMoS4
1.7227	42 CrMoS 4	42CrMoS4
1.7228	50 CrMo 4	50CrMo4
1.7264	20 CrMo 5	20CrMo5
1.7321	20 MoCr 4	20MoCr4
1.7323	20 MoCrS 4	20MoCrS4
1.7333	22 CrMoS 3 5	22CrMoS3-5
1.7335	13 CrMo 4 4	13CrMo4-5
1.7362	12 CrMo 19 5	12CrMo19-5
1.7380	10 CrMo 9 10	10CrMo9-10
1.7383	–	11CrMo9-10
1.7779	–	20CrMoV13-5-5
1.8159	50 CrV 4	51CrV4
1.8504	34 CrAl 6	34CrAl6
1.8519	31 CrMoV 9	31CrMoV9
1.8550	34 CrAlNi 7	34CrAlNi7
1.8807	13 MnNiMoV 5 4	13MnNiMoV5-4
1.8812	18 MnMoV 5 2	18MnMoV5-2
1.8815	18 MnMoV 6 3	18MnMoV6-3
1.8821	StE 355 TM	P355M
1.8824	StE 420 TM	P420M
1.8826	StE 460 TM	P460M
1.8828	EStE 420 TM	P420ML2
1.8831	EStE 460 TM	P460ML2
1.8832	TStE 355 TM	P355ML1
1.8835	TStE 420 TM	P420ML1
1.8837	TStE 460 TM	P460ML1
1.8879	StE ...	P690Q
1.8880	WStE ...	P690QH
1.8881	TStE ...	P690QL1
1.8882	10 MnTi 3	10MnTi3
1.8888	EStE ...	P690QL2
1.8900	StE 380	S380N
1.8901	StE 460	S460N
1.8902	StE 420	S420N
1.8903	TStE 460	S460NL
1.8905	StE 460	P460N
1.8907	StE 500	S500N
1.8910	TStE 380	S380NL
1.8911	EStE 380	S380NL1
1.8912	TStE 420	S420NL
1.8913	EStE 420	S420NL1
1.8915	TStE 460	P460NL1
1.8917	WStE 500	S500NL
1.8918	EStE 460	P460NL2
1.8919	EStE 500	S500NL1
1.8930	WStE 380	P380NH
1.8932	WStE 420	P420NH
1.8935	WStE 460	P460NH
1.8937	TStE 500	P500NH
1.8972	StE 415.7	L415NB
1.8973	StE 415.7 TM	L415MB
1.8975	StE 445.7 TM	L450MB
1.8977	StE 480.7 TM	L485MB
1.8978	StE 550.7 TM	L555MB

Deep hole drills

GÜHRING

Page

A brief introduction to the subject of deep hole gun drilling

In the machining world, drilling depths of 10xD and deeper are regarded as deep hole drilling operations, whereby smaller drilling depths can naturally also be produced with gun drills. Advantage is taken of the positive side effects, as for example good surface quality, low deviation from concentricity and optimised alignment accuracy..

High pressure cooling -
has become a matter of course.

In recent years, internal cooling has established itself for all drilling tools. Coolants are now living up to their name and being supplied via coolant ducts to where they are urgently required. Considerable improvements in tool life and less breakages have been achieved by this measure for twist drills, taps etc.

Every conventional machine tool currently on the market can be supplied with high pressure internal cooling and is therefore also suitable for deep hole drilling.

The share of gun drills on machining centres, lathes etc. is forever gaining more importance. The process is therefore increasing in popularity in the machining world.

All gun drills must have support for the pilot hole.
Gun drills must never operate at full speed without support in the machine shop.

Attention!
Gun drills with steel shanks are predominantly NOT suitable for shrink fitting! (exception T16 see next page)

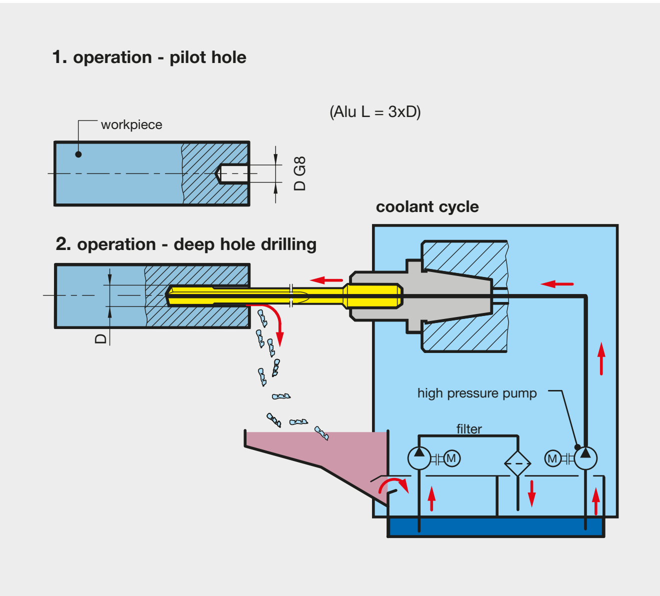
Typical procedure with all gun drills
on conventional machine tools

- production of pilot hole (L ≈ 3xD, tolerance H8)
- enter at low revolutions, approx. 200 rev./min, feed rate approx. 500 mm/min. With tools for drilling depths in excess than 40xD enter the pilot hole revolving in left hand direction.
- setting of coolant pressure and revolutions
- uninterrupted drilling to required drilling depth without wood pecking. When applying gun drills with increased length-diameter-ratio, we recommend machining with reduced cutting parameters (approx. 75% of the optimal cutting speed) up to a drilling depth of approx. 25 mm.
- switching off coolant supply after reaching the required hole depth
- withdrawal in top gear (max. 10 m/min) with stationary spindle

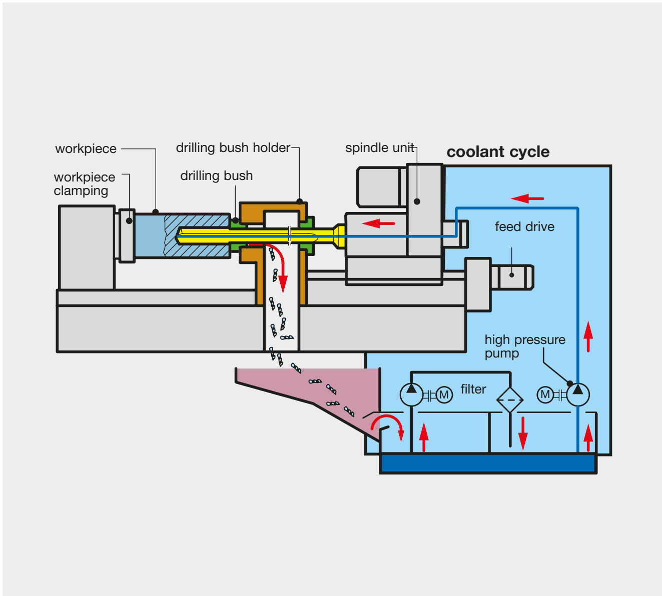
Application advice

- For drilling depths in excess than 40xD we recommend the use of two or more gun drills, e. g. Ø 10 x 400 mm and Ø 9.95 x 800 mm.
- Gun drills for drilling depths of more than 40xD should enter the pilot hole revolving in the left hand direction.
- When changing tools for drilling depths of more than 40xD, the tool can be damped by switching on coolant supply for just one second.
- Generally we recommend the use of soluble oil with a minimum oil content of 10 %.
- Single-fluted gun drills for long-chipping aluminium should be supplied with point grind 180° and coolant chamber.
- For optimized bore straightness an additional cylindrical guide part can be used (optional).

Deep hole drilling
on conventional machine tools



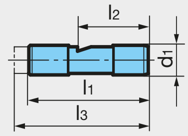
Deep hole drilling machines



The range of drivers introduced below is available ex stock. However, it only represents a small selection of drivers from our complete range. We naturally also produce individual drivers of the highest precision to customer drawings. Attention! EB 100 requires drivers with positioning lugs. Further information on request.

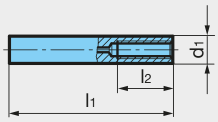
Drivers for deep drilling machines

1



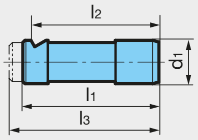
code no.	d_1	l_1	l_2	l_3
1.1	10	40	24	-
1.2	10	40	24	45
1.3	10	40	24	55
1.4	16	45	31,2	-
1.5	25	70	34	-
1.6	25	70	34	78

5



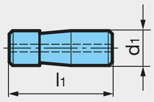
code no.	d_1	l_1	l_2
5.1	10	60	20
5.2	16	80	28
5.3	25	100	50
5.4	10	100	
5.5	10	110	

2



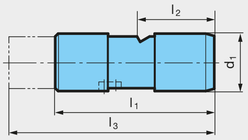
code no.	d_1	l_1	l_2	l_3
2.1	16	50	47	-
2.2	16	50	47	55
2.3	16	50	47	70

6



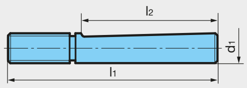
code no.	d_1	l_1
6.1	12,7	38
6.2	19,05	70
6.3	38,1	70

3



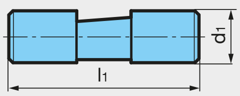
code no.	d_1	l_1	l_2	l_3
3.1	25	70	34	100

7



code no.	d_1	l_1	l_2
7.1	16	112	73
7.2	20	126	82

4

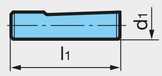


code no.	d_1	l_1
4.1	19,05	70
4.2	12,70	70
4.3	25,40	70
4.4	31,75	
4.5	36,10	70

Drivers to DIN 1835

form E

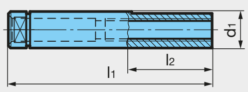
9



code no.	d_1	l_1
9.1	8	36
9.2	10	40
9.3	12	45
9.4	16	48
9.5	20	50
9.6	25	56
9.7	32	60
9.8	31,75	70
9.9	38,1	70
9.10	40	70

Drivers to VDI-draft

12

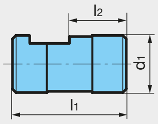


code no.	d_1	l_1
12.1	10	68
12.2	16	90
12.3	25	112

also be used for deep hole drilling machines

Drivers to Speed-Bit-System

13



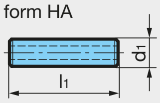
code no.	d_1	l_1	l_2
13.1	16	40	16
13.2	25	50	25
13.2	35,6	60	

also be used for deep hole drilling machines

Drivers to DIN 6535

form HA

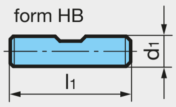
10



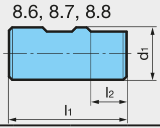
code no.	d_1	l_1
10.1	8	36
10.2	10	40
10.3	12	45
10.4	16	48
10.5	20	50
10.6	25	56
10.7	32	60
10.8	25	70
10.9	40	70

form HB

8



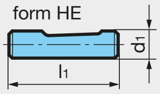
with code no. 8.6, 8.7, 8.8



code no.	d_1	l_1
8.1	8	36
8.2	10	40
8.3	12	45
8.4	16	48
8.5	20	50
8.6	25	56
8.7	32	60
8.8	40	70

form HE

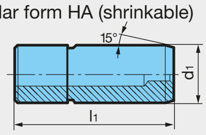
11



code no.	d_1	l_1
11.1	8	36
11.2	10	40
11.3	12	45
11.4	16	48
11.5	20	50
11.6	25,4	70
11.7	25	56
11.8	32	60
11.9	40	70

similar form HA (shrinkable)

16



code no.	d_1	l_1
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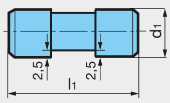
16.2	16	64
16.3	20	70
16.4	25	81
16.5	32	92

similar form HE

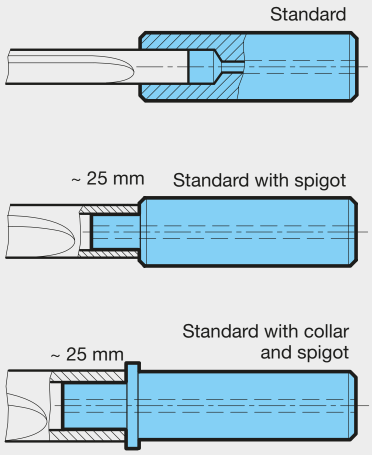
17



code no.	d_1	l_1
17.1	19,05	70
17.2	25,40	70
17.3	31,75	70
17.4	38,1	70

also be used for deep hole drilling machines

Driver variations to suit gun drill tubes



Solution for nom.-Ø < driver-Ø (difference must be appr. 6 mm): tube shank installed in driver

Solution for nom.-Ø ≠ driver-Ø (close to parallel): tube shank installed over spigot

Solution for nom.-Ø > driver-Ø: tube shank installed over spigot, inside-Ø of tube shank >driver-Ø, tube shank fits against collar shoulder.

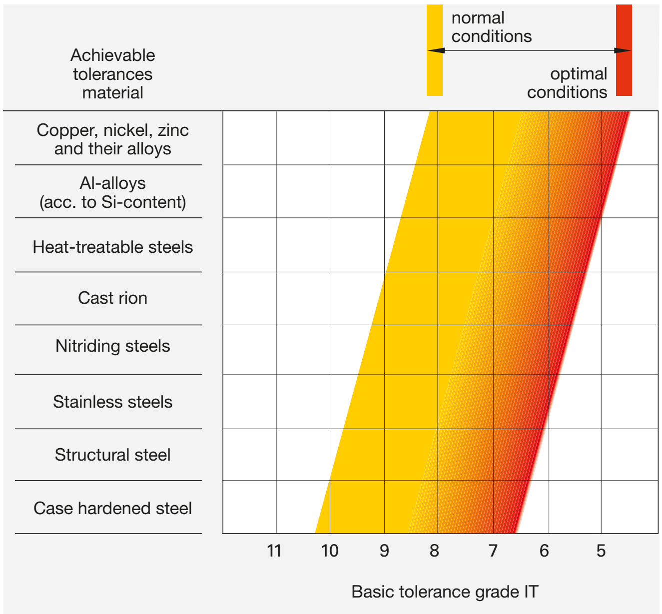
Single fluted gun drill accuracy

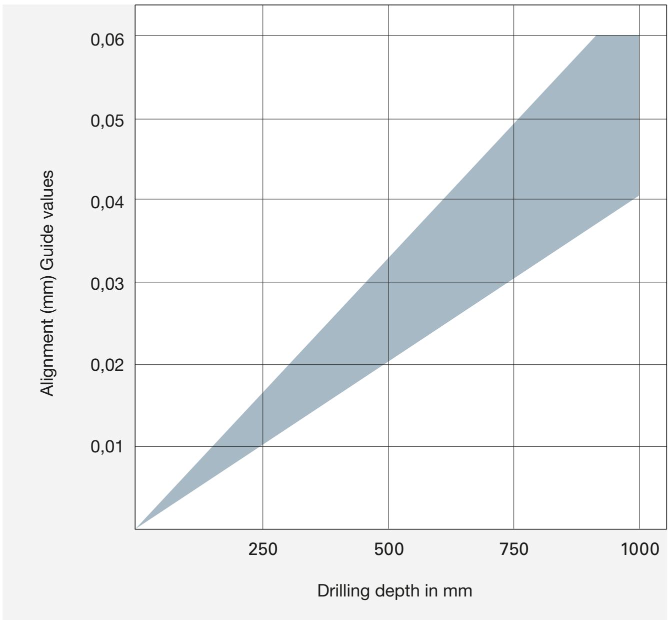
Basic tolerances*

The application of single-fluted gun drills can achieve a lower basic tolerance, as the cutting forces at the cutting edge are absorbed by the supporting strips, unlike twist drills where the slightest deviation of the two cutting edges causes a larger hole.

Alignment accuracy*

Because brazed single-fluted gun drills always have the precision carbide head brazed on to a flexible tube, the tool achieves very accurate aligned holes remaining unaffected by possible concentricity errors.
However, extreme material fluctuations and other influencing factors can impair the alignment accuracy.



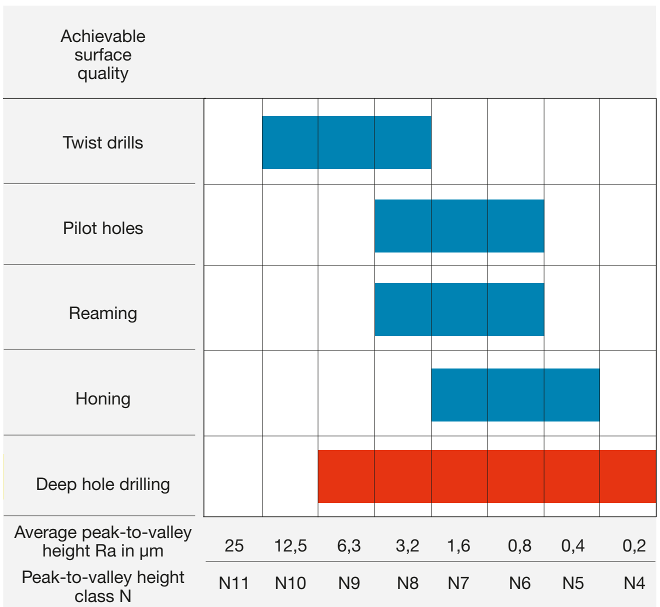


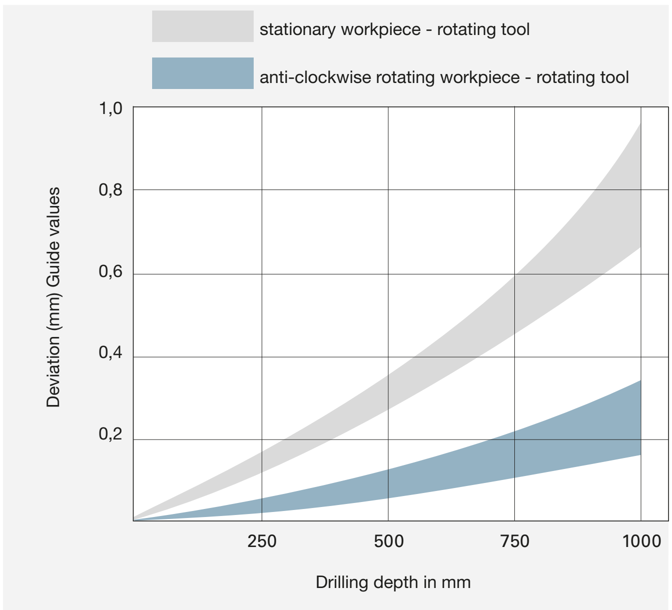
Surface quality*

The forces at the cutting edge are absorbed by the support bushes, which in return burnishes the surface.
Lubrication between the supporting strips and hole surface is therefore very important.
The better the lubricant, the better the surface quality.

Deviation from concentricity*

When a hole is produced with, for example, a commercial twist drill, the quality of the point grind affects the concentricity of the hole. An imbalance of forces is created at the cutting edges. With gun drills, these cutting forces are absorbed by the supporting strips, resulting in excellent concentricity.

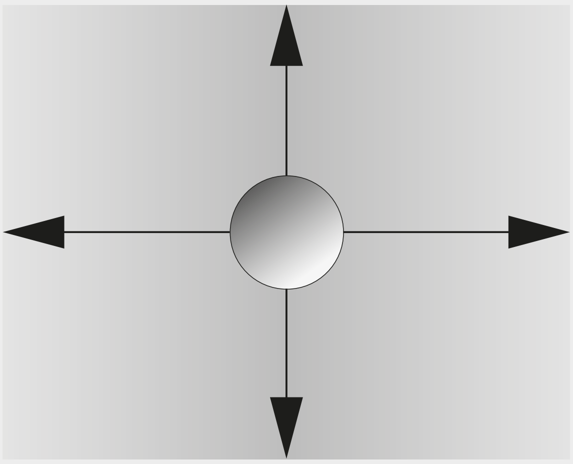




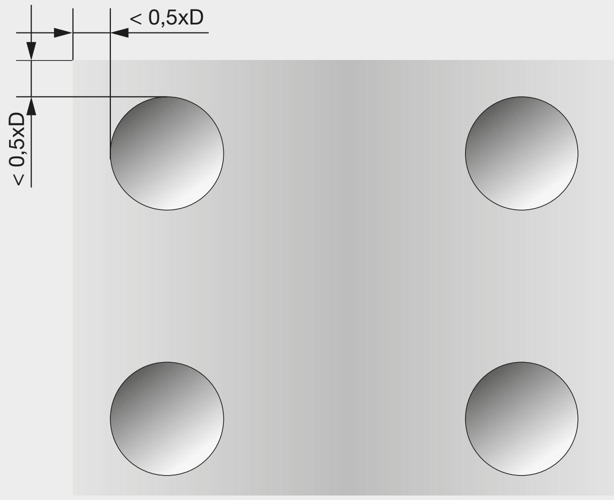
* gun drills with two cutting edges – straight-fluted as well as spiral-fluted – achieve approx. twice of the values stated

GÜHRING

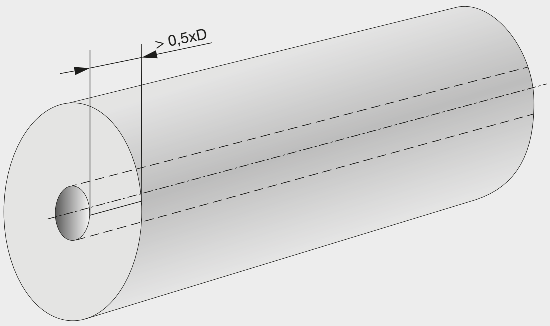
Hole straightness/deviation



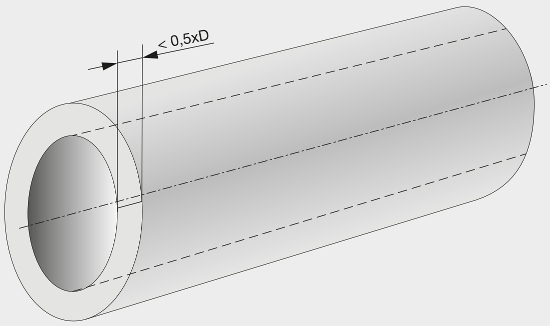
Hole distance to edge > 0.5xD



Hole distance to edge < 0.5xD



sufficient wall distance
(> 0.5xD) > optimal

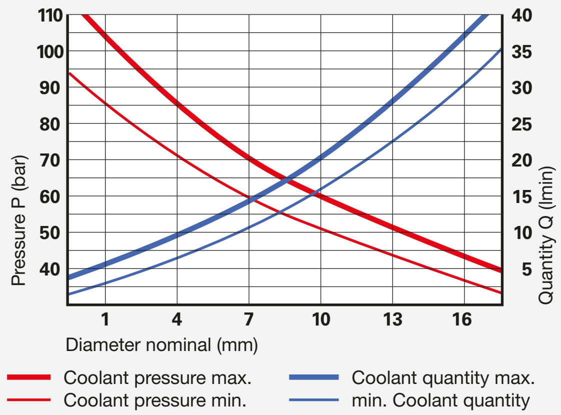


Minimum distance (0.5xD)
falling short → can lead to losses in hole straightnes

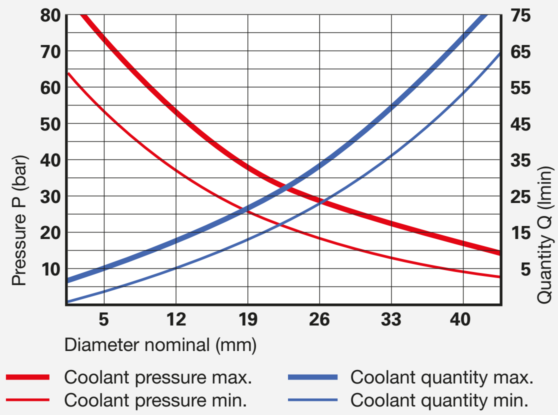
Coolant values

Please note:
- All gun drills must be applied with internal cooling, either air, water or oil. Without internal cooling the chips cannot be evacuated.
- All gun drills can be applied with oil as the medium for internal cooling. However, in this case a 30% higher pressure is required in order to achieve the same coolant volume.
- When MQL is applied with gun drills an increase in pressure may be necessary for smaller nominal diameters de pendent on the pressure of the MQL system.
- If the cooling lubricant data is insufficient the cutting parameters may be reduced. Pressure boosting systems are also possible.
- With increased gun drill length a pressure increase has to be expected to transport the required coolant volume through the coolant ducts.

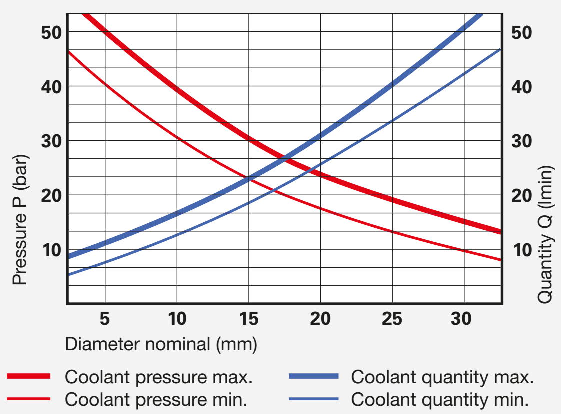
Coolant values EB 100
(Recommended values for soluble oil)



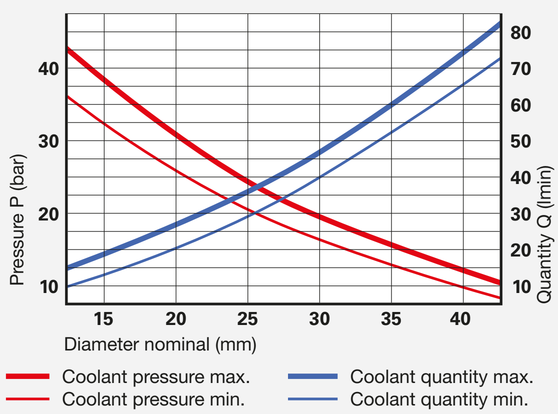
Coolant values EB 80
(Recommended values for soluble oil)



Coolant values ZB 80
(Recommended values for soluble oil)



Coolant values EB 800
(Recommended values for soluble oil)



Quality features

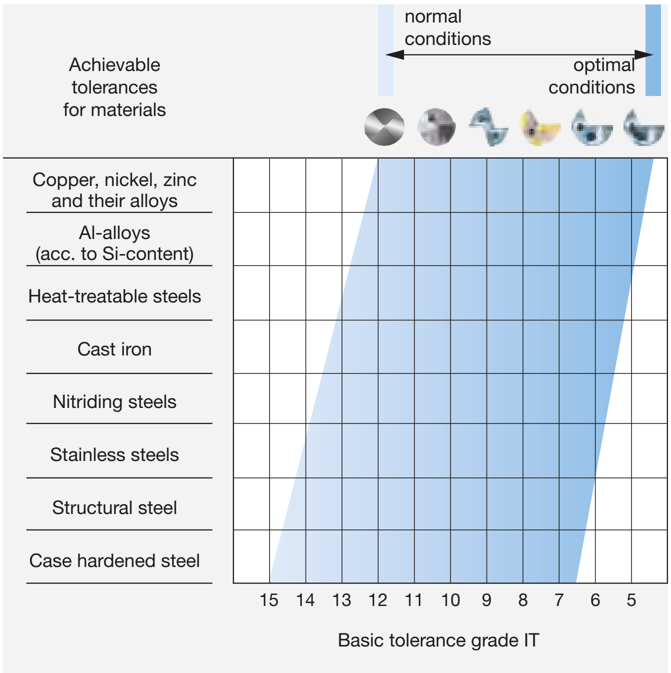
In machining technology, if the drilling depth is 15xD or deeper, this is referred to as deep hole drilling.
Today, Gühring's range comprises:

- classical single-fluted gun drills made of solid carbide or with a brazed carbide head
- classical two-fluted gun drills with a brazed carbide head
- replacement system with replaceable solid carbide cutting edges and supporting strips
- spiralled solid carbide or HSS/HSCO deep hole drills

The right tool is selected depending on the type of application and the required quality of the drilled hole.
The following diagrams provide guidance on which tool to choose:

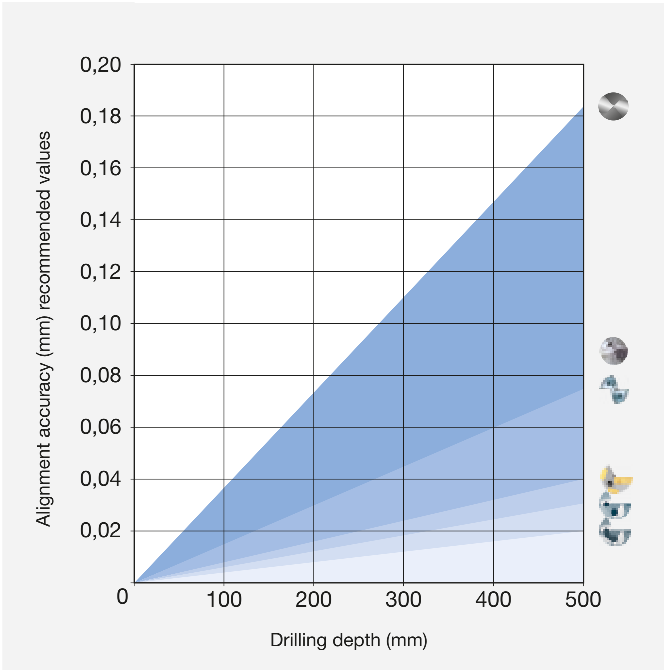
Basic tolerances

Depending on their shape and design, different types of tools result in different basic tolerances. The single-fluted drill creates extremely precise drilled holes. Under optimum conditions, it is possible to achieve tolerance grades of up to IT5 with a single-fluted gun drill.



Alignment accuracy

The straightness of hole describes a deviation in direction. This is influenced by the centring of the tool during spot drilling and depends on the shape and position of the pilot hole or drill bush. The properties of the material or workpiece as well as the stability of the tool and machine also influence the straightness.



Peak-to-valley height class		N12	N11	N10	N9	N8	N7	N6	N5	N4	N3
EB 100/EB 80 deep hole drilling											
EB 800 deep hole drilling											
ZB 80/RT 100 T deep hole drilling											
HSS/HSCO deep hole drilling											
EB 100/80/800 Pilot drilling											
Surface values	Rz (µm)	160	100	63	40	15,6	7,87	4,65	2,60	1,74	0,81
Roughness values	Ra (µm)	50	25	12,5	6,3	3,2	1,6	0,8	0,4	0,2	0,1

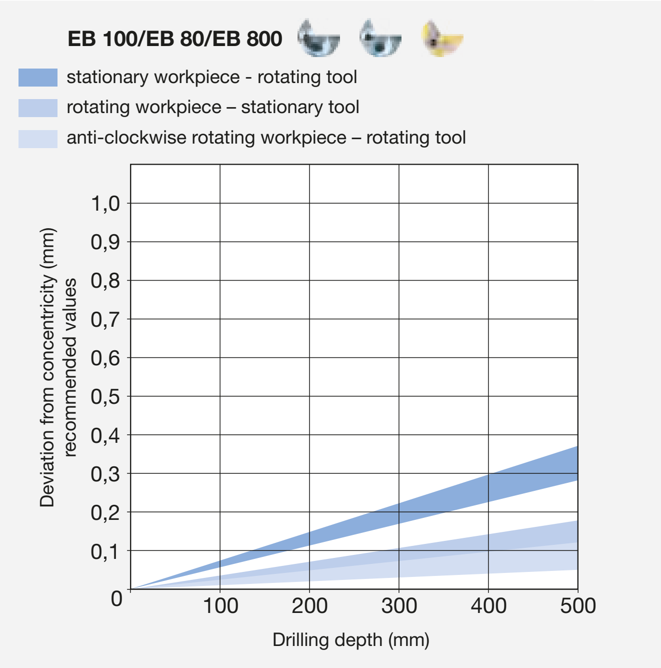
normal conditions (recommended values) — ideal conditions

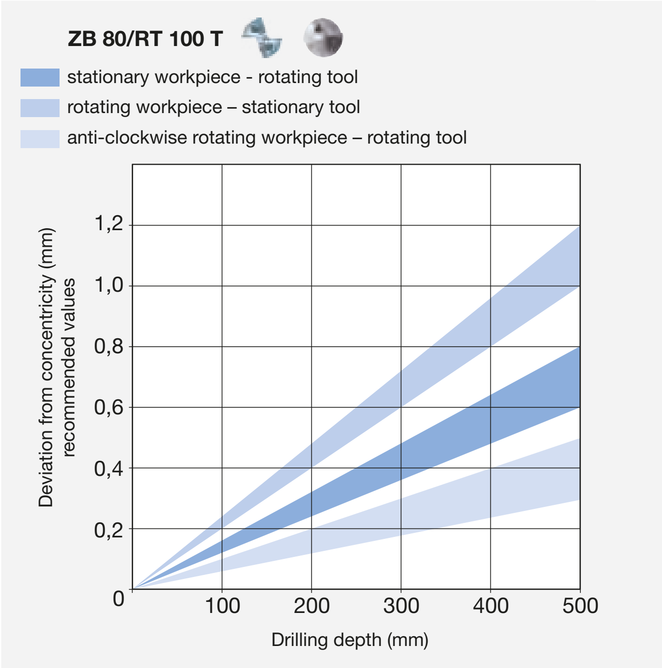
Surface quality

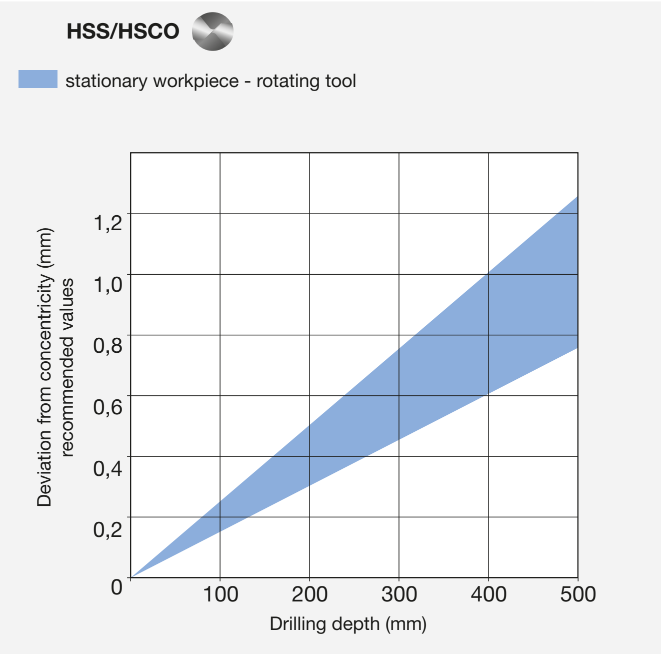
The roughness of the drilled hole is influenced by many factors. The most important of these are the material, the cooling lubricant and the type and geometry of the tool. When drilling with single-fluted drills, the guide pads smooth the bore wall further. This is not the case for drills with several cutting edges. The final quality of the surface is dependent on the surfaces of the tool (e.g. coating) or edge conditions (wear) on the primary and secondary cutting edges.

Deviation from concentricity

The deviation from concentricity describes a continuous displacement of the tool with increasing drilling depth. This curve is affected not only by the drill's geometric properties, but also by the cutting conditions, the material structure and the temperatures. Optimum results are achieved when machining with counter-rotating speeds of the workpiece and tool. A single-fluted drill achieves lower deviation from concentricity values than drills with several cutting edges.



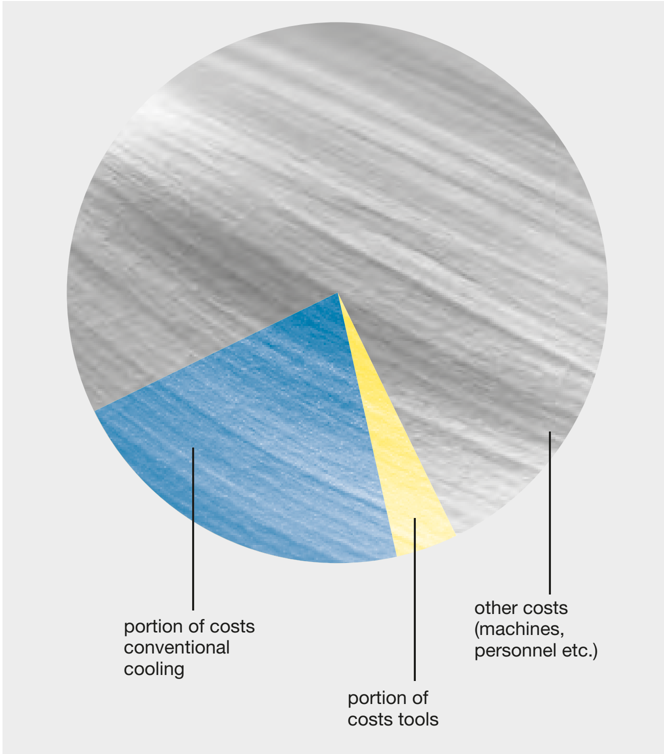




MQL Technology

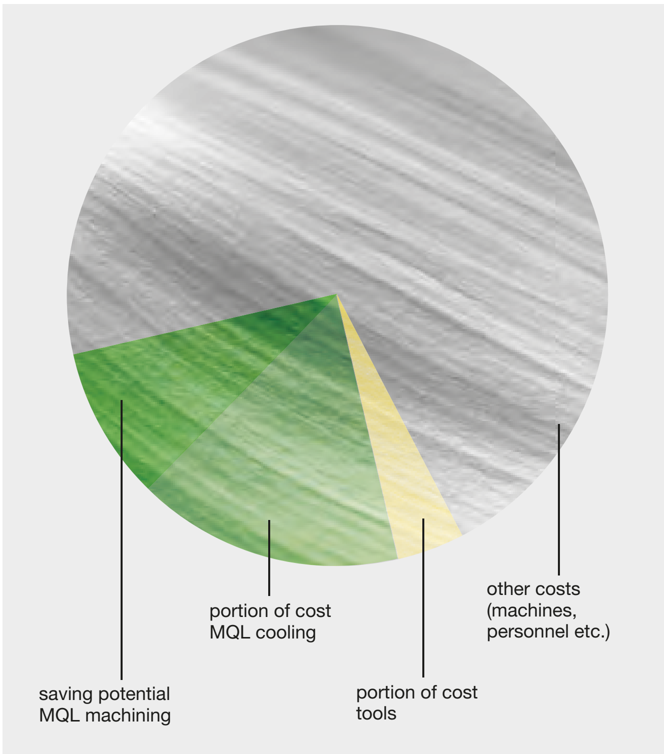
Basics

Minimal Quantity Lubrication (MQL) uses an aerosol comprising oil and air for cooling purposes during machining processes. Its cooling effect is assisted by the chip removal. The frictional heat generated during machining is removed with the chip.
The costs associated with cooling lubrication combined with the machine and tool costs represent a significant proportion of the overall machining process costs. Reducing the required amount of cooling lubricant therefore offers various potential savings and also contributes to environmental and health protection.



The aim of MQL machining

- reduction of thermal stresses at the tool point
- less tool wear/longer service life possible
- effective chip evacuation from deep holes
- reduction of cooling lubricant requirement
- high cooling and lubrication effect especially in deep holes
- reduction in consequential costs such as:
  - reduction in component cleaning costs
  - reduction in cooling lubricant disposal costs
  - reduction in cost of disposal of swarf contaminated with cooling lubricant
- protection of environment and health



A direct comparison of emulsion vs. MQL

	Medium	Purpose	Standard pressure	Usage (during process)
Soluble oil	Soluble oil	Chip removal, cooling and lubrication	approx. 40-80 bar	approx. 800-1.500 l/h
MQL	Oil/air mixture	Chip removal and lubrication	approx. 4-10 bar	Oil: approx. 5-100 ml/h Air: approx. 3-6 Nm^3/h

MQL Technology

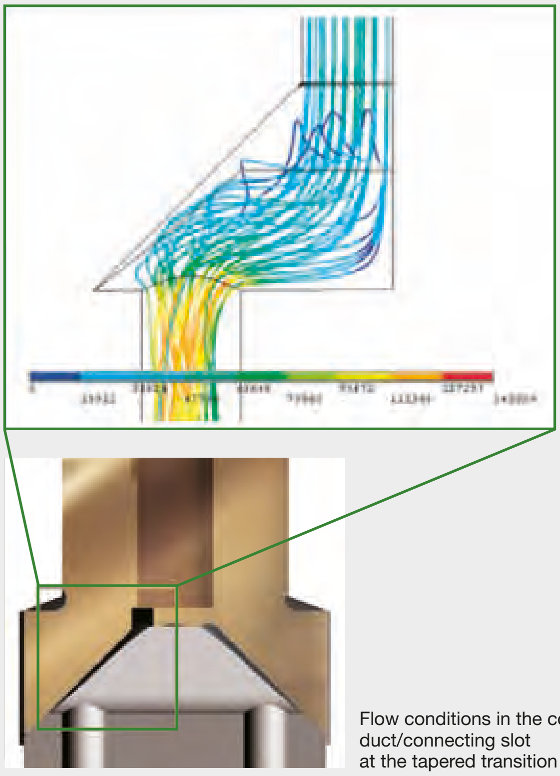
Perfectly shaped shaft end for reliable MQL transfer

It is important to feed the extremely small amount of oil directly to the point of action. The geometric shape of the shank end plays a vital role here. The tapered shank end designed by Gühring establishes ideal conditions for MQL. In addition, a special connecting slot at the shank end was developed especially for Deep hole drills. This is adapted to the shape of the cooling ducts and ensures optimal distribution into the individual ducts.

Advantages of the tapered shank end:

- a practically positive-fit connection ensures optimal sealing
- minimised dead zones ensure low-resistance flow with no consolidation
- excellent distribution to the individual cooling ducts
- easy handling/cost-effective production
- optimal response times/short time for aerosol delivery

Flow profile with little vortex formation



Flow conditions in the cooling duct/connecting slot at the tapered transition

A cool head at all times

With MQL, the process temperature compared to dry machining can be significantly reduced. This results in longer tool life and improved process reliability.

Tool diameter/pressure ratio inlet/outlet pressure

The oil to air ratio of the mixture is set according to the difference between the inlet and outlet pressure. This depends on the process and therefore varies greatly.

The following factors are considered:

- tool (dimensions of the kidney shape/cooling ducts)
- manufacturer of the MQL generator
- manufacturer of the MQL lubricant
- compressor capacity (6 bar standard/10 bar optimal)
- machine factors (connection to the tool)

Application of Gühring coatings

Material	ISO groups	EB/ZB	RT 100 T	HSS
C-steels, Free-cutting steels, Mn-steels	P	TiN Endurum Congressor	Endurum Raptor FIRE	FIRE – –
Steel, low-alloyed	P	bright TiN FIRE	FIRE Endurum Raptor	FIRE TiN –
Steel, alloyed	P	FIRE Signum Congressor	FIRE Signum nanoA	FIRE TiN –
Steel, hardened, <55 HRC	P	Signum FIRE TiAIN	Signum FIRE TiAIN	– – –
Steel, hardened, 55–65 HRC	P	Signum FIRE TiAIN	Signum FIRE TiAIN	– – –
Steel, stainless and acid-resistant	M	SuperA Sirius Congressor	nanoA Sirius Endurum	Sirius FIRE TiN
Cast iron	K	Signum Endurum FIRE	Signum FIRE nanoA	FIRE – –
Nickel-based alloys (i.e. Inconel)	S	nanoA Sirius Endurum	nanoA Signum FIRE	FIRE – –
Titanium/titanium-alloys	S	bright Zenit nanoA	Zenit nanoA	FIRE –
Cobalt-chromium-alloys	S	nanoA FIRE Congressor	nanoA Signum FIRE	– – –
Precious metals	S	nanoA Carbo	nanoA	–
Aluminium-wrought-alloys	N	bright Carbo –	bright Carbo Cristall	bright Carbo –
Aluminium-cast-alloys (<12% Silizium)	N	bright Zenit Carbo	bright Zenit Carbo	bright Zenit Carbo
Aluminium-cast-alloys (≥12% Silizium)	N	Cristall Signum –	Cristall – –	– – –
Copper/bronze/brass	N	bright Carbo ICE	ICE Carbo	TiN –
Ceramics	N	Cristall Signum	Cristall	–
Plastics, not reinforced	N	bright	Carbo	–
Plastics, fibre-reinforced	N	Cristall Signum	Cristall Signum	– –
Graphite	N	bright	–	–

Note: *The overview shows the general application recommendations for Guhring coatings. Prioritisation is from top to bottom.*

The drilling process on conventional machines (BAZ)

The work steps for deep hole drilling

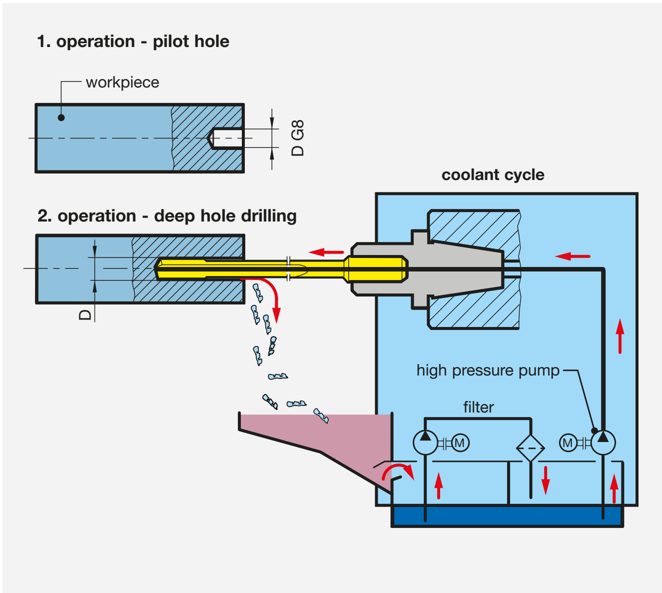
- production of pilot hole
- enter at low revolutions
- setting of coolant pressure and speed
- continuous drilling to required drilling depth without pecking
- switching off coolant supply after reaching the required hole depth
- retraction of the tool from the hole

Cutting parameters can be reduced if cooling parameters are insufficient. Pressure increase systems are also an option.

Procedure

In order to achieve optimal machining results when producing deep holes especially spotting on radii and/or on an uneven surface structure, we recommend the following machining steps:

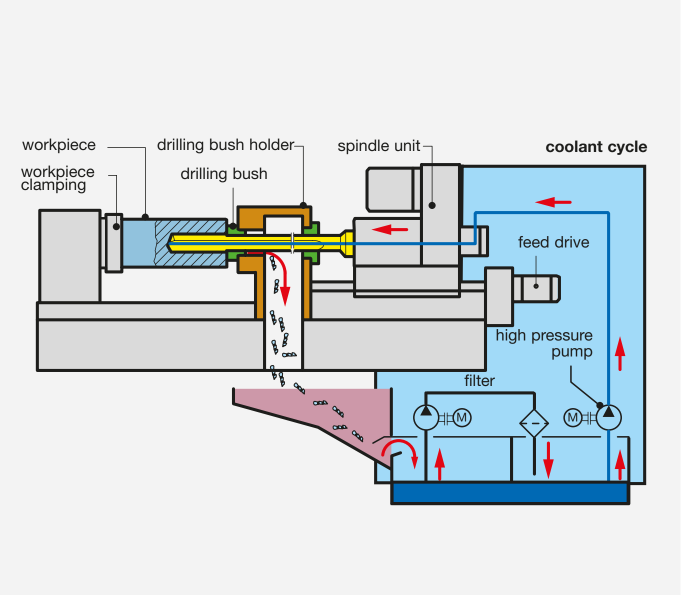
1. Initial milling of the surface, e.g. with the RF 100 Diver including centre cut. The surface must be machined at right angles to the entry angle of the drilling operation.
2. Drilling of a cylindrical pilot hole, e.g. with the RT 100 U. Thanks to its point angle of 140° and its Ø tolerance m7, this drill is ideally suited for this machining step.
3. Drilling into the pilot hole with a speed of approximately 200 rpm and a feed rate of approximately 500 mm/min with anti-clockwise rotation.
4. Adjustment of the cooling lubricant pressure and the rotational speed.
5. Uninterrupted drilling to the required drilling depth without chip removal. When using deep hole drills with a very large length/diameter ratio (e.g. solid carbide single-fluted drills with flute lengths greater than 160 mm), we recommend drilling with reduced cutting parameters (approx. 75 % of the optimal cutting speed) to a drilling depth of around 25 mm.
6. For through holes with a straight exit, i.e. 90°, reduce the feed speed v_f to 50 % approximately 1 mm before breaking through.
7. For through holes with an inclined exit, reduce the feed speed v_f to 40 % approximately 1 mm before breaking through.
8. After reaching the required drilling depth, switch off the speed and cooling lubricant and retract the drill at a speed of no more than 5,000 mm/min.



The drilling process on deep hole drilling machines

Where mass production, milling of very deep holes and high quality surface finishes are required, deep-hole drilling machines are used. A nearly endless range of drilling depth becomes available. The gun drill is guided by steady rest bushes. The accordion-like movement of the bushes allows a continuous drilling. „Drilling without pecking“.

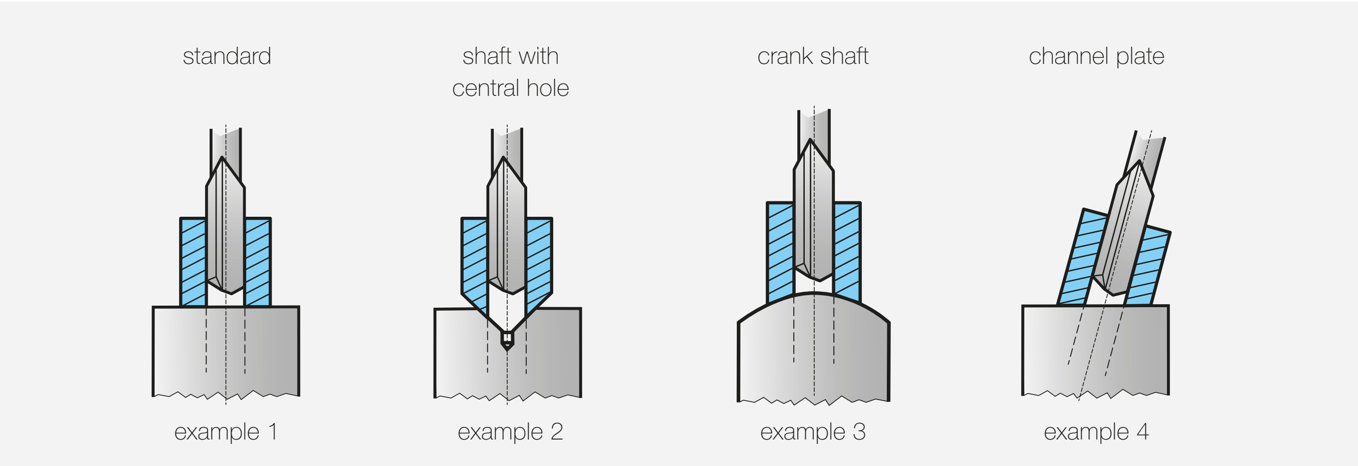
Pilot holes are not needed, thus reducing, time and costs for tool change. Offering a greater drilling depth (up to a couple of meters), and at the same time, an excellent drilling quality. High pressure pumps and a coolant filter system guarantuee maximum process security. The total length of the steady rest bushings and the drill bush support equals the so-called length loss, which is decisive for calculating the length of the tool.



Pilot hole and drill bush

Since the single-fluted gun drill is a tool with only one cutting edge and cannot centre itself automatically, the tool must be guided with a drill bush or pilot hole. Self-centering two-fluted drills also have to be guided by drill bushes or pilot holes, however, as they could otherwise start to vibrate.

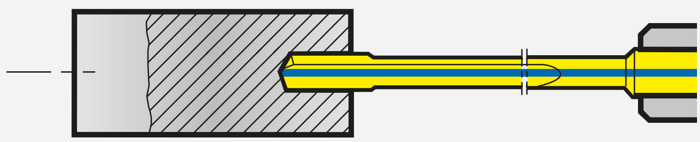
Example drill bush with art. no. 5747 (HSS) / 5748 (solid carbide)



To take into account when using drill bushes

- The drill bush must be in positive contact with the spot drilling contour.
- There should be as little play as possible between the drill bush and the tool.
- If the deep hole drill has a guide diameter, the drill bush should be at least long enough to guide both head types when spot drilling.
- The condition of the drill bush must be regularly checked to prevent any negative effects on the tool.
- We recommend HSS drill bushes for small series and solid carbide drill bushes for large series.

Example Pilot drilling



Guide values for the pilot hole depth

conv. deep hole drills	Ø nom. follow-on tool				
drilling depth	Ø 0.900-1.799	Ø 1.800-3.999	Ø 4.000-7.999	Ø 8.000-11.999	Ø 12.000-52.000
up to 20xD		2.5xD	2.0xD	1.5xD	
up to 30xD	3.0xD	3.0xD	2.5xD	2.0xD	1.5xD
up to 40xD		4.0xD	3.0xD	2.5xD	

Pilot hole and drill bush

Range of applications for pilot tools

	Diameter range [mm]																			
	0.9	1.0	1.4	2.0	3.0	6.0	8.0	11.0	12.0	15.5	16.0	19.5	20.0	25.0	30.0	35.0	40.0	45.0	50.0	52.0
ExclusiveLine Micro-precision drills	art. 6400 without IC																			
			6405 with IC																	
RT 100 U					art. no. 2473 without IC															
					art. no. 2479 with IC															
HT 800								art. no. 4111 insert for pilot drilling												
RF 100 P			art. no. 6716 4-fluted without IC																	
RF 100 Diver					art. no. 6737 4-fluted without IC															
GV 120	art. no. 659 HSCO without IC																			

ExclusiveLine Micro-precision drills
- for pilot holes < Ø3.000 / EB 100, EB 80
- for standard situations/flat spotting surface

RT 100 U
- universal pilot tool Ø3.000-19.500 / EB 100, EB 80, ZB 80, EB 800, RT 100 T
- for standard situations/flat spotting surface

HT 800
- insert pilot tool Ø11.000-40.000 / EB 100, EB 80, ZB 80, EB 800, RT 100 T
- for standard situations/flat spotting surface

RF 100 P
- milling cutter for high-precision pilot holes Ø1.400-12.000 / EB 100, EB 80, ZB 80, EB 800, RT 100 T
- for standard and special situations/flat, angled, cubic or other spot drilling surfaces

RF 100 Diver
- milling cutter for high-precision pilot holes Ø4.000-52.000 / EB 100, EB 80, ZB 80, EB 800, RT 100 T
- for standard and special situations/flat, angled, cubic or other spot drilling surfaces

GV 120
- HSS pilot drills Ø0.900-15.500 / HSS deep hole drills
- for standard situations/flat spotting surface

Please observe the following for pilot holes

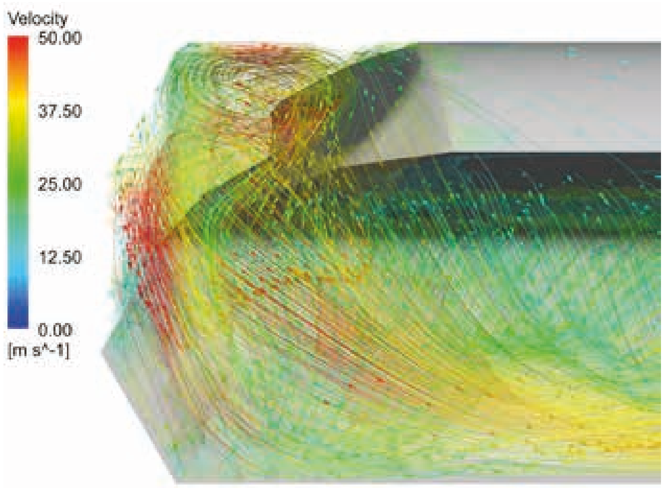
- The pilot hole diameter tolerance should be G8 and the nominal tool tolerance always Ø **m7**.
- If the single-fluted gun drill has a guide diameter, the pilot hole should be at least deep enough to support both head forms when spot drilling.
- Depending on the application, it may be advantageous if the pilot hole has an entry chamfer.
- If there are strict requirements regarding the position and concentricity of the deep drilled hole, then the pilot hole should be milled or be drilled on a lathe.

Important:
The quality of the drill bush and of the pilot hole has a very large influence on the deviation from concentricity and the tool life of the follow-on tool.

Cooling lubricant

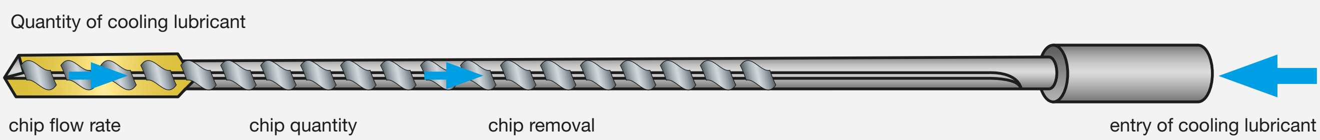
Introduction

The cooling lubricant is one of the most important elements when it comes to drilling holes with an LxD ratio of more than 15xD and for drilling deep holes. The selection of the cooling lubricant, taking into account its properties and performance such as pressure and flow rate, is decisive for process performance and thus also for the quality of the drilled hole. If the cooling lubricant pressure is too high, it can result in waviness and a larger deviation from concentricity.



Function

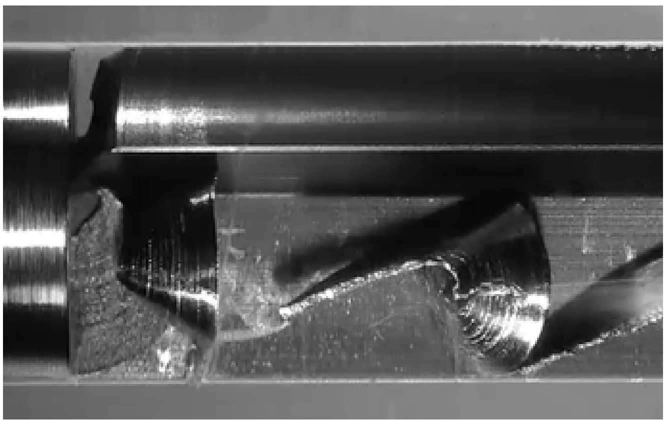
The cooling lubricant (oil, emulsion, MQL, air) flushes the chips out of the bore and lubricates all the parts of the tool (head and cutting edges) that come into contact with the workpiece. Drilling takes place under high pressure. However, the pressure is “only” the sum of the amount of cooling lubricant produced and existing resistances such as cooling duct cross-section or tool length and chip mass. Due to the amount of cooling lubricant and the resistances mentioned, a flow velocity occurs from a hydraulic point of view. When used correctly, this minimises the time that the chip is in contact with the cutting edge, prevents the drill from clogging and thus has a direct influence on the machining process. The lubricating properties of the cooling lubricant have a crucial effect on chip formation and the surface result. Appropriate additives such as EP additives (Extreme Pressure) ensure good sliding of the guide pads, which may be exposed to enormous surface pressure and rolling forces.



Filtration

If safe and reliable drilling processes are to be guaranteed, it is imperative to ensure that the cooling lubricant is sufficiently clean with reference to the tool diameter:

- < Ø 2.000 max. 15 µm
- Ø 2.000 up to ≤ Ø 6.000 max. 40 µm
- > Ø 6.000 up to 100 µm



Types of cooling lubricant

Soluble oil

Various types of water-miscible cooling lubricants are available, such as mineral, synthetic or natural compositions, and these, in addition to the selected oil proportion, significantly influence the drilling process. The ideal oil content for deep hole drilling is between 8 and 12 %. Lower values lead to a loss in performance or even to malfunctions.

Emulsion properties*

- At high pressures, EP additives (Extreme Pressure) should be used in the emulsion. Otherwise, foaming and an associated loss of lubrication may occur.
- Emulsions have a lower viscosity than oil, which means that pressures can be reduced by approximately 5 % to achieve comparable flushing properties.
- For materials that have a chrome content of more than 12 %, a tool life of less than 1.5 m must be expected.

Oil

Like the emulsions, deep drilling oils differ in their mineral, synthetic and natural composition. The higher viscosity of deep drilling oils compared to emulsions partly determines the increased coolant resistance, which in the case of low-viscosity oils leads to high flow rates (small diameters) and in the case of high-viscosity oils to larger hydraulic forces (significant in the case of larger diameters). The viscosity and lubricating properties of oils are strongly dependent on temperature. Overheating > 50° C must be avoided in order to be able to drill reliably.

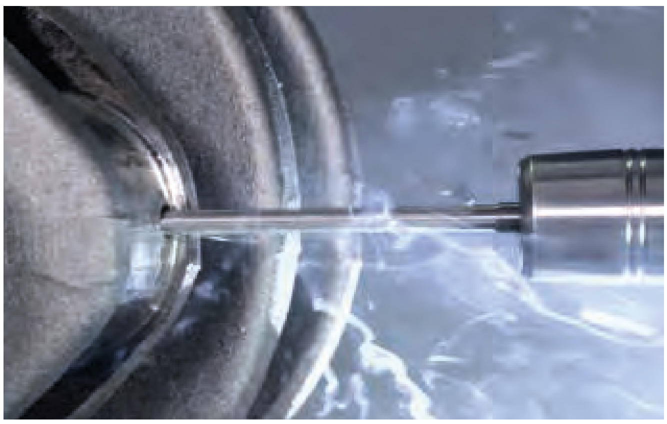
Oil properties*

- < Ø 2 mm 7-10 mm²/s
- > Ø 2 mm 10-20 mm²/s

MQL / Dry

Deep holes can be drilled dry or with MQL. The type of process depends on the material, diameter and drilling depth. The shape, size and mass of the chips are decisive.
Dry machining is only possible if dust-like chips are produced (e.g. with graphite or HM green compacts).

- For MQL 1-channel applications, the length adjustment screw #4937 (see GM 300 catalogue) can be selected.
- For MQL 2-channel applications, the length adjustment screw #4621 (see GM 300 catalogue) can be selected.



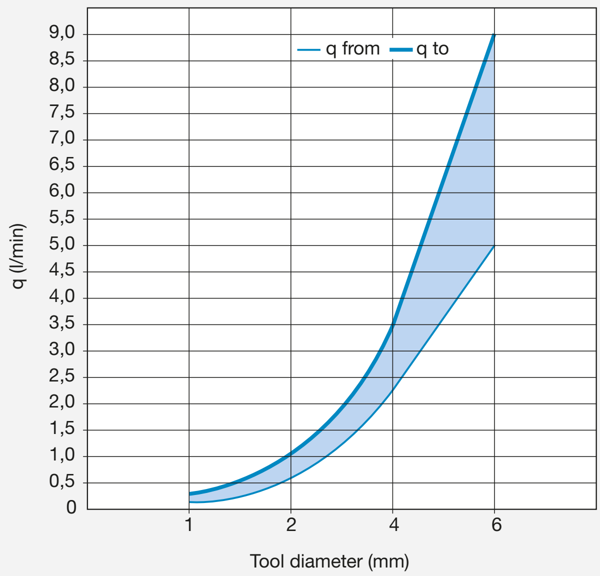
*No liability will be accepted in the case of deviations from the manufacturer's specifications

Cooling lubricant data

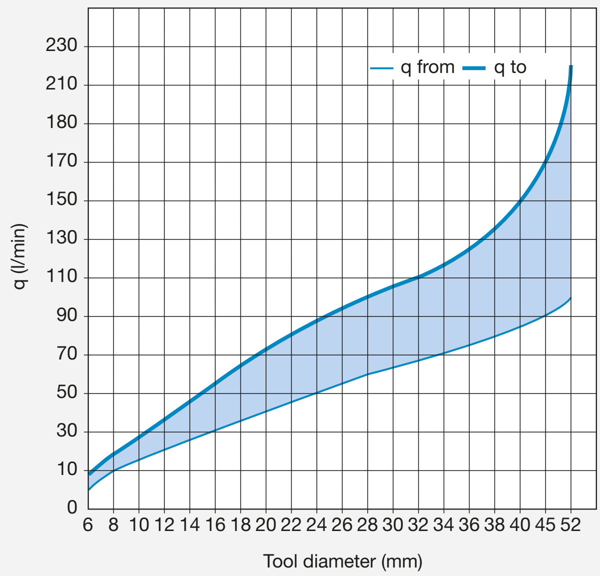
Please note:

- All gun drills must be applied with internal cooling, either air, water or oil.
  Internal cooling ensures better chip removal.
- All gun drills can be applied with oil as the medium for internal cooling.
  In this case, however, a higher pressure is required than with emulsions in order to obtain the same amount of coolant.
- When MQL is applied with gun drills an increase in pressure may be necessary for smaller nominal diameters dependent on the pressure of the MQL system.
- If the cooling lubricant data is insufficient the cutting parameters may be reduced. Pressure boosting systems are also possible.
- With increased gun drill length a pressure increase has to be expected to transport the required coolant volume through the coolant ducts.

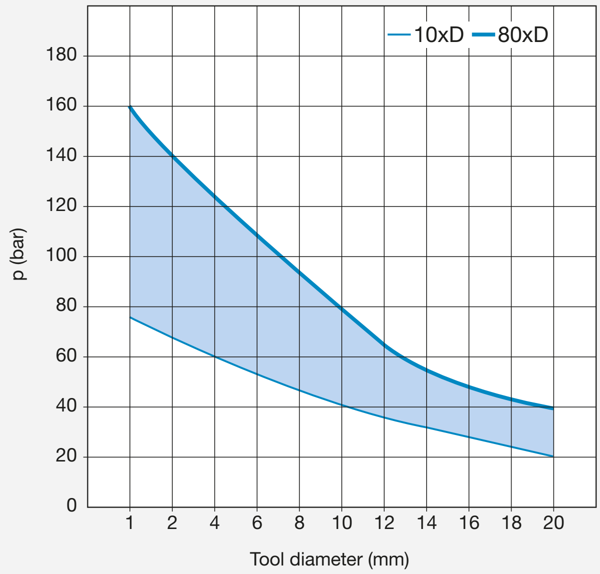
General flow data
EB 100/EB 80/EB 800/ZB 80



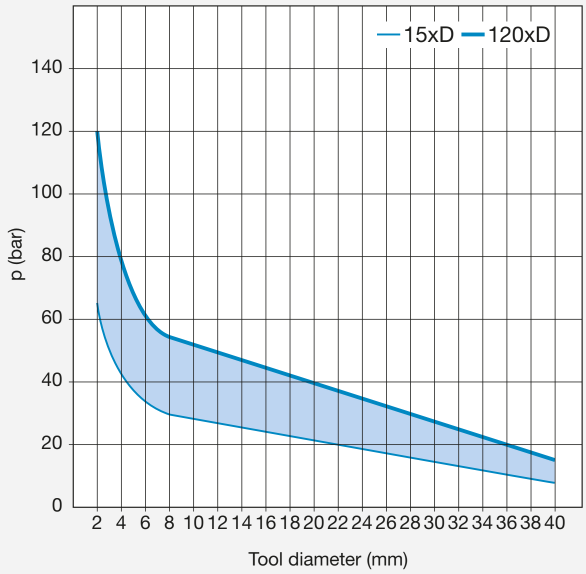
General flow data
EB 100/EB 80/EB 800/ZB 80



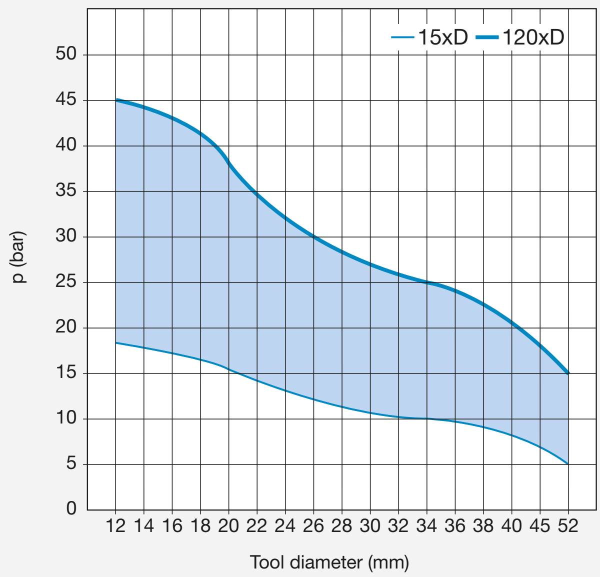
EB 100 Pressure specifications
depending on tool length



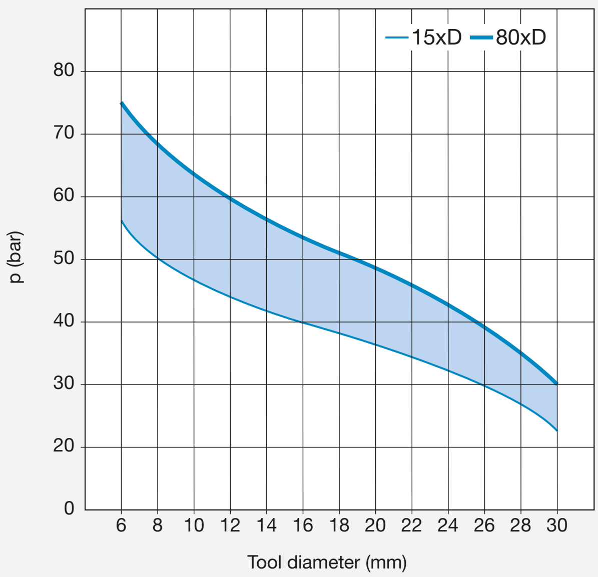
EB 80 Pressure specifications
depending on tool length



EB 800 Pressure specifications
depending on tool length



ZB 80 Pressure specifications
depending on tool length

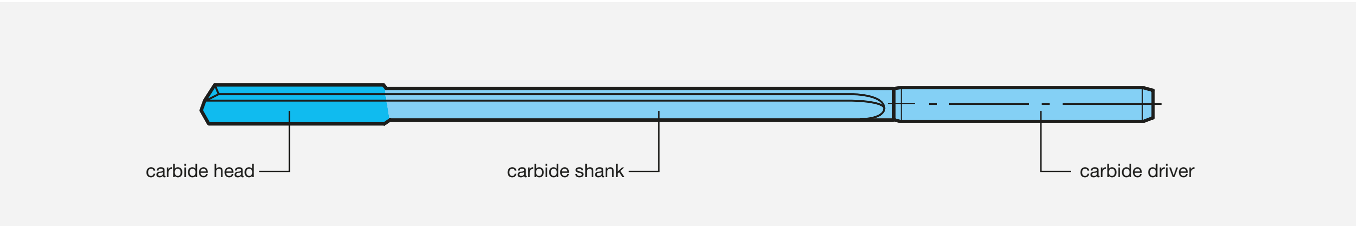


Characteristics

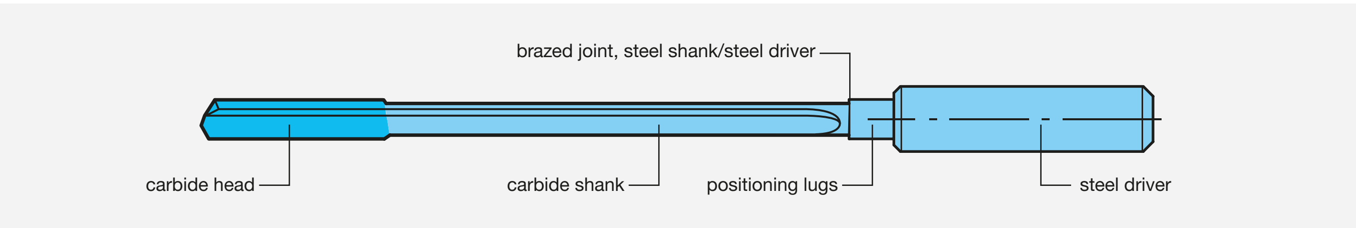
Range of applications

	Diameter range																		
	0.9	1.0	2.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0	52.0
EB 100 M		max. total length 615 mm																	
EB 100	max. total length 615 mm																		
EB 80			max. total length 3.600 mm																
ZB 80					max. total length 1.000 mm														
EB 800								max. total length 3.600 mm											

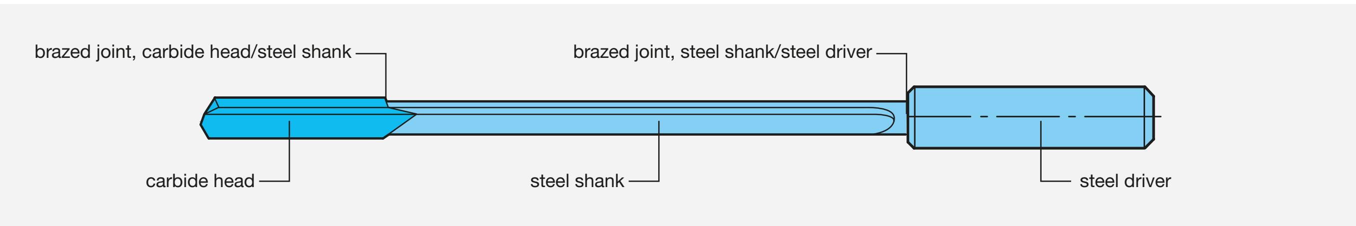
EB 100 M



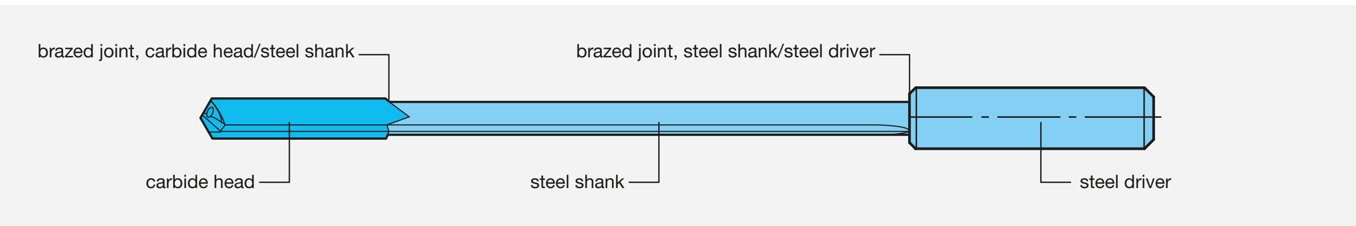
EB 100



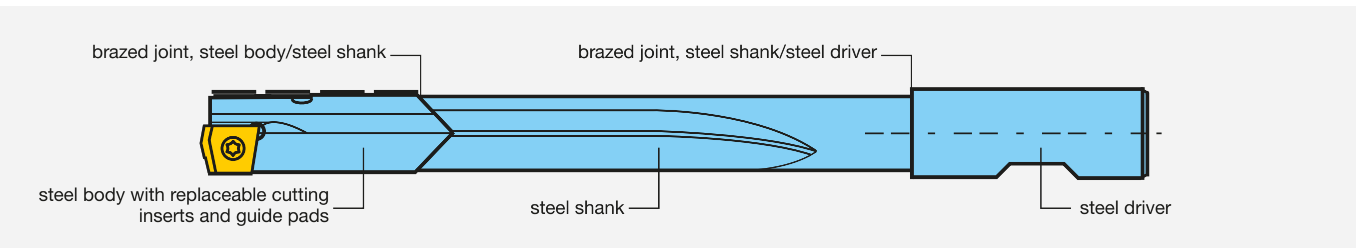
EB 80



ZB 80

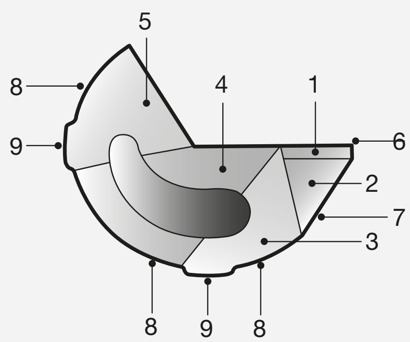


EB 800

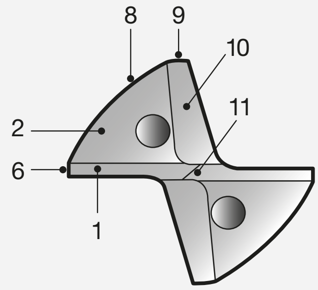


Characteristics

Characteristics – point grind EB



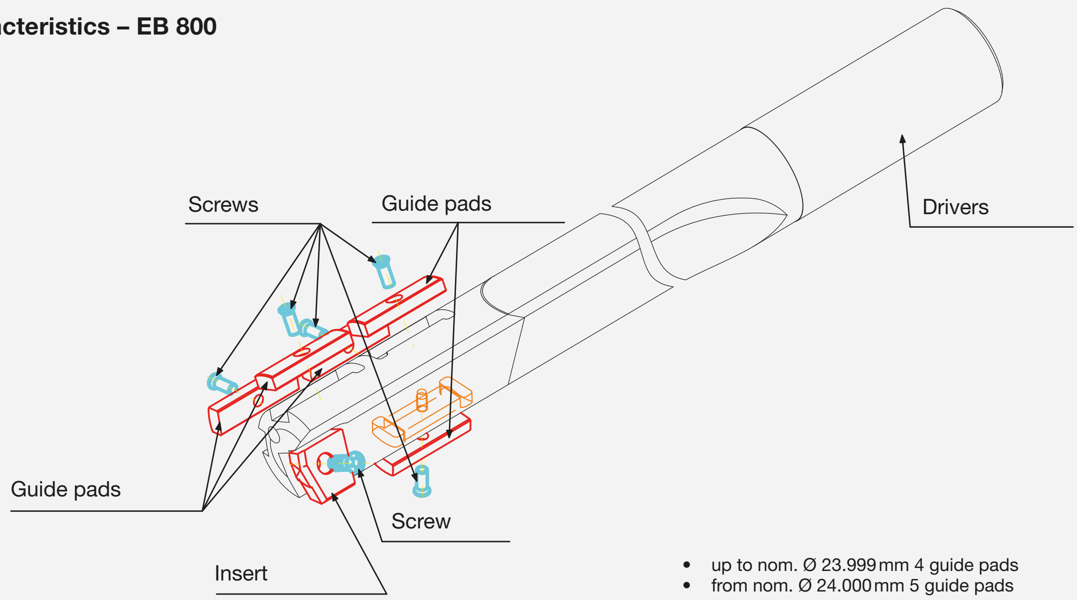
Characteristics – point grind ZB



Explanation:

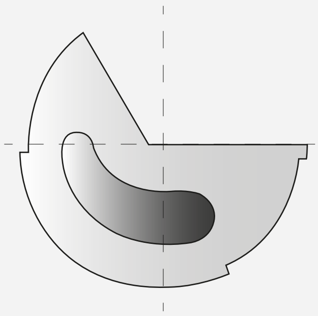
1 – Outer cutting edge, 1st flank
2 – Outer cutting edge, 2nd flank
3 – Flank, tip
4 – Inner cutting edge
5 – Oil chamber
6 – Secondary cutting edge (circular grinding chamfer)
7 – Primary clearance (oil pocket)
8 – Body clearance diameter
9 – Supporting strips (head form)
10 – Web thinning
11 – Chisel edge

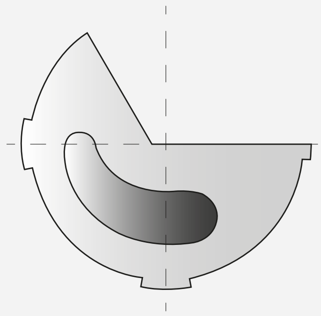
Characteristics – EB 800



- up to nom. Ø 23.999 mm 4 guide pads
- from nom. Ø 24.000 mm 5 guide pads

Standard head forms





Head form G

Standard head form. Suitable for most materials and drilling tasks. With this form, the tool diameter cannot be measured once it has been manufactured.

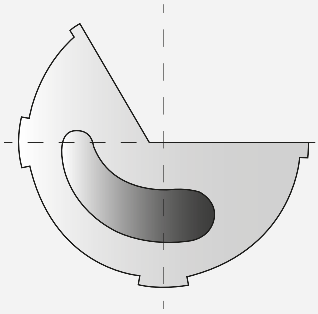
- suitable for most drilling tasks
- for all materials
- low deviation from concentricity
- reduced tendency to jam
- tight hole tolerances

Head form C

This head form is preferred where drilling tolerances are tight with regard to drill hole diameter and surface quality.

- for all materials
- steel, stainless steel, aluminium
- low deviation from concentricity
- reduced tendency to jam

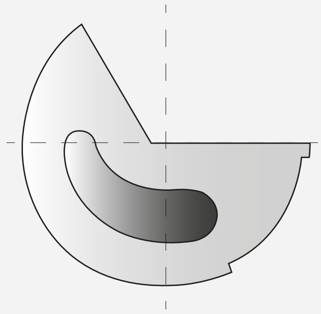
Special head forms



Head form A

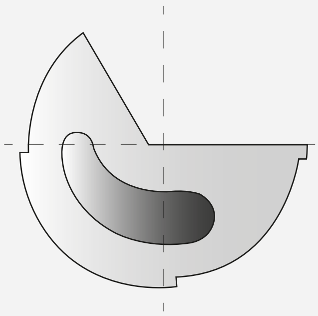
Head form for difficult drilling conditions when spot drilling and cross drilling. Machining of soft materials and/or where the lubrication performance of the cooling lubricant is poor. Used where tight drilling tolerances apply and as a guide part where extra long cutting heads are used.

- aluminium
- copper



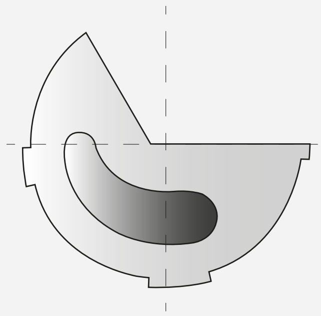
Head form D

This head form is used almost exclusively for soft materials such as grey cast iron, graphite etc. – especially in connection with tight drilling tolerances.



Head form E

Suitable for all materials, but for less stringent drilling tolerances.



Head form F

Head form for softer materials, lower friction and stable guidance, such as with aluminium.

This is just a small selection of our special head forms. Further special head forms for your particular application are available on enquiry.

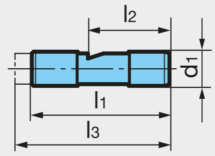
The range of drivers introduced below is available ex stock. However, it only represents a small selection of drivers from our complete range. We naturally also produce individual drivers of the highest precision to customer drawings.

Attention! EB 100 requires drivers with positioning lugs. Further information on request.

Drivers for EB 80

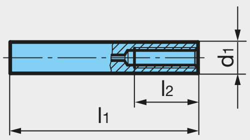
Drivers for deep drilling machines

(1) TBM-SEV



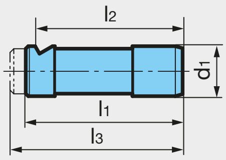
Code no.	d_1	l_1	l_2	l_3
1.1	10	40	24	-
1.2	10	40	24	45
1.3	10	40	24	55
1.4	16	45	31.2	-
1.5	25	70	34	-
1.6	25	70	34	78

(5) TBM-SGI



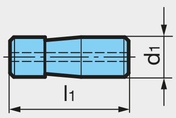
Code no.	d_1	l_1	l_2
5.1	10	60	20
5.2	16	80	28
5.3	25	100	50
5.4	10	100	20
5.5	10	110	24

(2) TBM-SV



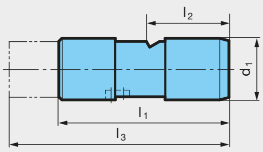
Code no.	d_1	l_1	l_2	l_3
2.1	16	50	47	-
2.2	16	50	47	55
2.3	16	50	47	70

(6) TBM-SKM



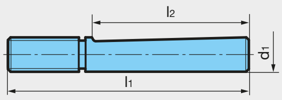
Code no.	d_1	l_1
6.1	12.7	38
6.2	19.05	70
6.3	38.1	70

(3) TBM-SEH



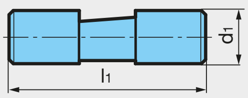
Code no.	d_1	l_1	l_2	l_3
3.1	25	70	34	-
3.2	25	70	34	100
3.3	25	70	34	105

(7) TBM-TRG



Code no.	d_1	l_1	l_2
7.1	16	112	73
7.2	20	126	82

(4) TBM-SFM

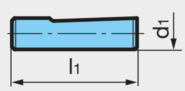


Code no.	d_1	l_1
4.1	19,05	70
4.2	12,7	70
4.3	25,4	70
4.4	31,75	70
4.5	38,1	70

Drivers to DIN 1835

form HE

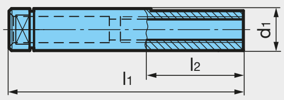
(9) TBM-SEV



Code no.	d_1	l_1
9.1	8	36
9.2	10	40
9.3	12	45
9.4	16	48
9.5	20	50
9.6	25	56
9.7	32	60
9.8	31.75	70
9.9	38.1	70
9.10	40	70

Drivers to VDI-draftrf

(12) TBM-VDI

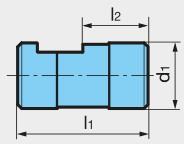


Code no.	d_1	l_1	l_2
12.1	10	68	40
12.2	16	90	40
12.3	25	112	50

also be used for
deep hole drilling machines

Drivers to Speed-Bit-System

(13) TBM-SPB



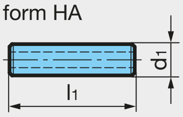
Code no.	d_1	l_1	l_2
13.1	16	40	14
13.2	25	50	25
13.3	35	60	20

also be used for
deep hole drilling machines

Drivers for EB 80

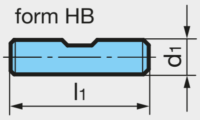
Drivers to DIN 6535

10 form HA

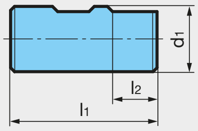


Code no.	d_1	l_1
10.1	8	36
10.2	10	40
10.3	12	45
10.4	16	48
10.5	20	50
10.6	25	56
10.7	32	60
10.8	25	70
10.9	40	70

8 form HB

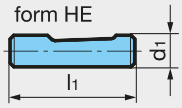


from code no. 8.6



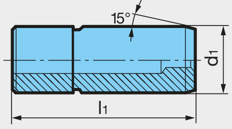
Code no.	d_1	l_1	l_2
8.1	8	36	-
8.2	10	40	-
8.3	12	45	-
8.4	16	48	-
8.5	20	50	-
8.6	25	56	17
8.7	32	60	19
8.8	40	70	19
8.9	50	80	23
8.10	63	90	23

11 form HE



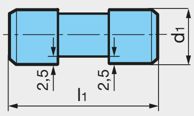
Code no.	d_1	l_1
11.1	8	36
11.2	10	40
11.3	12	45
11.4	16	48
11.5	20	50
11.6	25.4	70
11.7	25	56
11.8	32	60
11.9	40	70

16 sim. form HA (shrinkable)



Code no.	d_1	l_1
16.1	10	50
16.2	16	64
16.3	20	70
16.4	25	81
16.5	32	92

17 sim. form HE



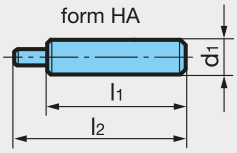
Code no.	d_1	l_1
17.1	19.05	70
17.2	25.4	70
17.3	31.75	70
17.4	38.1	70

also be used for
deep hole drilling machines

Drivers for EB 100

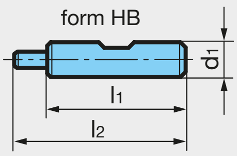
Drivers with positioning lugs to DIN 6535

18 form HA



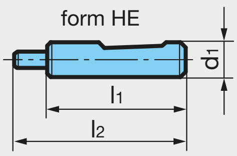
Code no.	d_1	l_1	l_2
4	4	28	40
6	6	36	51
10	10	40	55
12	12	45	60
16	16	48	63

19 form HB



Code no.	d_1	l_1	l_2
4	4	28	40
6	6	36	51
10	10	40	55
12	12	45	60
16	16	48	63

20 form HE

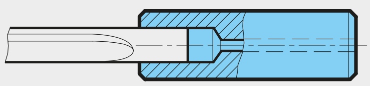


Code no.	d_1	l_1	l_2
4	4	28	40
6	6	36	51
10	10	40	55
12	12	45	60
16	16	48	63

Driver variations to suit gun drill tubes

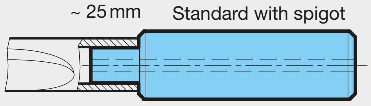
Solution for nom.-Ø < driver-Ø
(difference must be appr. 6 mm):
tube shank installed in driver

Standard



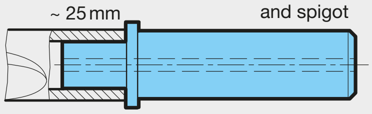
Solution for nom.-Ø ≠ driver-Ø
(close to parallel):
tube shank installed over spigot

~ 25 mm Standard with spigot



Solution for nom.-Ø > driver-Ø:
tube shank installed over spigot,
inside-Ø of tube shank >driver-Ø,
tube shank fits against collar shoulder.

~ 25 mm Standard with collar and spigot



Re-grinding and re-tipping

Even modern high-performance tools will wear at some point due to the enormous stresses they have to withstand. Guhring reproduces the tool performance thanks to professional re-grinding.

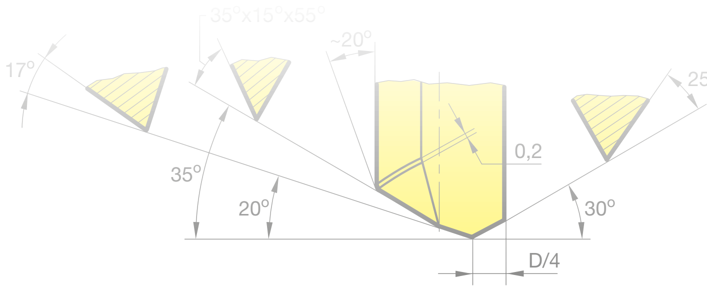
Thanks to the installation of identical machines and equipment in all re-grind centres a universal standard is ensured for gun drills of the highest quality.

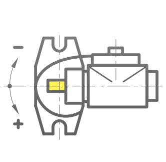
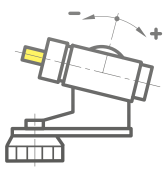
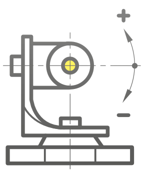
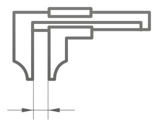
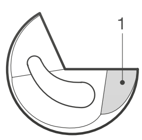
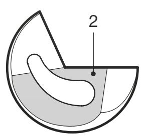
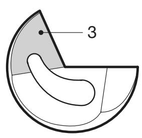
Solid carbide deep hole drills or deep hole drills with a brazed head can be re-ground up to 10 times, depending on the head length and wear mark width.

The following points must be taken into account:

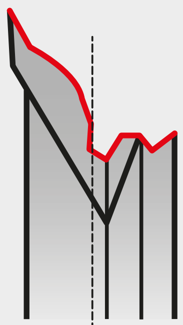
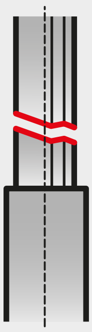
- The tool must be properly and cleanly re-ground, so that there are no traces of wear.
- The face of the tool must be smooth and shiny after re-grinding.
- At extra cost, the tools can also be coated after grinding.
- Deep hole drills with a brazed head can be fitted with a new one if the wear is severe or there is damage.
- Deep hole drills with positioning lugs are checked for concentricity after re-grinding and adjusted if necessary.
- Guideline values for the minimum head length when re-grinding, to ensure that the required quality of the drilled hole is achieved:

Diameter range	min. head length
Ø0.900 - Ø1.999	5 - 7 mm
Ø2.000 - Ø3.999	8 - 10 mm
Ø4.000 - Ø16.999	10 - 14 mm
Ø17.000 - Ø25.999	14 - 16 mm
Ø26.000 - Ø40.000	16 - 18 mm

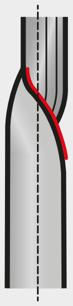
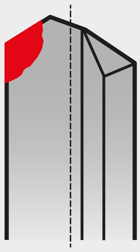
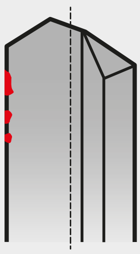


				
 1	- 25°	+ 30°	0°	
 2	+ 20°	+ 17°	0°	D/4
 3	+ 35°	+ 15°	+ 55°	

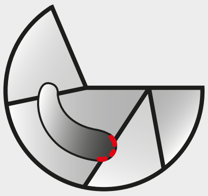
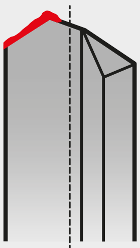
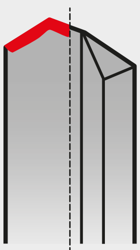
Application hints/Troubleshooting

Problem	Cause		Remedy
1. Tool breakage during spotting operation	Tool	- blunt cutting edge - incorrect point geometry - excessive feed rate - spotting at rapid feed rate - pre-damaged tool (breakage etc.) - too high length/diameter relation (LxD)	- re-grinding - correct point geometry - reduce feed rate - select drill feed - regrind- if necessary new tool - use several tools / support
	Pilot hole	- too small diameter - too large diameter - too poor drill hole quality (worn tool) - incorrect drilling method	- different tool (bigger Ø) - different tool (smaller Ø) - use new tool - correct programme
	Drill bush	- worn - broken - insufficient contact pressure /lifts off when spotting and chips get jammed - gap between bushes and workpiece / chips get entangled, chip jam	- new drill bush - new drill bush - increase contact pressure - correct position drill bushes
	Workpiece	- clamping not correct	- clamp workpiece correctly
	KSS	- coolant pressure too low, blockage - medium too contaminated --> blockage	- increase coolant pressure - control filtering
2. Tool breaks on the shank (drivers)	Tool	- too high length/diameter relation (LxD)	- use several tools / support
	Workpiece	- axis position of hole incorrect	- control workpiece clamping
	Machine	- machine to workpiece offset - drilling depth too deep (programming error)	- control offset and correct if necessary - control programming

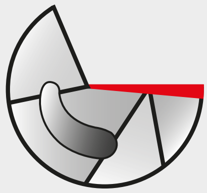
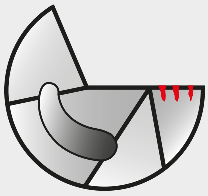
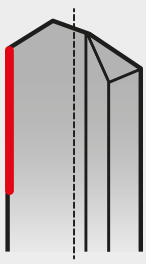
Application hints/Troubleshooting

Problem	Cause		Remedy
3. Tube bent/displaced 	Tool	- too high length / diameter relation (LxD) - excessive cutting forces (spec. torque)	- use several tools / support - reduce cutting data
	KSS	- coolant pressure too low, chip jam	- increase coolant pressure
4. Tool breaks/ flakes off	Tool	- overheating during grinding - side cutting edge (circular land) too blunt - tool not firmly clamped, oscillates axially - tool jams, flakes off during withdrawal - maximum tool life exceeded - machining performance too high - interrupted cut - deviation from concentricity too large	- correct parameters during grinding - control edge rounding on side cutting edge - optimise workpiece clamping - change cutting edge geometry or head form - shorten tool change intervals - reduce cutting data - reduce feed rates - check and correct concentricity if possible
	Pilot hole	- too large diameter (excessive play)	- different tool (smaller Ø)
	Drill bush	- too large diameter (excessive play)	- different drilling bush (smaller Ø)
	Workpiece	- insufficient clamping	- clamp workpiece correctly
5. Crumbling on round land	Tool	- interrupted cut	- reduce feed rates
	Pilot hole	- too large diameter (excessive play)	- different tool (smaller Ø)
	Drill bush	- too large diameter (excessive play) - gap between bushes and workpiece too large	- different drilling bush (smaller Ø) - reduce gap (drilling bush should ideally be in contact)
	Workpiece	- non-rigid conditions / insufficient work-piece clamping - transverse holes non closed (coolant loss)	- clamp workpiece correctly - seal transverse holes (Gühring sealing plugs)
	KSS	- unsuitable coolant for abrasive material	- choose suitable coolant, increase oil content of the emulsion / use oil

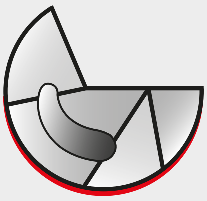
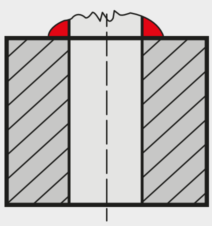
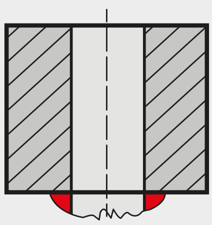
Application hints/Troubleshooting

Problem		Cause	Remedy
6. Crumbling on coolant duct 	Tool	- clearance angle too small - angle of oil space too small (insufficient oil flow) - material adhesions on face	- increase clearance angle - increase/adjust angle of oil space - tool coating if necessary
	KSS	- unsuitable coolant, improper oil (viscosity) or too thin emulsion (material deposits) - impure coolant due to small chips or other contamination	- choose suitable coolant, increase oil content of the emulsion / use oil - check filtering of the coolant, improve/ refine if necessary
7. Build-up on cutting edges 	Tool	- cutting speed too low - edge preparation/rounding of cutting edges too large - bright cutting edges - unsuitable cutting material - unsuitable coating	- increase cutting speed - reduce edge preparation / rounding of cutting edges - tool coating if necessary - suitable cutting material - choose different type of coating
	KSS	- unsuitable coolant, improper oil (viscosity) or too thin emulsion	- choose suitable coolant, increase oil content of the emulsion / use oil
8. Heavy crater wear 	Tool	- cutting speed too high - unsuitable chip shape - unsuitable cutting material	- reduce cutting speed - adjust point geometry - choose suitable cutting material, tool coating if necessary
	KSS	- unsuitable coolant, improper oil (viscosity) or too thin emulsion - coolant pressure / flow too low	- choose suitable coolant, increase oil content of the emulsion / use oil - increase coolant pressure / flow

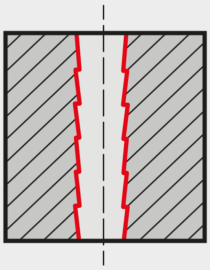
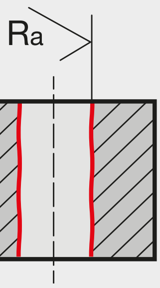
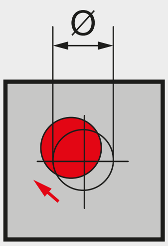
Application hints/Troubleshooting

Problem	Cause		Remedy
9. Wear at flank 	Tool	- cutting speed too high - chip brakes too strongly at the face - feed rate to small - clearance angle too small	- reduce cutting speed - remove coating on face - increase the feed rate - increase clearance angle
	KSS	- unsuitable coolant, improper oil (viscosity) or too thin emulsion	- choose suitable coolant, increase oil content of the emulsion / use oil
10. Comb cracks/chipping 	Tool	- excessive cutting forces - interrupted cut - wrong type of carbide selected - excessive cutting forces	- reduce cutting data - reduce feed rate - choose different type of carbide - reduce cutting data / change point geometry (angle of oil space)
	KSS	- unsuitable coolant, improper oil (viscosity) or too thin emulsion (too high temperatures due to insufficient lubrication)	- choose suitable coolant, increase oil content of the emulsion / use oil
11. Land wear 	Tool	- deviation from concentricity too large - back taper too small - edge preparation/ rounding of cutting edges too large - unsuitable point geometry for oil space (flow rate too low)	- check and correct concentricity if possible - enlarge back taper - reduce edge preparation / rounding of cutting edges - adjust oil space geometry (angle / recess / groove / 2. area)
	Workpiece	- non-rigid conditions / insufficient work-piece clamping	- clamp workpiece correctly
	KSS	- unsuitable coolant, improper oil (viscosity) or too thin emulsion	- choose suitable coolant, increase oil content of the emulsion / use oil

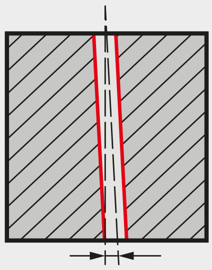
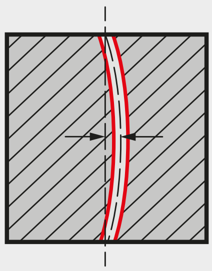
Application hints/Troubleshooting

Problem	Cause		Remedy
12. Wear on head form 	Tool	- deviation from concentricity too large - interrupted cut - wrong type of carbide selected - back taper too small - wrong coating selected	- check and correct concentricity if possible - reduce feed rates - correct carbide selection - enlarge back taper - correct coating selection
	Workpiece	- non-rigid conditions / insufficient work-piece clamping	- clamp workpiece correctly
	KSS	- unsuitable coolant for abrasive material	- choose suitable coolant, increase oil content of the emulsion / use oil
13. Large drill burr 	Tool	- excessive feed rate during spotting - maximum tool life exceeded (tool is blunt) - edge preparation / rounding of cutting edges too large - clearance angle too small	- reduce feed rate during spotting - shorten tool change intervals - reduce edge preparation / rounding of cutting edges - increase clearance angle
	Pilot hole	- too large diameter (excessive play)	- different tool (smaller Ø)
	Drill bush	- too large diameter (excessive play)	- different drilling bush (smaller Ø)
14. Large drill burr 	Tool	- excessive feed rate during drilling - maximum tool life exceeded (tool is blunt) - edge preparation / rounding of cutting edges too large	- reduce feed rate during drilling - shorten tool change intervals - reduce edge preparation / rounding of cutting edges

Application hints/Troubleshooting

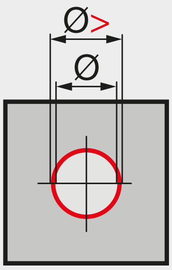
Problem	Cause		Remedy
15. Tool drills in steps	Tool	- drill head does not sit axially centered on the drill pipe (eb 80/eb 800) - coaxiality between head and shaft is too large	- re-braze the head / new tool - check coaxiality / use new tool
	Machine	- axis offset between spindle mount and drill bushes or pilot hole too large	- correct axis shifting, optimal is 0.02 mm offset
	KSS	- coolant pressure too high	- reduce coolant pressure
16. Unsatisfactory surface quality	Tool	- cutting edge broken - chamfer of side cutting edge (circular land) too large - weakly formed warping chamfer - too little pressure on the rear guide pads - deviation from concentricity too large - wrong coating selected	- regrind the tool - correct tool design - optimise warping chamfer - increase pressure by point geometry or by peeling chamfer/corner radius - check and correct concentricity if possible - correct coating selection
	Workpiece	- non-rigid conditions / insufficient work-piece clamping	- clamp workpiece correctly
	KSS	- coolant type / emulsion not sufficient - coolant qauntity not sufficient	- use oil if possible - increase coolant quantity (volume/pressure)
17. Centre offset	Tool	- deviation from concentricity too large	- check and correct concentricity if possible
	Pilot hole	- spotting on transverse area - wrong tool design	- apply pilot hole with milling cutter - optimize LxD / check tool-Ø
	Drill bush	- spotting on transverse area - worn drilling bush (inner Ø too large)	- use corrected drill bush - use new drill bush
	Workpiece	- non-rigid conditions / insufficient work-piece clamping	- clamp workpiece correctly
	Machine	- axis offset between spindle mount and drill bushes / pilot hole too large	- correct axis shifting, optimal is 0.02 mm offset

Application hints/Troubleshooting

Problem	Cause		Remedy
18. Large drilling path	Tool	- blunt cutting edge - incorrect point geometry - wrong head form - excessive feed rate - insufficient guidance - deviation from concentricity too large	- re-grinding - correct point geometry - correct head form - reduce feed rate - use long head section - check and correct concentricity if possible
	Pilot hole	- displacement of pilot hole - pilot hole non-circular	- check pilot hole if necessary different tool - adjust pilot tool
	Drill bush	- unsatisfactory drill bushing / drill bushing to drill bushing holder not correct	- change drilling bush if necessary also drill bush holder
	Workpiece	- non-rigid conditions / insufficient work-piece clamping - unfavourable drilling position / very thin walls - workpiece overheated (sharp rise in temperature)	- clamp workpiece correctly - consider drilling position if necessary correct - reduce cutting data
	Machine	- axis offset between spindle mount and drill bushes / pilot hole too large	- correct axis shifting, optimal is 0.02 mm offset
19. Unsatisfactory straightness of hole	Tool	- blunt cutting edge - incorrect point geometry - wrong head form - excessive feed rate - insufficient guidance - deviation from concentricity too large - wrong coating selected - too high length/diameter relation (LxD)	- re-grinding - correct point geometry - correct head form - reduce feed rate - use long head section - check and correct concentricity if possible - correct coating selection - use several tools / support
	Workpiece	- non-rigid conditions / insufficient work-piece clamping - unfavourable drilling position / very thin walls - workpiece overheated (sharp rise in temperature)	- clamp workpiece correctly - consider drilling position if necessary correct - reduce cutting data
	Machine	- workpiece without anti-clockwise rotating - axis offset between spindle mount and drill bushes / pilot hole too large	- if mechanically possible, drilling with anti-clockwise rotating - correct axis shifting, optimal is 0.02 mm offset

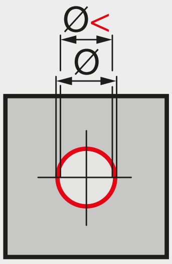
Application hints/Troubleshooting

20. Hole too large



Problem	Cause		Remedy
20. Hole too large	Tool	- too much pressure on the side cutting edge - deviation from concentricity too large	- change point geometry/ reduce pressure on the side cutting edge (change D/4 to D/3) - check and correct concentricity if possible
	KSS	- coolant pressure too high	- reduce coolant pressure

21. Hole too tight

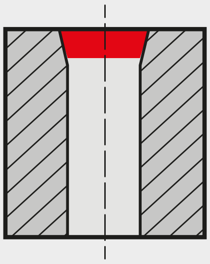
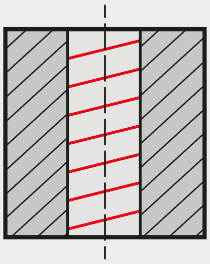
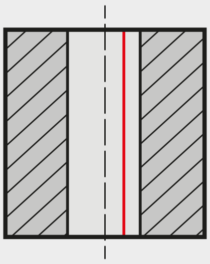


Problem	Cause		Remedy
21. Hole too tight	Tool	- too little pressure on the side cutting edge - wrong head form - tool reground too much (often) (back taper)	- change point geometry / increase pressure on side cutting edge (change D/3 to D/4) - correct head form (form “C”) - use new tool

22. Chip jam/ tool is blocked

Problem	Cause		Remedy
22. Chip jam/ tool is blocked	Tool	- ratio of cutting speed to feed rate does not fit - unsuitable point geometrie - flow chips - flow chips with coated tools - unsuitable point geometry for oil space (flow rate too low) - tool clamping leaking (coolant loss)	- correct/adjust ratio of cutting speed to feed - adjust point geometry to favor chip breaking - if necessary program Hiccup/Pecking - remove coating on face - adjust oil space geometry angle / recess / groove / 2. area - optimise workpiece clamping
	KSS	- coolant qauntity not sufficient	- increase coolant quantity (volume / pressure))

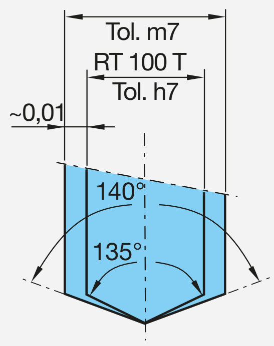
Application hints/Troubleshooting

Problem	Cause		Remedy
23. Large drilling width 	Tool	- excessive feed rate during spotting	- reduce feed rate during spotting
	Pilot hole	- displacement of pilot hole / non-circular	- check pilot hole if necessary use different tool
	Drill bush	- unsatisfactory drill bushing / drill bushing to drill bushing holder not correct	- change drill bush if necessary also drill bush holder
	Workpiece	- non-rigid conditions / insufficient workpiece clamping, vibrations during spotting	- clamp workpiece correctly
24. Spiralling 	Tool	- machining performance too high - blunt cutting edge - drill head does not sit axially centered on the drill pipe (EB80/EB800) - coaxiality between head and shaft is too large - wrong head form	- reduce cutting data - regrind tool / if necessary change - re-braze the head / new tool - check coaxiality / use new tool - correct head form
	Workpiece	- non-rigid conditions / insufficient workpiece clamping, vibrations during spotting	- clamp workpiece correctly / place vibration damper
25. Tool leaves retraction marks 	Tool	- feed rate too high when pulling out - cutting edges too sharp - deviation from concentricity too large - wrong head form	- reduce feed rate - cutting edge rounding - check and correct concentricity if possible - correct head form
	Workpiece	- non-rigid conditions / insufficient work-piece clamping	- clamp workpiece correctly
	Machine	- axis offset between spindle mount and drill bushes / pilot hole too large	- correct axis shifting, optimal is 0.02 mm offset

Application recommendations

The sequence of operations for deep hole drilling

- production of pilot hole (L = 1,5×D bis L = 3,0xD, tolerance G8)
- switching on coolant supply
- enter at revolutions of approx. 300 U/min, feed rate approx. 500 mm/min
- setting of revolutions and feed rate
- uninterrupted drilling to required drilling depth without wood pecking
- reducing revolutions to approx. 300 U/min
- withdrawal with max. 5,000 mm/min and rotating spindle



Pilot drill

All gun drills must have support for the pilot hole. Gun drills must never operate at full speed without support in the machine shop.

Procedure

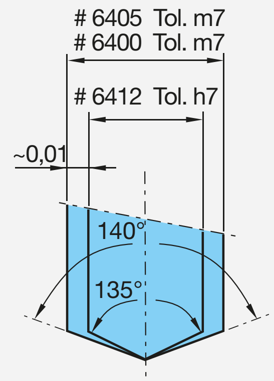
In order to achieve optimal machining results when producing deep holes especially spotting on radii or on an uneven surface structure, we recommend the following machining steps:

1. Initial milling of surface, i.e. with our centre cutting Ratio end mill RF 100 Diver. The surface must be machined at right angles to the entry angle of the drilling operation.
2. Producing of a cylindrical pilot hole, with a drilling depth of at least 1.5xD to 3xD (tolerance G8). For this operation we recommend our Ratio drills. Thanks to a 140° point angle and a m7 tolerance on diameter these Ratio drills are especially suitable for this machining task.
3. Setting of coolant pressure (see diagram „RT 100 T Pressure specifications") and switching on coolant supply.
4. Entry in the pilot hole at a speed of approx. 300 U/min and with a feed rate of approx. 500 mm/min.
5. Setting of speed and feed rate.
6. Uninterrupted drilling to required drilling depth without wood pecking.
7. For through holes with plain - i.e. 90° - exit, reduce feed rate v_f to 50 % approx. 1 mm prior to break-through.
   For through holes with oblique exit, reduce the feed rate v_f to 40% approx. 1 mm prior to break-through.
8. For through holes, reduce the speed to approx. 300 rpm after the final depth has been reached, or for blind holes, withdraw 1 mm from the bottom of the hole and then reduce the speed to approx. 300 rpm.
9. Withdrawal with max. 5,000 mm/min and rotating spindle.

Application recommendations

Solid carbide micro-precision drills

Pilot drilling
For the application of solid carbide micro-precision drills 15xD we recommend a pilot hole 1xD up to 2xD depth.
For this pilot hole, the solid carbide micro-precision drill 4xD is optimally suitable. His point angle and his diameter tolerance are perfectly adapted.



Filter quality
When applying solid carbide micro-precision drills we recommend constant monitoring of the lubricant's filter quality due to the extremely small coolant duct diameters, for example with our check instrument CC 3000 (fig. right).

General hints:
Play-free spindles, alignment accurate tool holders.
We recommend the use of hydraulic expansion chucks or shrink chucks.

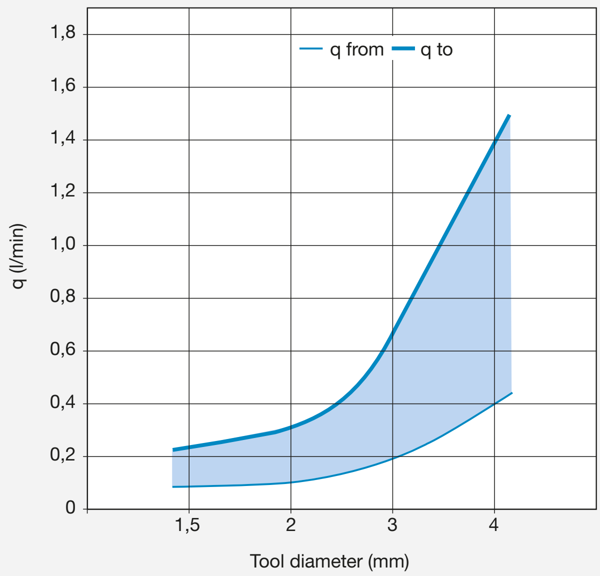
Notes regarding cooling:
We recommend using an emulsion for cooling lubrication: lubricant pressure at least 40 bar.

Coolant values

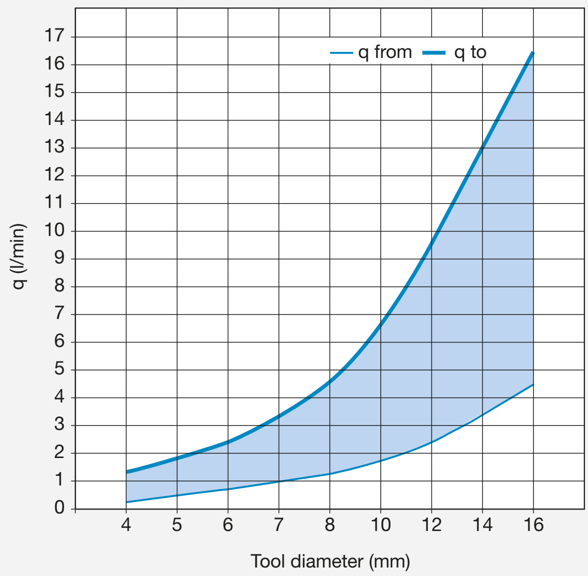
Please note:

- All gun drills must be applied with internal cooling, either air, soluble oil or oil. Without internal cooling the chips cannot be evacuated.
- All gun drills can be applied with oil as the medium for internal cooling.
  In this case, however, a higher pressure is required than with emulsions in order to obtain the same amount of coolant.
- When MQL is applied with gun drills an increase in pressure may be necessary for smaller nominal diameters dependent on the pressure of the MQL system.
- If the cooling lubricant data is insufficient the cutting parameters may be reduced. Pressure boosting systems are also possible.
- With increased gun drill length a pressure increase has to be expected to transport the required coolant volume through the coolant ducts.

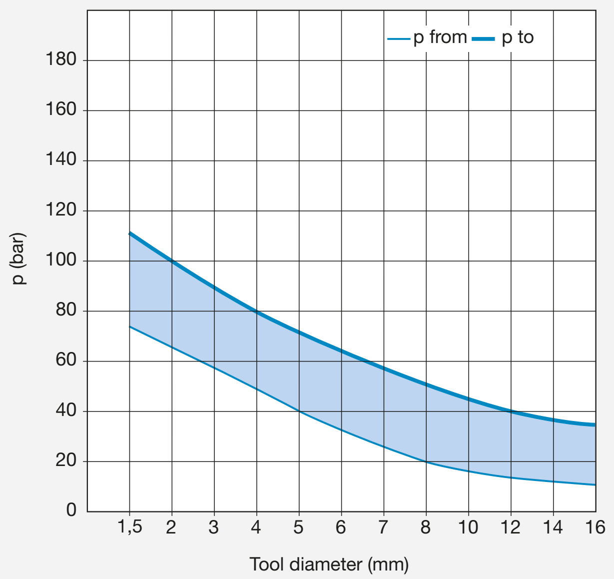
General flow data RT 100 T



General flow data RT 100 T



RT 100 T Pressure specifications
depending on tool length



Application recommendations

Pilot holes for drill lengths greater than DIN 1869

Before using the extra long HSS/HSCO drills according to DIN 1869 and factory standard, we recommend drilling a pilot hole.

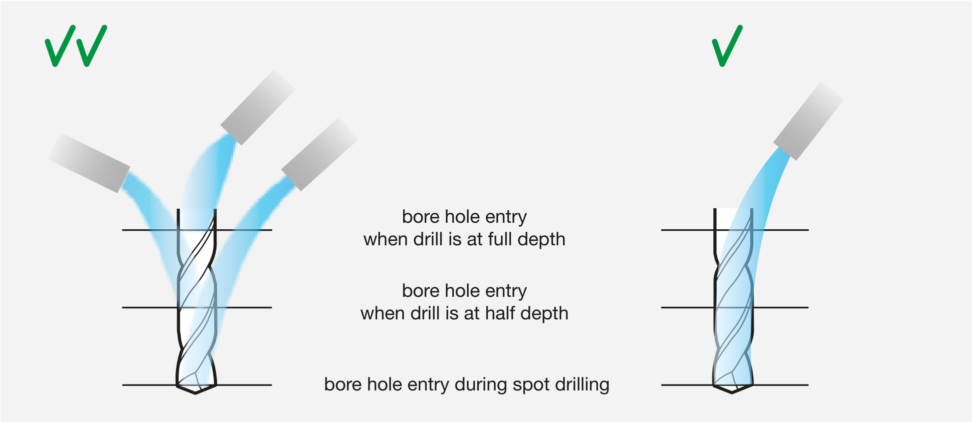
The following must be observed:

- The depth of the pilot hole should be 2-3xD.
- The point angle of the pilot drill should be at least as large or larger than the point angle of the deep hole drill.
- The diameter of the pilot drill should be equal to or up to 0.1 mm larger than the diameter of the deep hole drill.
- We recommend the use of an extra short twist drill according to DIN 1897 to drill the pilot hole, or alternatively a short twist drill according to DIN 338.

Procedure

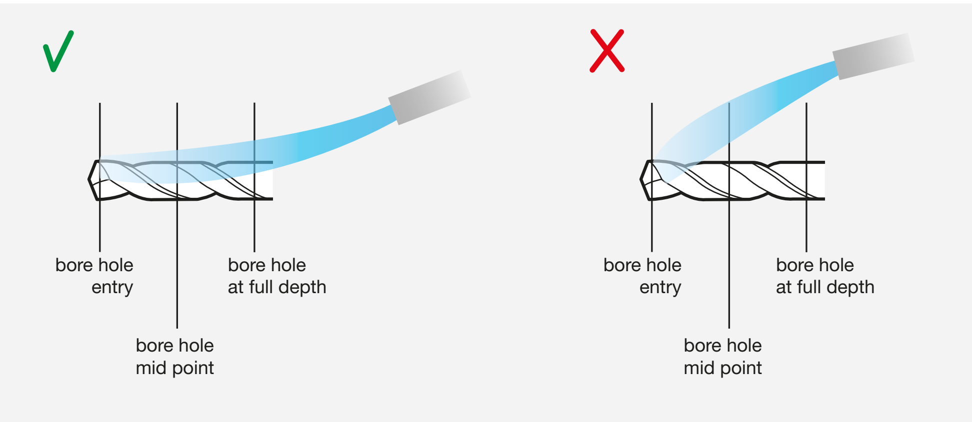
- The cooling lubricant supply must be adjusted in such a way that the entire cutting section of the deep hole drill is supplied with coolant.
- The approach to the component should be made with reduced rapid traverse, to avoid vibration of the deep hole drill.
- When introducing the deep hole drill into the pilot hole, we recommend reducing the rotational speed and feed speed by 50 %.
- As soon as the deep hole drill has reached 2/3 of the pilot hole depth, the rotational speed should be increased to the full working speed.
- Depending on the machining situation (vertical/horizontal machining) and the material to be machined, the chip removal cycles should be selected to allow optimum chip removal and avoid chip jams.
- The chip removal cycles can be run at working rotational speed and with an increased feed rate, making sure that a part of the deep hole drill – at least 1xD – always remains in the hole to keep it guided. Afterwards it is possible to advance to a depth of 2 mm before the previously drilled depth with the increased feed rate and the working rotational speed. The next drilling cycle is then started with the working feed rate and the working rotational speed.
- After the full drilling depth has been reached, it is possible to withdraw from the hole at the working speed and increased feed rate, provided that the hole was drilled with chip removal cycles.
  If drilling was carried out without chip removal cycles, we recommend reducing the rotational speed to 25 % of the working speed and slightly increasing the feed rate when withdrawing from the full drilling depth.

Vertical machining



Supplying the coolant via several nozzles is the ideal way to ensure constant cooling and lubrication.

Horizontal machining



If there is only one coolant nozzle, it is recommended to set the nozzle so that the drill still receives coolant when drilling to depth.

The new material abbreviations (selection)

Mat. nos.	Abbreviation old	Abbreviation old
0.6010	GG10	EN-GJL-100
0.6020	GG20	EN-GJL-200
0.6025	GG25	EN-GJL-250
0.6035	GG35	EN-GJL-350
0.7050	GGG50	EN-GJS-500-7
0.7070	GGG70	EN-GJS-700-2
0.8035	GTW35	EN-GJMW-350-4
0.8155	GTS55	EN-GJMB-550-4
0.8170	GTS70	EN-GJMB-700-2
1.0022	St 01Z	–
1.0035	St 33	S185
1.0039	St 37 -2	S235JRH
1.0044	St 44 -2	S275JR
1.0050	St 50 -2	E295
1.0060	St 60 -2	E335
1.0070	St 70 –2	E360
1.0114	St 37 –3U	S235J0
1.0226	St 02Z	DX51D
1.0242	StE 250 -2Z	S250GD
1.0244	StE 280 -2Z	S280GD
1.0250	StE 320 -3Z	S320GD
1.0301	C 10	–
1.0302	C 10 Pb	–
1.0306	St 06 Z	DX54D
1.0312	St 15	DC05 [Fe P05]
1.0319	RRStE 210.7	L210GA
1.0322	–	DX56D
1.0330	St 12 [St 2]	DC01 [Fe P01]
1.0333	USt 13	–
1.0338	St 14 [St 4]	DC04 [Fe P04]
1.0345	H I	P235GH
1.0347	RRSt 13 [RRSt 3]	DC03 [Fe P03]
1.0348	UH I	P195GH
1.0350	St 03Z	DX52D
1.0355	St 05Z	DX53D
1.0356	TTSt 35 N	P215NL
1.0358	St 05 Z	–
1.0401	C 15	–
1.0402	C 22	C22
1.0403	C 15 Pb	–
1.0406	C 25	C25
1.0419	St 52.0	L355
1.0424	St 45.8 (ersetzt)	P265
1.0424	St 42.8 (ersetzt)	P265
1.0425	H2	P265GH
1.0429	StE 290.7 TM	L290MB
1.0457	StE 240.7	L245NB
1.0459	RRStE 240.7	L245GA
1.0461	StE 255	S255N
1.0473	19 Mn 6	P355GH
1.0481	17 Mn 4	P295GH
1.0484	StE 290.7	L290NB
1.0486	StE 285	P275N
1.0501	C 35	C35
1.0503	C 45	C45
1.0505	StE 315	P315N
1.0511	C 40	C40
1.0528	C 30	C30
1.0529	StE 350 -3Z	S350GD
1.0535	C 55	C55
1.0539	StE 355N	S355NH
1.0540	C 50	C50
1.0547	St 52 –3U	S355J0H
1.0582	StE 360.7	L360NB
1.0601	C 60	C60
1.0710	15 S 10	–
1.0715	9 SMn 28	11SMn30
1.0718	9 SMnPb 28	11SMnPb30
1.0721	10 S 20	10S20
1.0722	10 S Pb 20	10SPb20
1.0726	35 S 20	35S20
1.0727	45 S 20	46S20

Mat. nos.	Abbreviation old	Abbreviation old
1.0728	60 S 20	–
1.0736	9 SMn 36	11SMn37
1.0737	9 SMnPb 36	11SMnPb37
1.0756	35 SPb 20	35SPb20
1.0757	45 SPb 20	46SPb20
1.0760	–	38SMn26
1.0761	–	38SMnPb26
1.0762	–	44SMn28
1.0763	–	44SMnPb28
1.0873	–	DC06 [Fe P06]
1.1103	EStE 255	S255NL1
1.1105	EStE 315	S315NL1
1.1121	Ck 10	C10E
1.1141	Ck15	C15E
1.1151	Ck 22	C22E
1.1158	Ck 25	C25E
1.1170	28 Mn 6	28Mn6
1.1178	Ck 30	C30E
1.1181	Ck 35	C35E
1.1186	Ck 40	C40E
1.1191	Ck 45	C45E
1.1203	Ck 55	C55E
1.1206	Ck 50	C50E
1.1221	Ck 60	C60E
1.1241	Cm 50	C50R
1.1750	C 75 W	C75W
1.2067	102 Cr 6	102Cr6
1.2080	–	X210Cr12
1.2083	–	X42Cr13
1.2419	–	105WCr6
1.2767	–	X45NiCrMo4
1.3243	S6-5-2-5	S 6-5-2-5
1.3343	S6-5-2	S 6-5-2
1.3344	S6-5-3	S 6-5-3
1.4000	X6Cr 13	X6Cr13
1.4002	X6CrAl 13	X6CrAl13
1.4003	X2Cr 11	X2CrNi12
1.4005	–	X12CrS13
1.4006	X10Cr 13	X12Cr13
1.4016	X6Cr 17	X6Cr17
1.4021	X20Cr 13	X20Cr13
1.4028	X30Cr 13	X30Cr13
1.4031	X38Cr 13	X38Cr13
1.4034	X46Cr 13	X46Cr13
1.4037	X65Cr13	X65Cr13
1.4057	X20CrNi 17 2	X17CrNi16-2
1.4104	X12CrMoS 17	X14CrMoS17
1.4105	X4CrMoS 18	X6CrMoS17
1.4109	X65CrMo 14	X70CrMo15
1.4110	X55CrMo 14	X55CrMo14
1.4112	X90CrMoV 18	X90CrMoV18
1.4113	X6CrMo 17 1	X6CrMo17-1
1.4116	X45CrMoV 15	X50CrMoV15
1.4120	X20CrMo 13	X20CrMo13
1.4122	X35CrMo 17	X39CrMo17-1
1.4125	X105CrMo 17	X105CrMo17
1.4301	X5CrNi 18 10	X5CrNi18-10
1.4303	X5CrNi 18 12	X4CrNi18-12
1.4305	X10CrNiS 18 9	X8CrNiS18-9
1.4306	X2CrNi 19 11	X2CrNi19-11
1.4310	X12CrNi 17 7	X10CrNi18-8
1.4311	X2CrNiN 18 10	X2CrNiN18-10
1.4313	X4CrNi 13 4	X3CrNiMo13-4
1.4318	X2CrNiN 18 7	X2CrNiN18-7
1.4335	X1CrNi 25 21	X1CrNi25-21
1.4361	X1CrNiSi 18 15	X1CrNiSi18-15-4
1.4362	X2CrNiN 23 4	X2CrNiN23-4
1.4401	X5CrNiMo 17 12 2	X5CrNiMo17-12-2
1.4404	X2CrNiMo 17 13 2	X2CrNiMo17-12-2
1.4410	X10CrNiMo 18 9	X2CrNiMoN25-7-4
1.4418	X4CrNiMo 16 5	X4CrNiMo16-5-1
1.4435	X2CrNiMo 18 14 3	X2CrNiMo18-14-3

Mat. nos.	Abbreviation old	Abbreviation old
1.4436	X5CrNiMo 17 13 3	X3CrNiMo17-13-3
1.4438	X2CrNiMo 18 16 4	X2CrNiMo18-15-4
1.4460	X4CrNiMo 27 5 2	X3CrNiMoN27-5-2
1.4462	X2CrNiMoN 22 5 3	X2CrNiMoN22-5-3
1.4509	X6CrTiNb 18	X2CrTiNb18
1.4510	X6CrTi 17	X3CrTi17
1.4511	X6CrNb 17	X3CrNb17
1.4512	X6CrTi 12	X2CrTi12
1.4520	X1CrTi 15	X2CrTi17
1.4521	X2CrMoTi 18 2	X2CrMoTi18-2
1.4522	X2CrMoNb 18 2	X2CrMoNb18-2
1.4532	X7CrNiMoAl 15 7	X8CrNiMoAl15-7-2
1.4541	X6CrNiTi18 10	X6CrNiTi18-10
1.4542	X5CrNiCuNb 17 4	X5CrNiCuNb16-4
1.4550	X6CrNiNb 18 10	X6CrNiNb18-10
1.4558	X2NiCrAlTi 32 20	X2NiCrAlTi32-20
1.4567	X3CrNiCu 18 9 X	X3CrNiCu18-9-4
1.4568	X7CrNiAl 17 7	X7CrNiAl17-7
1.4571	–	X6CrNiMoTi17-12-2
1.4577	X3CrNiMoTi 25 25	X3CrNiMoTi25-25
1.4592	X1CrMoTi 29 4	X2CrMoTi29-4
1.4713	X10CrAl 7	X10CrAlSi7
1.4724	X10CrAl 13	X10CrAlSi13
1.4742	X10CrAl 18	X10CrAlSi18
1.4762	X10CrAl 24	X10CrAlSi25
1.4821	X20CrNiSi 25 4	X20CrNiSi25-4
1.4828	X15CrNiSi 20 12	X15CrNiSi20-12
1.4833	X7CrNi 23 14	X7CrNi23-12
1.4841	X15CrNiSi 25 20	X15CrNiSi25-21
1.4845	X12CrNi 25 21	X12CrNi25-21
1.4864	X12NiCrSi 36 16	X12NiCrSi35-16
1.4878	X12CrNiTi18 9	X10CrNiTi18-10
1.4903	–	X10CrMoVNb9-1
1.5026	55 Si 7	55Si7
1.5131	50 MnSi 4	50MnSi4
1.5415	15 Mo 3	16Mo3
1.5530	21 MnB 5	20MnB5
1.5531	30 MnB 5	30MnB5
1.5532	38 MnB 5	38MnB5
1.5637	10 Ni 14	12Ni14
1.5662	–	X11CrMo5+I
1.5680	–	X12Ni5
1.5710	36 NiCr 6	36NiCr6
1.5715	–	16NiCrS4
1.5752	14 NiCr 14	15NiCr13
1.6210	15 MnNi 6 3	15MnNi6-3
1.6211	16 MnNi 6 3	16MnNi6-3
1.6310	20 MnMoNi 5 5	20MnMoNi5-5
1.6311	20 MnMoNi 4 5	20MnMoNi4-5
1.6341	11 NiMoV 5 3	11NiMoV5-3
1.6368	15 NiCuMoNb 5	15NiCuMoNb5
1.6511	36 CrNiMo 4	36CrNiMo4
1.6523	21 NiCrMo 2	21NiCrMo2-2
1.6526	21 NiCrMoS 2	21NiCrMoS2-2
1.6580	30 CrNiMo 8	30CrNiMo8
1.6582	34 CrNiMo 6	34CrNiMo6
1.6587	17 CrNiMo 6	18CrNiMo7-6
1.7003	38 Cr 2	38Cr2
1.7006	46 Cr 2	46Cr2
1.7016	17 Cr 3	17Cr3
1.7023	38 CrS 2	38CrS2
1.7025	46 CrS 2	46CrS2
1.7030	28 Cr 4	28Cr4
1.7033	34 Cr 4	34Cr4
1.7034	37 Cr 4	37Cr4
1.7035	41 Cr 4	41Cr4
1.7036	28 CrS 4	28CrS4
1.7037	34 CrS 4	34CrS4
1.7038	37 CrS 4	37CrS4
1.7039	41 CrS 4	41CrS4
1.7131	16 MnCr 5	16MnCr5
1.7139	16 MnCrS 5	16MnCrS5

Mat. nos.	Abbreviation old	Abbreviation old
1.7043	–	38Cr4
1.7147	20 MnCr 5	20MnCr5
1.7149	20 MnCrS 5	20MnCrS5
1.7176	55 Cr 3	55Cr3
1.7182	27 MnCrB 5 2	27MnCrB5-2
1.7185	33 MnCrB 5 2	33MnCrB5-2
1.7189	39 MnCrB 6 2	39MnCrB6-2
1.7213	25 CrMoS 4	25CrMoS4
1.7218	25 CrMo 4	25CrMo4
1.7219	–	26CrMo4-2
1.7220	34 CrMo 4	34CrMo4
1.7225	42 CrMo 4	42CrMo4
1.7226	34 CrMoS 4	34CrMoS4
1.7227	42 CrMoS 4	42CrMoS4
1.7228	50 CrMo 4	50CrMo4
1.7264	20 CrMo 5	20CrMo5
1.7321	20 MoCr 4	20MoCr4
1.7323	20 MoCrS 4	20MoCrS4
1.7333	22 CrMoS 3 5	22CrMoS3-5
1.7335	13 CrMo 4 4	13CrMo4-5
1.7362	12 CrMo 19 5	12CrMo19-5
1.7380	10 CrMo 9 10	10CrMo9-10
1.7383	–	11CrMo9-10
1.7779	–	20CrMoV13-5-5
1.8159	50 CrV 4	51CrV4
1.8504	34 CrAl 6	34CrAl6
1.8519	31 CrMoV 9	31CrMoV9
1.8550	34 CrAlNi 7	34CrAlNi7
1.8807	13 MnNiMoV 5 4	13MnNiMoV5-4
1.8812	18 MnMoV 5 2	18MnMoV5-2
1.8815	18 MnMoV 6 3	18MnMoV6-3
1.8821	StE 355 TM	P355M
1.8824	StE 420 TM	P420M
1.8826	StE 460 TM	P460M
1.8828	EStE 420 TM	P420ML2
1.8831	EStE 460 TM	P460ML2
1.8832	TStE 355 TM	P355ML1
1.8835	TStE 420 TM	P420ML1
1.8837	TStE 460 TM	P460ML1
1.8879	StE ...	P690Q
1.8880	WStE ...	P690QH
1.8881	TStE ...	P690QL1
1.8882	10 MnTi 3	10MnTi3
1.8888	EStE ...	P690QL2
1.8900	StE 380	S380N
1.8901	StE 460	S460N
1.8902	StE 420	S420N
1.8903	TStE 460	S460NL
1.8905	StE 460	P460N
1.8907	StE 500	S500N
1.8910	TStE 380	S380NL
1.8911	EStE 380	S380NL1
1.8912	TStE 420	S420NL
1.8913	EStE 420	S420NL1
1.8915	TStE 460	P460NL1
1.8917	WStE 500	S500NL
1.8918	EStE 460	P460NL2
1.8919	EStE 500	S500NL1
1.8930	WStE 380	P380NH
1.8932	WStE 420	P420NH
1.8935	WStE 460	P460NH
1.8937	TStE 500	P500NH
1.8972	StE 415.7	L415NB
1.8973	StE 415.7 TM	L415MB
1.8975	StE 445.7 TM	L450MB
1.8977	StE 480.7 TM	L485MB
1.8978	StE 550.7 TM	L555MB

Conversion table inch - millimetre from size 97 to 1 inch

Size (Inch)	mm	Part of inch (decimal)	Size (Inch)	mm	Part of inch (decimal)	Size (Inch)	mm	Part of inch (decimal)	Size (Inch)	mm	Part of inch (decimal)
-	0.10	0.0039	51	1.70	0.0670	4	5.31	0.2090	-	14.00	0.5512
97	0.15	0.0059		1.75	0.0689	3	5.41	0.213	9/16	14.29	0.5625
96	0.16	0.0063	50	1.78	0.0700		5.50	0.2165		14.50	0.5709
95	0.17	0.0067		1.80	0.0709	7/32	5.56	0.2188	37/64	14.68	0.5781
94	0.18	0.0071	49	1.85	0.0730	2	5.61	0.221	-	15.00	0.5906
93	0.19	0.0075		1.90	0.0748	1	5.79	0.228	19/32	15.08	0.5938
92	0.20	0.0079	48	1.93	0.0760	A	5.94	0.234	39/64	15.48	0.6094
91	0.21	0.0083		1.95	0.0768	15/64	5.95	0.2344		15.50	0.6102
90	0.22	0.0087	5/64	1.98	0.0781	-	6.00	0.2362	5/8	15.88	0.625
89	0.23	0.0091	47	1.99	0.0785	B	6.04	0.238	-	16.00	0.6299
88	0.24	0.0095	-	2.00	0.0787	C	6.15	0.242	41/64	16.27	0.6406
-	0.25	0.0098		2.05	0.0807	D	6.25	0.246		16.50	0.6496
87	0.25	0.0100	46	2.06	0.0810	1/4	6.35	0.25	21/32	16.67	0.6562
	0.26	0.0102	45	2.08	0.0820	E	6.35	0.25	-	17.00	0.6693
86	0.27	0.0105		2.15	0.0846		6.50	0.2559	43/64	17.07	0.6719
	0.27	0.0106	44	2.18	0.0860	F	6.53	0.257	11/16	17.46	0.6875
85	0.28	0.0110	43	2.26	0.0890	G	6.63	0.261		17.50	0.689
	0.29	0.0114	42	2.37	0.0935	17/64	6.75	0.2656	45/64	17.86	0.7031
84	0.29	0.0115	3/32	2.38	0.0938		6.75	0.2657	-	18.00	0.7087
-	0.30	0.0118	41	2.44	0.0960	H	6.76	0.266	23/32	18.26	0.7188
83	0.30	0.0120	40	2.50	0.0980	I	6.91	0.272		18.50	0.7283
82	0.32	0.0125	39	2.53	0.0995	-	7.00	0.2756	47/64	18.65	0.7344
	0.32	0.0126	38	2.58	0.1015	J	7.04	0.2772	-	19.00	0.748
81	0.33	0.0130	37	2.64	0.1040	K	7.14	0.281	3/4	19.05	0.75
80	0.34	0.0135	36	2.71	0.1065	9/32	7.14	0.2812	49/64	19.45	0.7656
79	0.37	0.0145	7/64	2.78	0.1094	L	7.37	0.29		19.50	0.7677
1/64	0.40	0.0156	35	2.79	0.11	M	7.49	0.2949	25/32	19.84	0.7812
78	0.41	0.0160	34	2.82	0.111		7.50	0.2953	-	20.00	0.7874
77	0.46	0.0180	33	2.87	0.113	19/64	7.54	0.2969	51/64	20.24	0.7969
-	0.50	0.0197		2.90	0.1142	N	7.67	0.3020		20.50	0.8071
76	0.51	0.0200	32	2.95	0.116		7.75	0.3051	13/16	20.64	0.8125
75	0.53	0.0210	-	3.00	0.1181	5/16	7.94	0.3125	-	21.00	0.8268
74	0.57	0.0225	31	3.05	0.12	-	8.00	0.315	53/64	21.03	0.8281
-	0.60	0.0236	1/8	3.18	0.125	O	8.03	0.316	27/32	21.43	0.8438
73	0.61	0.0240	30	3.26	0.1285	P	8.20	0.323		21.50	0.8465
72	0.64	0.0250		3.30	0.1299	21/64	8.33	0.3281	55/64	21.84	0.8594
71	0.66	0.0260	29	3.45	0.136	Q	8.43	0.332	-	22.00	0.8661
-	0.70	0.0276		3.50	0.1378		8.50	0.3346	7/8	22.23	0.875
70	0.71	0.0280	28	3.57	0.1405	R	8.61	0.339		22.50	0.8858
69	0.74	0.0292	9/64	3.57	0.1406	11/32	8.73	0.3438	57/64	22.62	0.8906
-	0.75	0.0295	27	3.66	0.144		8.75	0.3445	-	23.00	0.9055
68	0.79	0.0310	26	3.73	0.147	S	8.84	0.348	29/32	23.02	0.9062
1/32	0.79	0.0313		3.75	0.1476	-	9.00	0.3543	59/64	23.42	0.9219
-	0.80	0.0315	25	3.80	0.1495	T	9.09	0.358		23.50	0.9252
67	0.81	0.0320	24	3.86	0.152	23/64	9.13	0.3594	15/16	23.81	0.9375
66	0.84	0.0330	23	3.91	0.154	U	9.35	0.368	-	24.00	0.9449
65	0.89	0.0350	5/32	3.97	0.1562		9.50	0.374	61/64	24.21	0.9531
-	0.90	0.0354	22	3.99	0.157	3/8	9.53	0.375		24.50	0.9646
64	0.91	0.0360	-	4.00	0.1575	V	9.56	0.377	31/32	24.61	0.9688
63	0.94	0.0370	21	4.04	0.159	W	9.80	0.386	-	25.00	0.9843
62	0.97	0.0380	20	4.09	0.161	25/64	9.92	0.3906	63/64	25.00	0.9844
61	0.99	0.0390		4.20	0.1654	-	10.00	0.3937	1	25.40	1.00
-	1.00	0.0394	19	4.22	0.166	X	10.08	0.397			
60	1.02	0.0400	18	4.31	0.1695	Y	10.26	0.4040			
59	1.04	0.0410	11/64	4.37	0.1719	13/32	10.32	0.4062			
58	1.07	0.0420	17	4.39	0.173	Z	10.49	0.413			
57	1.09	0.0430	16	4.50	0.177		10.50	0.4134			
56	1.18	0.0465	15	4.57	0.18	27/64	10.72	0.4219			
3/64	1.19	0.0469	14	4.62	0.182	-	11.00	0.4331			
	1.20	0.0472	13	4.70	0.185	7/16	11.11	0.4375			
	1.25	0.0492	3/16	4.76	0.1875		11.50	0.4528			
	1.30	0.0512	12	4.80	0.189	29/64	11.51	0.4531			
55	1.32	0.0520	11	4.85	0.191	15/32	11.91	0.4688			
54	1.40	0.0550	10	4.91	0.1935	-	12.00	0.4724			
	1.45	0.0571	9	4.98	0.196	31/64	12.30	0.4844			
	1.50	0.0591	-	5.00	0.1968		12.50	0.4921			
53	1.51	0.0595	8	5.05	0.199	1/2	12.70	0.50			
	1.55	0.0610	7	5.11	0.2010	-	13.00	0.5118			
1/16	1.59	0.0625	13/64	5.16	0.2031	33/64	13.10	0.5156			
	1.60	0.0630	6	5.18	0.2040	17/32	13.49	0.5312			
52	1.61	0.0635	5	5.22	0.2055		13.50	0.5315			
	1.65	0.0650		5.25	0.2067	35/64	13.89	0.5469			

1 inch = 25.400 mm, see DIN 4890 (issue 2/75)

Milling tools

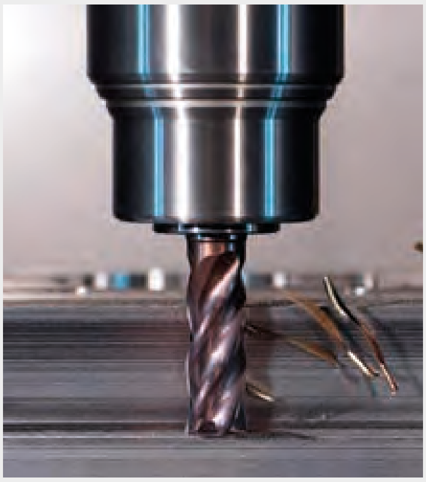
GÜHRING

Page

Correct milling with the most efficient strategies

HPC & HSC milling strategies

These milling strategies belong to the state-of-the-art and most effective application methods for current solid carbide milling tools. When applied, an enormously high metal removal rate ensures a considerable increase in productivity. Very high cutting parameters can be achieved even with less powerful machines or unstable machining conditions. With difficult-to-machine materials or unfavourable diameter-length-ratios of the tools a massive increase of process reliability can be achieved.



HPC **HIGH PERFORMANCE CUTTING**

max. metal removal rate/time → stable conditions; short de-clamping; high performance; good cooling

HSC **HIGH SPEED CUTTING**

at high speed/high feed rate → high dynamics; low cutting depth; low drive power

Principles and objectives

Maximum tool utilisation
- utilisation of entire cutting edge length
- full power delivery
- increased tool life
- balanced wear

Modification of cutting distribution
- low cutting widths a_e
- high cutting depths a_p

High process reliability
- low tool wrapping
- improved thermal conditions at tool cutting edge
- low mechanical stress

Maximum metal removal rate
- saving time/machine costs

Foundations for economically efficient milling

Peripheral requirements

Applicable in every material group

- P K H M S N
- easy to machine materials = increase in productivity
- difficult to machine materials = increase in process reliability

High-dynamic machining centres

- short acceleration distances
- higher speed range
- small to medium tool diameters

Heavy machines

- stable feed axes
- high spindle torque
- medium to large tool diameters

Unstable to stable workpiece clamping

- stable = vibration-free machining = maximum metal removal rate
- unstable = reduction of radial forces = increased process reliability

Application parameters

Low cutting width ae to 0.33 x D

- low angle of engagement <70°
- short t. of contact between cutting edge and component

Very high tooth feed f_z

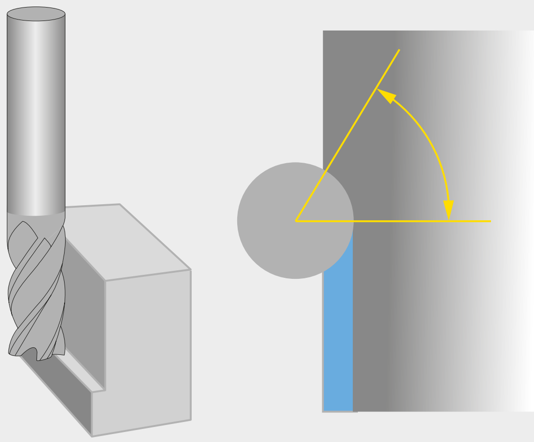
- reduced chip thickness allows considerably higher f_z

Very high cutting speed v_c

- reduced heating up and prolonged cooling down allow very high v_c values

High cutting depth a_p

- improved leverage effect
- high metal removal rate
- increase in contact points between tool and component



Tool angle of engagement &
tool contact time

Metal removal rate

The metal removal rate specifies how high the actual chip removal is per minute.
It is especially suitable for comparing different machining strategies.

$$a_p \text{ (mm) } \times a_e \text{ (mm) } \times v_f \text{ (m/min) } = Q \text{ (cm}^3\text{/min)}$$

Influence on process through tool engagement

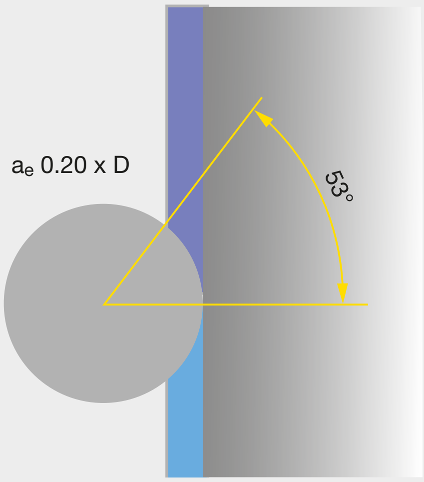
Angle of engagement

The angle of engagement inscribes the cutting range of the tool from start of chip formation to exit from the material. With these parameters the stress impacting on the tool can be assessed. With straight milling paths the angle is constant, with concave milling paths it increases and with convex milling paths it decreases.

Straight milling path

- constant angle of engagement
- constant tool stress

Example: a_e 0.20 x D = 53° engagement
Engagement remains a constant 53°



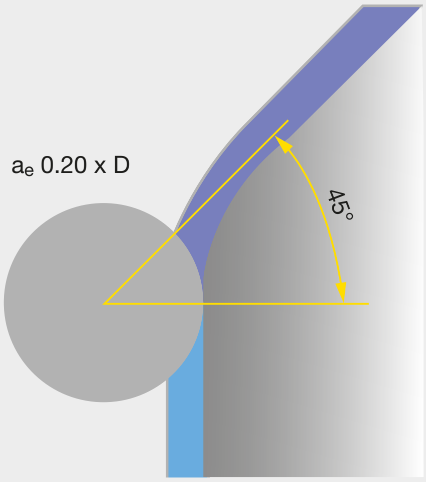
Angle of engagement with convex contour radii

Convex milling path

- decreasing angle of engagement
- reduced tool stress

Example: a_e 0.20 x D = 53° engagement
Engagement reduces to 45°

Measures: a_e may be increased
f_z can be increased



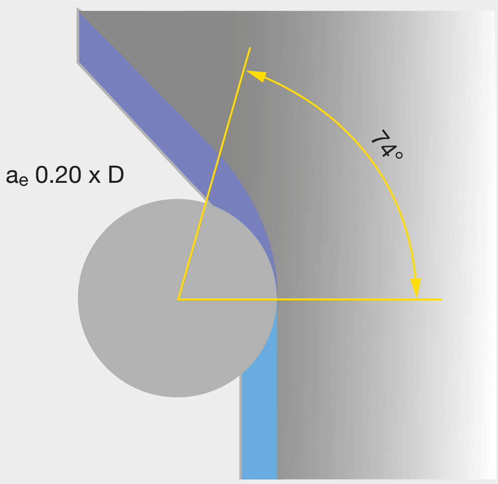
Angle of engagement with concave contour radii

Concave milling path

- increasing angle of engagement
- increased tool stress

Example: a_e 0.20 x D = 53° engagement
Engagement increases to 74°

Measures: a_e must be reduced
f_z must be reduced in radius



Influence on process through tool engagement

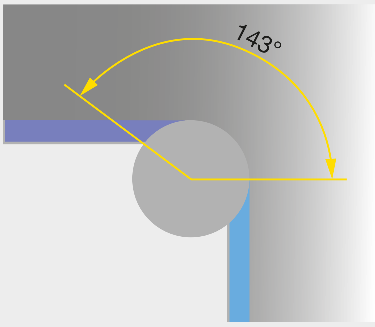
Angle of engagement with 90º corner radii

Tool radius = Corner radius
- very unfavourable for tool dynamics
- change of stress direction
- abrupt increase in tool stress

Example: Increase of engag. angle from 53° to 143° (270º)

Measures: v_c and f_z must be heavily reduced

a_e 0.20 x D

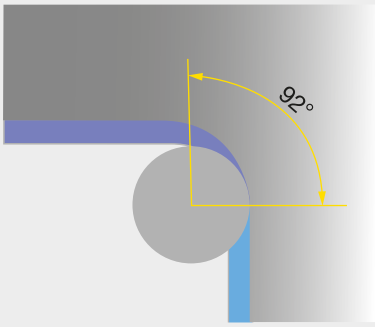


Tool radius < Corner radius
- machine can interpolate the path
- no "impact" on tool
- lower increase of tool stress

Example: Increase of engag. angle from 53° to 92° (174º)

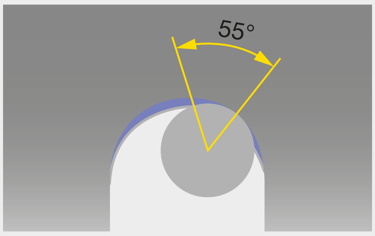
Measures: a_e must be reduced
f_z must be heavily reduced in radius

a_e 0.20 x D

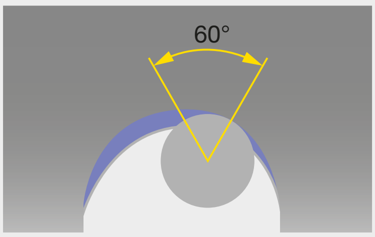


Ratio of flute width to tool diameter with trochoidal milling

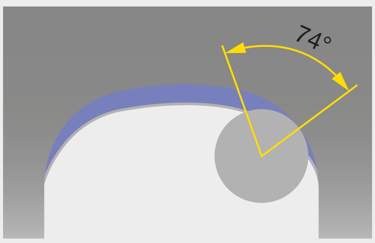
Flute width 1.7 – 2.0 x D
- cut in C-arc
- a_e max. 0.10 x D (theor. 37º)
- Increase of angles of engagement by up to 50%



Flute width 2.1 – 3.0 x D
- cut in C-arc
- a_e max. 0.15 x D (theor. 46º)
- increase of angles of engagement by up to 50%



Flute width ab 3.1 x D
- cut in D arc
- a_e max. 0,20 x D (theor. 53°)
- increase of angles of engagement by up to 40%



GTC HPC HSC

Guide values for increasing the cutting values with cutting edge lengths up to 3 x D					
GTC HPC HSC Roughing and HSC finishing					
Material	**Application**	**radial feed in % of Ø**	**vc factor ***	**fz factor ***	**Angle of engagement**
N P K M S	**Slotting**	**100%**	**1**	**1**	**180°**
	HPC Roughing	33%	1,5	1,3	70°
	HPC Roughing	25%	1,6	1,5	60°
	HPC Roughing	20%	1,7	1,6	53°
	HPC Roughing	15%	1,8	1,9	46°
	HSC Roughing	10%	1,9	2,3	37°
	HSC Roughing	8%	2,0	2,5	31°
	HSC Roughing	5%	2,1	2,5	26°
N P K M S	HSC Finishing	3%	2,0	1,2	20°
	HSC Finishing	2%	2,0	1,1	18°
	HSC Finishing	1%	2,0	1,0	11°
	HSC fine finishing	0,5	2,2	0,9	8°

* base value for the calculation with vc and fz factors is the value specified in the Guhring Navigator for "slotting" in the respective material group.

Base cutting values slotting – RF 100 tools – smooth cutting

Material	Hardness	Application	v_c	f_z (mm/z) with nom. Ø									
				3	4	5	6	8	10	12	16	20	25
P1	≤ 850 N/mm²	Slotting	180	0,015	0,020	0,025	0,030	0,040	0,060	0,072	0,096	0,120	0,150
P2	850-1200 N/mm²	Slotting	160	0,014	0,019	0,024	0,029	0,038	0,055	0,066	0,088	0,110	0,138
P3	850-1400 N/mm²	Slotting	135	0,014	0,018	0,023	0,027	0,036	0,050	0,060	0,080	0,100	0,125
M1	< 750 N/mm²	Slotting	120	0,014	0,018	0,023	0,027	0,036	0,050	0,060	0,080	0,100	0,125
M2	750-850 N/mm²	Slotting	80	0,012	0,016	0,020	0,024	0,032	0,045	0,054	0,072	0,090	0,113
M3	> 850 N/mm²	Slotting	70	0,011	0,014	0,018	0,021	0,028	0,040	0,048	0,064	0,080	0,100
S-Ni	≤ 1300 N/mm²	Slotting	30	0,008	0,011	0,014	0,017	0,022	0,032	0,038	0,051	0,064	0,080
S-Ti	≤ 1300 N/mm²	Slotting	60	0,012	0,016	0,020	0,024	0,032	0,045	0,054	0,072	0,090	0,113
K1	≤ 240 HB	Slotting	160	0,017	0,022	0,028	0,033	0,044	0,065	0,078	0,104	0,130	0,163
K2	> 240 HB	Slotting	140	0,015	0,020	0,025	0,030	0,040	0,055	0,066	0,088	0,110	0,138
Wr. al.alloy	≤ 5% Si	Slotting	500	0,020	0,026	0,033	0,039	0,052	0,075	0,090	0,120	0,150	0,188
Cast al. alloy	> 5% Si	Slotting	230	0,017	0,022	0,028	0,033	0,044	0,060	0,072	0,096	0,120	0,150
Non-fer.metals	≤ 850 N/mm²	Slotting	250	0,017	0,022	0,028	0,033	0,044	0,060	0,072	0,096	0,120	0,150

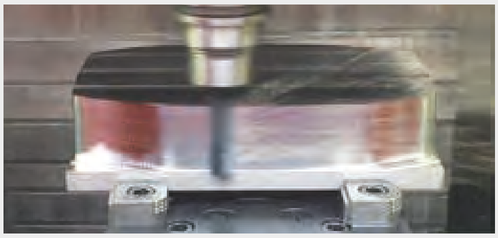
Metal removal rate $a_p \text{ (mm)} \times a_e \text{ (mm)} \times v_f \text{ (m/min)} = Q \text{ (cm}^3\text{/min)}$

Example:	HPC roughing: 15% a_e ; 2 x D a_p ; C45
Tool:	RF 100 U Ø 12mm - 4 flutes
Feed:	radial feed a_e 1.8 mm = 15% of D
Base value slotting	v_c slotting = 180 m/min, f_z slotting= 0.072 mm
Conversion:	v_c factor = 1.8 ⟶ v_c: 180 m/min x 1.8 = v_c 324 m/min f_z factor = 1.9 ⟶ f_z: 0.072 mm x 1.9 = f_z 0.137
Increased values:	v_c: 324 m/min / f_z: 0.137 mm n: 8594 U/min / v_f: 4710 mm/min
Metal removal rate:	Q = 203 cm³/min

HPC & HSC milling – fully optimised application examples

Application example – material 16MnCr5

RF 100 Speed, #6761, Ø 16 mm,
HPC clamping chuck + PINLock-safety
v_c 410 m/min f_z 0.450 mm h_m 0.123 mm
a_e 1.2 mm a_p 45 mm v_f 14690 mm/min
Q = 793 cm³/min



Application example – material Hardox 400 ®

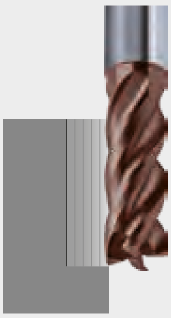
RF 100 U, #3871, Ø 20 mm,
Weldon clamping chuck
v_c 200 m/min f_z 0.180 mm h_m 0.049 mm
a_e 1.5 mm a_p 55 mm v_f 2290 mm/min
Q = 189 cm³/min

HPC & HSC milling – strategy comparison

Application comparison – material 42CrMo4

Gühring
RF 100 Diver, #6736, Ø 12 – Z4,
Weldon clamping chuck
v_c 300 m/min f_z 0.120 mm
n 7960 U/min v_f 3820 mm/min
a_e 1.5 mm a_p 24 mm
Q = 138 cm³/min

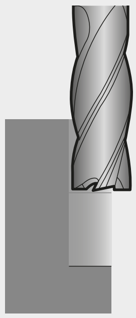
5 radial cuts per 1200 mm path
Machining time = **1.34 min**



Application comparison – material 42CrMo4

Competition
HPC milling cutter, Ø 16 – Z4
Weldon clamping chuck
v_c 140 m/min f_z 0.070 mm
n 2790 U/min v_f 780 mm/min
a_e 7.5 mm a_p 12 mm
Q = 70 cm³/min

2 axial cuts per 1200 mm path
Machining time = 3.05 min



Application comparison – material 1.4301

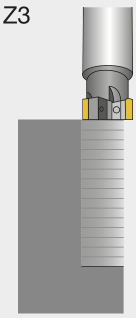
Gühring
RF 100 SF, #3632, Ø 16 – Z6,
Weldon clamping chuck
v_c 160 m/min f_z 0.100 mm
n 3185 U/min v_f 1910 mm/min
a_e 1.2 mm a_p 30 mm
Q = 69 cm³/min

10 radial cuts per 900 mm path
Machining time = **4.43 min**

Application comparison – material 1.4301

Competition
Indexable inserted milling cutter Ø 25 – Z3
v_c 200 m/min f_z 0.120 mm
n 2550 U/min v_f 920 mm/min
a_e 12 mm a_p 2 mm
Q = 22 cm³/min

15 axial cuts per 900 mm path
Machining time = 14.40 min

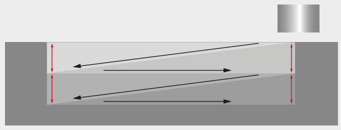


Plunging strategies and guide values

General plunging with standard face geometries Base f_z = f_z slotting

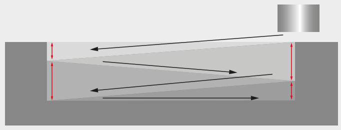
Ramping
- ramping angle = 2° - 5° to max. a_p 1 x D
- even load increase

f_z 75%



Oscillating
- ramping angle = 1° - 4° to max. a_p 1 x D
- results in load peaks

f_z 75%

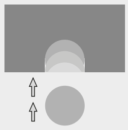


Helix
- feed = 0.05 – 0.1 x D per revolution
- smallest diameter to be produced = 1.7 x D

f_z 100%

Grooving
- alternative when problems through excess. radial forces
- a_e 0.25 x D – a_p cutting edge length / clearance ground length

f_z 100%



Drilling / pilot drilling
- max. depth feed 0.5 x D then pecking

f_z 50%

Special plunging – tools with special plunging geometry

RF 100 Diver - #6736 / #6737
- h10 cutting edge tolerance
- 36°/37°/38° helix
- reduced and nominal diameter
- good drilling characteristics
- very good milling characteristics

First choice: Milling and plunging

Ramping
- ramping angle = 15° - 45° to max. a_p 1 x D

Oscillating
- ramping angle = 10°-20° bis max. a_p 1 x D

Helix
- feed = 0.10 -0.30 x D pro Umdrehung
- smallest diameter to be produced = 1.7 x D

Grooving
- altern. when problems through excessive radial forces
- a_e 0.25 x D - a_p cutting edge length/ clearance grind

Drilling / pilot drilling
- max. depth feed 1.0 x D then pecking

Pilot milling cutter RF 100 P - #6716
- m8 cutting edge tolerance
- 30° helix
- a multitude of individual dimensions
- very good drilling characteristics
- sufficient milling characteristics

First choice: Drilling and pilot drilling

Cutting values “special plunging”
to cutting value tables RF 100 Diver & RF 100 P

GUHRING

General recommendation for tool cooling

Steel **Cast iron** **Hardened**	P K H	Dry machining, compressed air, MQL:	• Avoid thermal shock • Dissipate machining temperature via chip • Supporting chip evacuation
Stainless **Special alloy**	M S	Soluble oil, neat oil:	• Cooling of tool cutting edge • Preventing built-up edge • Supporting chip evacuation
Non-ferrous metals	N	Soluble oil, neat oil:	• Preventing built-up edge • Supporting chip evacuation

Exceptions for material ranges

P K

When **coolant** is not available the cutting speed (vc) and/or the radial feed (ae) should be reduced.
The resulting reduced temperature reduces the risk of thermal shock.

If there are **chip evacuation problems** the application of coolant should be taken into consideration, poor evacuation of chips can lead to massive tool wear and even tool breakage.

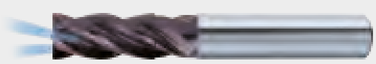
When **heat is being generated due to poor chip evacuation**, it should be checked if through coolant is available. By using a specifically directed "coolant jet", coolant can be supplied where congested without hitting the cutting area. Alternatively, the application of coolant for the entire machining operation is recommended.

Other notes

Finishing
The application of coolant is principally an advantage as a better surface finish can be achieved.

Very long tools
Coolant can result in a smoother process, as the lubricant has a vibration-reducing effect.

Alignment of coolant
- as acurate as possible in the cutting area from at least three directions
- no flushing back of small chips to the cutting area



Solid carbide milling cutters with internal cooling
- optimal chip evacuation, very good cutting edge cooling, very effective against built-up edges
- to be recommended especially for larger tool diameters and tough materials

Peripheral cooling / Guhrojet
Best external option: Optimal tool cooling and chip evacuation thanks to the direct route from coolant exit to cutting area

GÜHROJET

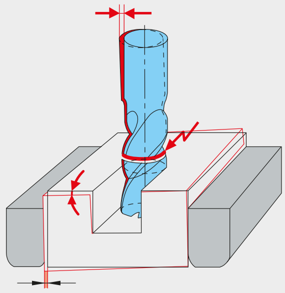
General notes

All the cutting rate recommendations specified in this catalogue are standard values valid exclusively for new tools or tools re-ground to Guhring specifications. Pre-requisites are stable machines, optimal cooling, optimal tool clamping and maximum concentricity of the tool and the machine spindle. Our recommended cutting rates must be reduced if the conditions deviate. The values may also be adjusted to influence surface quality, machining rate or tool life.

1. Workpiece clamping
Loss of tool life or tool breakage through unstable clamping

- improve workpiece clamping

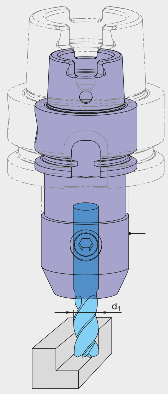
Alternative:
- reduce feed
- reduce cutting width or depth
- modify milling strategy



2. Tool clamping
Loss of tool life or tool breakage through unstable, worn or too small/long/thin tool holder

- apply new or larger tool holder or holder with increased clamping force and increased concentricity

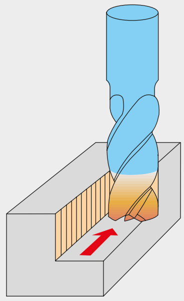
Alternative:
- reduce cutting rates
- reduce clamping length
- apply tool with smaller diameter
- check clamping screws for wear



3. Surface quality
Excessive peak-to-valley height Ra/Rz at the tool surface through excessive feed and feed rates or vibrations

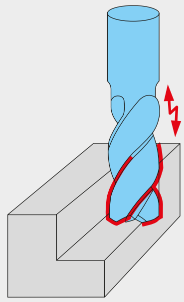
- improve workpiece clamping and tool clamping (see points 1 and 2)

Alternative:
- reduce feed and feed rate
- increase cutting speed
- use/improve cooling



4. Vibrations
High tool wear, insufficient workpiece surface quality and insufficient dimensional accuracy through vibration

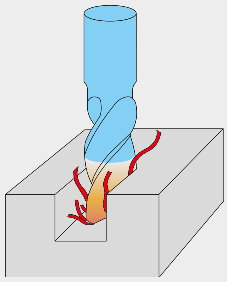
- improve workpiece and tool clamping (see points 1 and 2)
- increase tooth feed, because the chip centre thickness is too small
- modify speed
- modify milling strategy, i.e. select alternative cutting distribution
- change tool selection, i.e. reduce no. of teeth or spiral



5. Chip congestion/cooling
Significant reduction in tool life, crumbling on cutting lips, edge build-up or conglutination of flutes through insufficient chip evacuation

- select milling cutters with internal cooling

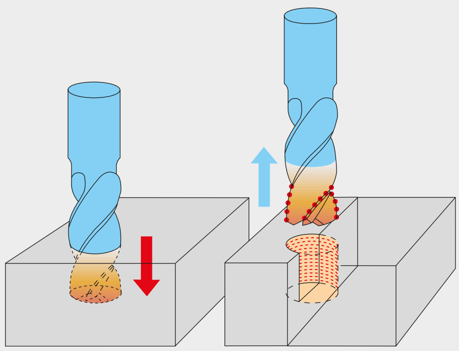
Alternative:
- peripheral cooling via GM 300 chuck
- increase volume flow
- adjust coolant flow
- apply compressed air cooling (according to tool and material)
- reduce feed rate
- modify cutting distribution



6. Pecking when drilling
Significant reduction in tool life as well as crumbling of cutting lips through insufficient chip evacuation and thermal stresses

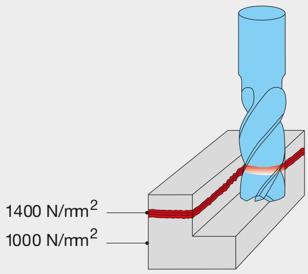
- select milling cutter with internal cooling
- with drilling depths > 0.5 x D pecking in stages

Alternative:
- peripheral cooling via GM 300 chuck
- increase volume flow
- adjust coolant flow
- reduce feed rate

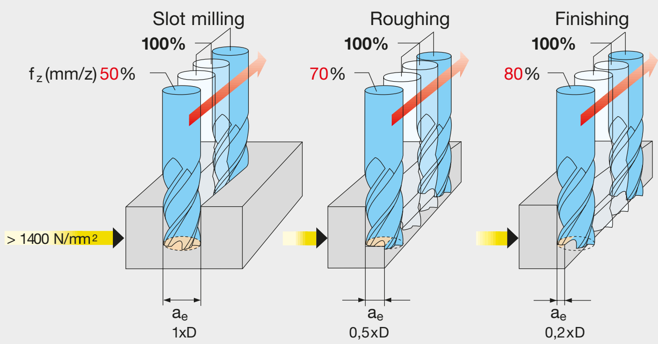


7. Thermal influence on materials
Through welding or torch cutting, the material characteristics at the parting line do not correspond with the specified material class

- reduce cutting rates
- select tool for materials with a higher tensile strength
- climb milling with solide carbide milling cutters



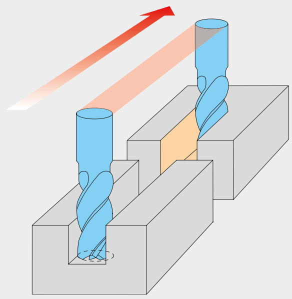
8. Entry in hardened materials
For entering materials over 1400 N/mm² (44HRC), reduce the feed rate v_f (mm/min) in accordance with the illustration on the right



9. Loss in tool life with interrupted cutting

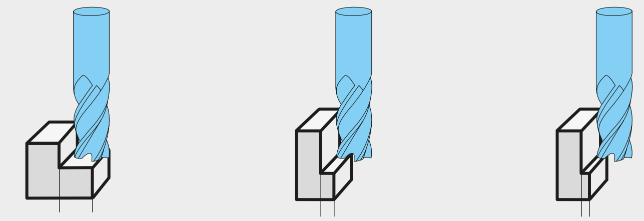
Significant loss in tool life through interrupted cutting (especially with milling angles of 90º)

- modify cutting distribution
- reduce feed rate for entry and exit
- reduce approach angle



10. Feed rate adjustment: Modifying the cutting width

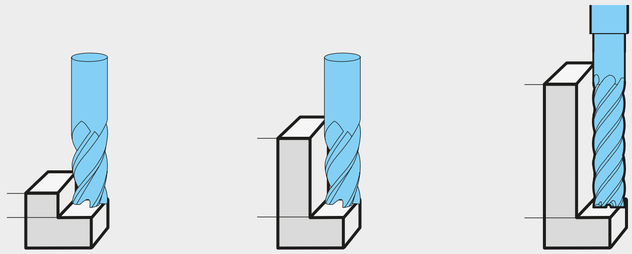
- when modifying the cutting width a_e, the feed rate must be reduced in accordance with the illustration on the right
- select cutting speed in accordance with cutting value tables
- for slotting and roughing with a feed of a_p > 1.5xD, v_c and f_z should be reduced by 25%



a_e = 1 x D f_z = 100 %	a_e = 0,66 x D f_z = 115 %	a_e = 0,25 x D f_z = 150 %

11. Feed rate adjustment: Modifying the cutting depth

- when modifying the cutting depth a_p, the feed rate must be reduced in accordance with the illustration on the right
- cutting speed or revolutions remain unchanged up to cutting depths of 2xD, must only be adapted over 2xD
- for longer tools revolutions and feed must be reduced in accordance with vibration



a_p = 1 x D f_z = 100 %	a_p = 2 x D f_z = 50 %	a_p = 3 x D f_z = 25 %

12. Plunging strategies:

for drilling

- reduce feed rate v_f (mm/min.)
- additional pecking for drilling depths > 0.5 x D or transition to radial machining

Attention: Danger of breakage through abrupt load increase!

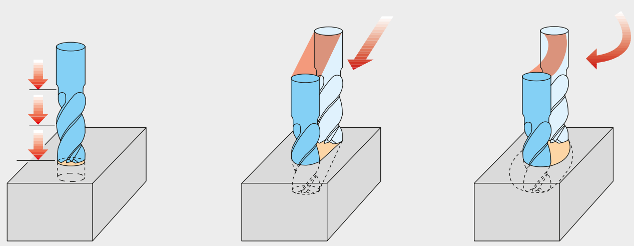
Oblique plunging up to 5º:

- reduce feed rate v_f (mm/min.) in accordance with the illustration on the right

Helical plunging:

- for helical plunging on a milling cycle, we recommend a feed of 0.1 to 0.2 per cycle
- reduce feed rate v_f (mm/min.) in accordance with the illustration on the right
- select preferred hole diameter 1.7 x D

Drilling	Oblique plunging	Helical plunging



90° f_z = 50 %	5° f_z = 75 %	f_z = 100 %

GUHRING

13. HSC milling with ball nosed copy milling cutters

HSC = High Speed Cutting:

Milling operations with very low metal removal but with consideration of the effective tool diameter.

3D machining with ball or Torus milling.

- **low cutting width (a_e)**
- **low cutting depth (a_p)**
- **high feed rate per tooth (f_z)**
- **very high cutting speed (v_c)**

Function and Advantages

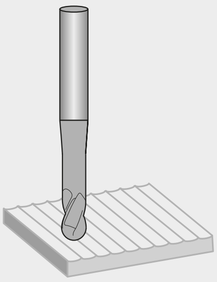
Calculation of the effective tool diameter

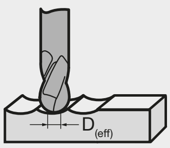
- adjusting speed to effective tool diameter
- Increasing the overall feed rate
- Improving the surface quality

Consideration of the pressure angle / width

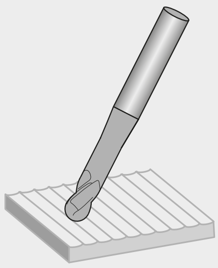
- adjusting the tooth feed to achieve the required surface quality

At cutting depths a_p <0.2xD the actual engaged effective diameter $D_{(eff)}$ must be used to calculate the speed. It is derived from the graphic below with the spindle not engaged. To increase the tool life, we recommend machining with a tilted spindle.



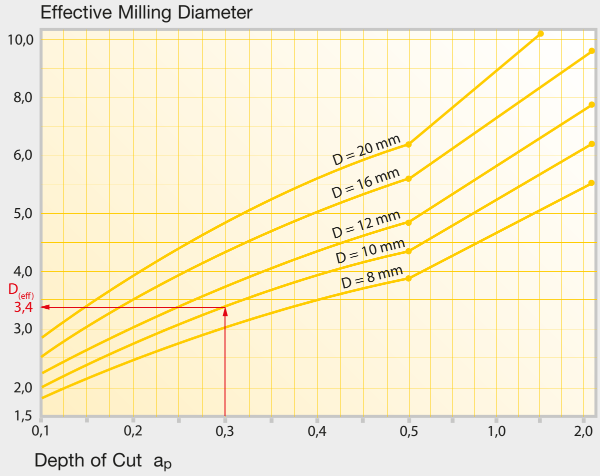


$$D_{(eff)} = 2 \cdot \sqrt{D \cdot a_p - a_p^2}$$

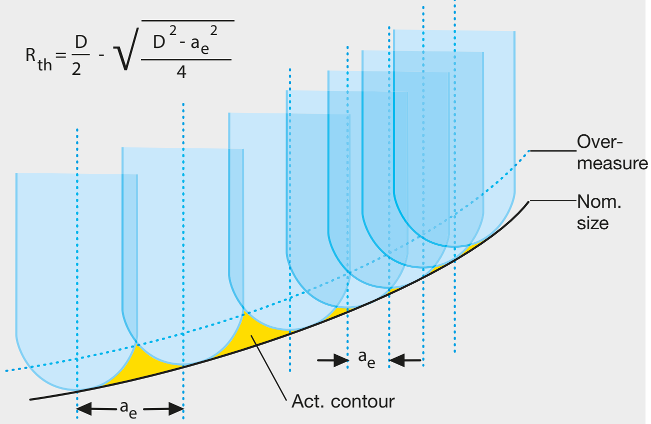


The ball-nosed milling cutter is perpendicular to the machining surface. In the centre of the tool is the cutting speed = 0 . Tool life and surface quality are not optimal.

The ball-nosed milling cutter is oblique to the machining surface. The centre of the tool is not engaged. Tool life and surface quality are improved.



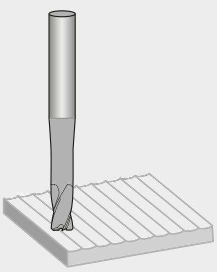
Example: For a full copy milling radius Ø 10 mm and a depth of cut a_p of 0.3 mm results in an effective diameter $D_{(eff)}$ = 3.4 mm
This $D_{(eff)}$ shall be used to calculate the cutting speed v_c



$$R_{th} = \frac{D}{2} - \sqrt{\frac{D^2 - a_e^2}{4}}$$

The reduction of the cutting width, ae. leads to an improvement of the surface quality of the workpiece (reduced peak-to-valley height).

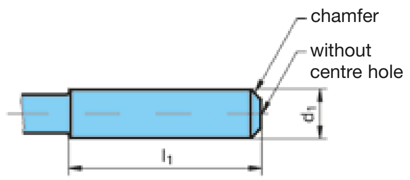
14. HSC milling with corner radius - copy milling cutters / Torus milling



HSC milling & Torus milling

3D-machining with Torus milling cutters. Engagement of the tool predominantly on the corner radius. Improves the surface quality and the tool life. Of advantage when 3D-machining flat contour areas on 3-axis machines.

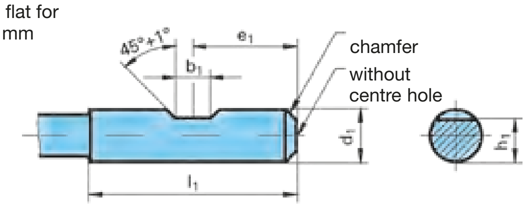
Form HA, plain
Dimensions in mm



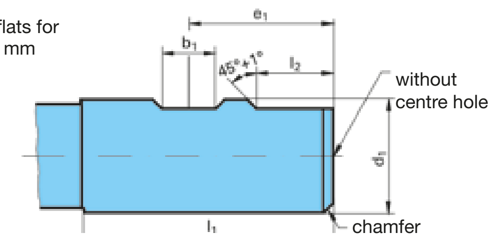
d_1 h6	l_1 +2 0	d_1 h6	l_1 +2 0	d_1 h6	l_1 +2 0
2	28	8	36	18	48
3	28	10	40	20	50
4	28	12	45	25	56
5	28	14	45	32	60
6	36	16	48		

Form HB, with drive flat
Dimensions in mm

with one drive flat for
d_1 = 6 and 20 mm



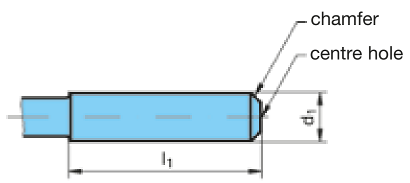
with two drive flats for
d_1 = 25 and 32 mm



d_1 h6	b_1 +0.05 0	e_1 0 -1	h_1 h11	l_1 +2 0	l_2 +1 0
6	4.2	18	5.1	36	–
8	5.5	18	6.9	36	–
10	7	20	8.5	40	–
12	8	22.5	10.4	45	–
14	8	22.5	12.7	45	–
16	10	24	14.2	48	–
18	10	24	16.2	48	–
20	11	25	18.2	50	–
25	12	32	23	56	17
32	14	36	30	60	19

High speed steel straight shanks, DIN 1835-1 (extract)

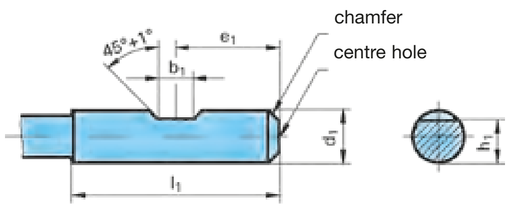
Form A, plain
Dimensions in mm



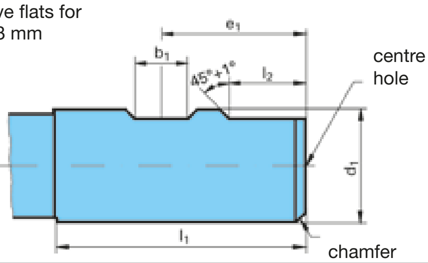
d_1 h8	l_1 +2 0	d_1 h8	l_1 +2 0	d_1 h8	l_1 +2 0
3	28	10	40	32	60
4	28	12	45	40	70
5	28	16	48	50	60
6	36	20	50	63	90
8	36	25	56		

Form B, with drive flat
Dimensions in mm

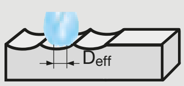
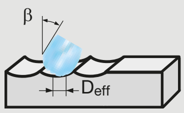
with one drive flat for
d_1 = 6 ... 20 mm

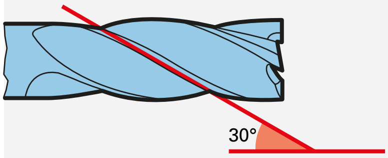


with two drive flats for
d_1 = 25 ... 63 mm



d_1 h6	b_1 +0.05 0	e_1 0 -1	h_1 h13	l_1 +2 0	l_2 +1 0	centre hole form R DIN 332 sect. 1
6	4.2	18	4.8	36	-	1.6x2.5
8	5.5	18	6.6	36	-	1.6x3.35
10	7	20	8.4	40	-	1.6x3.35
12	8	22.5	10.4	45	-	1.6x3.35
16	10	24	14.2	48	-	2.0x4.25
20	11	25	18.2	50	-	2.5x5.3
25	12	32	23	56	17	2.5x5.3
32	14	36	30	60	19	3.15x6.7
40	14	40	38	70	19	3.15x6.7
50	18	45	47.8	80	23	3.15x6.7
63	18	50	60.8	90	23	3.15x6.7

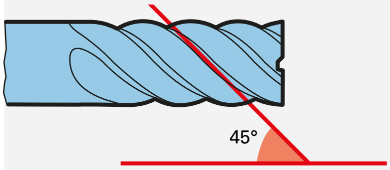
Symbol	Description	metric	Formula
z	No. of teeth		
D	Milling cutter diameter	mm	
a_p	Depth of cut	mm	
a_e	Width of cut	mm	
l_f	Milling length	mm	
n	Revolution per min.	U/min	$n = \frac{v_c \cdot 1000}{\pi \cdot D}$
v_c	Cutting speed	m/min	$v_c = \frac{\pi \cdot D \cdot n}{1000}$
v_f	Feed per min.	mm	$v_f = n \cdot z \cdot f_z$
f_z	Feed per tooth	mm	$f_z = \frac{v_f}{n \cdot z}$
f/U	Feed per revolution	mm	$f/U = \frac{v_f}{n}$
f/U	Feed per revolution	mm	$f/U = f_z \cdot z$
Q	Chip volume	cm^3/min	$Q = \frac{a_p \cdot a_e \cdot v_f}{1000}$
T	Milling time	min	$T = \frac{l_f}{v_f}$
hm	Average chip thickness	mm	$hm = fz \cdot \sqrt{\frac{a_e}{D}}$
$D_{(eff)}$	Effective diameter 	mm	$D_{(eff)} = 2 \cdot \sqrt{D \cdot a_p - a_p^2}$
	Effective diameter with approach angle 	mm	$D_{(eff)} = D \cdot \sin\left[\beta + \arccos\left(\frac{D - 2a_p}{D}\right)\right]$
R_{th}	Peak-to-valley height	mm	$R_{th} = \frac{D}{2} = \sqrt{\frac{D^2 - a_e^2}{4}}$
Z_b	Optimal step over for torus milling	mm	$Z_b = \frac{D - 2 \times R}{2}$



Type N

Quick spiral with 30° helical pitch, suitable for finish milling structural, case hardened and heat-treatable steels as well as short-chipping non-ferrous metals and materials up to

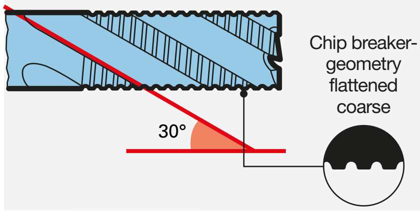
- 1200 N/mm² tensile strength applying high speed steel milling cutters
- 1600 N/mm² tensile strength applying solid carbide milling cutters



Type NH

Quick spiral with high 45° helical pitch, suitable for super fine finishing high-alloyed materials and grey cast iron up to appr.

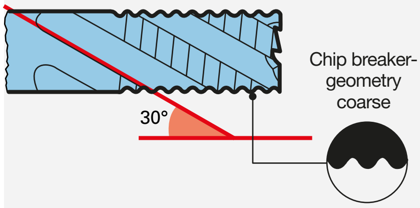
- 1600 N/mm² tensile strength



Type NF

Flat knuckle-type teeth/quick spiral, produces short chips and improved smoother surface quality in comparison to type NR or NRf. Suitable for milling standard materials up to appr.

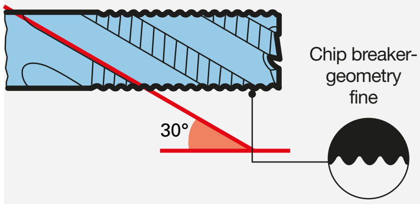
- 1200 N/mm² tensile strength applying high speed steel milling cutters
- 1600 N/mm² tensile strength applying solid carbide milling cutters



Type NR

Standard knuckle-type teeth, produces short chips and good chip evacuation. Suitable for milling standard materials up to appr.

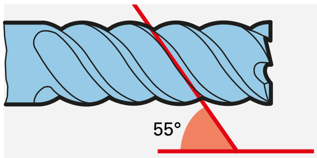
- 1000 N/mm² tensile strength applying high speed steel milling cutters
- 1200 N/mm² tensile strength applying solid carbide milling cutters



Type NRf

Fine knuckle-type teeth, produces short chips and good chip evacuation. Better feed rates possible than with type NR. Suitable for milling materials with a high tensile strength up to appr.

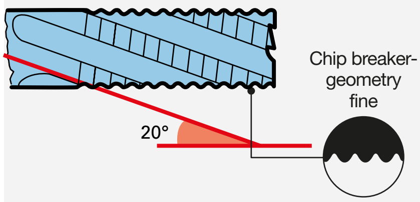
- 1400 N/mm² tensile strength applying high speed steel milling cutters
- 1600 N/mm² tensile strength applying solid carbide milling cutters



Type H

Quick spiral with high 55° helical pitch, suitable for super-fine finishing as well as HSC* machining of all hardened materials and chilled cast iron up to appr.

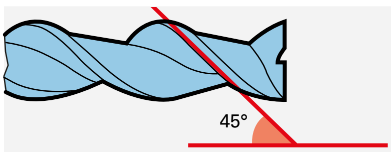
- 62 HRC hardness



Type HR

Fine knuckle-type teeth, produces short chips with good chip evacuation. Suitable for milling hardened materials as well as grey and chilled cast iron with up to appr.

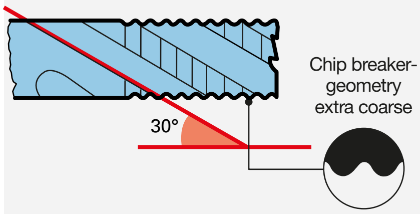
- 56 HRC hardness



Type W

Quick spiral with 45° helical pitch, suitable for finish milling soft materials such as aluminium, Al-alloys and non-ferrous metals up to appr.

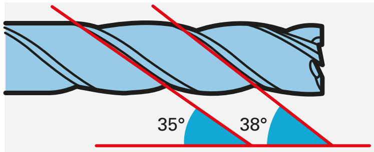
- 600 N/mm² tensile strength



Type WR

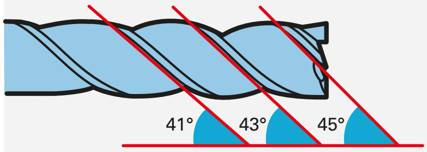
Coarse knuckle-type teeth, produces short chips with good chip evacuation. Suitable for milling aluminium, non-ferrous metals as well as soft steels up to appr.

- 600 N/mm² tensile strength.



RF 100 U (type N)

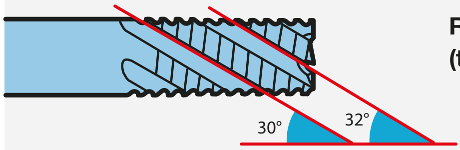
35°/38° helix. Suitable for slotting, roughing and finishing steel, high-alloyed steel and hardened steel up to
- 1600 N/mm² tensile strength (48 HRC)



RF 100 U (type NH) 3-fluted

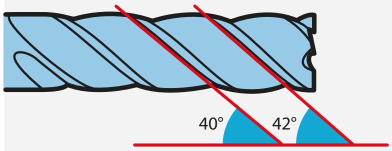
41°/43°/45° helix. Suitable for slotting, roughing and finishing steel, high-alloyed steel and stainless steel up to
- 1400 N/mm² tensile strength (44 HRC)

3-fluted suitable for extreme cutting depths



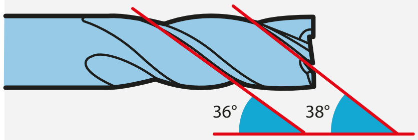
RF 100 U/HF (type HF)

30°/32° helix and roughing and finishing geometry. Suitable for slotting and roughing with large cutting widths and depths in steel, high-alloyed steel and hardened steel up to
- 1600 N/mm² tensile strength (48 HRC)



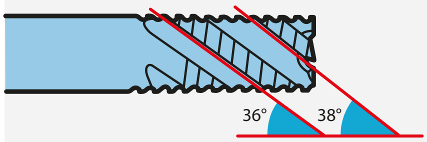
RF 100 F (type NH)

40°/42° helix. Suitable for slotting, roughing and finishing as well as HPC-milling/imachining tough steels as well as other long-chipping materials up to
- 850 N/mm² tensile strength (25 HRC)



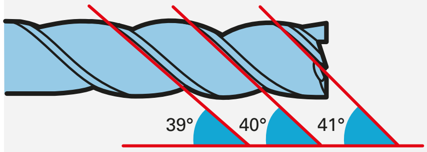
RF 100 VA (type N)

36°/38° helix. Suitable for slotting, roughing and finishing VA steels and stainless materials



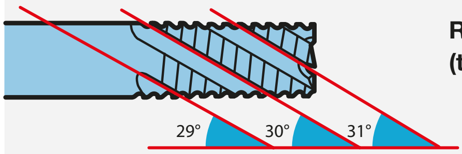
RF 100 VA/NF (type NF)

36°/38° helix and roughing and finishing geometry. Suitable for slotting and roughing VA steels and stainless materials



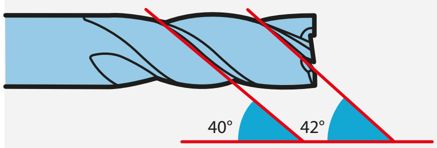
RF 100 A (type W)

39°/40°/41° helix. Suitable for slotting, roughing and finishing aluminium and Al-alloys as well as long-chipping materials and non-ferrous metals



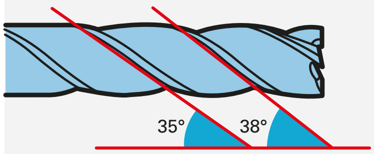
RF 100 A/WF (type WF)

29°/30°/31° helix and roughing and finishing geometry. Suitable for slotting and roughing aluminium and Al-alloys



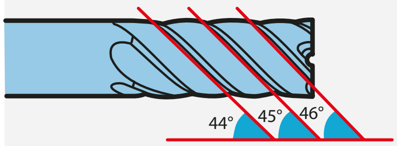
RF 100 H (type H)

40°/42° helix and progressive core diameter. Suitable for roughing up to 1xD in materials up to 54 HRC, for finishing over the entire cutting edge length in materials over 63 HRC. With HPC strategy suitable for roughing materials > 63 HRC.



RF 100 Ti (type N)

35°/38° helix with corner radius. Suitable for slotting and roughing of titanium alloys as well as difficult-to-cut alloys



RF 100 SF (type NH)

44°/45°/46° helix. Suitable for HSC super fine finishing for semi-roughing with feed widths up to max. 0.3xD and HPC roughing over the entire cutting edge length for standard steels, c ast iron, non-ferrous metals and high-alloyed materials

The new material abbreviations (selection)

mat. nos.	abbreviation old	abbreviation new
0.6010	GG10	EN-GJL-100
0.6020	GG20	EN-GJL-200
0.6025	GG25	EN-GJL-250
0.6035	GG35	EN-GJL-350
0.7050	GGG50	EN-GJS-500-7
0.7070	GGG70	EN-GJS-700-2
0.8035	GTW35	EN-GJMW-350-4
0.8155	GTS55	EN-GJMB-550-4
0.8170	GTS70	EN-GJMB-700-2
1.0022	St 01Z	–
1.0035	St 33	S185
1.0039	St 37 -2	S235JRH
1.0044	St 44 -2	S275JR
1.0050	St 50 -2	E295
1.0060	St 60 -2	E335
1.0070	St 70 –2	E360
1.0114	St 37 –3U	S235J0
1.0226	St 02Z	DX51D
1.0242	StE 250 -2Z	S250GD
1.0244	StE 280 -2Z	S280GD
1.0250	StE 320 -3Z	S320GD
1.0301	C 10	–
1.0302	C 10 Pb	–
1.0306	St 06 Z	DX54D
1.0312	St 15	DC05 [Fe P05]
1.0319	RRStE 210.7	L210GA
1.0322	–	DX56D
1.0330	St 12 [St 2]	DC01 [Fe P01]
1.0333	USt 13	–
1.0338	St 14 [St 4]	DC04 [Fe P04]
1.0345	H I	P235GH
1.0347	RRSt 13 [RRSt 3]	DC03 [Fe P03]
1.0348	UH I	P195GH
1.0350	St 03Z	DX52D
1.0355	St 05Z	DX53D
1.0356	TTSt 35 N	P215NL
1.0358	St 05 Z	–
1.0401	C 15	–
1.0402	C 22	C22
1.0403	C 15 Pb	–
1.0406	C 25	C25
1.0419	St 52.0	L355
1.0424	St 45.8 (ersetzt)	P265
1.0424	St 42.8 (ersetzt)	P265
1.0425	H2	P265GH
1.0429	StE 290.7 TM	L290MB
1.0457	StE 240.7	L245NB
1.0459	RRStE 240.7	L245GA
1.0461	StE 255	S255N
1.0473	19 Mn 6	P355GH
1.0481	17 Mn 4	P295GH
1.0484	StE 290.7	L290NB
1.0486	StE 285	P275N
1.0501	C 35	C35
1.0503	C 45	C45
1.0505	StE 315	P315N
1.0511	C 40	C40
1.0528	C 30	C30
1.0529	StE 350 -3Z	S350GD
1.0535	C 55	C55
1.0539	StE 355N	S355NH
1.0540	C 50	C50
1.0547	St 52 –3U	S355J0H
1.0582	StE 360.7	L360NB
1.0601	C 60	C60
1.0710	15 S 10	–
1.0715	9 SMn 28	11SMn30
1.0718	9 SMnPb 28	11SMnPb30
1.0721	10 S 20	10S20
1.0722	10 S Pb 20	10SPb20
1.0726	35 S 20	35S20
1.0727	45 S 20	46S20

mat. nos.	abbreviation old	abbreviation new
1.0728	60 S 20	–
1.0736	9 SMn 36	11SMn37
1.0737	9 SMnPb 36	11SMnPb37
1.0756	35 SPb 20	35SPb20
1.0757	45 SPb 20	46SPb20
1.0760	–	38SMn26
1.0761	–	38SMnPb26
1.0762	–	44SMn28
1.0763	–	44SMnPb28
1.0873	–	DC06 [Fe P06]
1.1103	EStE 255	S255NL1
1.1105	EStE 315	S315NL1
1.1121	Ck 10	C10E
1.1141	Ck15	C15E
1.1151	Ck 22	C22E
1.1158	Ck 25	C25E
1.1170	28 Mn 6	28Mn6
1.1178	Ck 30	C30E
1.1181	Ck 35	C35E
1.1186	Ck 40	C40E
1.1191	Ck 45	C45E
1.1203	Ck 55	C55E
1.1206	Ck 50	C50E
1.1221	Ck 60	C60E
1.1241	Cm 50	C50R
1.1750	C 75 W	C75W
1.2067	102 Cr 6	102Cr6
1.2080	–	X210Cr12
1.2083	–	X42Cr13
1.2419	–	105WCr6
1.2767	–	X45NiCrMo4
1.3243	S6-5-2-5	S 6-5-2-5
1.3343	S6-5-2	S 6-5-2
1.3344	S6-5-3	S 6-5-3
1.4000	X6Cr 13	X6Cr13
1.4002	X6CrAl 13	X6CrAl13
1.4003	X2Cr 11	X2CrNi12
1.4005	–	X12CrS13
1.4006	X10Cr 13	X12Cr13
1.4016	X6Cr 17	X6Cr17
1.4021	X20Cr 13	X20Cr13
1.4028	X30Cr 13	X30Cr13
1.4031	X38Cr 13	X38Cr13
1.4034	X46Cr 13	X46Cr13
1.4037	X65Cr13	X65Cr13
1.4057	X20CrNi 17 2	X17CrNi16-2
1.4104	X12CrMoS 17	X14CrMoS17
1.4105	X4CrMoS 18	X6CrMoS17
1.4109	X65CrMo 14	X70CrMo15
1.4110	X55CrMo 14	X55CrMo14
1.4112	X90CrMoV 18	X90CrMoV18
1.4113	X6CrMo 17 1	X6CrMo17-1
1.4116	X45CrMoV 15	X50CrMoV15
1.4120	X20CrMo 13	X20CrMo13
1.4122	X35CrMo 17	X39CrMo17-1
1.4125	X105CrMo 17	X105CrMo17
1.4301	X5CrNi 18 10	X5CrNi18-10
1.4303	X5CrNi 18 12	X4CrNi18-12
1.4305	X10CrNiS 18 9	X8CrNiS18-9
1.4306	X2CrNi 19 11	X2CrNi19-11
1.4310	X12CrNi 17 7	X10CrNi18-8
1.4311	X2CrNiN 18 10	X2CrNiN18-10
1.4313	X4CrNi 13 4	X3CrNiMo13-4
1.4318	X2CrNiN 18 7	X2CrNiN18-7
1.4335	X1CrNi 25 21	X1CrNi25-21
1.4361	X1CrNiSi 18 15	X1CrNiSi18-15-4
1.4362	X2CrNiN 23 4	X2CrNiN23-4
1.4401	X5CrNiMo 17 12 2	X5CrNiMo17-12-2
1.4404	X2CrNiMo 17 13 2	X2CrNiMo17-12-2
1.4410	X10CrNiMo 18 9	X2CrNiMoN25-7-4
1.4418	X4CrNiMo 16 5	X4CrNiMo16-5-1
1.4435	X2CrNiMo 18 14 3	X2CrNiMo18-14-3

mat. nos.	abbreviation old	abbreviation new
1.4436	X5CrNiMo 17 13 3	X3CrNiMo17-13-3
1.4438	X2CrNiMo 18 16 4	X2CrNiMo18-15-4
1.4460	X4CrNiMo 27 5 2	X3CrNiMoN27-5-2
1.4462	X2CrNiMoN 22 5 3	X2CrNiMoN22-5-3
1.4509	X6CrTiNb 18	X2CrTiNb18
1.4510	X6CrTi 17	X3CrTi17
1.4511	X6CrNb 17	X3CrNb17
1.4512	X6CrTi 12	X2CrTi12
1.4520	X1CrTi 15	X2CrTi17
1.4521	X2CrMoTi 18 2	X2CrMoTi18-2
1.4522	X2CrMoNb 18 2	X2CrMoNb18-2
1.4532	X7CrNiMoAl 15 7	X8CrNiMoAl15-7-2
1.4541	X6CrNiTi18 10	X6CrNiTi18-10
1.4542	X5CrNiCuNb 17 4	X5CrNiCuNb16-4
1.4550	X6CrNiNb 18 10	X6CrNiNb18-10
1.4558	X2NiCrAlTi 32 20	X2NiCrAlTi32-20
1.4567	X3CrNiCu 18 9 X	X3CrNiCu18-9-4
1.4568	X7CrNiAl 17 7	X7CrNiAl17-7
1.4571	–	X6CrNiMoTi17-12-2
1.4577	X3CrNiMoTi 25 25	X3CrNiMoTi25-25
1.4592	X1CrMoTi 29 4	X2CrMoTi29-4
1.4713	X10CrAl 7	X10CrAlSi7
1.4724	X10CrAl 13	X10CrAlSi13
1.4742	X10CrAl 18	X10CrAlSi18
1.4762	X10CrAl 24	X10CrAlSi25
1.4821	X20CrNiSi 25 4	X20CrNiSi25-4
1.4828	X15CrNiSi 20 12	X15CrNiSi20-12
1.4833	X7CrNi 23 14	X7CrNi23-12
1.4841	X15CrNiSi 25 20	X15CrNiSi25-21
1.4845	X12CrNi 25 21	X12CrNi25-21
1.4864	X12NiCrSi 36 16	X12NiCrSi35-16
1.4878	X12CrNiTi18 9	X10CrNiTi18-10
1.4903	–	X10CrMoVNb9-1
1.5026	55 Si 7	55Si7
1.5131	50 MnSi 4	50MnSi4
1.5415	15 Mo 3	16Mo3
1.5530	21 MnB 5	20MnB5
1.5531	30 MnB 5	30MnB5
1.5532	38 MnB 5	38MnB5
1.5637	10 Ni 14	12Ni14
1.5662	–	X11CrMo5+I
1.5680	–	X12Ni5
1.5710	36 NiCr 6	36NiCr6
1.5715	–	16NiCrS4
1.5752	14 NiCr 14	15NiCr13
1.6210	15 MnNi 6 3	15MnNi6-3
1.6211	16 MnNi 6 3	16MnNi6-3
1.6310	20 MnMoNi 5 5	20MnMoNi5-5
1.6311	20 MnMoNi 4 5	20MnMoNi4-5
1.6341	11 NiMoV 5 3	11NiMoV5-3
1.6368	15 NiCuMoNb 5	15NiCuMoNb5
1.6511	36 CrNiMo 4	36CrNiMo4
1.6523	21 NiCrMo 2	21NiCrMo2-2
1.6526	21 NiCrMoS 2	21NiCrMoS2-2
1.6580	30 CrNiMo 8	30CrNiMo8
1.6582	34 CrNiMo 6	34CrNiMo6
1.6587	17 CrNiMo 6	18CrNiMo7-6
1.7003	38 Cr 2	38Cr2
1.7006	46 Cr 2	46Cr2
1.7016	17 Cr 3	17Cr3
1.7023	38 CrS 2	38CrS2
1.7025	46 CrS 2	46CrS2
1.7030	28 Cr 4	28Cr4
1.7033	34 Cr 4	34Cr4
1.7034	37 Cr 4	37Cr4
1.7035	41 Cr 4	41Cr4
1.7036	28 CrS 4	28CrS4
1.7037	34 CrS 4	34CrS4
1.7038	37 CrS 4	37CrS4
1.7039	41 CrS 4	41CrS4
1.7131	16 MnCr 5	16MnCr5
1.7139	16 MnCrS 5	16MnCrS5

mat. nos.	abbreviation old	abbreviation new
1.7043	–	38Cr4
1.7147	20 MnCr 5	20MnCr5
1.7149	20 MnCrS 5	20MnCrS5
1.7176	55 Cr 3	55Cr3
1.7182	27 MnCrB 5 2	27MnCrB5-2
1.7185	33 MnCrB 5 2	33MnCrB5-2
1.7189	39 MnCrB 6 2	39MnCrB6-2
1.7213	25 CrMoS 4	25CrMoS4
1.7218	25 CrMo 4	25CrMo4
1.7219	–	26CrMo4-2
1.7220	34 CrMo 4	34CrMo4
1.7225	42 CrMo 4	42CrMo4
1.7226	34 CrMoS 4	34CrMoS4
1.7227	42 CrMoS 4	42CrMoS4
1.7228	50 CrMo 4	50CrMo4
1.7264	20 CrMo 5	20CrMo5
1.7321	20 MoCr 4	20MoCr4
1.7323	20 MoCrS 4	20MoCrS4
1.7333	22 CrMoS 3 5	22CrMoS3-5
1.7335	13 CrMo 4 4	13CrMo4-5
1.7362	12 CrMo 19 5	12CrMo19-5
1.7380	10 CrMo 9 10	10CrMo9-10
1.7383	–	11CrMo9-10
1.7779	–	20CrMoV13-5-5
1.8159	50 CrV 4	51CrV4
1.8504	34 CrAl 6	34CrAl6
1.8519	31 CrMoV 9	31CrMoV9
1.8550	34 CrAlNi 7	34CrAlNi7
1.8807	13 MnNiMoV 5 4	13MnNiMoV5-4
1.8812	18 MnMoV 5 2	18MnMoV5-2
1.8815	18 MnMoV 6 3	18MnMoV6-3
1.8821	StE 355 TM	P355M
1.8824	StE 420 TM	P420M
1.8826	StE 460 TM	P460M
1.8828	EStE 420 TM	P420ML2
1.8831	EStE 460 TM	P460ML2
1.8832	TStE 355 TM	P355ML1
1.8835	TStE 420 TM	P420ML1
1.8837	TStE 460 TM	P460ML1
1.8879	StE ...	P690Q
1.8880	WStE ...	P690QH
1.8881	TStE ...	P690QL1
1.8882	10 MnTi 3	10MnTi3
1.8888	EStE ...	P690QL2
1.8900	StE 380	S380N
1.8901	StE 460	S460N
1.8902	StE 420	S420N
1.8903	TStE 460	S460NL
1.8905	StE 460	P460N
1.8907	StE 500	S500N
1.8910	TStE 380	S380NL
1.8911	EStE 380	S380NL1
1.8912	TStE 420	S420NL
1.8913	EStE 420	S420NL1
1.8915	TStE 460	P460NL1
1.8917	WStE 500	S500NL
1.8918	EStE 460	P460NL2
1.8919	EStE 500	S500NL1
1.8930	WStE 380	P380NH
1.8932	WStE 420	P420NH
1.8935	WStE 460	P460NH
1.8937	TStE 500	P500NH
1.8972	StE 415.7	L415NB
1.8973	StE 415.7 TM	L415MB
1.8975	StE 445.7 TM	L450MB
1.8977	StE 480.7 TM	L485MB
1.8978	StE 550.7 TM	L555MB

Tens. strength (N/mm²)	HRC	HB30	HV10
240		71	75
255		76	80
270		81	85
285		86	90
305		90	95
320		95	100
335		100	105
350		105	110
370		109	115
385		114	120
400		119	125
415		124	130
430		128	135
450		133	140
465		138	145
480		143	150
495		147	155
510		152	160
530		157	165
545		162	170
560		166	175
575		171	180
595		176	185
610		181	190
625		185	195
640		190	200
660		195	205
675		199	210
690		204	215
705		209	220
720		214	225
740		219	230
755		223	235
770		228	240
785		233	245
800	22	238	250
820	23	242	255
835	24	247	260
860	25	255	268
870	26	258	272
900	27	266	280
920	28	273	287
940	29	278	293
970	30	287	302
995	31	295	310
1020	32	301	317
1050	33	311	327
1080	34	319	336
1110	35	328	345
1140	36	337	355
1170	37	346	364

Tens. strength (N/mm²)	HRC	HB30	HV10
1200	38	354	373
1230	39	363	382
1260	40	372	392
1300	41	383	403
1330	42	393	413
1360	43	402	423
1400	44	413	434
1440	45	424	446
1480	46	435	458
1530	47	449	473
1570	48	460	484
1620	49	472	497
1680	50	488	514
1730	51	501	527
1790	52	517	544
1845	53	532	560
1910	54	549	578
1980	55	567	596
2050	56	584	615
2140	57	607	639
2180	58	622	655
	59		675
	60		698
	61		720
	62		745
	63		773
	64		800
	65		829
	66		864
	67		900
	68		940

Threading tools

GÜHRING

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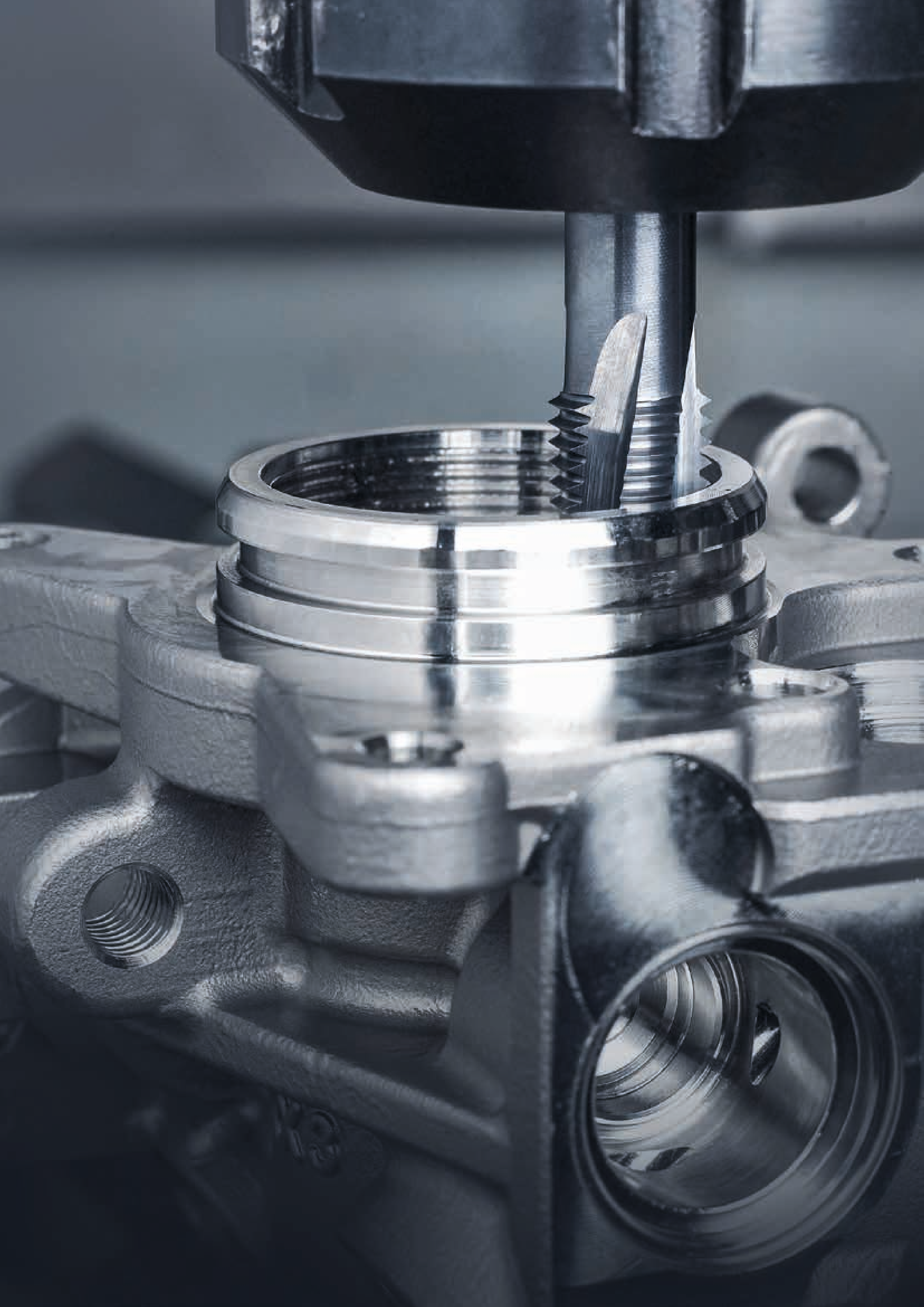


Tapping size holes for thread cutting

Std. ISO metric threads DIN 13

nom. Ø	pitch P mm	tapping size hole Ø DIN 336 mm	core diameter of int. thread 6H* min. mm	max. mm
M 1	0.25	**0.75**	0.729	0.785
M 1.1	0.25	**0.85**	0.829	0.885
M 1.2	0.25	**0.95**	0.929	0.985
M 1.4	0.30	**1.10**	1.075	1.142
M 1.6	0.35	**1.25**	1.221	1.321
M 1.8	0.35	**1.45**	1.421	1.521
M 2	0.40	**1.60**	1.567	1.679
M 2.2	0.45	**1.75**	1.713	1.838
M 2.5	0.45	**2.05**	2.013	2.138
M 3	0.50	**2.50**	2.459	2.599
M 3.5	0.60	**2.90**	2.850	3.010
M 4	0.70	**3.30**	3.242	3.422
M 4.5	0.75	**3.70**	3.688	3.878
M 5	0.80	**4.20**	4.134	4.334
M 6	1.00	**5.00**	4.917	5.153
M 7	1.00	**6.00**	5.917	6.153
M 8	1.25	**6.80**	6.647	6.912
M 9	1.25	**7.80**	7.647	7.912
M 10	1.50	**8.50**	8.376	8.676
M 11	1.50	**9.50**	9.376	9.676
M 12	1.75	**10.20**	10.106	10.441
M 14	2.00	**12.00**	11.835	12.210
M 16	2.00	**14.00**	13.835	14.210
M 18	2.50	**15.50**	15.294	15.744
M 20	2.50	**17.50**	17.294	17.744
M 22	2.50	**19.50**	19.294	19.744
M 24	3.00	**21.00**	20.752	21.252
M 27	3.00	**24.00**	23.752	24.252
M 30	3.50	**26.50**	26.211	26.771
M 33	3.50	**29.50**	29.211	29.771
M 36	4.00	**32.00**	31.670	32.270
M 39	4.00	**35.00**	34.670	35.270
M 42	4.50	**37.50**	37.129	37.799
M 45	4.50	**40.50**	40.129	40.799
M 48	5.00	**43.00**	42.587	43.297
M 52	5.00	**47.00**	46.587	47.297
M 56	5.50	**50.50**	50.046	50.796

ISO metric fine threads DIN 13

nom. Ø x pitch P mm	tapping size hole Ø DIN 336 mm	core diameter of int. thread 6H min. mm	max. mm
M 2.5 x 0.35	**2.15**	2.121	2.221
M 3.0 x 0.35	**2.65**	2.621	2.721
M 3.5 x 0.35	**3.15**	3.121	3.221
M 4.0 x 0.50	**3.50**	3.459	3.599
M 4.5 x 0.50	**4.00**	3.959	4.099
M 5.0 x 0.50	**4.50**	4.459	4.599
M 5.5 x 0.50	**5.00**	4.959	5.099
M 6.0 x 0.75	**5.20**	5.188	5.378
M 7.0 x 0.75	**6.20**	6.188	6.378
M 8.0 x 0.50	**7.50**	7.459	7.599
M 8.0 x 0.75	**7.20**	7.188	7.378
M 8.0 x 1.00	**7.00**	6.917	7.153
M 9.0 x 0.75	**8.20**	8.188	8.378
M 9.0 x 1.00	**8.00**	7.917	8.153
M 10 x 0.75	**9.20**	9.188	9.378
M 10 x 1.00	**9.00**	8.917	9.153
M 10 x 1.25	**8.80**	8.647	8.912
M 11 x 0.75	**10.20**	10.188	10.378
M 11 x 1.00	**10.00**	9.917	10.153
M 12 x 1.00	**11.00**	10.917	11.153
M 12 x 1.25	**10.80**	10.647	10.912
M 12 x 1.50	**10.50**	10.376	10.676
M 14 x 1.00	**13.00**	12.917	13.153
M 14 x 1.25	**12.80**	12.647	12.912
M 14 x 1.50	**12.50**	12.376	12.676
M 15 x 1.00	**14.00**	13.917	14.153
M 15 x 1.50	**13.50**	13.376	13.676
M 16 x 1.00	**15.00**	14.917	15.153
M 16 x 1.25	**14.80**	14.647	14.912
M 16 x 1.50	**14.50**	14.376	14.676
M 17 x 1.00	**16.00**	15.917	16.153
M 17 x 1.50	**15.50**	15.376	15.676
M 18 x 1.00	**17.00**	16.917	17.153
M 18 x 1.50	**16.50**	16.376	16.676
M 20 x 1.00	**19.00**	18.917	19.153
M 20 x 1.50	**18.50**	18.376	18.676
M 20 x 2.00	**18.00**	17.835	18.210
M 22 x 1.00	**21.00**	20.917	21.153

nom. Ø x pitch P mm	tapping size hole Ø DIN 336 mm	core diameter of int. thread 6H min. mm	max. mm
M 22 x 1.50	**20.50**	20.376	20.676
M 22 x 2.00	**20.00**	19.835	20.210
M 24 x 1.00	**23.00**	22.917	23.153
M 24 x 1.50	**22.50**	22.376	22.676
M 24 x 2.00	**22.00**	21.835	22.210
M 25 x 1.00	**24.00**	23.917	24.153
M 25 x 1.50	**23.50**	23.376	23.676
M 25 x 2.00	**23.00**	22.835	23.210
M 27 x 1.00	**26.00**	25.917	26.153
M 27 x 1.50	**25.50**	25.376	25.676
M 27 x 2.00	**25.00**	24.835	25.210
M 28 x 1.00	**27.00**	26.917	27.153
M 28 x 1.50	**26.50**	26.376	26.676
M 28 x 2.00	**26.00**	25.835	26.210
M 30 x 1.00	**29.00**	28.917	29.153
M 30 x 1.50	**28.50**	28.376	28.676
M 30 x 2.00	**28.00**	27.835	28.210
M 30 x 3.00	**27.00**	26.752	27.252
M 32 x 1.50	**30.50**	30.376	30.676
M 32 x 2.00	**30.00**	29.835	30.210
M 33 x 1.50	**31.50**	31.376	31.676
M 33 x 2.00	**31.00**	30.835	31.210
M 33 x 3.00	**30.00**	29.752	30.252
M 35 x 1.50	**33.50**	33.376	33.676
M 36 x 1.50	**34.50**	34.376	34.676

UNC threads ASME B1.1

nom. Ø	threads per inch	tapping size hole Ø DIN 336 mm	core diameter of int. thread 2B min. mm	max. mm
Nr. 1	64	**1.55**	1.425	1.580
Nr. 2	56	**1.85**	1.694	1.872
Nr. 3	48	**2.10**	1.941	2.146
Nr. 4	40	**2.35**	2.157	2.385
Nr. 5	40	**2.65**	2.487	2.698
Nr. 6	32	**2.85**	2.642	2.896
Nr. 8	32	**3.50**	3.302	3.531
Nr. 10	24	**3.90**	3.683	3.937
Nr. 12	24	**4.50**	4.343	4.597
1/4	20	**5.10**	4.978	5.258
5/16	18	**6.60**	6.401	6.731
3/8	16	**8.00**	7.798	8.153
7/16	14	**9.40**	9.144	9.550
1/2	13	**10.80**	10.592	11.024
9/16	12	**12.20**	11.989	12.446
5/8	11	**13.50**	13.386	13.868
3/4	10	**16.50**	16.307	16.840
7/8	9	**19.50**	19.177	19.761
1	8	**22.25**	21.971	22.606
1 1/8	7	**25.00**	24.638	25.349
1 1/4	7	**28.00**	27.813	28.524
1 3/8	6	**30.75**	30.353	31.115
1 1/2	6	**34.00**	33.528	34.290
1 3/4	5	**39.50**	38.938	39.802
2	4.5	**45.00**	44.679	45.593

* M 1.1 up to M 1.4 tapping size hole of int. thread 5H

MJ threads DIN ISO 5855

nom. Ø x pitch P mm	tapping size hole Ø DIN 336 mm	core diameter of int. thread 5H* min. mm	max. mm
MJ 3 x 0.50	**2.60**	2.513	2.653
MJ 4 x 0.70	**3.40**	3.318	3.498
MJ 5 x 0.80	**4.30**	4.221	4.421
MJ 6 x 0.50	**5.55**	5.513	5.625
MJ 6 x 0.75	**5.35**	5.269	5.419
MJ 6 x 1.00	**5.10**	5.026	5.216
MJ 8 x 0.50	**7.55**	7.513	7.625
MJ 8 x 0.75	**7.35**	7.269	7.419
MJ 8 x 1.00	**7.10**	7.026	7.216
MJ 8 x 1.25	**6.90**	6.782	6.994
MJ 10 x 1.00	**9.10**	9.026	9.216
MJ 10 x 1.25	**8.90**	8.782	8.994
MJ 10 x 1.50	**8.60**	8.539	8.775
MJ 12 x 1.75	**10.40**	10.295	10.560
MJ 16 x 2.00	**14.20**	14.051	14.351

UNC threads ISO 3161

nom. Ø	threads per inch	tapping size hole Ø DIN 336 mm	core diameter of int. thread 3B min. mm	max. mm
Nr. 6	32	**2.85**	2.733	2.939
Nr. 8	32	**3.55**	3.393	3.599
Nr. 10	24	**4.00**	3.795	4.064
Nr. 12	24	**4.60**	4.455	4.704
1/4	20	**5.30**	5.113	5.387
5/16	18	**6.75**	6.563	6.833
3/8	16	**8.20**	7.978	8.255
7/16	14	**9.60**	9.346	9.639
1/2	13	**11.00**	10.798	11.095
9/16	12	**12.40**	12.228	12.482
5/8	11	**13.80**	13.627	13.904

UNF threads ISO 3161

nom. Ø	threads per inch	tapping size hole Ø DIN 336 mm	core diameter of int. thread 3B min. mm	max. mm
Nr. 6	40	**3.00**	2.888	3.053
Nr. 8	36	**3.60**	3.480	3.663
Nr. 10	32	**4.20**	4.054	4.255
Nr. 12	28	**4.75**	4.602	4.816
1/4	28	**5.60**	5.466	5.662
5/16	24	**7.00**	6.906	7.109
3/8	24	**8.60**	8.494	8.679
7/16	20	**10.00**	9.876	10.084
1/2	20	**11.60**	11.463	11.661
9/16	18	**13.00**	12.913	13.122
5/8	18	**14.60**	14.501	14.702

* MJ3 x 0.50 up to MJ 5 x 0.80 tapping size hole of int. thread 6H

UNF threads ASME B1.1 nom. Ø	threads per inch	tapping size hole Ø DIN 336 mm	core diameter of int. thread 2B min. mm	max. mm
Nr. 1	72	**1.55**	1.473	1.610
Nr. 2	64	**1.85**	1.755	1.910
Nr. 3	56	**2.15**	2.024	2.197
Nr. 4	48	**2.40**	2.271	2.459
Nr. 5	44	**2.70**	2.550	2.741
Nr. 6	40	**2.95**	2.819	3.023
Nr. 8	36	**3.50**	3.404	3.607
Nr. 10	32	**4.10**	3.962	4.166
Nr. 12	28	**4.60**	4.496	4.724
1/4	28	**5.50**	5.359	5.588
5/16	24	**6.90**	6.782	7.036
3/8	24	**8.50**	8.382	8.636
7/16	20	**9.90**	9.728	10.033
1/2	20	**11.50**	11.328	11.608
9/16	18	**12.90**	12.751	13.081
5/8	18	**14.50**	14.351	14.681
3/4	16	**17.50**	17.323	17.678
7/8	14	**20.40**	20.269	20.650
1	12	**23.25**	23.114	23.571
1 1/8	12	**26.50**	26.289	26.746
1 1/4	12	**29.50**	29.464	29.921
1 3/8	12	**32.75**	32.639	33.096
1 1/2	12	**36.00**	35.814	36.271

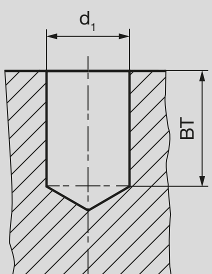
BSW (Whitworth) threads BS84 nom. Ø inch	threads per inch	tapping size hole Ø DIN 336 mm	core diameter of int. thread min. mm	max. mm
W 1/16	60	**1.20**	1.045	1.230
W 3/32	48	**1.80**	1.704	1.912
W 1/8	40	**2.50**	2.362	2.591
W 5/32	32	**3.20**	2.952	3.214
W 3/16	24	**3.60**	3.407	3.745
W 7/32	24	**4.50**	4.201	4.539
W 1/4	20	**5.10**	4.724	5.156
W 5/16	18	**6.50**	6.130	6.590
W 3/8	16	**7.90**	7.492	7.987
W 7/16	14	**9.20**	8.789	9.330
W 1/2	12	**10.50**	9.989	10.591
W 9/16	12	**12.00**	11.577	12.179
W 5/8	11	**13.50**	12.918	13.558
W 3/4	10	**16.25**	15.797	16.483
W 7/8	9	**19.25**	18.611	19.353
W 1	8	**22.00**	21.334	22.147
W 1 1/8	7	**24.50**	23.928	24.832
W 1 1/4	7	**27.75**	27.103	28.007
W 1 3/8	6	**30.50**	29.504	30.528
W 1 1/2	6	**33.50**	32.679	33.703
W 1 5/8	5	**35.50**	34.769	35.963
W 1 3/4	5	**39.00**	37.944	39.138
W 2	4.5	**44.50**	43.571	44.877

(Whitworth) threads (DIN-ISO 228-1) nom. Ø inch	threads per inch	tapping size hole Ø DIN 336 mm	core diameter of int. thread min. mm	max. mm
G 1/16	28	**6.80**	6.561	6.843
G 1/8	28	**8.80**	8.566	8.848
G 1/4	19	**11.80**	11.445	11.890
G 3/8	19	**15.25**	14.950	15.395
G 1/2	14	**19.00**	18.631	19.172
G 5/8	14	**21.00**	20.587	21.128
G 3/4	14	**24.50**	24.117	24.658
G 7/8	14	**28.25**	27.877	28.418
G 1	11	**30.75**	30.291	30.931
G 1 1/8	11	**35.50**	34.939	35.579
G 1 1/4	11	**39.50**	38.952	39.592
G 1 1/2	11	**45.25**	44.845	45.485
G 1 3/4	11	**51.00**	50.788	51.428
G 2	11	**57.00**	56.656	57.296

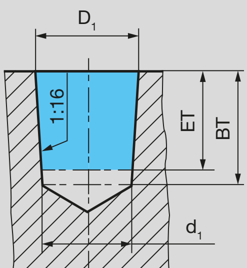
Steel armoured conduit threads to DIN 40430 nom. Ø	threads per inch	tapping size hole Ø DIN 336 mm	core diameter of int. thread min. mm	max. mm
Pg 7	20	**11.40**	11.280	11.430
Pg 9	18	**14.00**	13.860	14.010
Pg 11	18	**17.30**	17.260	17.410
Pg 13.5	18	**19.00**	19.060	19.210
Pg 16	18	**21.30**	21.160	21.310
Pg 21	16	**26.90**	26.780	27.030
Pg 29	16	**35.50**	35.480	35.730
Pg 36	16	**45.50**	45.480	45.730
Pg 42	16	**52.50**	52.480	52.730
Pg 48	16	**57.80**	57.780	58.030

NPT ANSI B 2.1
American tapered pipe thread 1:16

Version A (avoid if possible)



Version B



nom. Ø	threads per inch	tapp. size hole Ø cylindrical (A) d_1	tapp. size hole Ø conical (B) D_1	cutting depth ET mm	cutting depth BT (min) mm
1/16	27	**6.15**	6.39	9.29	10.7
1/8	27	**8.40**	8.74	9.32	10.8
1/4	18	**11.10**	**11.36**	13.52	15.6
3/8	18	**14.30**	**14.80**	13.83	16.0
1/2	14	**17.90**	**18.32**	18.07	20.8
3/4	14	**23.30**	**23.67**	18.55	21.3
1	11.5	**29.00**	**29.69**	22.29	25.6
1 1/4	11.5	**37.70**	**38.45**	22.80	26.1
1 1/2	11.5	**43.70**	**44.52**	22.80	26.1
2	11.5	**55.60**	**56.56**	23.20	26.5
2 1/2	8	**66.30**	**67.62**	31.75	36.3
3	8	**82.30**	**83.52**	33.74	38.5

Metric/metric fine EG-threads (EG M14 x 1.25) for wire thread inserts DIN 8140 nom. Ø	x pitch P mm	tapping size hole Ø DIN 336 mm	core diameter of int. thread min. mm	max. mm
EG M 4	0.70	**4.20**	4.152	4.292
EG M 5	0.80	**5.25**	5.174	5.334
EG M 6	1.00	**6.30**	6.217	6.407
EG M 8	1.25	**8.40**	8.271	8.483
EG M10	1.50	**10.50**	10.324	10.560
EG M12	1.75	**12.50**	12.379	12.644
EG M14 x	1.25	**14.40**	14.271	14.483
EG M16	2.00	**16.50**	16.433	16.733

UNC (UNC-STI) EG-threads for wire thread inserts ASME B18.29.1 nom. Ø	threads per inch	tapping size hole Ø DIN 336 mm	core diameter of int. thread min. mm	max. mm
EG Nr. 6	32	**3.80**	3.678	3.879
EG Nr. 8	32	**4.40**	4.338	4.524
EG Nr. 10	24	**5.20**	5.055	5.283
EG Nr. 12	24	**5.80**	5.715	5.944
EG 1/4	20	**6.70**	6.624	6.868
EG 5/16	18	**8.40**	8.242	8.489
EG 3/8	16	**10.00**	9.868	10.127
EG 7/16	14	**11.60**	11.506	11.783
EG 1/2	13	**13.30**	13.122	13.393
EG 9/16	12	**14.90**	14.747	15.032
EG 5/8	11	**16.50**	16.375	16.673

UNF (UNF-STI) EG-threads for wire thread inserts ASME B18.29.1 nom. Ø	threads per inch	tapping size hole Ø DIN 336 mm	core diameter of int. thread min. mm	max. mm
EG Nr. 6	40	**3.70**	3.644	3.818
EG Nr. 8	36	**4.40**	4.321	4.498
EG Nr. 10	32	**5.10**	4.999	5.184
EG Nr. 12	28	**5.70**	5.682	5.809
EG 1/4	28	**6.60**	6.546	6.721
EG 5/16	24	**8.25**	8.166	8.352
EG 3/8	24	**9.80**	9.754	9.931
EG 7/16	20	**11.50**	11.389	11.585
EG 1/2	20	**13.10**	12.974	13.172
EG 9/16	18	**14.70**	14.592	14.798
EG 5/8	18	**16.25**	16.180	16.386

Recommended tapping size holes for thread forming

Std. ISO metric threads DIN 13

nom. Ø	pitch mm	tapp. size hole Ø mm	tapp. size hole Ø min. mm	tapp. size hole Ø max. mm	core Ø of int. thread 7H* min. mm	core Ø of int. thread 7H* max. mm
M1	0.25	**0.90**	0.89	0.92	0.729	0.819
M1.2	0.25	**1.10**	1.09	1.12	0.929	1.019
M1.4	0.30	**1.28**	1.27	1.30	1.075	1.181
M1.6	0.35	**1.46**	1.45	1.48	1.221	1.346
M1.7	0.35	**1.56**	1.55	1.58	1.321	1.446
M1.8	0.35	**1.66**	1.65	1.68	1.421	1.546
M 2	0.40	**1.85**	1.84	1.88	1.567	1.679
M 2.2	0.45	**2.00**	2.01	2.05	1.713	1.838
M 2.5	0.45	**2.30**	2.28	2.32	2.013	2.138
M 3	0.50	**2.80**	2.78	2.85	2.459	2.639
M 3.5	0.60	**3.25**	3.23	3.30	2.850	3.050
M 4	0.70	**3.70**	3.68	3.76	3.242	3.466
M 4.5	0.75	**4.20**				
M 5	0.80	**4.65**	4.62	4.71	4.134	4.384
M 6	1.00	**5.55**	5.52	5.62	4.917	5.217
M 7	1.00	**6.55**	6.52	6.62	5.917	6.217
M 8	1.25	**7.40**	7.36	7.47	6.647	6.982
M 9	1.25	**8.40**	8.36	8.47	7.647	7.982
M 10	1.50	**9.30**	9.26	9.38	8.376	8.751
M 11	1.50	**10.30**	10.26	10.38	9.376	9.751
M 12	1.75	**11.20**	11.15	11.29	10.106	10.531
M 14	2.00	**13.10**	13.05	13.20	11.835	12.310
M 16	2.00	**15.10**	15.05	15.20	13.835	14.310
M 18	2.50	**16.90**	16.83	17.02	15.294	15.854
M 20	2.50	**18.90**	18.83	19.02	17.294	17.854
M 22	2.50	**20.90**	20.83	21.02	19.294	19.854
M 24	3.00	**22.70**	22.62	22.80	20.752	21.382
M 27	3.00	**25.70**	25.62	25.80	23.752	24.382
M 30	3.50	**28.50**	28.40	28.60	26.211	26.921
M 33	3.50	**31.50**	31.40	31.60	29.211	29.921
M 36	4.00	**34.30**	34.17	34.40	31.670	32.420
M 39	4.00	**37.30**	37.17	37.40	34.670	35.420
M 42	4.50	**40.10**	39.95	40.20	37.129	37.979

* M 2 up to M 2.5 tapping size hole of int. thread 6H

ISO metric fine threads DIN 13

nom. x pitch Ø mm	tapp. size hole Ø mm	tapp. size hole Ø min. mm	tapp. size hole Ø max. mm	core Ø of int. thread 7H* min. mm	core Ø of int. thread 7H* max. mm
M 2.5 x 0.35	**2.35**	2.35	2.38	2.121	2.221
M 3 x 0.35	**2.85**	2.85	2.88	2.621	2.721
M 4 x 0.35	**3.85**	3.85	3.88	3.621	3.721
M 4 x 0.50	**3.80**	3.78	3.83	3.459	3.639
M 5 x 0.50	**4.80**	4.78	4.83	4.459	4.639
M 5.5 x 0.50	**5.30**	5.28	5.33	4.959	5.139
M 6 x 0.75	**5.65**	5.62	5.70	5.188	5.424
M 7 x 0.75	**6.65**	6.62	6.70	6.188	6.424
M 8 x 0.75	**7.65**	7.62	7.70	7.188	7.424
M 8 x 1.00	**7.55**	7.52	7.62	6.917	7.217
M 9 x 0.75	**8.65**	8.62	8.70	8.188	8.424
M 9 x 1.00	**8.55**	8.52	8.62	7.917	8.217
M 10 x 0.75	**9.65**	9.62	9.70	9.188	9.424
M 10 x 1.00	**9.55**	9.52	9.62	8.917	9.217
M 10 x 1.25	**9.40**	9.36	9.47	8.647	8.982
M 11 x 0.75	**10.65**	10.62	10.70	10.188	10.424
M 11 x 1.00	**10.55**	10.52	10.62	9.917	10.217
M 12 x 1.00	**11.55**	11.52	11.62	10.917	11.217
M 12 x 1.25	**11.40**	11.36	11.47	10.647	10.982
M 12 x 1.50	**11.30**	11.26	11.38	10.376	10.751
M 14 x 1.00	**13.55**	13.52	13.62	12.917	13.217
M 14 x 1.25	**13.40**	13.36	13.47	12.647	12.982
M 14 x 1.50	**13.30**	13.26	13.38	12.376	12.751
M 15 x 1.00	**14.55**	14.52	14.62	13.917	14.217
M 15 x 1.50	**14.30**	14.26	14.38	13.376	13.751
M 16 x 1.00	**15.55**	15.52	15.62	14.917	15.217
M 16 x 1.50	**15.30**	15.26	15.38	14.376	14.751
M 17 x 1.00	**16.55**	16.52	16.62	15.917	16.217
M 17 x 1.50	**16.30**	16.26	16.38	15.376	15.751
M 18 x 1.00	**17.55**	17.52	17.62	16.917	17.217
M 18 x 1.50	**17.30**	17.26	17.38	16.376	16.751
M 18 x 2.00	**17.10**	17.05	17.20	15.835	16.310
M 20 x 1.00	**19.55**	19.52	19.62	18.917	19.217
M 20 x 1.50	**19.30**	19.26	19.38	18.376	19.751
M 24 x 1.00	**23.55**	23.52	23.62	22.917	23.217
M 24 x 1.50	**23.30**	23.26	23.38	22.376	22.751
M 24 x 2.00	**23.10**	23.05	23.20	21.835	22.310
M 27 x 1.50	**26.30**	26.26	26.38	25.376	25.751
M 30 x 1.50	**29.30**	29.26	29.38	28.376	28.751
M 33 x 1.50	**32.30**	32.26	32.38	31.376	31.751
M 36 x 1.50	**35.30**	35.26	35.38	34.376	34.751
M 39 x 1.50	**38.30**	38.26	38.38	37.376	37.751
M 42 x 1.50	**41.30**	41.26	41.38	42.376	42.751

* M 2.5 x 0.35 up to M 4 x 0.35 tapping size hole of int. thread 6H

Tapping size hole diameter tolerance zone for thread forming (to DIN 13, section 50)
Due to the tensile strength it is not necessary to adhere to the tapping size hole diameter tolerance class 6H; tolerance class 7H satisfies the requirement that the flank coverage of external and internal threads should not fall below 0.32 x P. In addition, formed threads generally possess a higher tensile strength in comparison to cut threads thanks to an uninterrupted grain flow and subsequent work hardening.

UNC-threads ASME B1.1

nom. Ø	pitch per inch	tapp. size hole Ø mm	tapp. size hole Ø min. mm	tapp. size hole Ø max. mm	core Ø of int. thread 2B min. mm	core Ø of int. thread 2B max. mm
Nr. 1	- 64	**1.68**	1.67	1.70	1.425	1.580
Nr. 2	- 56	**1.98**	1.97	2.01	1.694	1.872
Nr. 3	- 48	**2.28**	2.27	2.32	1.941	2.146
Nr. 4	- 40	**2.55**	2.54	2.59	2.157	2.385
Nr. 5	- 40	**2.90**	2.89	2.94	2.487	2.698
Nr. 6	- 32	**3.15**	3.14	3.19	2.642	2.896
Nr. 8	- 32	**3.80**	3.78	3.82	3.302	3.531
Nr. 10	- 24	**4.35**	4.33	4.39	3.683	3.937
Nr. 12	- 24	**5.00**	4.97	5.03	4.343	4.597
1/4	- 20	**5.75**	5.72	5.80	4.978	5.258
5/16	- 18	**7.30**	7.26	7.37	6.401	6.731
3/8	- 16	**8.80**	8.77	8.88	7.798	8.153
7/16	- 14	**10.30**	10.27	10.37	9.144	9.550
1/2	- 13	**11.80**	11.77	11.88	10.592	11.024
9/16	- 12	**13.30**	13.28	13.39	11.989	12.446
5/8	- 11	**14.80**	14.78	14.90	13.386	13.868
3/4	- 10	**17.90**	17.85	17.97	16.307	16.840
7/8	- 9	**21.00**	20.95	21.10	19.177	19.761
1	- 8	**24.00**	23.95	24.12	21.971	22.606

UNF-threads ASME B1.1

nom. Ø	pitch per inch	tapp. size hole Ø mm	tapp. size hole Ø min. mm	tapp. size hole Ø max. mm	core Ø of int. thread 2B min. mm	core Ø of int. thread 2B max. mm
Nr. 1	- 72	**1.70**	1.69	1.72	1.473	1.610
Nr. 2	- 64	**2.00**	1.99	2.03	1.755	1.910
Nr. 3	- 56	**2.30**	2.29	2.34	2.024	2.197
Nr. 4	- 48	**2.60**	2.59	2.63	2.271	2.459
Nr. 5	- 44	**2.90**	2.89	2.93	2.550	2.741
Nr. 6	- 40	**3.20**	3.19	3.24	2.819	3.023
Nr. 8	- 36	**3.85**	3.83	3.88	3.404	3.607
Nr. 10	- 32	**4.45**	3.43	4.49	3.962	4.166
Nr. 12	- 28	**5.10**	5.07	5.13	4.496	4.724
1/4	- 28	**5.95**	5.92	5.99	5.359	5.588
5/16	- 24	**7.45**	7.42	7.50	6.782	7.036
3/8	- 24	**9.05**	9.02	9.10	8.382	8.682
7/16	- 20	**10.55**	10.48	10.58	9.728	10.033
1/2	- 20	**12.10**	12.08	12.18	11.328	11.608
9/16	- 18	**13.65**	13.61	13.72	12.751	13.081
5/8	- 18	**15.25**	15.21	15.32	14.351	14.681
3/4	- 16	**18.35**	15.30	18.41	17.323	17.678
7/8	- 14	**21.40**	21.35	21.49	20.269	20.650
1	- 12	**24.45**	24.40	24.54	23.114	23.571

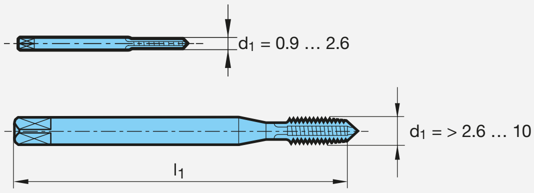
(Whitworth-) pipe thread G DIN EN ISO 228-1

nom. Ø inch	pitch per inch	tapp. size hole Ø mm	tapp. size hole Ø min. mm	tapp. size hole Ø max. mm	core Ø of int. thread min. mm	core Ø of int. thread max. mm
G 1/16	28	**7.30**	7.28	7.35	6.561	6.843
G 1/8	28	**9.30**	9.28	9.35	8.566	8.848
G 1/4	19	**12.50**	12.48	12.55	11.445	11.890
G 3/8	19	**16.00**	15.98	16.05	14.950	15.395
G 1/2	14	**20.00**	19.98	20.12	18.631	19.172
G 5/8	14	**22.00**	21.98	22.12	20.587	21.128
G 3/4	14	**25.50**	25.48	25.62	24.117	24.658
G 7/8	14	**29.25**	29.23	29.37	27.877	28.418
G 1	11	**32.00**	31.98	32.15	30.291	30.931
G 1 1/4	11	**40.75**	40.70	40.85	38.952	39.592

Characteristic features of the individual standards

DIN 371

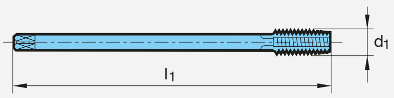
in the master standard
DIN 2184-**1**



Standard for machine taps with reinforced shank for standard ISO metric threads and ISO metric fine threads. Long design.
Shank design in accordance with diameter ranges shown above (mm).

DIN 376

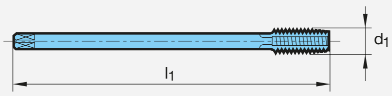
in the master standard
DIN 2184-**1**



Standard for machine taps with reduced shank for standard ISO metric threads. Long design.
Diameter range d_1 = 1.6 … 68 mm
(≤ Ø M3, shank without square)

DIN 374

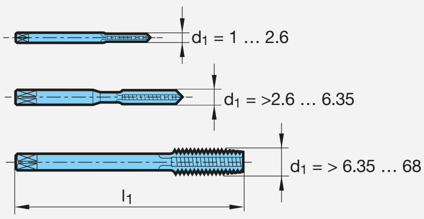
in the master standard
DIN 2184-**1**



Standard for machine taps with reduced shank for ISO metric fine threads. Long design.
Diameter range d_1 = 3 … 52 mm

DIN 352

in the master standard
DIN 2184-**2**

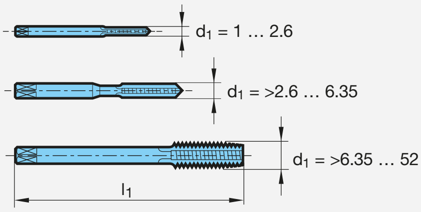


Standard for hand and machine taps for standard ISO metric threads. Short design.
Shank design in accordance with diameter ranges shown opposite (mm).

Characteristic features of the individual standards

DIN 2181

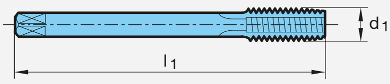
in the master standard
DIN 2184-**2**



Standard for hand and machine taps for standard ISO metric threads. Short design. Shank design in accordance with diameter ranges shown opposite (mm).

DIN 5156

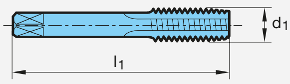
in the master standard
DIN 2184-**1**



Standard for machine taps for BSP threads to DIN ISO 228 and for BSW threads to DIN 2999.
Long design.
Diameter ranges:
BSP threads G $^{1}/_{16}$“ ... G 4“
BSW threads W $^{1}/_{16}$“... W 4“

DIN 5157

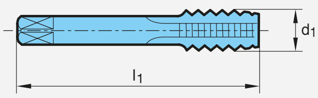
in the master standard
DIN 2184-**2**



Standard for machine taps for BSP threads to DIN ISO 228 and for BSW threads to DIN EN 10 226-1. Short design.
Diameter ranges:
BSP threads G $^{1}/_{16}$“ ... G 4“
BSW threads W $^{1}/_{16}$“...W 4“

DIN 40 432

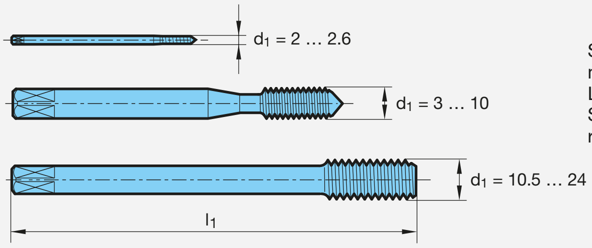
in the master standard
DIN 2184-**2**



Standard for machine taps for steel armoured conduit threads to DIN 40 430. Short design.
Diameter range:
Pg 7 (12.5 mm) ... Pg 48 (59.3 mm)
Will be replaced by DIN 374 ISO 3 6G.

DIN 2174

in the master standard
DIN 2184-**1**

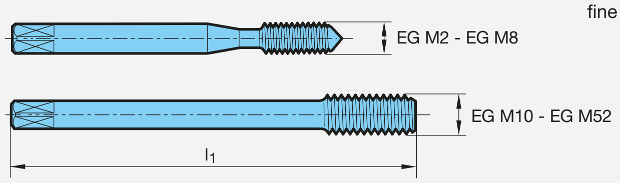


Standard for fluteless taps for standard ISO metric threads and ISO metric fine threads.
Long design.
Shank design in accordance with diameter ranges shown opposite (mm).

DIN 40 435

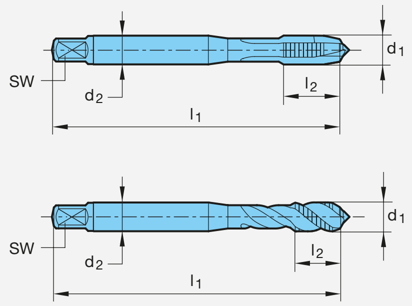
in the master standard
DIN 2184-**1**

Standard for machine taps for tapped holes (EG) for wire thread inserts as in DIN 8140 for ISO metric threads.
Standard thread tapped holes EG M2 to EG M52 and fine thread tapped holes EG M8 x1 to EG M48 x 3



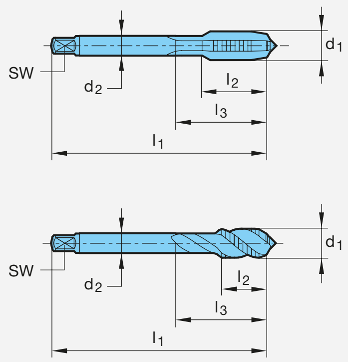
DIN - International Standards

DIN 2184-1
DIN 2184-2

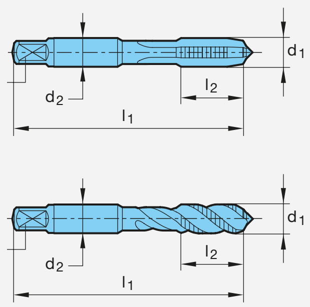


JIS B 4430

Japan Industrial Standard

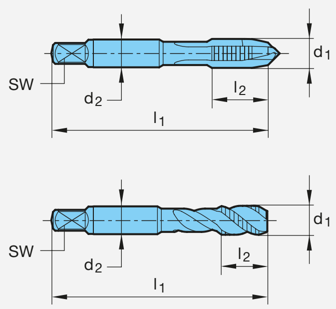


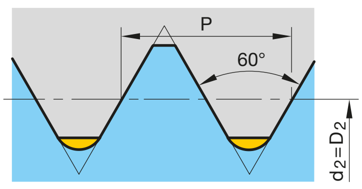
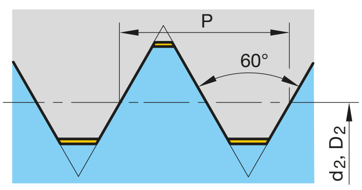
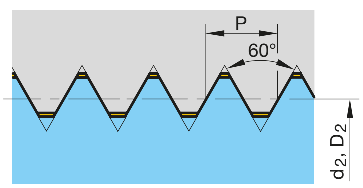
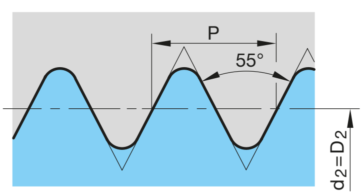
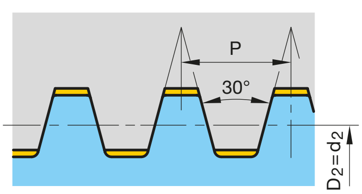
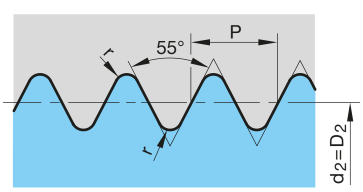
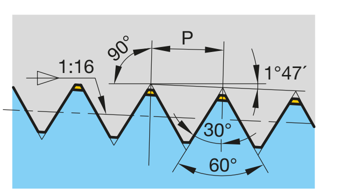
ISO 529

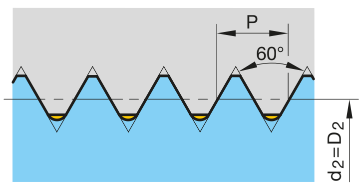
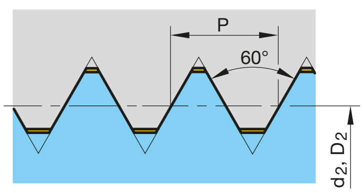
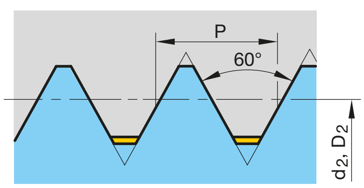
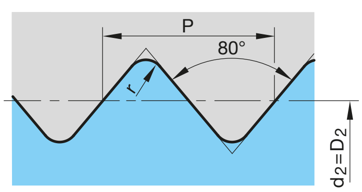
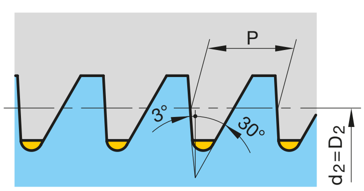
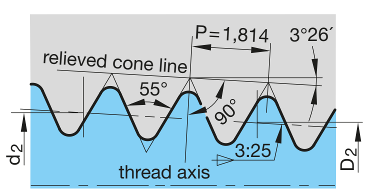
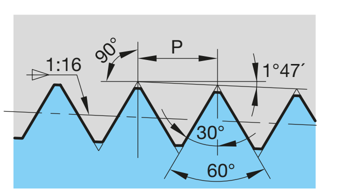


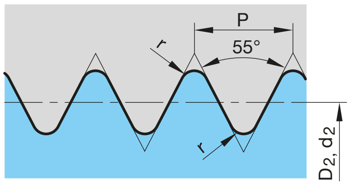
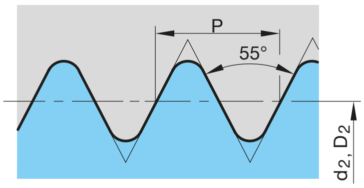
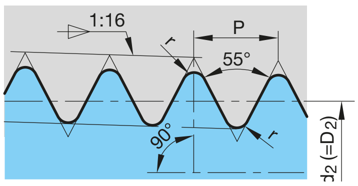
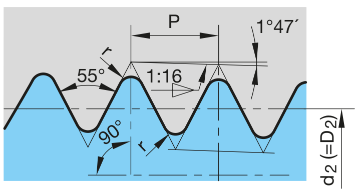
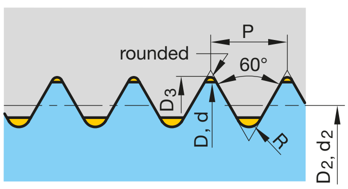
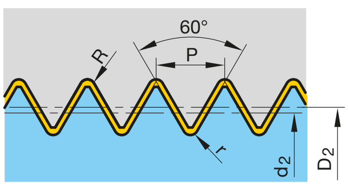
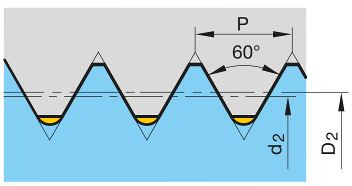
ASME B94.9

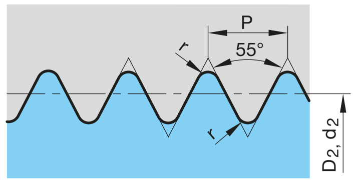
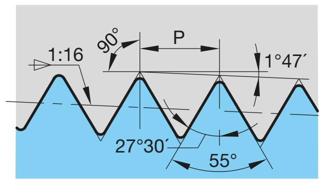
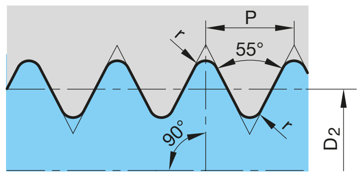
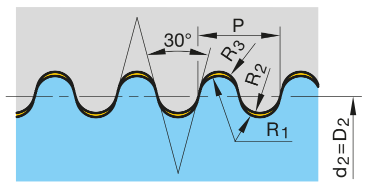
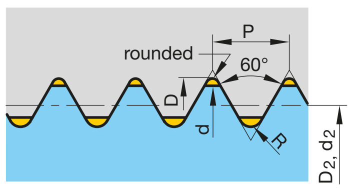
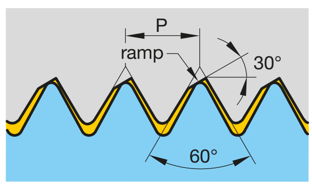
The American Society of Mechanical Engineers



geometry drawing	Standard	application
M ISO-metric thread		
	DIN 13-1	General standard thread
UNC Unified National Coarse Thread		
	ASME B1.1	General UN standard thread
UNEF Unified National Extra Fine Thread		
	ASME B1.1	General UN Extra Fine Thread
G Cylindrical Pipe Thread without thread sealing connections		
	DIN EN ISO 228-1	Threads for pipes, pipe connections and fittings
TR ISO-metric trapezoidal thread		
	DIN 103	General, draw collets, rolling stock
W Cylindrical Whitworth Thread		
	DIN 477	Side connector and accessories for gas bottle valves
NPT American Standard Pipe Threads tapered for sealing		
	ANSI/ ASME B1.20.1	pipe threads and fittings

geometry drawing	Standard	application
MF ISO-metric fine thread		
	DIN 13-2 to DIN 13-11	General fine thread
UNF Unified National Fine Thread		
	ASME B1.1 ISO-metric trapezoidal thread	General UN Fine Thread
UNS Unified Special Thread		
	ASME B1.1	General UN Special Thread
PG steel conduit thread		
	DIN 40430 cylindrical round thread	electrical engineering
S metric saw thread		
	DIN 513	when absorbing uni-directional forces
W Whitworth Taper Thread		
	DIN 477	Threaded connection in gas cylinder bottles for valves
NPTF American Standard Pipe Thread tapered for dry sealing		
	ANSI B1.20.3	pipe threads and fittings

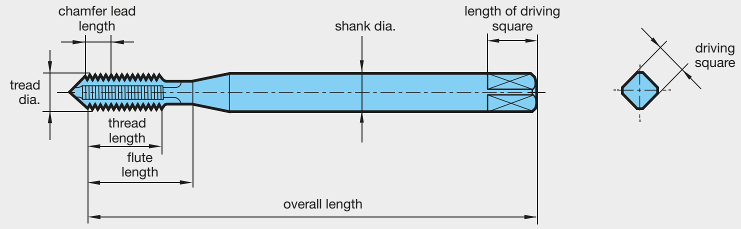
geometry drawing	Standard	application
BSW cylindrical Whitworth thread		
	B.S. 84 British Standard	Threads for pipes, pipe connections and fittings
BSP pipe thread cylindrical (identical to G)		
	B.S. 93 British Standard	Threads for pipes, pipe connections and fittings
R Whitworth pie thread tapered external thread		
	DIN EN 10226-1 (based on ISO 7-1) replace-ment for DIN 2999-1	External thread for pipe threads and fittings (for in the thread sealing connections)
Rc Whitworth pipe thread tapered internal thread		
	DIN ISO 10226-2 (hardly used in Europe, replaceable with pipe threads to ISO 7-1)	Internal thread for pipe threads and fittings (for in the thread sealing connections)
MJ thread metric thread		
	DIN ISO 5855-1	For the aero-space industry
Vg valve thread		
	DIN 7756	Valves for car tyres manifold block
MFS		
	DIN 8141	Interference fits in Aluminium-cast alloys

geometry drawing	Standard	application
BSF Whitworth fine thread cylindrical		
	B.S. 84 British Standard Fine	Threads for pipes, pipe con-nections and fittings
BSPT pipe thread tapered (identical to Rc)		
	B.S. 93 British Standard	Internal thread for pipe threads and fittings
Rp Whitworth pipe thread cylindrical internal thread		
	DIN EN 10226-1 (based on ISO 7-1) Replace-ment for DIN 2999-1	Internal thread for pipe threads and fittings (for in the thread sealing connections)
RD cylindrical round thread		
	DIN 405	General, load hook, mining, food industry
UNJ inch thread		
	ISO 3161	For the aero-space industry
MSG lock nut thread		
	Guhring standard	Self-locking thread transmission housing etc.

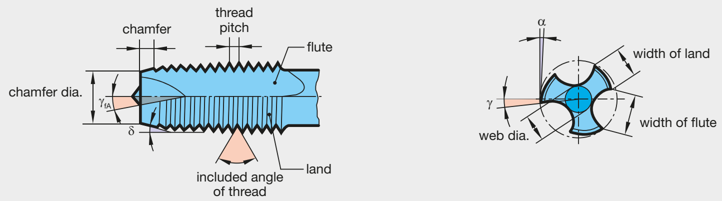
external thread

internal thread

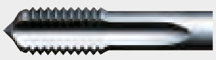
play



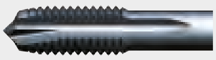
δ = try square
γ fA = spiral point angle
α = clearance angle
γ = rake angle



Flute forms

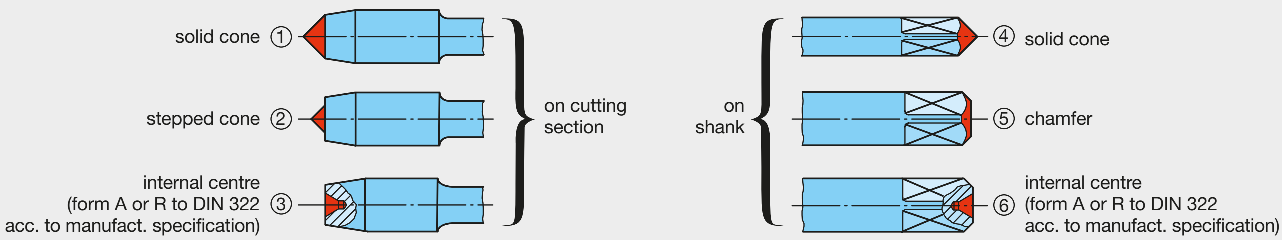

straight fluted, form C
without spiral point


helix angle
15°


straight fluted, form B
with spiral point


helix angle
40°

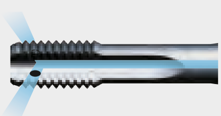
Types of centres (standard, to DIN 2197/DIN 2175)



Thread dia. range mm	Centre on cutting section: with chamfer forms A, C, D, E	Centre on cutting section: with chamfer form B	Centre on shank
≤ 4.2	①	①	④⑤⑥
> 4.2 … 5.6	①②	①	④⑤⑥
> 5.6 … 10.0	①②③	①②③	④⑤⑥
> 10.0	③	③	⑥

Coolant duct geometries

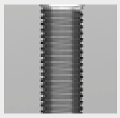

axial coolant delivery with axial coolant duct exit


axial coolant delivery with radial coolant duct exit in the flutes at the chamfer

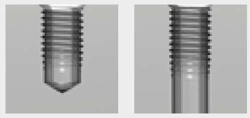
When cutting internal threads, all the machining is carried out by the cutting teeth of the chamfer. Therefore, a decision on the best type of chamfer form has to be carefully made as both tool life and quality of thread are thereby greatly affected.

Generally speaking, the form and length of chamfer depend on the type of hole to be tapped. The tapping of through holes does not normally give rise to any difficulties whereas the production of blind holes can create certain problems associated with the need to evacuate swarf in the reverse direction to the feed, i.e. up to the flutes of the tap and then cut off such swarf when the tap is reversed out of the hole.

The length of chamfer is determined by taking into account various conflicting factors. To avoid overloading, premature bluntness and oversize threads the number of chamfer cutting threads must not be kept too low. A too long chamfer lead, however, increases the torque and thus the danger of breakage. The spiral point with form B ensures a chip removal always in the direction of feed.



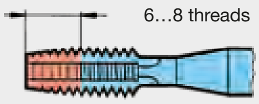
through hole



blind hole

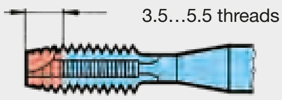
Chamfer forms to DIN 2197

Form A



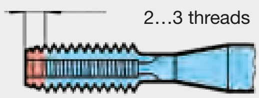
long, 6 - 8 threads
for short
through holes

Form B



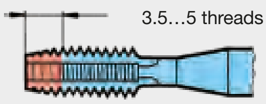
medium, 3.5 - 5.5 threads,
with spiral point,
for all through holes
and deep tapping holes in medium
and long-chipping materials

Form C



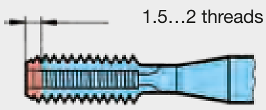
short, 2 - 3 threads
for blind holes
and generally for
aluminium, grey cast iron
and brass

Form D



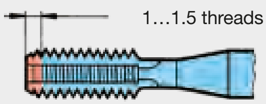
medium, 3.5 - 5 threads
for short
through holes

Form E



extremely short, 1.5-2 threads,
for blind holes with
extremely short thread runout.

Form F

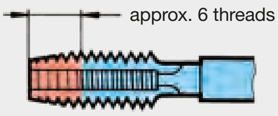


extremely short, 1-1.5 threads,
for blind holes with
extremely short thread runout.
Avoid use if possible.

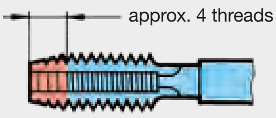
Chamfer forms, selection and application

Chamfer lead length for sets of 3 taps

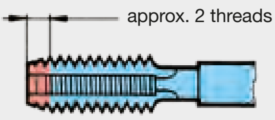
Form A
first tap



Form D
second tap

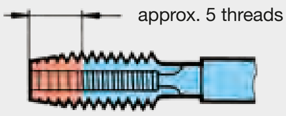


Form C
bottoming tap

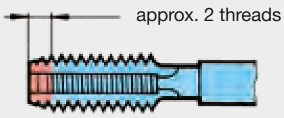


Chamfer lead length for sets of 2 taps

Form D
first tap



Form C
bottoming tap



Application recommendations

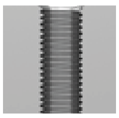
While in the first instance, the type of tapped hole required determines the chamfer, generally the tap geometry - i.e. form, number and direction of flutes, cutting angle, etc. - depend on the material to be machined and on the application. Basically, taps up to M16 for tapping ISO metric threads or for the engineering industry in general, have 3 flutes, and above this size 4 or more flutes.

Taps with left-hand flutes and taps with spiral points remove the chips in the cutting direction or direction of feed and are therefore especially suitable for tapping through holes. Taps with straight flutes and long chamfer lead (form D) also give good results.

As far as blind holes are concerned we recommend taps with right-hand spiral flutes or straight fluted taps with a short chamfer lead length. Tools with right-hand spiral flutes have the chip flow in the backward direction, i.e. up the flutes. The chamfer lead length is designed in such a way so that during the return movement chips do not jam and are reliably sheared off.

The tapping of aluminium, grey cast iron and brass requires taps with a short chamfer lead length, regardless of whether through or blind holes are required. In these materials a long chamfer lead length would act as a core drill with chip breaker grooves and would only drill the tapping size hole to the major diameter instead of cutting a thread.

Straight fluted taps without spiral point are general purpose tools and have the disadvantage of not showing optimum results in particular materials. It's well worth the effort to take the trouble of ascertaining the most suitable tool for any given metal-cutting task.

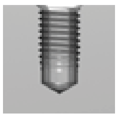


through hole

Straight fluted tap with spiral point

Left-hand spiral fluted tap

Straight fluted tap with long chamfer lead

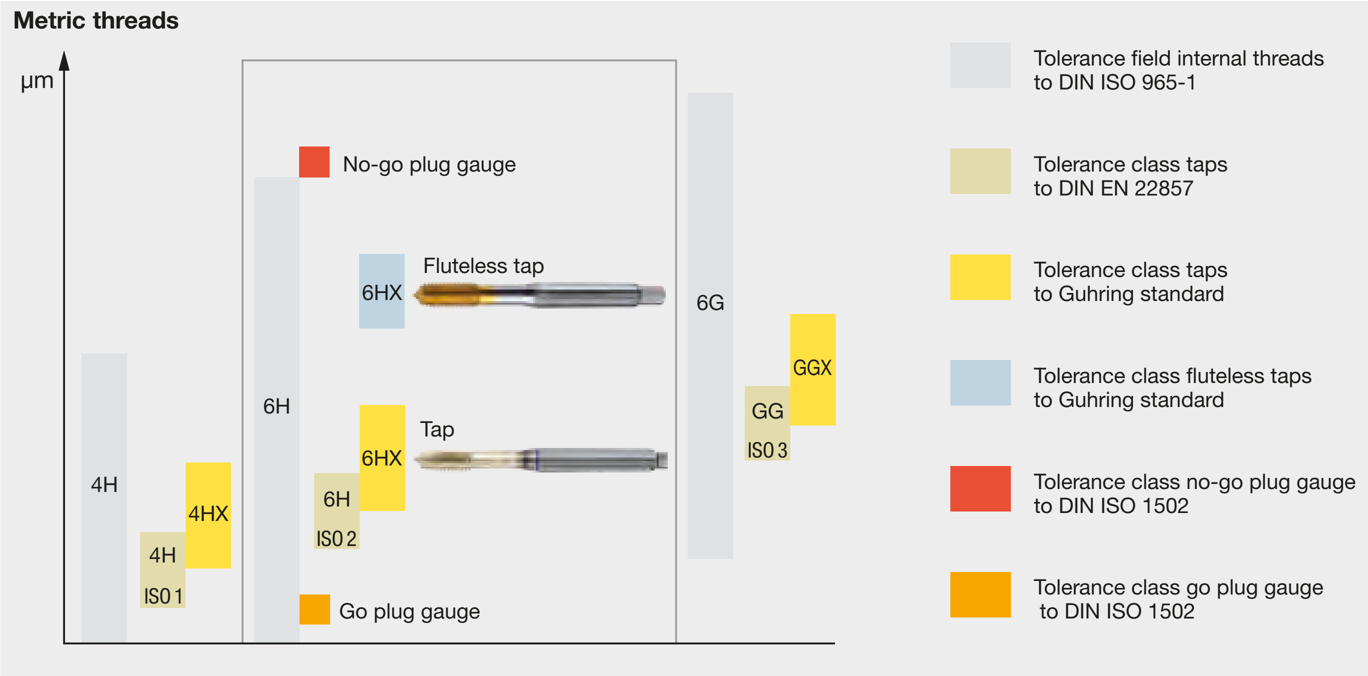


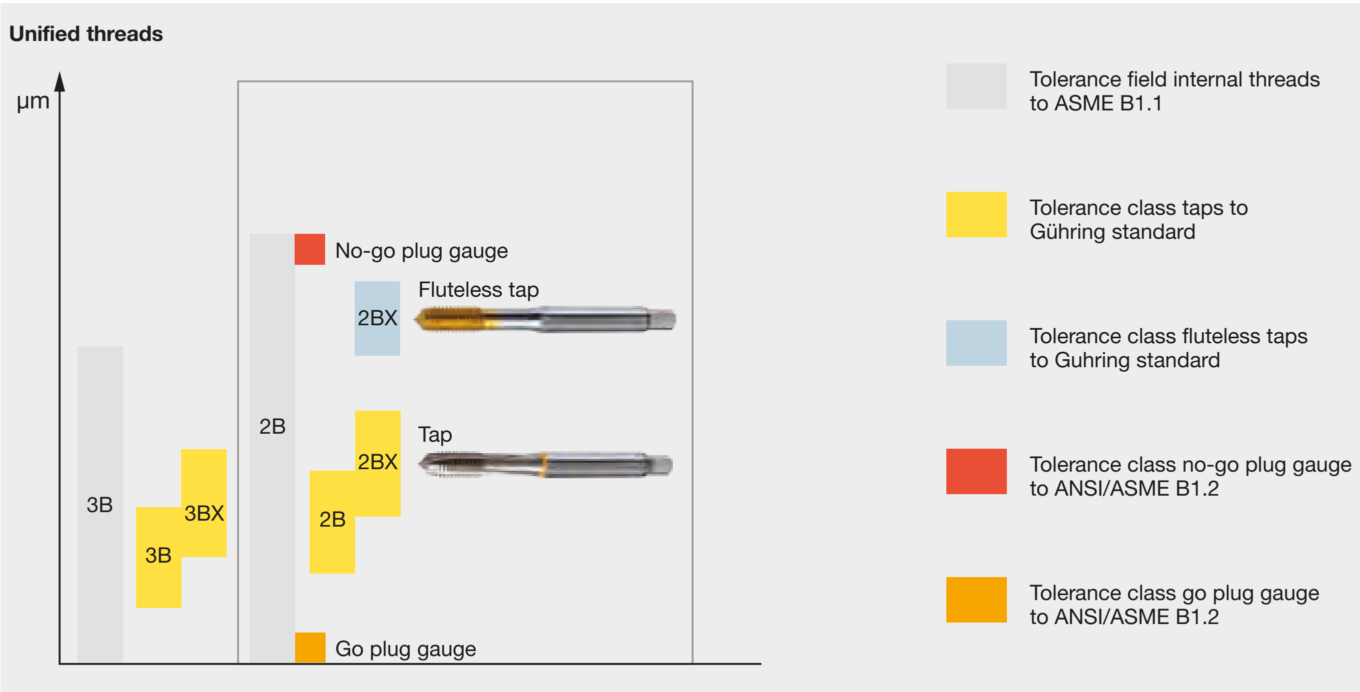
blind hole

Right-hand spiral fluted tap

Straight fluted tap with short chamfer lead

Tolerance fields to DIN EN 22857





Taps for ISO metric threads DIN EN 22857 (extract)

Thread clearances and fits
Fits between internal and external threads are separated by a diagonal stroke, as for example 6H/6g (internal/external thread). The fit has to be selected in conjunction with the appropriate thread connection.
The tolerance zones of the tolerance classes fine, medium and coarse are allocated to three screw-in lengths short S), normal (N) and long (L). Generally, the following rules apply for selecting a tolerance class:

Fine tolerance zone (S):
For precision threads, when only a small variation in the fit is permitted.

Medium tolerance zone (N):
General application

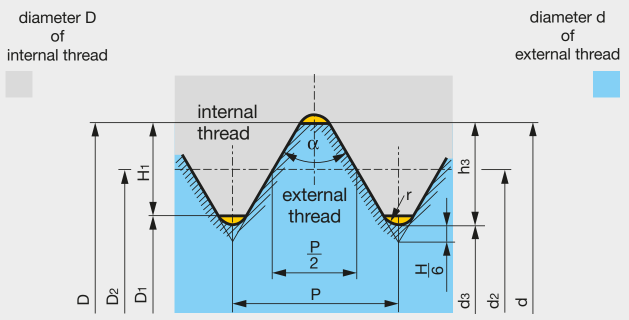
Coarse tolerance zone (L):
There are no special precision requirements and in cases where production difficulties may occur, e.g. thread production in hot-rolled rods, deep blind holes or plastic components.

Screw-in lengths
The quality of thread connection is also affected by the screw-in length. The ISO tolerance system was, especially as regards the pitch diameter, divided into three groups, i.e.

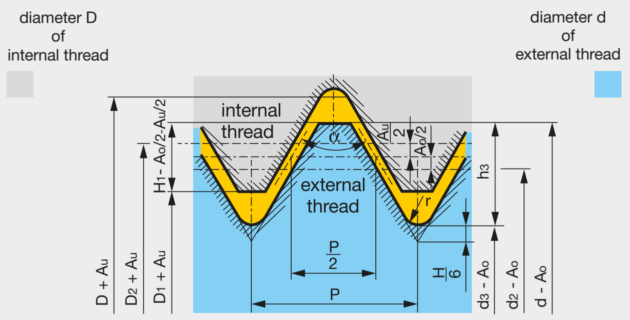
S	(Short)	= short screw-in length
N	(Normal)	= normal screw-in length
L	(Long)	= long screw-in length

The following fit should be selected for normal screw-in length N: To ensure a tighter fit of thread connections, we recommend for short screw-in lengths a narrower fit. As far as long screw-in lengths are concerned, fits with a larger tolerance must be used to compensate for pitch deviations.

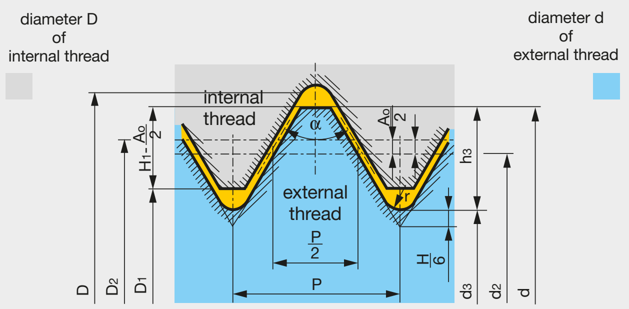
Thread fits with different flank clearance



Zero profile of thread fit without flank clearance (H/h-fit).



Thread fit with wide flank clearance (G/g-fit or G/e-fit) in external and internal thread.



Thread fit with narrow flank (H/g- or H/e-fit) by basic deviation of external thread.

Explanation of symbols

D	=	Ø nom. of internal thread
D_1	=	Tapping size hole Ø of internal thread
D_2	=	Basic pitch Ø of internal thread
d	=	Ø nom. of external thread
d_2	=	Basic pitch Ø of external thread
d_3	=	Tapping size hole Ø of external thread
P	=	Pitch
α	=	Included angle of thread
H	=	Height of peak to peak thread profile
A_o	=	Upper tolerance limit
A_u	=	Lower tolerance limit

GÜHRING

Hard machining taps for hardened steel (45 - 55 HRC)

For tapping operations in materials with a tensile strength in excess of 1200 N/mm^2 we have developed a HSS-E-PM tap with TiCN coating.

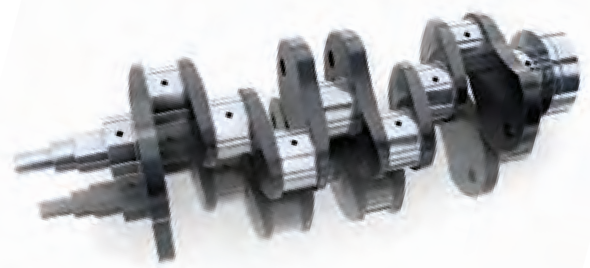
The special design makes the process reliable production of threads in hard materials possible and provides excellent tool life.

Suitable for applications in the mold and die industry as well as for various machine or automotive components following heat treatment.

Recommended cutting speed vc = 2 –8 m/min
dependent on the hardness of the component.

Process reliable thread production thanks to short chips

In order to achieve absolute process reliability and a long tool life in series production of high tensile strength steels (850-1250 N/mm^2), as for example a crankshaft, short chips are essential. This is only possible in combination with bright flutes / corrections. For this, Guhring provides the ideal solution in the standard range with Guhring nos. 1188, 1194 and 1200.



Universal taps with coolant ducts for short-chipping materials (GG, Al, steel)

Usually, with a tap the chips are evacuated from a blind hole via the spiral flutes. Cast iron, AlSi-alloys, brass and copper alloys are short-chipping materials. Straight-fluted taps are applied for such materials. With taps with coolant ducts, the coolant evacuates the short chips from the blind hole.

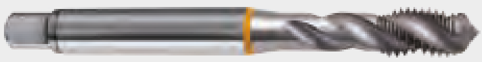
Our new straight-fluted M taps (Guhring no. 4448) and MF taps (Guhring no. 4472) with coolant ducts are especially suitable for short-chipping materials.

Evacuating long chips from steel components via the spiral flutes is an increasing problem.
Consequently, the aim is to produce short chips with straight-fluted taps and evacuate them from the blind hole with the cooling lubricant.

The tap with IC in the machine spindle achieves an improved tool life and surface quality of the thread.

Typical applications are the machining of gearboxes, cylinder blocks and heads, crankshafts, pump housings, hydraulic components etc.

Bright surface finish

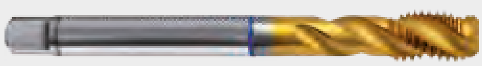


Our high speed steel or own carbide production tools offer good basic characteristics for the machining of various materials.

Steam tempered surface finish

When steam tempering, the border zones of steel surfaces are chemically modified in the µm range, thereby developing a crystalline iron oxide coating (3-10 µmm). These surfaces improve the reactional behaviour of the tools. Thanks to this surface transition the lubricant / coolant adheres better to the tool. This procedure is normally applied for the machining of carbon steel that tends to develop built up edges and cold welding at low cutting speeds. An additional nitriding of bright tools ensures an increased hardness of the surface thanks to the incorporation of nitrogen which also makes abrasive applications possible.

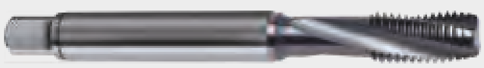
TiN-coating



Max. application temperature: < 600° C
Colour: Yellow gold
Hardness: 2300 HV0.05

The TiN-coating, introduced by Guhring in the early 1980's displays, especially in thread production, good performance characteristics, in this area it is applied as proven broad band coating.

TiCN-coating



Max. application temperature: < 600° C
Colour: Grey violet
Hardness: 3000 HV0.05

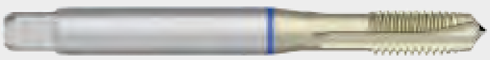
An additional incorporation of carbon increases the toughness and hardness of TiCN and possesses a lower friction coefficient than the TiN-coating. Thanks to its wear-resistance it is especially suitable for abrasive applications.

TiAlN-coating

Max. application temperature: < 800º C
Colour: Violet
Hardness: 3300 HV0.05

The classic TiAlN-coating provides higher hardness values and at the same time a better thermal resistance in comparison to the TiN and TiCN-coating, in addition it is very well suited for applications in cast iron and for the general machining of steel.

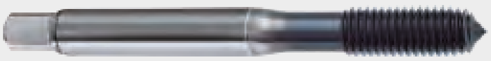
SIRIUS-coating



Max. application temperature: < 900º C
Colour: Pale gold
Hardness: 3400 HV0.05

Sirius is a multi-layer coating. Due to its TiAlN component it displays a higher wear resistance and at the same time a lower tendency to built up edges. It is especially suitable for the machining of through hole threads in stainless steel.

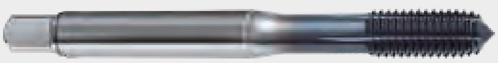
Carbo-coating



Max. application temperature: < 500º C
Colour: Grey black
Hardness: 5000 HV0.05

The carbon (CARBO) coating (ta-C) opens a broad field of application the range of non-ferrous metals. Carbo can be applied for tapping, fluteless tapping and for the machining of aluminium cast iron (<12% Si) and aluminium wrought alloys, copper, brass and bronze.

AlCrN-coating



Max. application temperature: < 1100º C
Colour: Grey blue
Hardness: 3200 HV0.05

AlCrN can be an alternative to the TiN-/TiCN-coating in the fluteless tapping of steels sector. The Ti free coating excels thanks to its excellent wear resitance and high oxidation hardness resistance.

	Tapping			Thread milling		Fluteless tapping		
	Carbide		HSS	Carbide		Carbide		HSS
	conventional	MQL		conventional	MQL	conventional	MQL	
C-steels **Free-cutting steels** **Mn-steels**	- - -	- - -	TiCN TiAlN TiN	TiCN - -	TiCN - -	TiCN TiN -	TiCN TiN -	TiCN TiN -
Steel, low-alloyed	- - -	- - -	TiCN TiAlN TiN	TiCN - -	TiCN - -	TiCN TiN -	TiCN TiN -	TiCN TiN AlCrN
Steel, alloyed	- - -	- - -	TiCN TiAlN TiN	TiCN - -	TiCN - -	TiCN TiN -	TiCN TiN -	TiCN TiN AlCrN
Steel, hardened < 55 HRC	- - -	- - -	TiCN - -	TiAlN - -	TiAlN - -	- - -	- - -	- - -
Steel, hardened 55-65 HRC	TiCN - -	- - -	- - -	TiAlN - -	TiAlN - -	- - -	- - -	- - -
Steel, stainless and acid resistant	- - -	- - -	Sirius[1]/TiAlN[2] TiN -	TiCN - -	TiCN - -	TiCN TiN -	TiCN - -	TiCN TiN -
Cast iron	TiAlN TiCN -	TiAlN - -	TiAlN TiCN TiN	TiCN - -	TiCN - -	TiCN TiN -	TiCN TiN -	TiCN TiN -
Aluminium wrought alloys	bright Carbo -	bright Carbo -	bright Carbo -	bright - -	bright - -	Carbo - -	Carbo - -	Carbo - -
Aluminium cast alloys (< 12% silicon)	TiCN - -	TiCN - -	TiCN - -	TiCN bright -	TiCN bright -	TiCN Carbo -	TiCN Carbo -	TiCN Carbo -
Aluminium cast alloys (≥ 12% silicon)	TiCN Cristall -	TiCN - -	TiCN - -	TiCN Cristall -	TiCN - -	- - -	- - -	- - -
Nickel based alloys (i.e. Inconel)	- - -	- - -	TiCN TiAlN -	TiCN - -	TiCN - -	TiCN - -	TiCN - -	TiCN - -
Titanium / titanium alloys	- -	- -	TiCN TiAlN	TiCN -	TiCN -	TiCN -	TiCN -	TiCN -
Copper / bronze / brass	bright Carbo	bright Carbo	bright Carbo	bright -	- -	Carbo -	Carbo -	Carbo -
Cobalt chrome alloys	bright - -	- - -	bright - -	TiCN - -	TiCN - -	- - -	- - -	- - -
Precious metals	-	-	-	-	-	-	-	-
Ceramic	-	-	-	-	-	-	-	-
Plastics, non-reinforced	bright	-	bright	bright	bright	-	-	-
Plastics, fibre-reinforced	TiCN -	TiCN -	- -	TiCN -	TiCN -	- -	- -	- -

[1]... for through holes [2]... for blind holes

Note:

The overview shows the general application recommendations for Guhring coatings. Prioritisation is from top to bottom.

Application problems with new taps

Problem	Possible causes	Solution
1. Thread surface not according to requirements 	cutting edge geometry not suitable for the application	apply “correct” tap for the material to be machined
	cutting speed too high	reduce cutting speed optimise lubrication
	insufficient coolant (concentration and supply)	ensure suitable coolant and sufficient volume
	chip congestion	apply suitable tap type
	tapping size hole too small	observe tapping size hole diameter specifications to DIN 336 or respective standards. Observe table for fluteless taps
	with tough, hard materials loading on tool too much or pitch too steep	apply hand tap sets
	built-up edge	apply coated tap
	cold welding	improve coolant supply
2. Tool life insufficient	surface hardening of tappinge size hole	check drill (cutting edge) for wear heat or surface treatment following thread production
	reasons listed under: “thread surface not according to requirements“	reasons listed under: thread surface “not according to requirements“
	chip congestion	apply correct tap
3. Tool breakage during advance or return 	tapping size hole too small	observe tapping size hole dia. acc. to DIN 336 or respective standards
	teeth of chamfer lead overloaded	longer chamfer lead (blind or through hole) increase no. of teeth of chamfer lead by increasing no. of flutes apply tap sets
	tap hits bottom of tapping size hole	check hole depth apply tension/compression tap chuck
	lack of or incorrect chamfer of tapping size hole postional or angle error of tapping size hole	correct chamfer angle of tapping size hole ensure correct tool clamping apply floating tap holder check core drill
	tool hardness not suitable for the application cutting edge geometry not suitable for the application	apply suitable tap for the individual application

Errors and difficulties with reground taps

Problem	Possible causes	Solution
1. Thread produced is too large	burrs	remove burrs
	cutting edge geometry (chamfer lead, rake-, chamfer-, spiral point angle) not retained	observe technical specifications when regrinding observe regrinding instruction
2. Thread produced is too small	worn section has not been reground correctly	regrind again or apply new tool observe max. regrinding limits
	tap too small due to no. of regrinds	max. regrinding limit reached apply new tap
3. Thread produced not according to requirements	burrs	remove burrs
	cutting edge geometry (chamfer lead, rake-, chamfer-,spiral point angle) not retained	observe technical specifications when regrinding observe regrinding instruction
	peak-to-valley height of the reground tap too large	regrind again or apply new tool observe max. regrinding limits
	cold welding at the flanks	remove cold welding marks
4. Tool life insufficient	cutting edge geometry (chamfer lead, rake-, chamfer-, spiral point angle) not retained	check quality of grinding wheel check coolant supply
	loss of tap hardness due to heat development during the regrinding process	check quality of grinding wheel check coolant supply
	loss of coating	recoat check coating of the material to be machined

Thread production by pressure deformation

Fluteless taps are used for the forming of internal threads without chip removal. In contrast to conventional tapping where material is cut from the workpiece, thread forming is a pressure deformation process without chip removal for the production of internal threads. During the process the material is cold formed without interrupting the grain flow.

According to DIN 8583, thread forming is described as "pressing the thread into the workpiece with a tool possessing a spiral working area". The spiral threaded, polygonal portion of the fluteless tap is "screwed" into the pre-drilled workpiece with an appropriate constant feed rate equal to the thread pitch. Hereby the thread profile is pressed gradually via the forming lead into the material of the workpiece so to speak. Subsequently, the pressure in the deformation zone exceeds the compression limit, the workpiece becomes ductile and is deformed. The material yields radially, "flows" along the thread profile in the unoccupied base of the tool and forms the minor diameter of the nut thread. The flow process creates the process specific form pockets (claws).

The tapping size hole diameter is heavily dependent on the formability of the material, the workpiece geometry and the required effective depth of the thread. In comparison to conventional tapping, a larger diameter tapping size hole should be selected. With a larger diameter tapping size hole the load on the tool is reduced whilst increasing the tool life. Thanks to the uninterrupted grain flow, the loading capacity of the thread remains sufficient with a 50% effective thread depth.

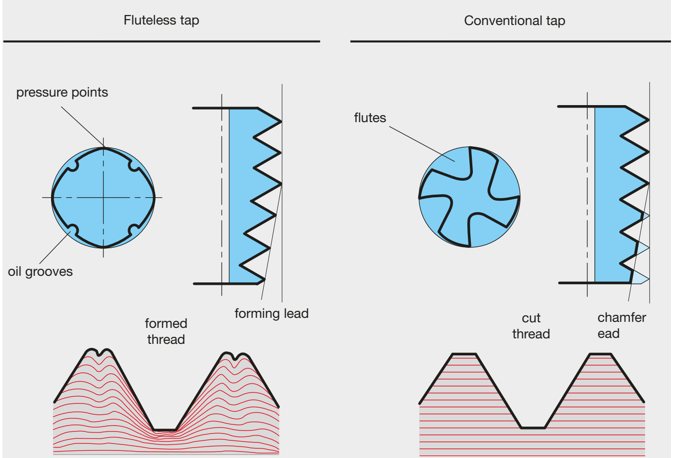
The partially formed crests of the thread with decreasing effective thread depth are a typical characteristic of threads produced by the thread forming process. With the flanks of the thread fully formed, they have no influence on the tensile strength of the thread. If necessary, the required deformation level of the thread should be determinded by performing a test.

Lubrication is of significant importance. The lubrication prevents material from building up on the thread flanks and ensures that the necessary torque for the forming process is not too high. Therefore, under no circumstances should there ever be a break-down in lubrication! Preference should be given to lubricants such as cooling agents of oils containing graphite such as those used in rolling processes. Always follow the rule: "The better the lubrication the easier the thread forming process!"

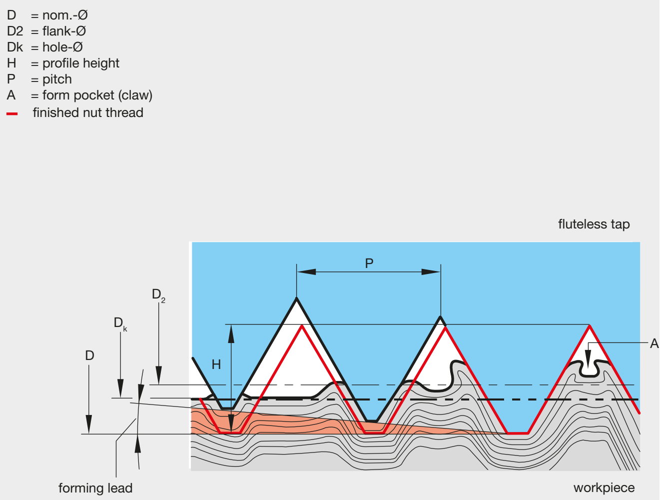
It offers the following advantages:

- no chip formation.
- one tool for the production of threads in through and blind holes.
- application in wide range of materials.
- no cutting errors.
- pitch and angle of thread errors that can occur with thread cutting are eliminated.
- internal threads produced by thread forming possess a higher tensile strength particularly at the thread flanks thanks to the so-called "uninterrupted grain flow" and the cold forming process.
- the surface of the thread is improved.
- fluteless taps can be applied at higher speeds because the formability of many materials increases with the forming speed. This does not have a negative effect on the tool life.
- reduced danger of breakage through rigid design

Process
The production of internal threads without chip removal (thread forming) in comparison to conventional tapping



Flow characteristics of the material during thread forming and the deformation process



"Profile"- Guhring's new fluteless tap generation Characteristics and advantages

Conventional fluteless taps, produced by a grinding process only, show traces of microscopic, very fine grinding marks on the surface of the tool. This also applies to the threaded portion of the tool required to perform the thread forming operation.

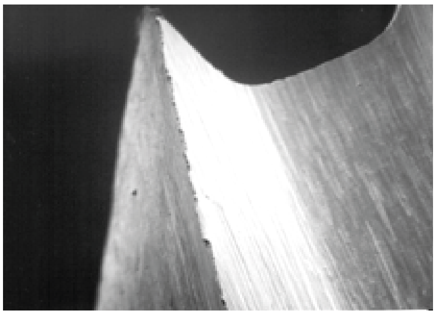
This surface topography (structure) has a negative effect on the friction between the tool and the material to be re-formed as well as on the herewith associated heat development, on the necessary torque and last but not least on the wear of the pressure points of the fluteless tap. In addition, the "grinding marks" encourage the build-up of the material to be re-formed in the thread flanks of the fluteless tap. This is also called cold welding.

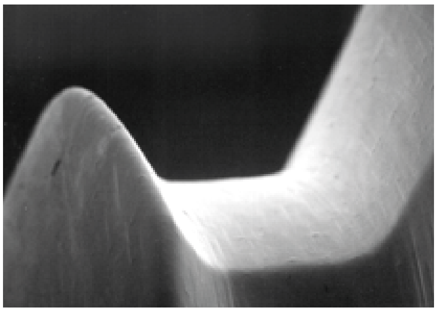
Thanks to a special process to improve the surface topography (structure), Guhring's new Profile fluteless taps no longer possess these "grinding marks". This has been confirmed in research and tool life studies in varying materials under production conditions.

For the user, a longer tool life and increased cutting speeds are the benefits of this special process. The tool life can be increased considerably depending on the material to be machined and the application condi-tions. A 100% increase in tool life is not unusual.

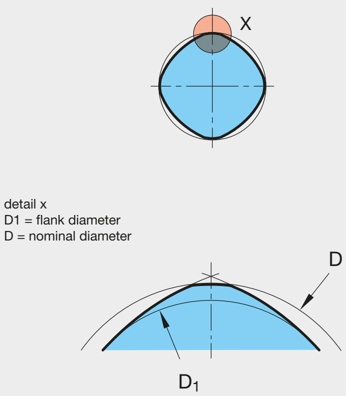
The improved surface topography is not only of benefit to tools with bright finish. Particularly coated tools also benefit from the new process. Outer contour and forming lead greatly determine the performance of the fluteless tap. Numerous tests have shown that fluteless taps with optimal pressure point geometry and quantity achieve increased tool life and dimensional accuracy.

Further improvements in quality are achieved when the fluteless tap is produced completely in one setting and with one grinding wheel - set-up with a special roll. Pitch errors between the thread crests and former lead transition area do not occur as with the conventional grinding process.

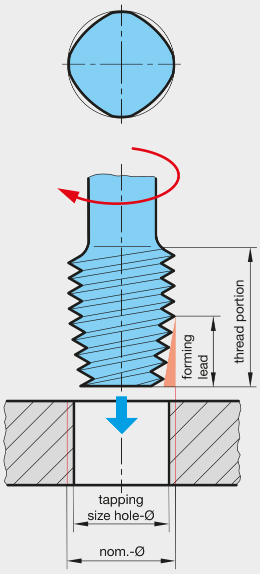

Surface of a conventional fluteless tap


Optimised surface of a Guhring Profile fluteless tap

Cross section of fluteless tap



The principle

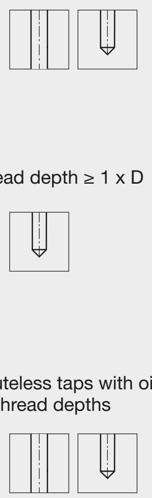


Types of tapping size hole

with fluteless taps without oil grooves for thread depth ≤ 1 x D

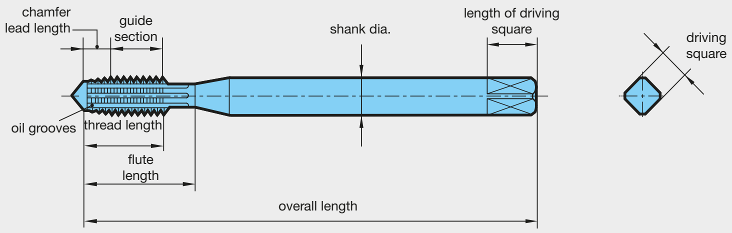
for thread depth ≥ 1 x D

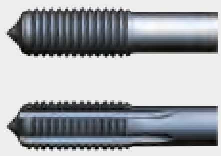
with fluteless taps with oil grooves for all thread depths



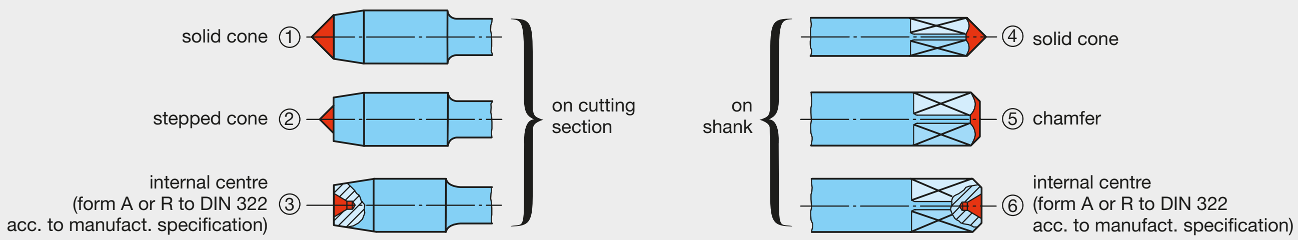
Definitions, angles, centres, thread tolerances and fits

Thread portion





Types of centres (standard, to DIN 2197/DIN 2175)



Thread dia. range mm	Centre on cutting section with chamfer forms A, C, D, E	Centre on cutting section with chamfer form B	Centre on shank
≤ 5.6	①	①	④⑤⑥
> 5.6 … 12.8	①②③	①②③	④⑤⑥
> 12.8	③	③	⑥

Thread tolerances and fits

Fits between internal and external threads are separated by a diagonal stroke, as for example 6H/6g (internal/external thread). The fit has to be selected in conjunction with the appropriate thread connection.
The tolerance zones of the tolerance classes fine, medium and coarse are allocated to three screw-in lengths short S), normal (N) and long (L). Generally, the following rules apply for selecting a tolerance class:

Fine tolerance zone (S):
For precision threads, when only a small variation in the fit is permitted.

Medium tolerance zone (N):
General application

Coarse tolerance zone (L):
There are no special precision requirements and in cases where production difficulties may occur, e.g. thread production in hot-rolled rods, deep blind holes or plastic components.

Screw-in lengths
The quality of thread connection is also affected by the screw-in length. The ISO tolerance system was, especially as regards the pitch diameter, divided into three groups, i.e.

S (Short) = short screw-in length
N (Normal) = normal screw-in length
L (Long) = long screw-in length

The following fit should be selected for normal screw-in length N:
To ensure a tighter fit of thread connections, we recommend for short screw-in lengths a narrower fit.

Tapping size hole diameter

With fluteless tapping, the tapping size hole diameter influences the distinction of the formed thread. A too small tapping size hole diameter results in an over-forming of the thread which must definitely be prevented because this can lead to tool breakage. A too large tapping size hole is acceptable with certain tolerances because formed threads have a sufficient loading capacity from a 50% bearing depth.

The thread M18x1.5 mm example clearly shows the influence of the tapping size hole diameter selection:

M 18 x 1.00	**17.55**	**17.52**	**17.62**	**16.917**	**17.217**
M 18 x 1.50	**17.30**	**17.26**	**17.38**	**16.376**	**16.751**
M 18 x 2.00	**17.10**	**17.05**	**17.20**	**15.835**	**16.310**

Pre-drilling Ø 17.1 mm

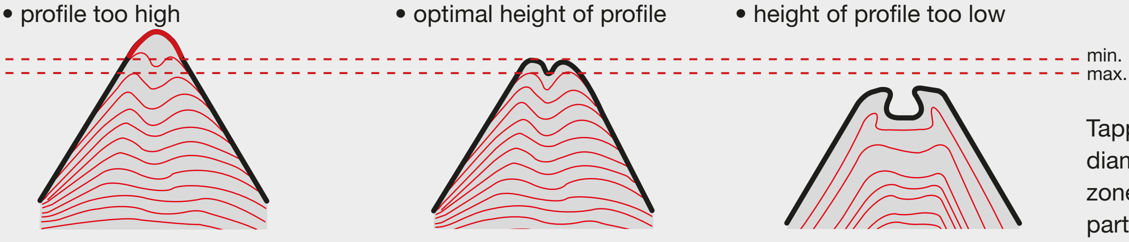
Pre-drilling Ø 17.3 mm

Pre-drilling Ø 17.4 mm

Tapping size hole diameter is too small:
- thread over-formed
- no form pocket (claw)
- profile too high

Optimal tapping size hole diameter:
- thread fully formed
- small form pocket (claw)
- optimal height of profile

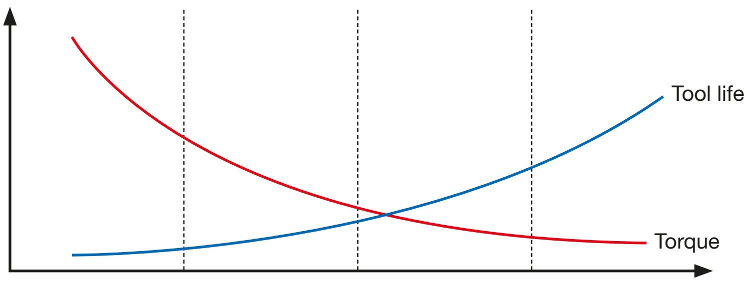
Tapping size hole diameter is too large:
- thread not formed
- large form pocket (claw)
- height of profile too low



Tapping size hole diameter tolerance zone to DIN 13, part 50

Influence of the tapping size hole on tool life, torque and process reliability

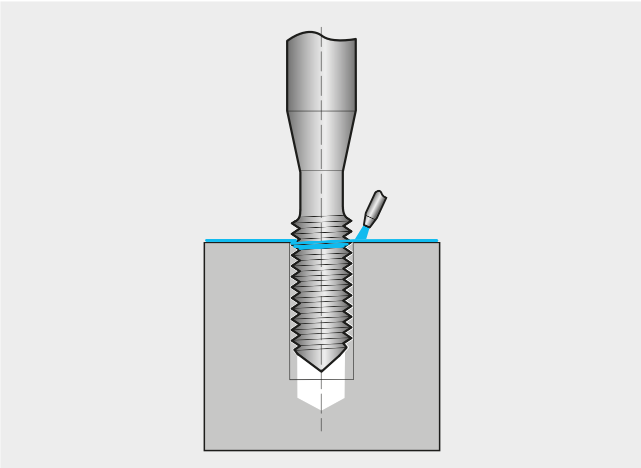
The optimisation of the pre-drilling diameter is especially worthwhile in mass production.
The larger it is, the longer the tool life and the less the required torque is. The graphic clearly shows the relationship



Lubrication for thread forming

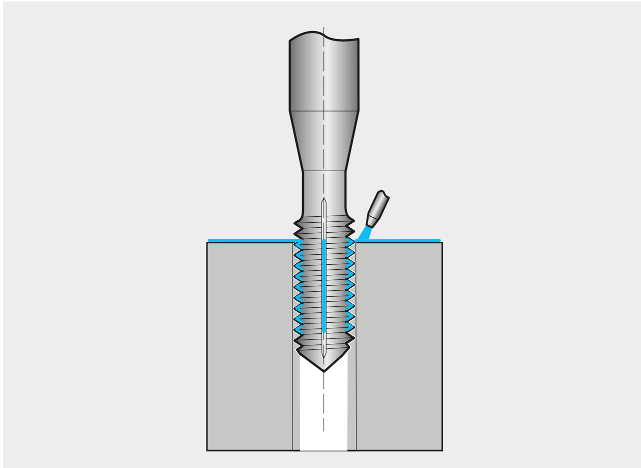
For tool design four different cases should be differentiated between

Vertical machining of a blind hole



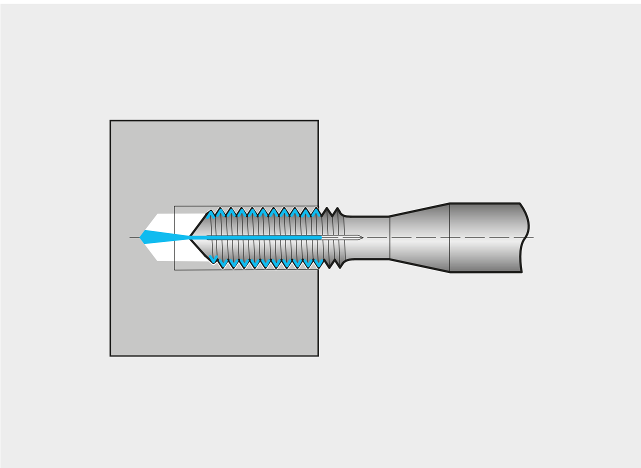
Lubrication grooves and internal coolant delivery is not necessary; external coolant delivery is sufficient
(Axial coolant is recommended for very deep threads).

Vertical machining of a through hole (> 1,5xD$_N$)



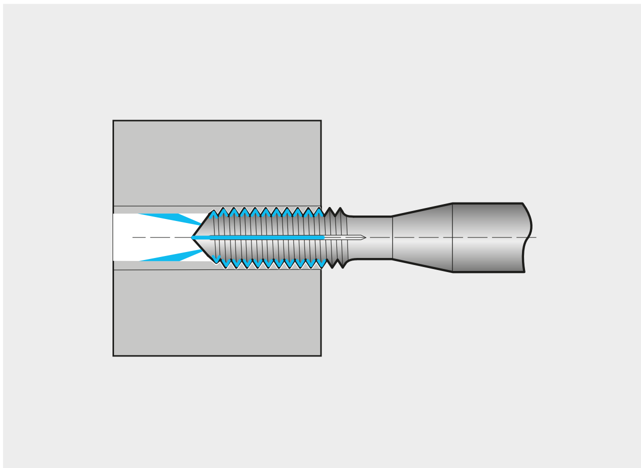
Lubrication grooves are required; internal coolant delivery is not necessary. Via the lubrication grooves the externally delivered coolant can advance to the form edges
(Radial coolant is recommended for very deep threads).

Horizontal machining of blind hole



Lubrication grooves and internal coolant delivery is necessary. Axial coolant exit is sufficient.

Horizontal machining of through hole



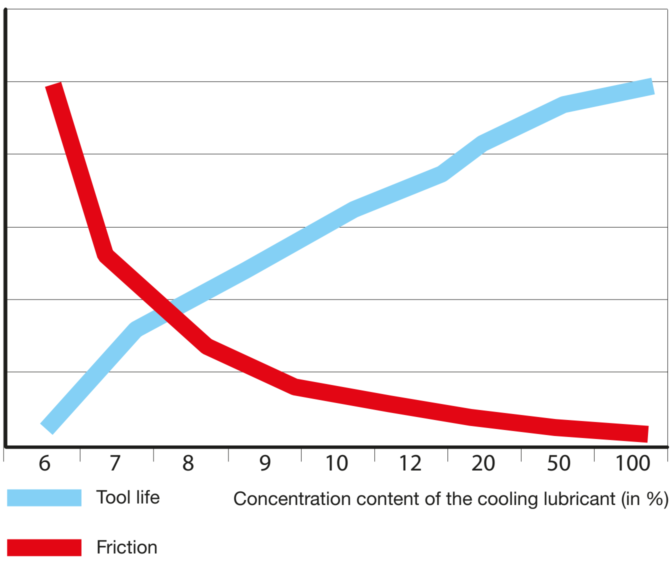
Lubrication grooves are required. Internal coolant delivery with radial exit is recommended.

Cooling lubricants with fluteless taps

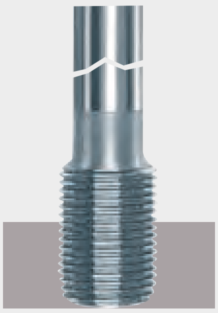
With fluteless taps the main task of the coolant is lubrication. The better the lubrication with the maximum concentration, the longer the tool life.
There are two different types of lubricant:

Oil based lubricants
These are mineral oils with the best lubricating characteristics. They reduce friction and achieve optimal life.

Soluble lubricants
These soluble lubricants are a concentrate thinned to an emulsion prior to the use with water. The concentration must not be below 6%. A content more than 12% is ideal in order to achieve a long life thanks to a good lubrication effect



Application problems with new fluteless taps

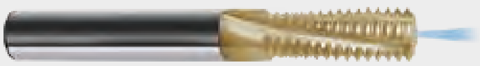
Problem	Possible causes	Solution
1 **Thread produced is too small** 	Tapping size hole diameter too large	Select correct tapping size hole diameter according to table
2 **Thread overformed** 	Tapping size hole diameter too small	Select correct tapping size hole diameter according to table
3 **Thread surface not according to requirements** 	Cold welding on the tool	Increase oil content in lubricant or apply neat oil
	Lubricant with too little oil content	Increase oil content in lubricant or apply neat oil
4 **Tool life insufficient**	Lubricant with too little oil content	Increase oil content in lubricant or apply neat oil
	Tapping size hole diameter too small	Select correct tapping size hole diameter according to table
	Cutting speed too high	Adjust cutting speed
	Lubricant soiled	Check filtration
5 **Tool breakage** 	Lubricant with too little oil content	Increase oil content in lubricant or apply neat oil
	Tapping size hole diameter too small	Select correct tapping size hole diameter according to table
	Incorrect tool clamping	Check tool clamping

What are the advantages of thread milling compared to tapping and fluteless tapping?

- Different materials can be machined with one tool (aluminium, steel, cast iron, stainless steel, titanium, Inconel, max. HRC 65 and much more)
- Various diameters and tolerances are possible with one tool (i.e. 6H+0.1, 7G, EG and much more).
- One tool for through and blind holes as well as right- and left-hand threads
- Thread depth possible up to the base of the hole (0.5xP).
- No axial cross-cutting
- Saving tool locations (type TMC, type DTMC).
- Problem-free chips because short milling chips are produced.
- Reduced tooling costs with the same pitch and large threads (type TMU)
- Short cycle times thanks to high cutting speed and feed rate.
- High process reliability even in the event of tool breakage as the thread milling cutter can be completely removed from the workpiece and the machine.
- High economic efficiency thanks to Guhring's re-grind and re-coating service.

The Guhring thread milling cutter types

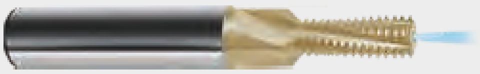
TM SP – thread milling cutter w/o countersink step



- Simple and cost-efficient tool for the milling of internal threads
- 2-3 thread sizes with the same pitch can be produced over the specified nominal dimension
- Application in materials ≤ 1000 N/mm^2
- Available with or without internal cooling

Thread types: M, MF, UNC, UNF, G, NPT, NPTF

TMCP SP – Thread milling cutter with 45° countersinking step



- Countersinking and thread milling with only one tool
- Very smooth running and low lateral forces
- Designed for the application of difficult-to-machine materials also available w/o countersinking step
- 2-3 thread sizes with the same pitch can be produced over the specified nominal dimension
- Only available with internal cooling

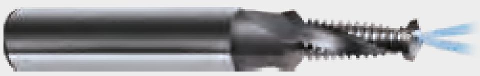
Thread types: M, MF,UNC, UNF,G, NPT, NPTF

TMU SP – universal milling cutter with collar recess

- Universal application possibilities
- For various thread sizes with the same pitch, i.e. thread M30x1.5 with milling cutter Ø 12xM1.5, Ø 16xM1.5 or Ø 20xM1.5
- Only available with internal cooling

Thread types: M, MF, G, UN, NPT, NPTF and external thread M, MF, G

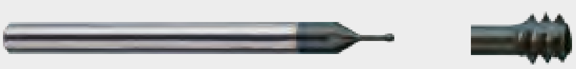
DTMC SP – drill/thread milling cutter with 2 cutting edges and 45° chamfer



- Drilling, countersinking and thread milling with only one tool
- Resulting in reduced machining times and tool costs as well as reduced space requirements
- Application only in aluminium, cast materials, brass and plastics
- Available with or without internal cooling

Thread types: M, MF, UNC, UNF

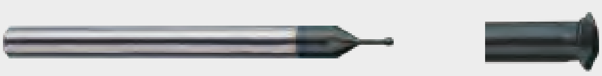
MTM 3 SP – micro-thread milling cutter (3-tooth type)



- Thread size and pitch are predetermined
- Excellent characteristics with high-tensile materials such as titanium, stainless steel etc.
- Suitable for the machining of hardened steel 45HRC-65HRC
- Threads up to 3xD
- Available with or without internal cooling

Thread types: M, MF, G, UNC, UNF, MJ, UNJC, UNJF

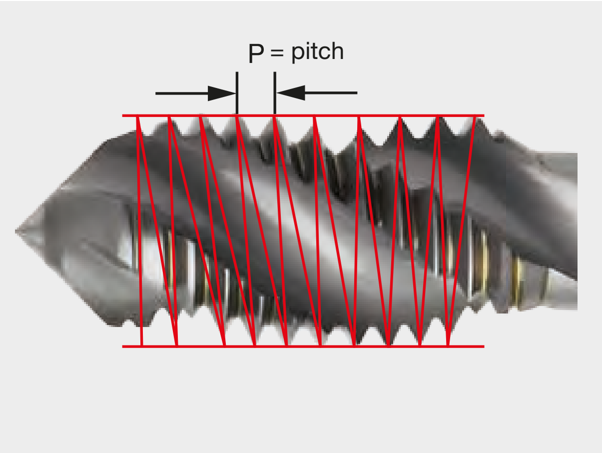
MTM 1 SP – micro-thread milling cutter (1-tooth type)



- Universal production of nominal thread diameters up to a maximum pitch
- Only available with internal cooling

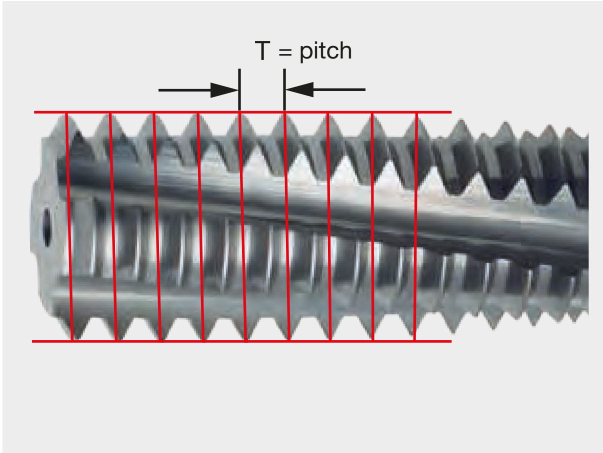
Thread types: M, MF

Taps/fluteless taps



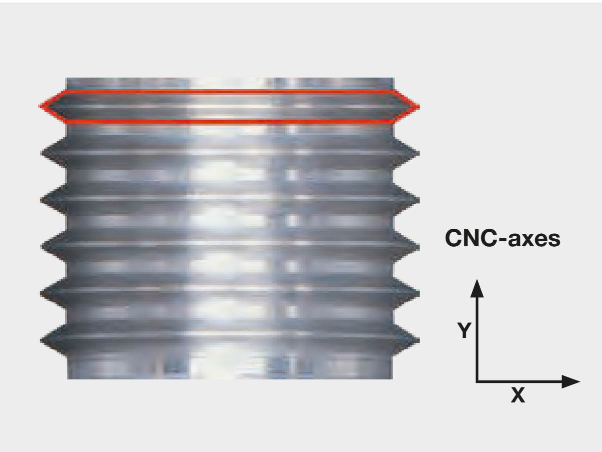
The red lines show the pitch angle of the thread that is ground into the tool. This means the pitch is cut into the workpiece by the tool.

Thread milling cutters

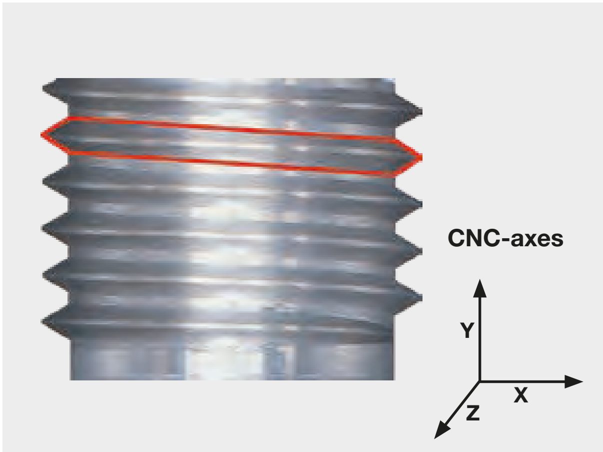


The red lines show that the tool does not possess a pitch angle. The pitch is produced by the Z-axis of a CNC machine.

Creation of the thread with thread milling



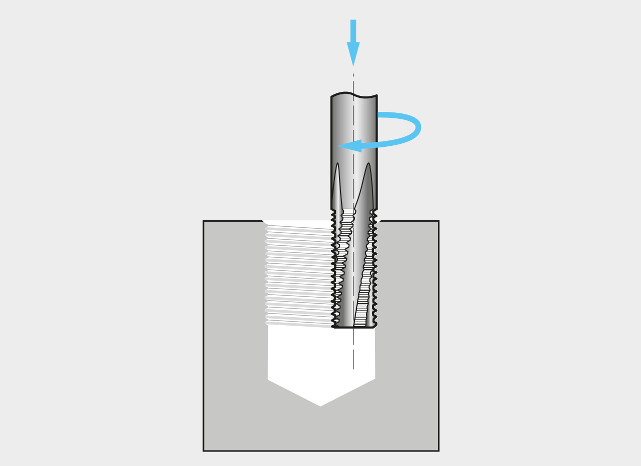
Thread profile without axial feed (Z-axis) of the machine. A groove profile is created without pitch. A functioning thread is not created



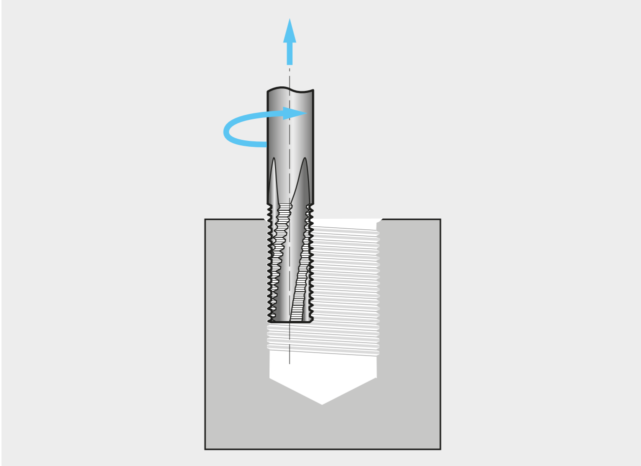
Through the additional programming of the Z-axis the necessary pitch is produced.

Note:
Due to diagonal milling in the pitch angle **(Z-axis)** the thread profile of the tool is **transferred onto the component distorted.**
The more the milling cutter diameter (80% of nom. Ø) approaches the nominal thread diameter and the higher the thread pitch the more pronounced the profile distortion is.

Conventional milling	Climb milling
clockwise, with G02	anticlockwise, with G03



Conventional milling is preferentially applied for the machining of harder materials or to remedy taper threads.

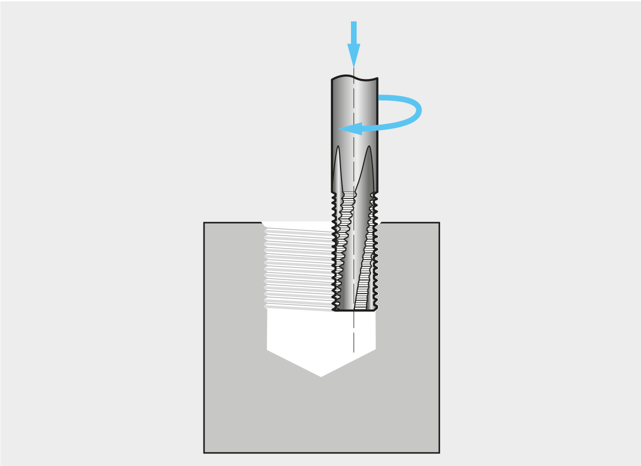


Climb milling is applied with thread depths smaller than 1.5xD.
Advantage: A better surface finish is achieved.

Thread production with one tool

Right-hand thread

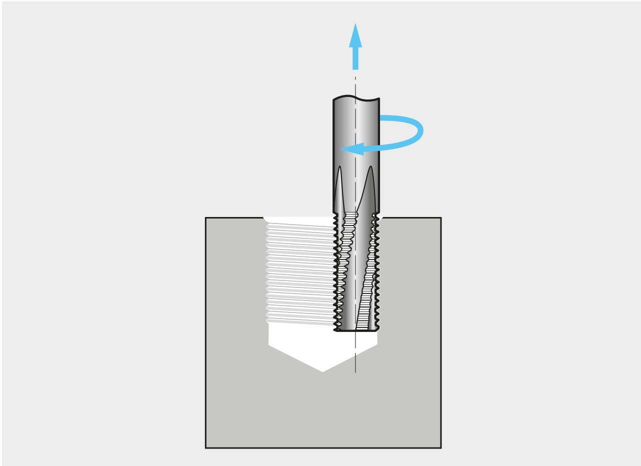
Conventional milling



Tool rotates clockwise from top to bottom

Left-hand thread

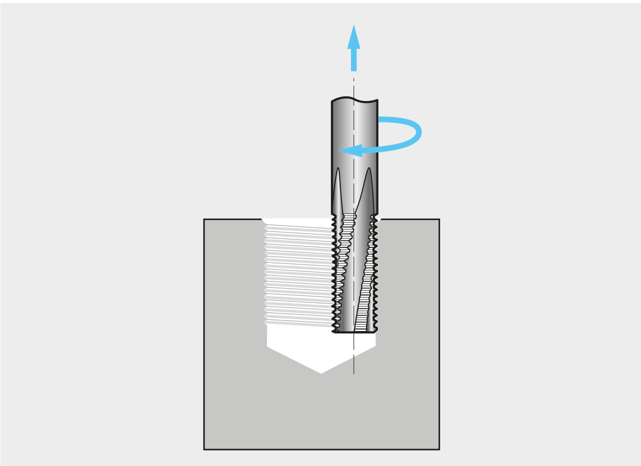
Conventional milling



Tool rotates clockwise from bottom to top

Right-hand thread

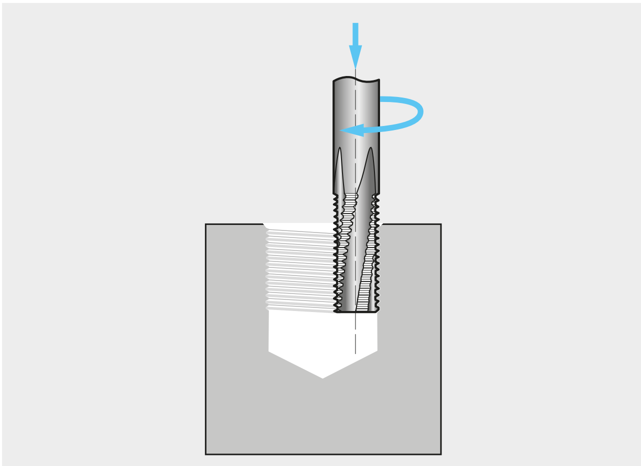
Climb milling



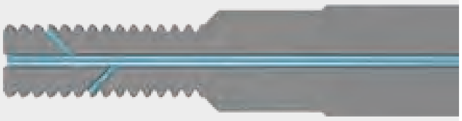
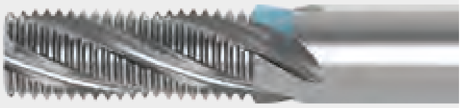
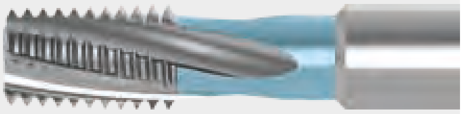
Tool rotates clockwise from bottom to top

Left-hand thread

Climb milling



Tool rotates clockwise from top to bottom

Illustration	Modification	Effect
	Cooling slots on shank	Targeted cooling, without weakening the tool cross-section in the cutting edge area
	Radial coolant exits	Targeted cooling with through hole threads
	Threads removed	Reduced cutting forces but longer machining time because two cycles are required
	De-burring cutting edge	Removing the incomplete threads at the thread run-in without additional operating step.
	First thread profile lengthened at the face	Chamfering a tapping size hole
	Grinding collar	Enables axial distribution of cuts – useful for deep threads

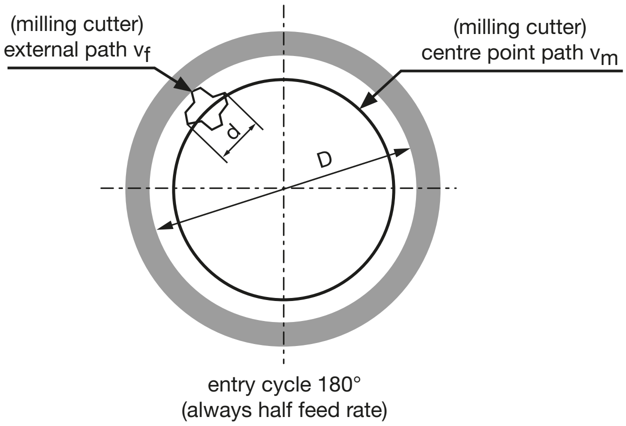
Program specifications

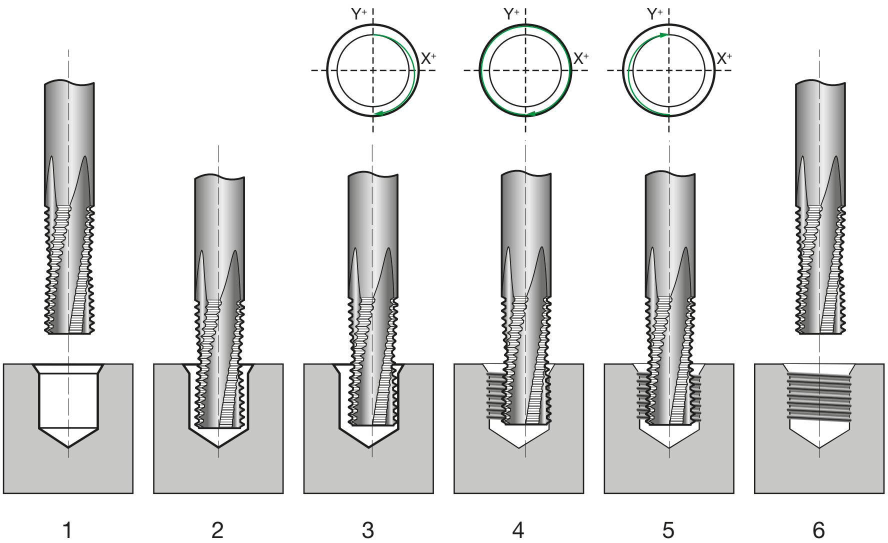
Thread milling functions

G00	Rapid movement	**G90**	Absolute dimension
G01	Feed	**G91**	Incremental dimension
G02	Circular interpolation (clockwise)	**M03**	Spindle on (clockwise rotation)
G03	Circular interpolation (anti-clockwise)	**M05**	Spindle stop
G17	Layer selection x-y axis	**M08**	Coolant on
G18	Layer selection z-x axis	**X**	Axis
G19	Layer selection y-z axis	**Y**	Axis
G40	Cancel tool correction	**Z**	Axis
G41	Tool path correction (left of contour)	**I**	Thread pitch parallel to X-axis
G42	Tool path correction (right of contour)	**J**	Thread pitch parallel to Y-axis
G43	Tool length compensation (call-up)	**S**	Spindle speed
G49	Tool length compensation (deselect)	**F**	Feed
G54	Work offset		

CNC internal thread milling

1. Moving to start position
2. Moving to thread depth in bore
3. 180° descending loop to contour
4. 360° full circular movement of thread milling cutter
5. 180° exit loop to centre of bore
6. Rapid movement from bore to start position





Formula of calculation

$$v_c = \frac{d \cdot \pi \cdot n}{1000}$$

$$n = \frac{v_c \cdot 1000}{d \cdot \pi}$$

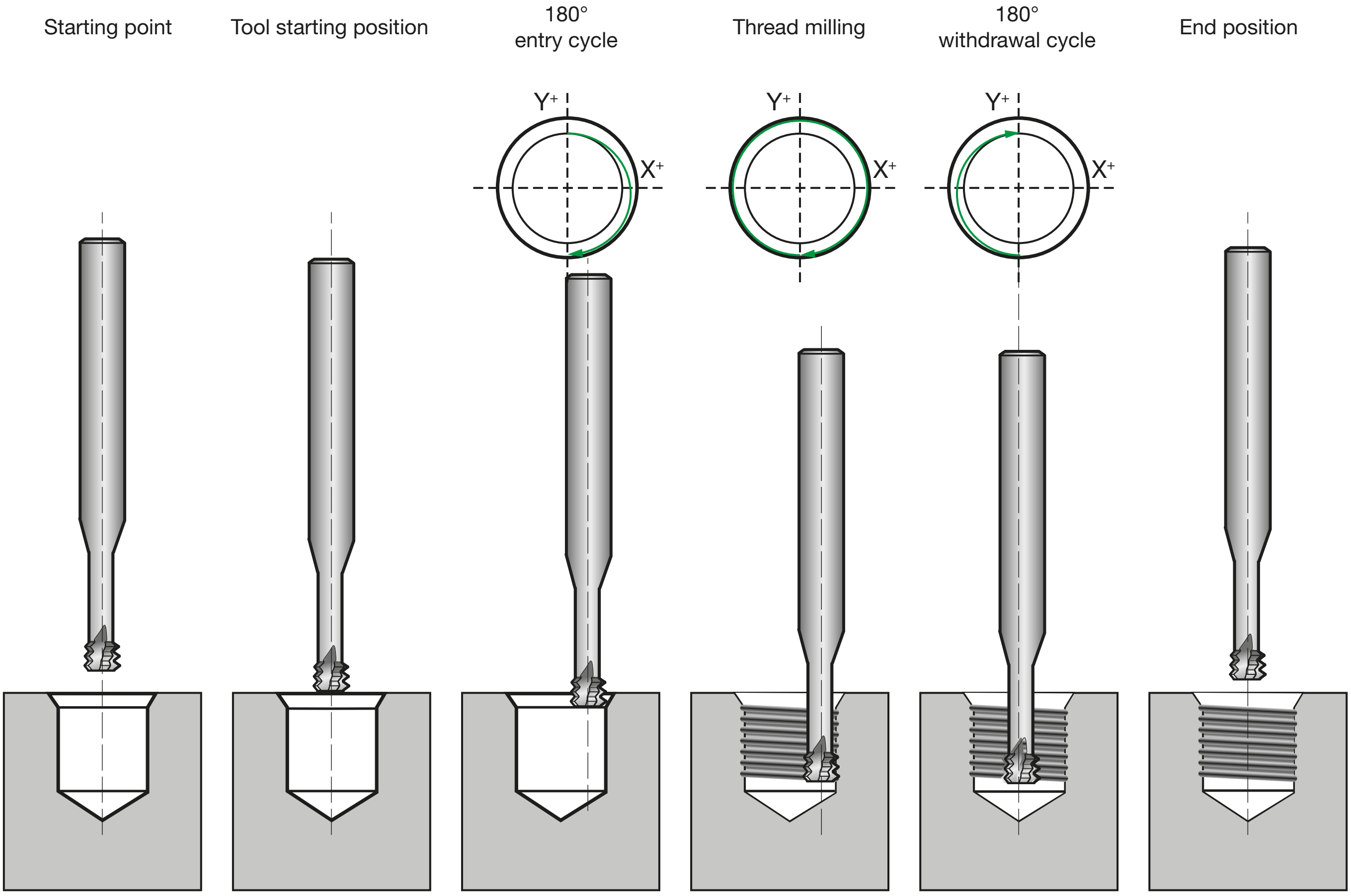
$$v_f = n \cdot z \cdot f_z$$

$$v_m = \frac{v_f \cdot (D - d)}{D}$$

$$v_b = n \cdot f_b$$

v_c = cutting speed
v_f = contour feed
v_m = centre point path feed
n = revolutions
z = number of teeth
f_z = feed per tooth
f_b = feed per drill per revolution*
v_b = drill feed rate*
D = Ø nom. of thread [mm]
d = milling cutter nom. Ø [mm]
* for drill/thread milling

Programming process for micro-thread milling (right-hand thread in reverse rotation)



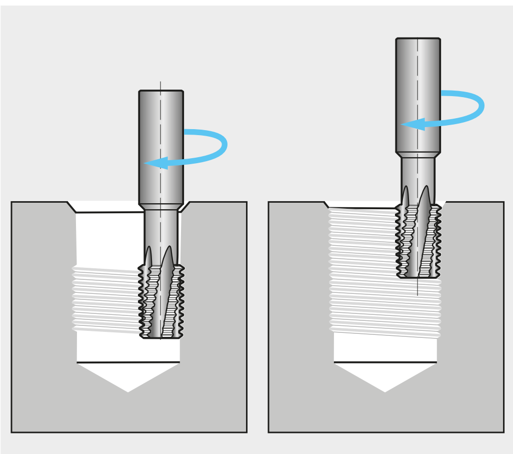
Possibilities to reduce radial forces

To reduce radial forces cut distribution can be undertaken:

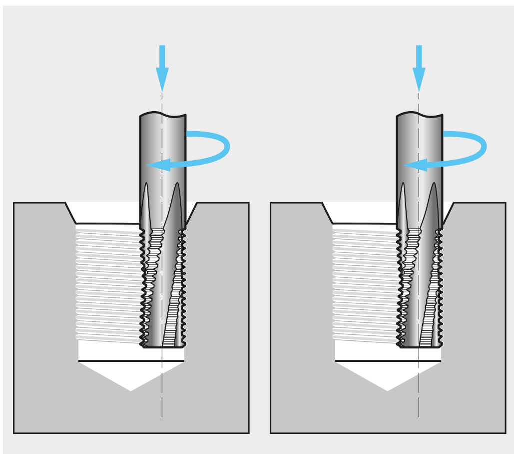
Advantage:
- for larger thread depths
- counteracts taper threads
- for unstable clamping conditions

Disadvantage:
- increased tool wear
- longer production time

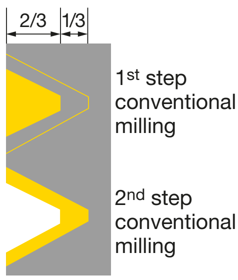
Axial distribution of cut	Radial distribution of cut



1st step **2nd step**



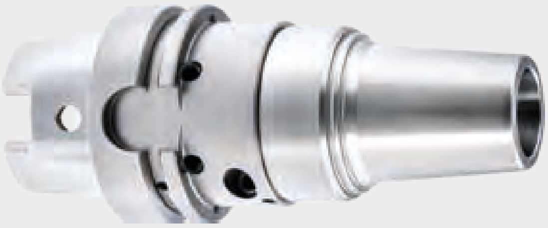
1st step **2nd step**



Selecting the correct clamping chuck

Correct tool clamping also plays a essential role with thread milling. Thread milling cutters should as a rule be clamped as short as possible. A compact and mechanical clamping force is preferable. The error in concentricity should not exceed 0.02 millimetres.

Power chucks



max. permissible error in concentricity: 0.003 mm

A power chuck excels thanks to extremely accurate concentricity. The high clamping forces and optimal smooth running are a perfect prerequisite for the production of threads in all materials including a high pitch.

Side lock holders

max. permissible error in concentricity: 0.002 mm

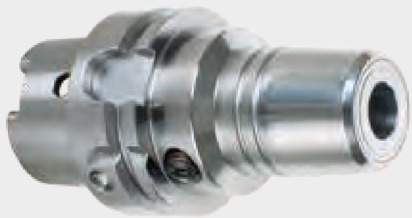
A side lock holder for HB and HE shanks is a robust, cost-efficient clamping chuck with a maximum clamping force. The clamping surface prevents the tool twisting or being pulled out during machining. Therefore, side lock holders are suitable for the production in all materials including a high pitch.

Shrink fit chucks

max. permissible error in concentricity: 0.005 mm

A shrink fit chuck creates a rigid connection with the shrink fitted tool. Incorrect shrink fitting or older shrink fit chucks can result in the pulling out of the tool. Tool breakage and possible loss of the component would be the consequence. Therefore, the shrink fit chuck is only suitable for a thread pitch < P=1.5 mm.

Hydraulic chucks



max. permissible error in concentricity: 0.005 mm

A hydraulic chuck, similar to the shrink fit chuck, has only limited suitability for thread milling. Especially with high radial forces this clamping chuck reaches its limits. Therefore, the hydraulic chuck is recommended for softer materials such as aluminium and a thread pitch < P=1.5 mm.

Collet holders

max. permissible error in concentricity: 0.01 mm

Collet chucks are very well suited for micro-thread milling because only axial stresses are created. The low clamping forces omly permit the milling of softer materials. Consequently, collet holders are not suitable for conventional thread milling.

Practical application of thread milling cutters

1.) Tool clamping:
good concentricity is important, therefore clamping as short and rigid as possible

2.) Enter tool data in machine memory
1.) Tool length from the front face, take drill/thread milling cutters (DTMC) rom point.
2.) Measure tool radius with tool pre-setting equipment. General rule: measured radius - 0.022 x pitch provides the input value in machine memory.

3.) Input of CNC program in control
(preferably integrated as sub-program at corresponding positions)
a.) Call-up of a self-controlling cycle (procedures should be known)
b.) Integration of data file from our threadmill-software (DIN or Haidenhain).

4.) Trial run over workpiece
a) Tool length dimension in memory extending by an approximate value dependent on contact length (i.e. 30 mm) or offset zero point.
b) Run program in single set, visual check of travel path.
c) Allow program to run in automatic mode.

Attention:
With controls where it is not definitely clear what milling path is assigned it it must be clarified if the feed is positioned on the external path vf or at the centre path vm. As a rule we specify the milling centre point path vm.

5.) Application in workpiece
Re-set the tool extension or the zero point. Then allow the program to run in the workpiece the feed regulation must be 100% selected. Should the thread not be true to gauge, the tool radius requires correction in the tool memory:
Example:
• thread too tight: Radius correction - input
• thread too large: Radius correction + input

TM SP – Thread milling cutters without chamfer

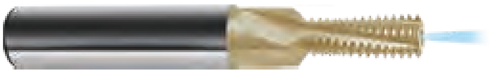
Processing example type TM

Guhring no.:	3737 TiCN	**Cutting speed [v_c]:**	80 m/min
Thread size:	M10x(1)	**Feed per tooth:**	0.05 mm
Thread depth:	20 mm / blind hole	**Processing sequence:**	conventional milling
Material:	St- 37	**Processing time:**	6.9 sec.

CNC program

N10 M6 T1	
N20 G90 G54 G00 X0 Y0	
N30 Z2 S3203 M3 M8	position over workpiece
N40 Z-18.70	position for thread depth
N50 G91	incremental
N60 G42 G01 X0 Y3.975 F50	radius compensation
N70 G02 X0 Y-9.005 I0 J-4.503 Z-0.150	entry cycle 180°
N80 G02 X0 Y0 I0 J5.030 Z-1.000 F101	thread pitch 360°
N90 G02 X0 Y9.005 I0 J4.503 Z-0.150	withdrawal cycle 180°
N100 G40 G01 X0 Y-3.975	radius compensation off
N110 G90	switch to absolute
N120 G00 Z2 M9	rapid movement to start position
N130 M30	

TMC SP – Thread milling cutters with 45° chamfer



Processing example type TMC

Guhring no.:	3528 TiCN	**Cutting speed [v_c]:**	100 m/min
Thread size:	M12x(1.5)	**Feed per tooth:**	0.075 mm
Thread depth:	18 mm / blind hole	**Processing sequence:**	conventional milling
Material:	42CrMo4	**Processing time:**	4.15 sec.

CNC program

N10 M6 T1	
N20 G90 G54 G00 X0 Y0	
N30 Z2 S1600 M3 M8	position over workpiece
N40 Z-26.20	position for 45° countersinking
N50 G01 Z-27.57 F85	chamfering 45°
N60 G00 Z-16.05 S3199	position for thread depth
N70 G91	incremental
N80 G42 G01 X0 Y4.975 F85	radius compensation
N90 G02 X0 Y-11.015 I0 J-5.508 Z-0.225	entry cycle 180°
N100 G02 X0 Y0 I0 J6.040 Z-1.5 F169	thread pitch 360°
N110 G02 X0 Y11.015 I0 J5.508 Z-0.225	withdrawal cycle 180°
N120 G40 G01 X0 Y-4.975	radius compensation off
N130 G90	switch to absolute
N140 G00 Z2 M9	rapid movement to start position
N150 M30	

TMU SP – Universal thread milling cutters

Processing example type TMU

Guhring no.:	3541 Ø 12xM1 TiCN	**Cutting speed [v_c]:**	60 m/min
Thread size:	M28x1	**Feed per tooth:**	0.05 mm
Thread depth:	12 mm / blind hole	**Processing sequence:**	conventional milling
Material:	VA [1.4301]	**Processing time:**	28.96 sec.

CNC program

N10 M6 T1	
N20 G90 G54 G00 X0 Y0	
N30 Z2 S1598 M3 M8	position over workpiece
N40 Z-10.70	position for thread depth
N50 G91	incremental
N60 G42 G01 X0 Y5.975 F92	radius compensation
N70 G02 X0 Y-20.015 I0 J-10.008 Z-0.150	entry cycle 180°
N80 G02 X0 Y0 I0 J14.040 Z-1.000 F184	thread pitch 360°
N90 G02 X0 Y20.015 I0 J10.008 Z-0.150	withdrawal cycle 180°
N100 G40 G01 X0 Y-5.975	radius compensation off
N110 G90	switch to absolute
N120 G00 Z2 M9	rapid movement to start position
N130 M30	

DTMC SP – Drill thread milling cutters

Processing example type DTMC

Guhring no.:	3779 bright	**Cutting speed [v_c]:**	230 m/min
Thread size:	M8x(1,25)	**Drill feed:**	0.1 mm / rev.
Thread depth:	15 mm / blind hole	**Feed per tooth:**	0.05 mm
Material:	AlSi 10%	**Processing sequence:**	conventional milling
		Processing time:	3.44 sec.

CNC program

N10 M6 T1	
N20 G90 G54 G00 X0 Y0	
N30 Z2 S11529 M3 M8	position over workpiece
N40 G01 Z-1 F577	boring (improved centering)
N50 G01 Z-19.86 F1153	drilling to tapping size hole depth with 45° countersink
N60 G00 Z2 S11529	rapid movement from hole to flush out chips
N70 Z-13.38	position for thread depth
N80 G91	incremental
N90 G42 G01 X0 Y3.175 F122	radius compensation
N100 G02 X0 Y-7.205 I0 J-3.603 Z-0.188	entry cycle 180°
N110 G02 X0 Y0 I0 J4.030 Z-1.250 F245	thread pitch 360°
N120 G02 X0 Y7.205 I0 J3.603 Z-0.188	withdrawal cycle 180°
N130 G40 G01 X0 Y-3.175	radius compensation off
N140 G90	switch to absolute
N150 G00 Z2 M9	rapid movement to start position
N160 M30	

TMU SP – Universal thread milling cutters for external threads

Free
CNC programming
on request!

Programming example M14x1.5 – 6g (external thread)

Tool type:	TMU D12x20xM1.5-A TiCN Z=4 (tool-Ø 11.95 mm)	
	(alternatively TMU D16x25xM1.5 A TiCN Z=5 can be applied)	
Material:	38MnSiV5	
Parameter:	v_c = 130 m/min, f_z = 0.06 (conventional milling) v_f = 831 mm/min, v_m = 1548 mm/min	
N10 M6 T1		
N20 G90 G54 G00 X0 Y0		
N30 Z2 S3463 M3 M8		travel centrally over bolt
N40 G91		incremental
N50 X7.033 Y11.99		starting position lateral to bolt
N60 G01 Z-14.5		travel to starting depth
N70 G42 G01 X0 Y-5.975		radius compensation
N80 G01 X-7.033 Y0.000 F774		linear approach path
N90 G03 X0.000 Y0.000 Z1.5 I0 J-6.015 F1548		thread pitch 360°
N100 G01 X-7.033 Y0.000		linear exit path
N110 G40 G01 X0.000 Y5.975		radius compensation off
N120 G90		switch to absolute
N130 G80 G00 Z2 M9		end position over bolt
N140 M30		

GÜHRING

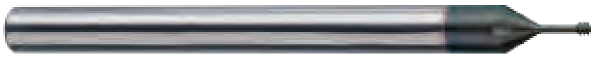
Type TM SP – für NPT threads (conical, taper 1:16)

Programming example NPT ¼-18: (conical, taper 1:16)

Tool type:	TM D 9.95x19,05xNPT18 IK (4-fluted)
Tool Ø:	d1 = 9.95 mm (measured on the first tooth)
Tool length:	Measured at the face
Tapping size Ø:	Ø 11.10 mm cylindrical (conical pre-machining preferred D1 = 11.36 mm / d1 = 11.10 mm)
Material:	16 Mn Cr 5
Parameter:	v_c = 70 m/min, f_z = 0.05 (conventional milling) v_f = 447 mm/min, v_m = 102 mm/min

N10 M6 T1	
N20 G90 G54 G00 X0.000 Y0.000	
N30 Z2.000 S2239 M3 D1	position over workpiece
N40 G00 Z-10.016	drive tool into bore
N50 G91	incremental
N60 G42 G01 X0.000 Y4.975 F1000	radius compensation
N70 G02 X0.000 Y-11.432 I0.000 J-5.716 Z-0.212 F51	entry cycle 180°
N80 G02 X-6.457 Y6.457 I0.000 J6.457 Z-0.353 F102	¼ thread, without correction
N90 G02 X6.445 Y6.445 I6.445 J0.000 Z-0.353	¼ thread, with correction
N100 G02 X6.434 Y-6.434 I0.000 J-6.434 Z-0.353	¼ thread, with correction
N110 G02 X-6.423 Y-6.423 I-6.423 J0.000 Z-0.353	¼ thread, with correction
N120 G02 X0.000 Y11.387 I0.000 J5.694 Z-0.212	withdrawal cycle 180°
N130 G40 G01 X0.000 Y-4.975 F1000	radius compensation off
N140 G90	switch to absolute
N150 G53 G00 Z2.000	rapid movement to start position
N160 M30	

MTM 3 SP Micro-thread milling cutters



Micro-thread milling cutters

Solid carbide micro-thread milling cutters have been specially developed for the production of threads in small holes:

- excellent characteristics in higher-strength materials (i.e. titanium alloys, stainless steels, …..)
- blind holes and through holes up to 3xD
- minimum cutting force
- very good thread quality
- short machining times
- also suitable for softer materials (e.g. aluminium or plastics)

Programming example: M3x(0.5) MTM 3 SP	
Material:	TiAl6V4
Thread:	M3, depth 7.0 mm / blind hole
Tool:	MTM 3 SP M3x(0.5) tool Ø 2.4 mm Z=3
Parameter:	v_c = 40 m/min, f_z = 0.025 (conventional milling) v_f = 398 mm/min, v_m = 84 mm/min
N10 M6 T1	
N20 G90 G54 G00 X0 Y0	
N30 Z2 S5305 M3 M8	
N40 Z0.1	
N50 G91	
N60 G42 G01 X0 Y1.200 F42	
N70 G02 X0 Y-2.720 I0 J-1.360 Z-0.075	
N80 G02 X0 Y0 I0 J1.520 Z-0.500 F84	
Number of repeats of set N80 =15	
N90 G02 X0 Y2.720 I0 J1.360 Z-0.075	
N100 G40 G01 X0 Y-1.200	
N110 G90	
N120 G00 Z2 M9	
N130 M30	

Application recommendations thread milling cutters

Type: TM  TMC  TMU 

ISO	Material group	Cutting speed v_c (m/min)	Ø2 mm	Ø3 mm	Ø4 mm	Ø5 mm	Ø6 mm	Ø7 mm	Ø8 mm	Ø9 mm	Ø10 mm	Ø12 mm	Ø14 mm	Ø16 mm	Ø18 mm	Ø20 mm	TM	TMC	TMU
			Feed mm / per tooth fz for Ø (**up-cut milling**) Milling part diameter																
P	Common structural steels Free-cutting steels Unalloyed case hardened steels Unalloyed heat-treatable steels	110	0.02	0.02	0.025	0.03	0.035	0.045	0.05	0.055	0.06	0.06	0.065	0.065	0.07	0.08	++	++	++
P	Alloyed case hardened steels Alloyed heat-treatable steels Alloyed tool steels	90	0.015	0.015	0.02	0.025	0.03	0.035	0.04	0.045	0.05	0.05	0.05	0.055	0.06	0.07	+	++	++
M	Stainless and acid-resit. steel Steels, sulfured austenitic martensitic	60	0.01	0.01	0.015	0.02	0.025	0.03	0.03	0.035	0.04	0.045	0.05	0.05	0.055	0.06	+	++	++
K	Grey cast iron, cast iron Spher. graph. iron mall. cast iron	120	0.02	0.02	0.025	0.03	0.035	0.045	0.05	0.055	0.06	0.06	0.065	0.07	0.08	0.1	++	++	++
N	Non-ferrous metals: Aluminium and other non-ferrous met., copper alloys	250	0.03	0.035	0.04	0.045	0.05	0.055	0.06	0.065	0.07	0.08	0.085	0.09	0.1	0.12	++	++	++
N	Plastics	350	0.03	0.04	0.045	0.05	0.055	0.055	0.06	0.07	0.075	0.085	0.09	0.1	0.12	0.15	++	++	++
S	Special alloys and Titanium	35	0.01	0.01	0.015	0.02	0.025	0.03	0.03	0.035	0.04	0.045	0.05	0.05	0.055	0.06	+	++	++
H	Hardened steel [max. 55 HRC]	25	-	0.005	0.005	0.01	0.012	0.014	0.018	0.02	0.02	0.022	0.025	0.03	0.035	0.04	+	++	+

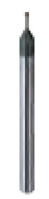
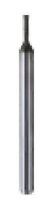
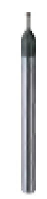
Note: In hardened steels up to max. 55HRC diameter must be programmed in 3 passes!

Application recommendations drill thread milling cutters 2xD, 2,5xD

Type: DTMC 

ISO	Material group	Cutting speed v_c (m/min)	M3 fb mm/U	M3 fz mm	M4 fb mm/U	M4 fz mm	M5 fb mm/U	M5 fz mm	M6 fb mm/U	M6 fz mm	M8 fb mm/U	M8 fz mm	M10 fb mm/U	M10 fz mm	M12 fb mm/U	M12 fz mm	DTMC
			Feed mm / per tooth fz for Ø (**up-cut milling**) Milling part diameter														
K	Grey cast iron, cast iron Spher. graph. iron mall. cast iron	100	0.05	0.01	0.06	0.02	0.07	0.025	0.08	0.035	0.1	0.04	0.12	0.055	0.14	0.065	+
N	Non-ferrous metals: Aluminium and other non-ferrous met., copper alloys	230	0.06	0.015	0.07	0.025	0.08	0.03	0.1	0.04	0.12	0.05	0.15	0.07	0.18	0.08	++
N	Plastics	300	0.07	0.02	0.08	0.03	0.09	0.04	0.12	0.05	0.13	0.06	0.18	0.09	0.2	0.12	++

Application recommendations micro-thread milling cutters

Type: MTM 3  MTM 1  MTMH 3 

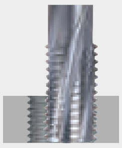
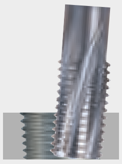
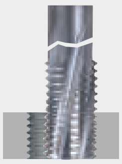
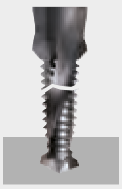
ISO	Material group	Cutting speed v_c (m/min)	Ø1 mm	Ø1.5 mm	Ø2 mm	Ø3 mm	Ø4 mm	Ø5 mm	Ø6 mm	Ø7 mm	Ø8 mm	Ø9 mm	Ø10 mm	Ø12 mm	Ø14 mm	MTM 3	MTM 1	MTMH 3
			Feed mm / per tooth fz for Ø (**up-cut milling**) Milling part diameter															
P	Common structural steels Free-cutting steels Unalloyed case hardened steels Unalloyed heat-treatable steels	70 - 120	0.04	0.04	0.05	0.05	0.06	0.06	0.07	0.07	0.08	0.09	0.09	0.1	0.12	++	++	–
P	Alloyed case hardened steels Alloyed heat-treatable steels Alloyed tool steels	60-90	0.03	0.03	0.04	0.04	0.05	0.05	0.06	0.06	0.07	0.07	0.08	0.09	0.1	++	++	–
M	Stainless and acid-resit. steel Steels, sulfured austenitic	40-80	0.02	0.02	0.02	0.03	0.03	0.04	0.05	0.05	0.05	0.06	0.06	0.06	0.07	++	++	–
M	martensitic	40-80	0.02	0.03	0.03	0.04	0.04	0.05	0.05	0.05	0.06	0.07	0.07	0.08	0.09	++	++	–
K	Grey cast iron, cast iron Spher. graph. iron mall. cast iron	60-80	0.04	0.04	0.05	0.05	0.06	0.06	0.07	0.07	0.08	0.09	0.09	0.1	0.12	++	++	–
N	Non-ferrous metals: Aluminium and other non-ferrous met., copper alloys	80 - 150	0.04	0.05	0.05	0.06	0.06	0.07	0.07	0.08	0.09	0.1	0.11	0.12	0.14	++	++	–
N	Plastics	60 - 200	0.05	0.05	0.06	0.07	0.07	0.08	0.09	0.09	0.1	0.11	0.12	0.13	0.15	++	++	–
S	Special alloys and Titanium	20-40	0.02	0.02	0.02	0.03	0.03	0.04	0.05	0.05	0.05	0.06	0.06	0.06	0.07	++	++	+
H	Hardened steel (max. 65 HRC)	40-50	0.01	0.02	0.02	0.03	0.03	0.035	0.035	0.04	0.045	0.045	0.05	0.055	0.06	–	–	++

Please note:
The cutting values specified in the respective columns are guide values, they have to be adapted according to application conditions (material, lubrication, tool clamping, machine etc.)
Depending on the machining task the optimal cutting values can differ from those in the table by up to +- 30%!

++ optimally suited + suited

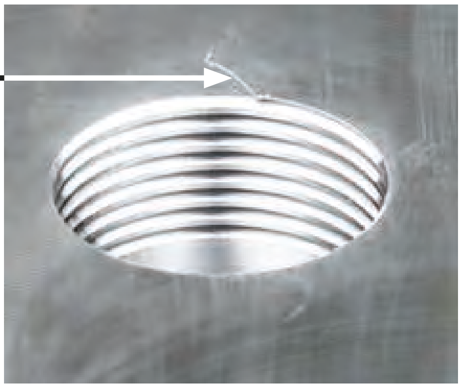
GuhroThreadmill
(CNC-programming made easy) Guhring‘s Threadmill software considerably simplifies CNC programming. With the assistance of a clear input mask, the user enters all the necessary data such as, for example, type of thread milling cutter, thread type,diameter, machine parameters etc.and immediately obtains the appropriate CNC program based on the data.
The sotware is free of cost on request, for DIN or Heidenhain control.

Application problems with new thread milling cutters

Problem	Possible causes	Solution
1. Thread produced is too large or too small 	Incorrect radius in CNC program and therefore milling of incorrect circle	Correct milling radius until thread is dimensionally correct
2. Thread not cylindrical 	Feed rate too high Climb milling path with long threads	Reduce feed rate Modify milling direction to opposite direction
3. Thread surface not according to requirements, chatter marks 	Cutting speed too high Insufficient tool or workpiece clamping	Adjust cutting speed Check tool and workpiece clamping
4. Tool breakage 	CNC program error Cutting rates too high	Check CNC program Adjust cutting rates
5. Tool life insufficient	Cutting rates too high Tool applied uncoated Insufficient lubrication and chip evacuation	Adjust cutting rates Apply coated tool Improve lubrication, coolant delivery via the spindle
6. Tool breakage with drill/milling cutter 	Chip problems when drilling Feed rates too high when drilling	Apply tool with IC Incorporate pecking cycles

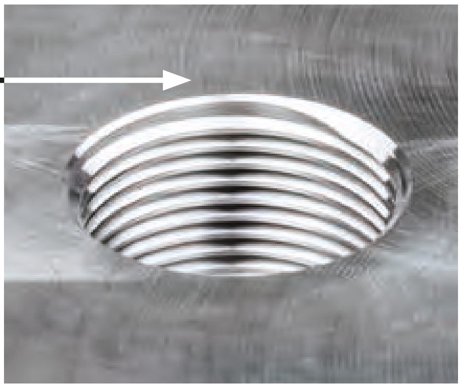
Burr-free thread machining at the thread intake - no problem for Guhring's thread milling cutters

Problem:
Burr-formation at the thread entry



Solution:
Special tool
with relief-ground de-burring edge

Result:
When thread milling to the relevant plunging depth the incomplete, burr afflicted thread entry is milled



Our technical know-how is at your disposal to develop special solutions at any time.

Special thread milling cutters

You cannot find a suitable tool in our diverse thread milling cutter range?
Then we are more than happy to provide a tool optimally adapted to your machining task as a special solution.
Please contact us!

Re-grinding and re-coating

Guhring provides a life-long re-grind and re-coating service for thread milling cutters. By professionally re-grinding and re-coating with original geometries and original coatings Guhring re-produces the 100 per cent tool efficiency.

Re-grind service

In our service centres, tools are re-ground on the front rake face according to the degree of wear.

According to width of wear marks the re-grind service is possible two or three times (from milling part diameter d1 > 5.0 mm).

In order to re-define the milling portion diameter, the number of re-grinds is indicated by a notch on the end of the shank. This means every notch is assigned to a diameter and re-etched.

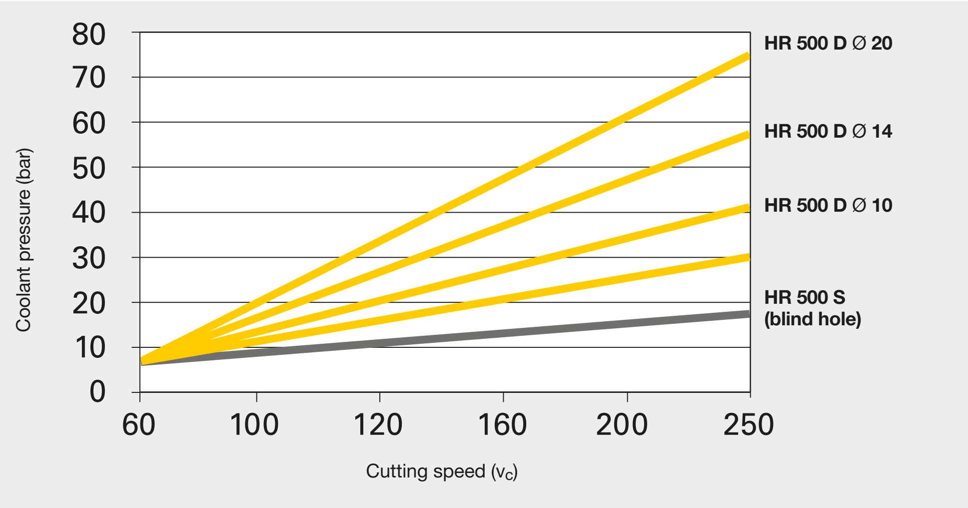
Re-coating

If a thread mill was enhanced with a coating, the tool is re-coated following the re-grind. This way, not only the wear- and corrosion-protection as well as the glide characteristics are re-produced but also the tool life prolonged.

Reaming, countersinking and deburring tools

GÜHRING

Coolant pressure



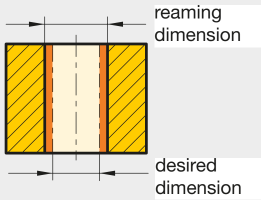
Coolant pressure - cutting speed
valid for standard dimensions.
Preconditions: sufficient capacity of coolant pump

Adapted cutting speed, an appropriate feed rate and good cooling and lubricating agents should always be a top priority for reaming operations. A further point to be considered is that the reamer always follows the direction of the pre-drilled hole. An exception is the machine bottoming reamer or a very small reamer. Consequently reamers do not correct alignment errors of pre-drilled holes. Errors between the spindle axis and the axis of a pre-drilled hole can be adjusted with the aid of floating holders. The following fault finding chart will be found useful in tracing the cause of some common reaming problems.

Wording:

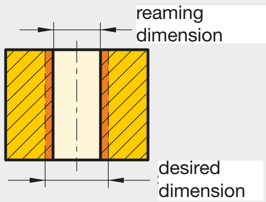
Desired dim.	Required finish dimension of bore hole, defined as max./min. dimension of tolerance zone
Reaming dim.	the finish dimension reached in fact
„Bore hole“	The reached bore hole after reaming

1 Holes too large



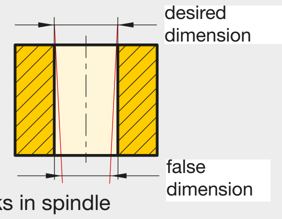
- Tool diameter too large
- Cutting speed too high
- Concentricity error of machine spindle
- Bevel lead of tool too short/uneven
- Cutting edge build up due to wrong cutting speeds oder schlechte Schmierung
- Lubricating agent unsuitable, holes too large due to lubrication

2 Holes too small



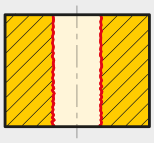
- Reamer blunt. Does not cut, scrapes
- Cutting speed too low
- Component is thin-walled, springs back
- Insufficient stock removal allowance, tool seizes in hole
- Hole is not round due to distortion

3 Conical hole malformation



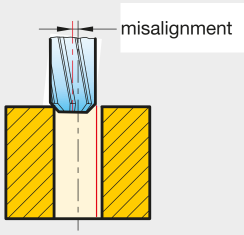
- Tool knocks in spindle
- Bevel lead incorrect
- Axis shifting between tool and pre-drilled hole. Application of floating holders
- Pre-machining inaccurate

4 Unsatisfactory surface finish



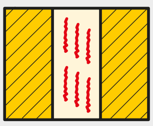
- Cutting speed too low
- No/insufficient lubrication. Cutting edge build-up.
- Tool damaged, i. e. broken cutting edge
- Material has a tendancy to cause build up on cutting edges.
- Concentricity bevel lead incorrect
- Chip evacuation restricted

5 Misalignment of hole



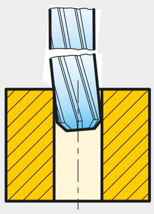
- Pre-drilled hole misaligned
- Concentricity bevel lead incorrect
- Apply floating holder if necessary
- If necessary pilot drill to correct pre-drilled position

6 Hole has chatter marks



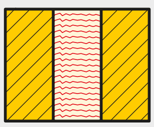
- Feed too low
- Cutting edge build-up
- Grease content in coolant too low
- Circular lands too small
- Stock removal allowance insufficient
- Tool incorrectly clamped in tool holder
- Machine spindle not concentric

7 Reamer seizes and breaks



- Position to pilot hole incorrect
- Back taper incorrect
- Circular lands too wide
- Pre-drilled hole is too small
- Bevel lead blunt/ground unevenly
- Feed rate too high
- Chip congestion – increase feed rate to produce shorter chips

8 Feed scoring marks in hole



- Cutting speed too low
- Worn cutting edges
- Crumbling on cutting edges
- Build up on cutting edges
- Position to pilot hole incorrect
- Insufficient lubrication

Nominal diameter in mm over	to	A 9	A 11	B 8	B 9	B 10	B 11	C 8	C 9	C 10	C 11
0	3	+295 +270	+330 +270	+154 +140	+165 +140	+180 +140	+200 +140	+74 +60	+85 +60	+100 +60	+120 +60
3	6	+300 +270	+345 +270	+158 +140	+170 +140	+188 +140	+215 +140	+88 +70	+100 +70	+118 +70	+145 +70
6	10	+316 +280	+370 +280	+172 +150	+186 +150	+208 +150	+240 +150	+102 +80	+116 +80	+138 +80	+170 +80
10	18	+333 +290	+400 +290	+177 +150	+193 +150	+220 +150	+260 +150	+122 +95	+138 +95	+165 +95	+205 +95
18	30	+352 +300	+430 +300	+193 +160	+212 +160	+244 +160	+290 +160	+143 +110	+162 +110	+194 +110	+240 +110
30	40	+372 +310	+470 +310	+209 +170	+232 +170	+270 +170	+330 +170	+159 +120	+182 +120	+220 +120	+280 +120
40	50	+382 +320	+480 +320	+219 +180	+242 +180	+280 +180	+340 +180	+169 +130	+192 +130	+230 +130	+290 +130
50	65	+414 +340	+530 +340	+236 +190	+264 +190	+310 +190	+380 +190	+186 +140	+214 +140	+260 +140	+330 +140
65	80	+434 +360	+550 +360	+246 +200	+274 +200	+320 +200	+390 +200	+196 +150	+224 +150	+270 +150	+340 +150
80	100	+467 +380	+600 +380	+274 +220	+307 +220	+360 +220	+440 +220	+224 +170	+257 +170	+310 +170	+390 +170
100	120	+497 +410	+630 +410	+294 +240	+327 +240	+380 +240	+460 +240	+234 +180	+267 +180	+320 +180	+400 +180

Nominal diameter in mm over	to	D 8	D 9	D 10	D 11	D 12	E 7	E 8	E 9	F 6	F 7	F 8	F 9
0	3	+34 +20	+45 +20	+60 +20	+80 +20	+120 +20	+24 +14	+28 +14	+39 +14	+12 +6	16 +6	+20 +6	+31 +6
3	6	+48 +30	+60 +30	+78 +30	+105 +30	+150 +30	+32 +20	+38 +20	+50 +20	+18 +10	+22 +10	+28 +10	+40 +10
6	10	+62 +40	+76 +40	+98 +40	+130 +40	+190 +40	+40 +25	+47 +25	+61 +25	+22 +13	+28 +13	+35 +13	+49 +13
10	18	+77 +50	+93 +50	+120 +50	+160 +50	+230 +50	+50 +32	+59 +32	+75 +32	+27 +16	+34 +16	+43 +16	+59 +16
18	30	+98 +65	+117 +65	+149 +65	+195 +65	+275 +65	+61 +40	+73 +40	+92 +40	+33 +20	+41 +20	+53 +20	+72 +20
30	50	+119 +80	+142 +80	+180 +80	+240 +80		+75 +50	+89 +50	+112 +50	+41 +25	+50 +25	+64 +25	+87 +25
50	80	+146 +100	+174 +100	+220 +100	+290 +100		+90 +60	+106 +60	+134 +60	+49 +30	+60 +30	+76 +30	+104 +30
80	120	+174 +120	+207 +120	+260 +120	+340 +120		+107 +72	+126 +72	+159 +72	+58 +36	+71 +36	+90 +36	+123 +36
120	180							+148 +85					
180	250							+172 +100					

Nominal diameter in mm over	to	G 6	G 7	H 6	H 7	H 8	H 9	H 10	H 11	H 12	J 6	J 7	J 8
0	3	+8 +2	+12 +2	+6 0	+10 0	+14 0	+25 0	+40 0	+60 0	+100 0	+2 -4	+4 -6	+6 -8
3	6	+12 +4	+16 +4	+8 0	+12 0	+18 0	+30 0	+48 0	+75 0	+120 0	+5 -3	+6 -6	+10 -8
6	10	+14 +5	+20 +5	+9 0	+15 0	+22 0	+36 0	+58 0	+90 0	+150 0	+5 -4	+8 -7	+12 -10
10	18	+17 +6	+24 +6	+11 0	+18 0	+27 0	+43 0	+70 0	+110 0	+180 0	+6 -5	+10 -8	+15 -12
18	30	+20 +7	+28 +7	+13 0	+21 0	+33 0	+52 0	+84 0	+130 0	+210 0	+8 -5	+12 -9	+20 -13
30	50	+25 +9	+34 +9	+16 0	+25 0	+39 0	+62 0	+100 0	+160 0	+250 0	+10 -6	+14 -11	+24 -15
50	80	+29 +10	+40 +10	+19 0	+30 0	+46 0	+74 0	+120 0	+190 0	+300 0	+13 -6	+18 -12	+28 -18
80	120	+34 +12	+47 +12	+22 0	+35 0	+54 0	+87 0	+140 0	+220 0	+350 0	+16 -6	+22 -13	+34 -20
120	180		+54 +14	+25 0	+40 0	+63 0	+100 0	+160 0	+250 0		+18 -7	+26 -14	+41 -22
180	250		+61 +15	+29 0	+46 0	+72 0	+115 0	+185 0	+290 0		+22 -7	+30 -16	+47 -25

Nominal diameter in mm over	to	JS 6	JS 7	JS 8	JS 9	K 6	K 7	K 8	M 6	M 7	M 8
0	3	+3 -3	+5 -5	+7 -7	+12,5 -12.5	0 -6	0 -10	0 -14	-2 -8	-2 -12	-4 -18
3	6	+4 -4	+6 -6	+9 -9	+15 -15	+2 -6	+3 -9	+5 -13	-1 -9	0 -12	+2 -16
6	10	+4.5 -4.5	+7.5 -7.5	+11 -11	+18 -18	+2 -7	+5 -10	+6 -16	-3 -12	0 -215	+1 -21
10	18	+5.5 -5.5	+9 -9	+13.5 -13.5	+21.5 -21.5	+2 -9	+6 -12	+8 -19	-4 -15	0 -18	+2 -25
18	30	+6.5 -6.5	+10.5 -10.5	+16.5 -16.5	+26 -26	+2 -11	+6 -15	+10 -23	-4 -17	0 -21	+4 -29
30	50	+8 -8	+12.5 -12.5	+19.5 -19.5	+31 -31	+3 -13	+7 -18	+12 -27	-4 -20	0 -25	+5 -34
50	80	+9.5 -9.5	+15 -15	+23 -23	+37 -37	+4 -15	+9 -21	+14 -32	-5 -24	0 -30	+5 -41
80	120	+11 -11	+17.5 -17.5	+27 -27	+43.5 -43.5	+4 -18	+10 -25	+16 -38	-6 -28	0 -35	+6 -48
120	180					+4 -21	+12 -28				
180	250					+5 -24	+13 -33				

Nominal diameter in mm		N						P			R	
over	to	6	7	8	9	10	11	6	7	9	6	7
0	3	-4	-4	-4	-4	-4	-4	-6	-6	-6	-10	-10
		-10	-14	-8	-29	-44	-64	-12	-16	-31	-16	-20
3	6	-5	-4	-2	0	0	0	-9	-8	-12	-12	-11
		-13	-16	-20	-30	-48	-75	-17	-20	-42	-20	-23
6	10	-7	-4	-3	0	0	0	-12	-9	-15	-16	-13
		-16	-19	-25	-36	-58	-90	-21	-24	-51	-25	-28
10	18	-9	-5	-3	0	0	0	-15	-11	-18	-20	-16
		-20	-23	-30	-43	-70	-110	-26	-29	-61	-31	-34
18	30	-11	-7	-3	0	0	0	-18	-14	-22	-24	-20
		-24	-28	-36	-52	-84	-130	-31	-35	-74	-37	-41
30	50	-12	-8	-3	0	0	0	-21	-17	-26	-29	-25
		-28	-33	-42	-62	-100	-160	-37	-42	-88	-45	-50
50	65	-14	-9	-4	0	0	0	-26	-21	-32	-35	-30
		-33	-39	-50	-74	-120	-190	-45	-51	-106	-54	-60
65	80	-14	-9	-4	0	0	0	-26	-21	-32	-37	-32
		-33	-39	-50	-74	-120	-190	-45	-51	-106	-56	-62
80	100	-16	-10	-4	0	0	0	-30	-24	-37	-44	-38
		-38	-45	-58	-87	-140	-220	-52	-59	-124	-66	-73
100	120	-16	-10	-4	0	0	0	-30	-24		-47	-41
		-38	-45	-58	-87	-140	-220	-52	-59		-69	-76

Nominal diameter in mm		S		T	U			X		Z	
over	to	6	7	6	6	7	10	10	11	10	11
0	3	-14	-14	-18	-18	-18	-18	-20	-20	-26	-26
		-20	-24	-24	-24	-28	-58	-60	-80	-66	-86
3	6	-16	-15	-20	-20	-19	-23	-28	-28	-35	-35
		-24	-27	-28	-28	-31	-71	-76	-103	-83	-110
6	10	-20	-17	-25	-25	-22	-28	-34	-34	-42	-42
		-29	-32	-34	-34	-37	-86	-92	-124	-100	-132
10	14	-25	-21	-30	-30	-26	-33	-40	-40	-50	-50
		-36	-39	-41	-41	-44	-103	-110	-150	-120	-160
14	18	-25	-21	-30	-30	-26	-33	-45	-45	-60	-60
		-36	-39	-41	-41	-44	-103	-115	-155	-130	-170
18	24	-31	-27	-37	-37	-33	-41	-54	-54	-73	-73
		-44	-48	-50	-50	-54	-125	-138	-184	-157	-203
24	30	-31	-27	-37	-44	-40	-48	-64	-64	-88	-88
		-44	-48	-50	-57	-61	-132	-148	-194	-172	-218
30	40	-38	-34	-43	-55	-51	-60	-80	-80	-112	-112
		-54	-59	-59	-71	-76	-160	-180	-240	-212	-272
40	50	-38	-34	-49	-65	-61	-70	-97	-97	-136	-136
		-54	-59	-65	-81	-86	-170	-197	-257	-236	-296
50	65	-47	-42	-60	-81	-76	-87	-122	-122	-172	-172
		-66	-72	-79	-100	-106	-207	-242	-312	-292	-362
65	80	-53	-48	-69	-96	-91	-102	-146	-146	-210	-210
		-72	-78	-88	-115	-121	-222	-266	-336	-330	-400
80	100	-64	-58	-84	-117	-111	-124	-178	-178	-258	-258
		-86	-93	-106	-139	-146	-264	-318	-398	-398	-478
100	120	-72	-66	-97	-137	-131	-144	-210	-210	-310	-310
		-94	-101	-119	-159	-166	-284	-350	-430	-450	-530

(tolerance zones A ... G)
DIN 1420

Nominal diameter in mm		Permissible upper and lower tolerances on nominal reamer diameter d_1 in µm for hole tolerance zone									
over	to	A9	A11	B8	B9	B10	B11	C8	C9	C10	C11
1	3	+ 291	+ 321	+ 151	+ 161	+ 174	+ 191	+ 71	+ 81	+ 94	+ 111
		+ 282	+ 300	+ 146	+ 152	+ 160	+ 170	+ 66	+ 72	+ 80	+ 90
3	6	+ 295	+ 333	+ 155	+ 165	+ 180	+ 203	+ 85	+ 95	+ 110	+ 133
		+ 284	+ 306	+ 148	+ 154	+ 163	+ 176	+ 78	+ 84	+ 93	+ 106
6	10	+ 310	+ 356	+ 168	+ 180	+ 199	+ 226	+ 98	+ 110	+ 129	+ 156
		+ 297	+ 324	+ 160	+ 167	+ 178	+ 194	+ 90	+ 97	+ 108	+ 124
10	18	+ 326	+ 383	+ 172	+ 186	+ 209	+ 243	+ 117	+ 131	+ 154	+ 188
		+ 310	+ 344	+ 162	+ 170	+ 184	+ 204	+ 107	+ 115	+ 129	+ 149
18	30	+ 344	+ 410	+ 188	+ 204	+ 231	+ 270	+ 138	+ 154	+ 181	+ 220
		+ 325	+ 364	+ 176	+ 185	+ 201	+ 224	+ 126	+ 135	+ 151	+ 174
30	40	+ 362	+ 446	+ 203	+ 222	+ 255	+ 306	+ 153	+ 172	+ 205	+ 256
		+ 340	+ 390	+ 189	+ 200	+ 220	+ 250	+ 139	+ 150	+ 170	+ 200
40	50	+ 372	+ 456	+ 213	+ 232	+ 265	+ 316	+ 163	+ 182	+ 215	+ 266
		+ 350	+ 400	+ 199	+ 210	+ 230	+ 260	+ 149	+ 160	+ 180	+ 210
50	65	+ 402	+ 501	+ 229	+ 252	+ 292	+ 351	+ 179	+ 202	+ 242	+ 301
		+ 376	+ 434	+ 212	+ 226	+ 250	+ 284	+ 162	+ 176	+ 200	+ 234
65	80	+ 422	+ 521	+ 239	+ 262	+ 302	+ 361	+ 189	+ 212	+ 252	+ 311
		+ 396	+ 454	+ 222	+ 236	+ 260	+ 294	+ 172	+ 186	+ 210	+ 244
80	100	+ 453	+ 567	+ 265	+ 293	+ 339	+ 407	+ 215	+ 243	+ 289	+ 357
		+ 422	+ 490	+ 246	+ 262	+ 290	+ 330	+ 196	+ 212	+ 240	+ 280
100	120	+ 483	+ 597	+ 285	+ 313	+ 359	+ 427	+ 225	+ 253	+ 299	+ 367
		+ 452	+ 520	+ 266	+ 282	+ 310	+ 350	+ 206	+ 222	+ 250	+ 290
120	140	+ 545	+ 672	+ 313	+ 345	+ 396	+ 472	+ 253	+ 285	+ 336	+ 412
		+ 510	+ 584	+ 290	+ 310	+ 340	+ 384	+ 230	+ 250	+ 280	+ 324
140	160	+ 605	+ 732	+ 333	+ 365	+ 416	+ 492	+ 263	+ 295	+ 346	+ 422
		+ 570	+ 644	+ 310	+ 330	+ 360	+ 404	+ 240	+ 260	+ 290	+ 334
160	180	+ 665	+ 792	+ 363	+ 395	+ 446	+ 522	+ 283	+ 315	+ 366	+ 442
		+ 630	+ 704	+ 340	+ 360	+ 390	+ 434	+ 260	+ 280	+ 310	+ 354

Nominal diameter in mm		Permissible upper and lower tolerances on nominal reamer diameter d_1 in µm for hole tolerance zone												
over	to	D8	D9	D10	D11	E7	E8	E9	F6	F7	F8	F9	G6	G7
1	3	+ 31	+ 41	+ 54	+ 71	+ 22	+ 25	+ 35	+ 11	+ 14	+ 17	+ 27	+ 7	+ 10
		+ 26	+ 32	+ 40	+ 50	+ 18	+ 20	+ 26	+ 8	+ 10	+ 12	+ 18	+ 4	+ 6
3	6	+ 45	+ 55	+ 70	+ 93	+ 30	+ 35	+ 45	+ 16	+ 20	+ 25	+ 35	+ 10	+ 14
		+ 38	+ 44	+ 53	+ 66	+ 25	+ 28	+ 34	+ 13	+ 15	+ 18	+ 24	+ 7	+ 9
6	10	+ 58	+ 70	+ 89	+ 116	+ 37	+ 43	+ 55	+ 20	+ 25	+ 31	+ 43	+ 12	+ 17
		+ 50	+ 57	+ 68	+ 84	+ 31	+ 35	+ 42	+ 16	+ 19	+ 23	+ 30	+ 8	+ 11
10	18	+ 72	+ 86	+ 109	+ 143	+ 47	+ 54	+ 68	+ 25	+ 31	+ 38	+ 52	+ 15	+ 21
		+ 62	+ 70	+ 84	+ 104	+ 40	+ 44	+ 52	+ 21	+ 24	+ 28	+ 36	+ 11	+ 14
18	30	+ 93	+ 109	+ 136	+ 175	+ 57	+ 68	+ 84	+ 31	+ 37	+ 48	+ 64	+ 18	+ 24
		+ 81	+ 90	+ 106	+ 129	+ 49	+ 56	+ 65	+ 26	+ 29	+ 36	+ 45	+ 13	+ 16
30	50	+ 113	+ 132	+ 165	+ 216	+ 71	+ 83	+ 102	+ 38	+ 46	+ 58	+ 77	+ 22	+ 30
		+ 99	+ 110	+ 130	+ 160	+ 62	+ 69	+ 80	+ 32	+ 37	+ 44	+ 55	+ 16	+ 21
50	80	+ 139	+ 162	+ 202	+ 261	+ 85	+ 99	+ 122	+ 46	+ 55	+ 69	+ 92	+ 26	+ 35
		+ 122	+ 136	+ 160	+ 194	+ 74	+ 82	+ 96	+ 39	+ 44	+ 52	+ 66	+ 19	+ 24
80	120	+ 165	+ 193	+ 239	+ 307	+ 101	+ 117	+ 145	+ 54	+ 65	+ 81	+ 109	+ 30	+ 41
		+ 146	+ 162	+ 190	+ 230	+ 88	+ 98	+ 114	+ 46	+ 52	+ 62	+ 78	+ 22	+ 28
120	180	+ 198	+ 230	+ 281	+ 357	+ 119	+ 138	+ 170	+ 64	+ 77	+ 96	+ 128	+ 35	+ 48
		+ 175	+ 195	+ 225	+ 269	+ 105	+ 115	+ 135	+ 55	+ 63	+ 73	+ 93	+ 26	+ 34

(tolerance zones H ... P) DIN 1420

Nominal diameter in mm over to	Permissible upper and lower tolerances on nominal reamer diameter d_1 in µm for hole tolerance zone													
	H6	H7	H8	H9	H10	H11	H12	J6	J7	J8	JS6	JS7	JS8	JS9
>1.......3	+ 5	+ 8	+11	+21	+ 34	+ 51	+ 85	+ 1	+ 2	+ 3	+ 2	+ 3	+ 4	+ 8
	+ 2	+ 4	+ 6	+12	+ 20	+ 30	+ 50	− 2	− 2	− 2	− 1	− 1	− 1	− 1
>3.......6	+ 6	+10	+15	+25	+ 40	+ 63	+102	+ 3	+ 4	+ 7	+ 2	+ 4	+ 6	+10
	+ 3	+ 5	+ 8	+14	+ 23	+ 36	+ 60	0	− 1	0	− 1	− 1	− 1	− 1
>6.....10	+ 7	+12	+18	+30	+ 49	+ 76	+127	+ 3	+ 5	+ 8	+ 3	+ 5	+ 7	+12
	+ 3	+ 6	+10	+17	+ 28	+ 44	+ 74	− 1	− 1	0	− 1	− 1	− 1	− 1
>10.....18	+ 9	+15	+22	+36	+ 59	+ 93	+153	+ 4	+ 7	+10	+ 3	+ 6	+ 8	+15
	+ 5	+ 8	+12	+20	+ 34	+ 54	+ 90	0	0	0	− 1	− 1	− 1	− 1
>18.....30	+11	+17	+28	+44	+ 71	+110	+178	+ 6	+ 8	+15	+ 4	+ 7	+11	+18
	+ 6	+ 9	+16	+25	+ 41	+ 64	+104	+ 1	0	+ 3	− 1	− 1	− 1	− 1
>30.....50	+13	+21	+33	+52	+ 85	+136	+212	+ 7	+10	+18	+ 5	+ 8	+13	+21
	+ 7	+12	+19	+30	+ 50	+ 80	+124	+ 1	+ 1	+ 4	− 1	− 1	− 1	− 1
>50.....80	+16	+25	+39	+62	+102	+161	+255	+10	+13	+21	+ 6	+10	+16	+25
	+ 9	+14	+22	+36	+ 60	+ 94	+150	+ 3	+ 2	+ 4	− 1	− 1	− 1	− 1
>80...120	+18	+29	+45	+73	+119	+187	+297	+12	+16	+25	+ 7	+12	+18	+30
	+10	+16	+26	+42	+ 70	+110	+174	+ 4	+ 3	+ 6	− 1	− 1	− 1	− 1
>120...180	+21	+34	+53	+85	+136	+212	+340	+14	+20	+31	+ 8	+14	+22	+35
	+12	+20	+30	+50	+ 80	+124	+200	+ 5	+ 6	+ 8	− 1	0	− 1	0

Our standard manufacturing accuracy (H7)

Nominal diameter in mm over	to	Permissible upper and lower tolerances on nominal reamer diameter d_1 in µm for hole tolerance zone													
		K6	K7	K8	M6	M7	M8	N6	N7	N8	N9	N10	N11	P6	P7
1	3	− 1	− 2	− 3	− 3	− 4		− 5	− 6	− 7	− 8	−10	− 13	− 7	− 8
		− 4	− 6	− 8	− 6	− 8		− 8	−10	−12	−17	−24	− 34	−10	−12
3	6	0	+ 1	+ 2	− 3	− 2	− 1	− 7	− 6	− 5	− 5	− 8	− 12	−11	−10
		− 3	− 4	− 5	− 6	− 7	− 8	−10	−11	−12	−16	−25	− 39	−14	−15
6	10	0	+ 2	+ 2	− 5	− 3	− 3	− 9	− 7	− 7	− 6	− 9	− 14	−14	−12
		− 4	− 4	− 6	− 9	− 9	−11	−13	−13	−15	−19	−30	− 46	−18	−18
10	18	0	+ 3	+ 3	− 6	− 3	− 3	−11	− 8	− 8	− 7	−11	− 17	−17	−14
		− 4	− 4	− 7	−10	−10	−13	−15	−15	−18	−23	−36	− 56	−21	−21
18	30	0	+ 2	+ 5	− 6	− 4	− 1	−13	−11	− 8	− 8	−13	− 20	−20	−1
		− 5	− 6	− 7	−11	−12	−13	−18	−19	−20	−27	−43	− 66	−25	−26
30	50	0	+ 3	+ 6	− 7	− 4	− 1	−15	−12	− 9	−10	−15	− 24	−24	−21
		− 6	− 6	− 8	−13	−13	−15	−21	−21	−23	−32	−50	− 80	−30	−30
50	80	+ 1	+ 4	+ 7	− 8	− 5	− 2	−17	−14	−11	−12	−18	− 29	−29	−26
		− 6	− 7	−10	−15	−16	−19	−24	−25	−28	−38	−60	− 96	−36	−37
80	120	0	+ 4	+ 7	−10	− 6	− 3	−20	−16	−13	−14	−21	− 33	−34	−30
		− 8	− 9	−12	−18	−19	−22	−28	−29	−32	−45	−70	−110	−42	−43
120	180	0	+ 6	+10	−12	− 6	− 2	−24	−18	−14	−15	−24	− 38	−40	−43
		− 9	− 8	−13	−21	−20	−25	−33	−32	−37	−50	−80	−126	−49	−48

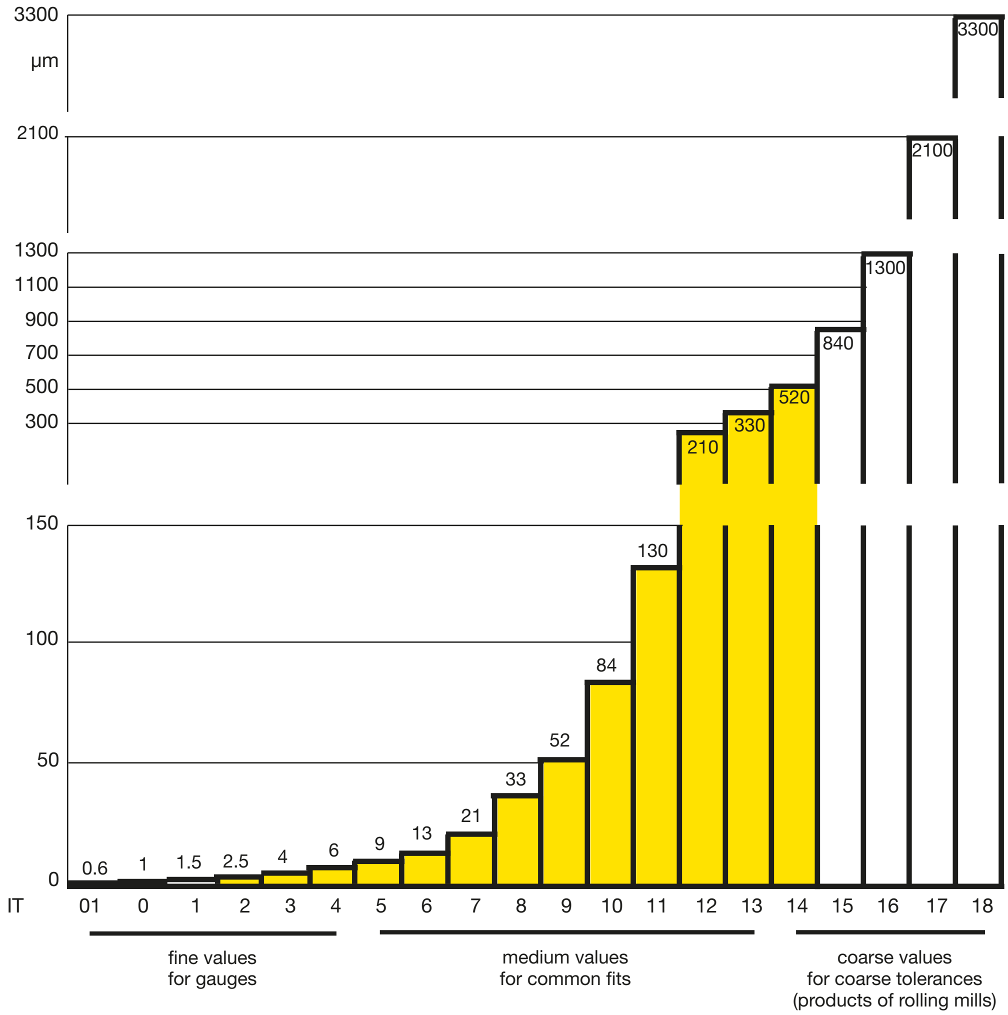
(tolerance zones R ... Z) DIN 1420

Nominal diameter in mm		Permissible upper and lower tolerances on nominal reamer diameter d_1 in µm for hole tolerance zone											
over	to	R6	R7	S6	S7	T6	U6	U7	U10	X10	X11	Z10	Z11
1	3	– 11	– 12	– 15	– 16		– 19	– 20				– 32	
		– 14	– 16	– 18	– 20		– 22	– 24				– 46	
3	6	– 14	– 13	– 18	– 17		– 22	– 21	– 31			– 43	
		– 17	– 18	– 21	– 22		– 25	– 26	– 48			– 60	
6	10	– 18	– 16	– 22	– 20		– 27	– 25	– 37			– 51	
		– 22	– 22	– 26	– 26		– 31	– 31	– 58			– 72	
10	14	– 22	– 19	– 27	– 24		– 32	– 29	– 44			– 61	
		– 26	– 26	– 31	– 31		– 36	– 36	– 69			– 86	
14	18	– 22	– 19	– 27	– 24		– 32	– 29	– 44	– 56		– 71	
		– 26	– 26	– 31	– 31		– 36	– 36	– 69	– 81		– 96	
18	24	– 26	– 24	– 33	– 31		– 39	– 37		– 67		– 86	
		– 31	– 32	– 38	– 39		– 44	– 45		– 97		–116	
24	30	– 26	– 24	– 33	– 31	– 39	– 46	– 44		– 77		–101	–108
		– 31	– 32	– 38	– 39	– 44	– 51	– 52		–107		–131	–154
30	40	– 32	– 29	– 41	– 38	– 46	– 58	– 55		– 95		–127	–136
		– 38	– 38	– 47	– 47	– 52	– 64	– 64		–130		–162	–192
40	50	– 32	– 29	– 41	– 38	– 52	– 68	– 65	– 85	–112		–151	–160
		– 38	– 38	– 47	– 47	– 58	– 74	– 74	–120	–147		–186	–216
50	65	– 38	– 35	– 50	– 47	– 63	– 84	– 81	–105	–140	–151	–190	–201
		– 45	– 46	– 57	– 58	– 70	– 91	– 92	–147	–182	–218	–232	–268
65	80	– 40	– 37	– 56	– 53	– 72	– 99	– 96	–120	–164	–175	–228	–239
		– 47	– 48	– 63	– 64	– 79	–106	–107	–162	–206	–242	–270	–306
80	100	– 48	– 44	– 68	– 64	– 88	–121	–117	–145	–199	–211	–279	–291
		– 56	– 57	– 76	– 77	– 96	–129	–130	–194	–248	–288	–328	–368
100	120	– 51	– 47	– 76	– 72	–101	–141	–137	–165	–231	–243	–331	–343
		– 59	– 60	– 84	– 85	–109	–149	–150	–214	–280	–320	–380	–420
120	140	– 60	– 54	– 89	– 83	–119	–167	–161	–194	–272	–286	–389	–403
		– 69	– 68	– 98	– 97	–128	–176	–175	–250	–328	–374	–445	–491
140	160	– 62	– 56	– 97	– 91	–131	–187	–181	–214	–304	–318	–439	–453
		– 71	– 70	–106	–105	–140	–196	–195	–270	–360	–406	–495	–541
160	180	– 65	– 59	–105	– 99	–143	–207	–201	–234	–334	–348	–489	–503
		– 74	– 73	–114	–113	–152	–216	–215	–290	–390	–436	–545	–591

DIN ISO 286-1

Range of nominal size mm		IT in µm											
		3	4	5	6	7	8	9	10	11	12	13	14
from / to	1 / 3	2	3	4	6	10	14	25	40	60	100	140	250
over / to	3 / 6	2.5	4	5	8	12	18	30	48	75	120	180	300
over / to	6 / 10	2.5	4	6	9	15	22	36	58	90	150	220	360
over / to	10 / 18	3	5	8	11	18	27	43	70	110	180	270	430
over / to	18 / 30	4	6	9	13	21	33	52	84	130	210	330	520
over / to	30 / 50	4	7	11	16	25	39	62	100	160	250	390	620
over / to	50 / 80	5	8	13	19	30	46	74	120	190	300	460	740
over / to	80 / 120	6	10	15	22	35	54	87	140	220	350	540	870

Example: Basic ISO tolerances for a range of nominal sizes over 18 to 30 mm



GÜHRING

General remarks for the determination of manufacturing tolerances for reamers

The manufacturing tolerances to DIN 1420 are allocated to certain tolerance zones of the holes to be reamed. Generally they ensure the positioning of reamed holes within the relevant tolerance zone as well as the most economical use of the reamer.

It must, however, be taken into account that the size of the reamed hole depends, in addition to the manufacturing tolerance of the reamer, on various other factors, such as angles of cutting edges; bevel lead of reamer; clamping of the workpiece; the tool holder; condition of the machine; the coolant and on the material of the workpiece. Therefore, from time to time other manufacturing tolerances than IT7 (H7) might prove more advantageous.

However, in the interest of economic production and storage, it is recommended that non-standard manufacturing tolerances are used only in exceptional cases.

For determing the manufacturing tolerances the following well-proven *basic rules* were stipulated:

Determination of perm. max. and min. sizes of reamers

The largest permitted reamer diameter ranges at about 15% of the approximate hole tolerance (0.15 IT) below the permissible maximum diameter of the hole (see fig.), whereby the value 0.15 IT will be rounded of to the next higher integer or half µm-value, so that even µm values are derived for d_{1max}. The permissible smallest reamer diameter d_{1min} ranges at about 35% of the approximate hole tolerance (0.35 IT) below the permissible maximum diameter d_{1max} (ex. 1).

Simplified determination of permissible max. and min. reamer dimensions

In order to facilitate calculations, the table on page 15 indicates the upper and lower tolerance limits on the nominal diameter d_1 for the most common "H" tolerance zones. With the aid of these tolerance limits the permissible maximum and minimum reamer dimensions can be calculated (ex. 2).

Example 1

nominal diameter d1	= 20.000 mm
maximum diameter of the hole	= 20.021 mm
hole tolerance (IT 7)	= 0.021 mm
15% of the hole tolerance (0.15 IT 7)	= 0.0031 mm
	≈ 0.004 mm
maximum reamer diameter:	
d1 max = 20.021 – 0.004	= <u>20.017 mm</u>
manufacturing tolerance of reamer:	
35% of the hole tolerance (0.35 IT 7)	= 0.0073 mm
	≈ 0.008 mm

minimum reamer diameter:

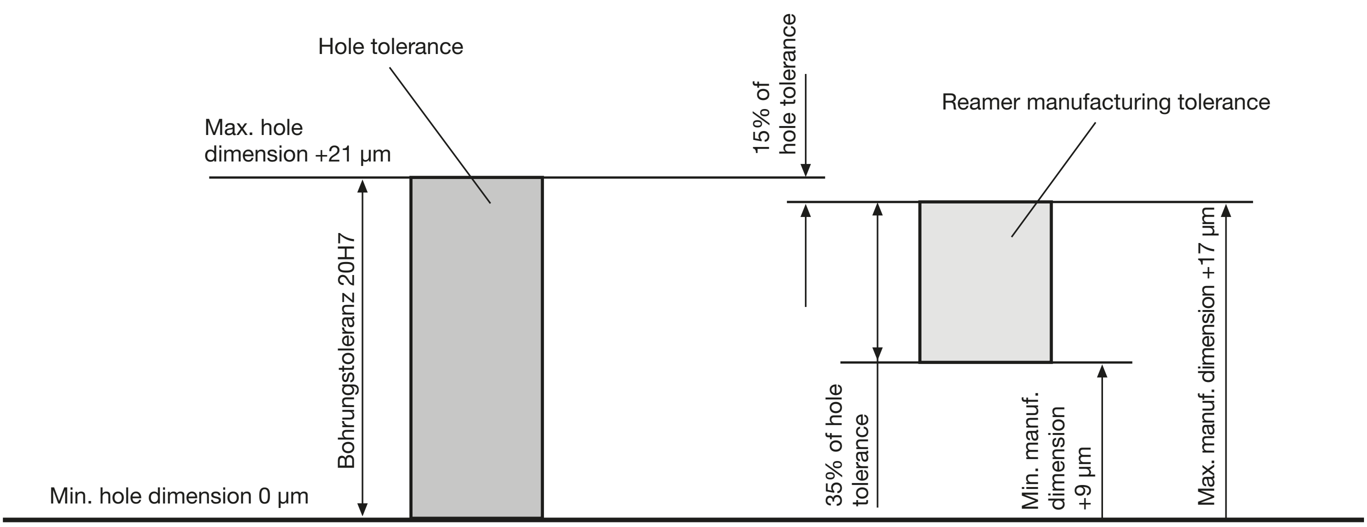
$d_{1\,min} = d_{1\,max}$ – 0,35 IT 7	
= 20.017 – 0.008	= <u>20.009 mm</u>

Example 2

nominal diameter d1	= 20.000 mm
upper tol limit (s. table p. 70) + 17 µm	= 0.017 mm
lower tol. limit (s. table p. 70) + 9 µm	= 0.009 mm
i. e.: $d_{1\,max}$ = 20.000 + 0.017	= <u>20.017 mm</u>
$d_{1\,min}$ = 20.000 + 0.009	= 20.009 mm

Simplified calculation of the permissible maximum and minimum dimensions for reamers

Example: Hole tolerance zone Ø 20 H7/nom. dimension d1 of reamer 20 mm



Zero line Ø 20.0

Designation

For the designation of reamers the ISO abbreviation for the tolerance zone of the hole is indicated after the nominal diameter. Designation of a reamer with nominal diameter d1 = 20 mm, for hole tolerance H 7:

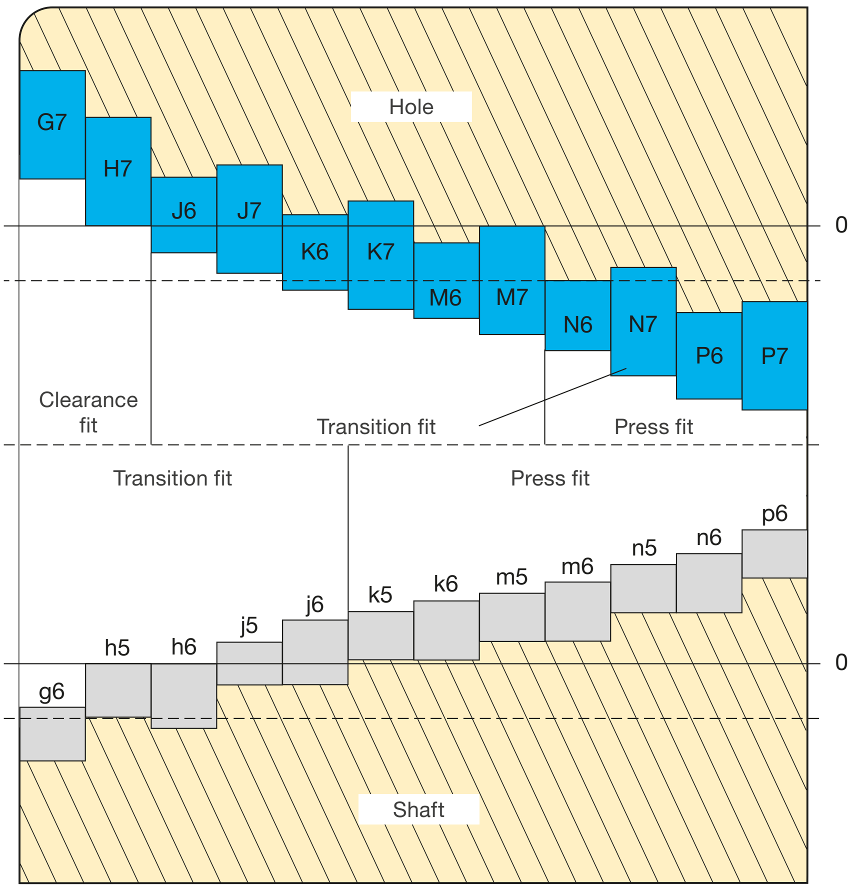
reamer 20 H 7 DIN ... (" ... ": for DIN no. indication of appropriate reamer)

In special cases, reamers are ordered with maximum and minimum dimensions deviating from this standard, the ISO abbreviation for the hole tolerance zone must be replaced by the upper and lower tolerance limit of the reamer in µm, e.g. for a reamer with a nominal diameter d1 = 20 mm, upper tolerance limit = + (p) 25 µm and lower tolerance limit = + (p) 15 µm:

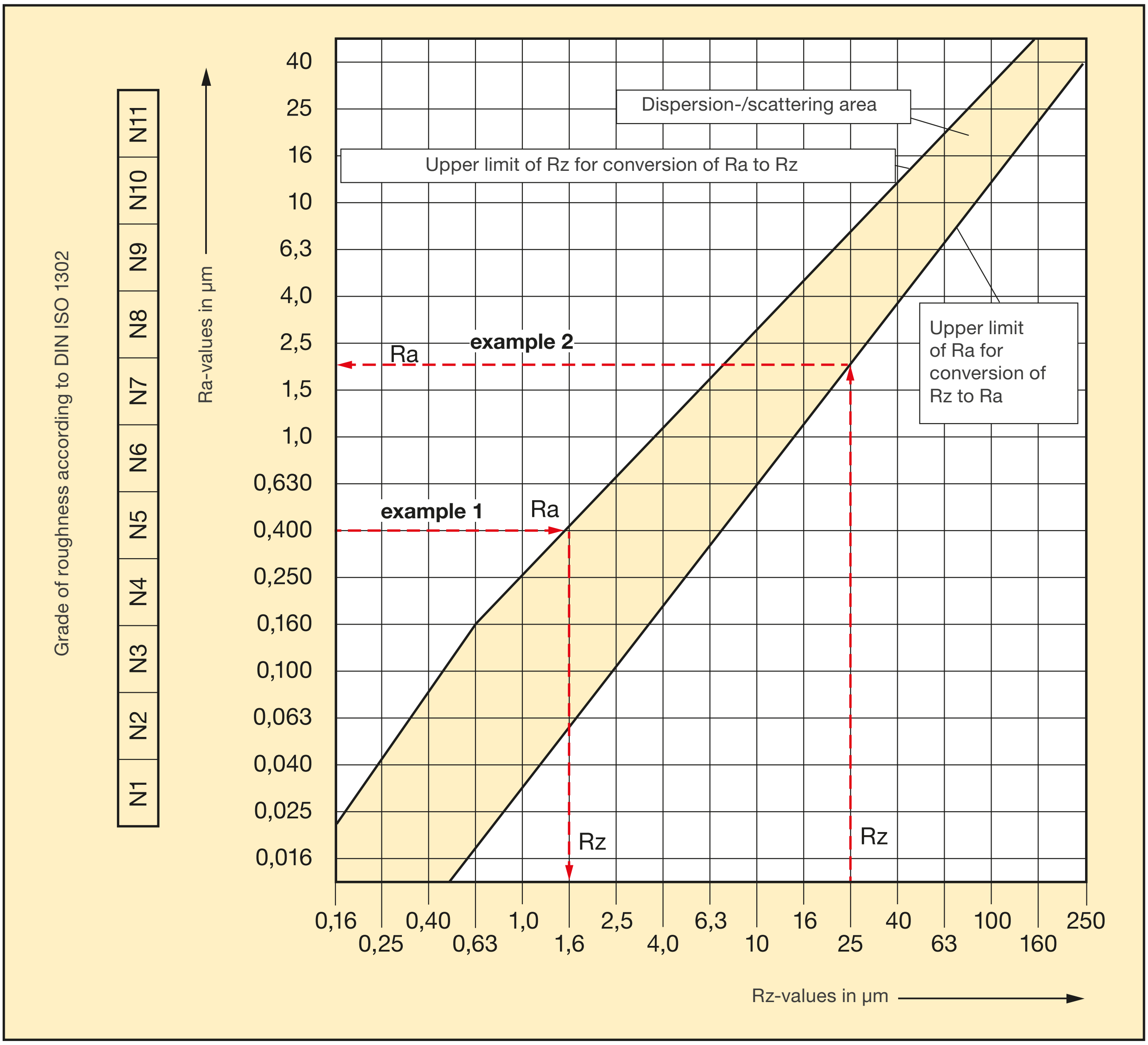
reamer 20 p 25 p 15 DIN ...

The designation shows a 'p' instead of the plus and an 'm' instead of the minus sign, because »+« and » – « cannot be written on all machines, particularly not on data processing machines.

Tolerance position



Conversion ratio to DIN 47



Reading example: 1

When comparing the average roughness index R_a = 0.4 µm to the average roughness R_z we achieve a value of R_z = 1.6 µm.

Reading example: 2

When comparing the average roughness R_z = 25 µm to the average roughness index R_a we achieve a value of R_a = 2 µm.

	Roughness classes	N11	N10	N9	N8		N7	N6		N5	N4	N3	N2	N1
	Average roughness R_a	25	12.5	6.3	3.2		1.6	0.8		0.4	0.2	0.1	0.05	0.025
	Average peak-to-valley height R_z	100	63	40	25	16	10	6.3	4	2.5	1.6	1	0.63	0.25
P	Struct. steel, low-alloyed steels: Case-hard. and heat-treat. steels						■	■	■	■	■			
M	Stainless steels Heat-resistant steels						■	■	■	■	■			
K	Grey cast iron, ferritic			■	■	■	■	■						
K	Grey cast iron, pearlitic				■	■	■	■	■					
K	Spheroidal graphite iron, ferritic			■	■	■	■	■	■					
K	Spheroidal graphite iron, pearlitic				■	■	■	■	■	■				
N	Copper-alloy, brass					■	■	■	■	■				
N	Aluminium wrought alloy						■	■	■	■	■			
N	Aluminium cast alloy: Si-content < 10 %						■	■	■	■				
N	Aluminium cast alloy: Si-content > 10 %						■	■	■	■				
S	Special alloy: Inconel					■	■	■	■					
S	Titanium, titanium alloys					■	■	■	■					
H	Hardened steel < 45 HRC						■	■	■	■				
H	Hardened steel > 45 HRC, ≤ 63 HRC						■	■	■	■				

achievable → limited achievability

Tens. strength (N/mm²)	HRC	HB30	HV10
240		71	75
255		76	80
270		81	85
285		86	90
305		90	95
320		95	100
335		100	105
350		105	110
370		109	115
385		114	120
400		119	125
415		124	130
430		128	135
450		133	140
465		138	145
480		143	150
495		147	155
510		152	160
530		157	165
545		162	170
560		166	175
575		171	180
595		176	185
610		181	190
625		185	195
640		190	200
660		195	205
675		199	210
690		204	215
705		209	220
720		214	225
740		219	230
755		223	235
770		228	240
785		233	245
800	22	238	250
820	23	242	255
835	24	247	260
860	25	255	268
870	26	258	272
900	27	266	280
920	28	273	287
940	29	278	293
970	30	287	302
995	31	295	310
1020	32	301	317
1050	33	311	327
1080	34	319	336
1110	35	328	345
1140	36	337	355
1170	37	346	364

Tens. strength (N/mm²)	HRC	HB30	HV10
1200	38	354	373
1230	39	363	382
1260	40	372	392
1300	41	383	403
1330	42	393	413
1360	43	402	423
1400	44	413	434
1440	45	424	446
1480	46	435	458
1530	47	449	473
1570	48	460	484
1620	49	472	497
1680	50	488	514
1730	51	501	527
1790	52	517	544
1845	53	532	560
1910	54	549	578
1980	55	567	596
2050	56	584	615
2140	57	607	639
2180	58	622	655
	59		675
	60		698
	61		720
	62		745
	63		773
	64		800
	65		829
	66		864
	67		900
	68		940

The reamer is the most commonly used tool for the production of holes true to form and tolerance with high surface quality. The latter meets the requirement of 'finishing' or 'fine finishing' i.e. from approximately Ra 0.2 to 6.5 µm according to the scales laid down in DIN 4766. However, finishes to Ra = 0.5 µm can be regarded as satisfactory. Generally, the achievable tolerance ranks at IT 7. In special cases IT 6 or even IT 5 are possible, provided that the reamer is appropriately ground and all other operating conditions meet the high specifications.

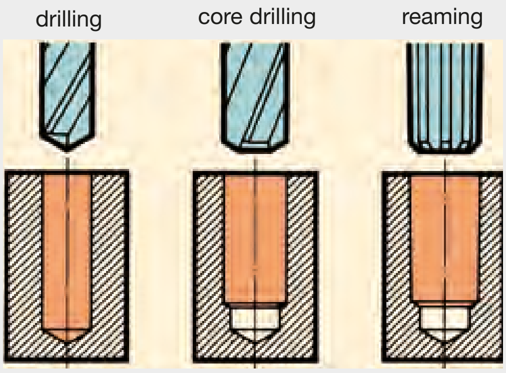


Fig. 1

In preparation for the reaming process, holes have to be pre-drilled and normally core drilled (fig. 1). Pre-drilled holes produced with gun drills, are due to their highly compressed surface, not particularly suitable for reaming. Moreover, holes produced with gun drills show generally excellent tolerances on fit and surface qualities, so that additional fine finishing is usually not required. Should any further information on our gun drills be needed, please do not hesitate to contact us.

Which reamer for which purpose?
With regard to their application we differentiate between:
- hand reamers
- machine reamers

Hand reamers
Hand reamers are turned in the hole by means of a tap wrench which is mounted on the square. The feeding action is produced manually. Because of the low cutting rates these tools are made of HSS. To ensure a proper guidance in the hole the taper lead length of hand reamers is made considerably longer than that of machine reamers. Hand reamers are available for both cylindrical and tapered holes.

Hand reamers to DIN 859 may be adjusted within the elasticity tolerance range of hardened HSS. This corresponds in practice to 1% of the diameter, i.e. for example 0.1 mm on a reamer with 10 mm diameter. In the fully expanded condition these tools are not very resistant to breakage and must therefore be protected against impact. They should be stored with the tension released.

Expanding reamers can be adjusted over a much larger range, even up to a few millimeters! For accuracy reasons setting must be carried out with a ring gauge.

A basic rule for reaming by hand: turn the tool only in the cutting direction, i.e. never reverse the tool contrary to standard practice in thread cutting. Cutting edges will become immediately blunt if the reamer is turned back.

Fig. 2: taper hand reamer

Fig. 3: adjustable hand reamer

Fig. 4: expanding hand reamer with blades

Machine reamers
Machine reamers are - as the name implies - exclusively designed for use on machines and differ with regard to the type of tool material. Due to the possibility of higher cutting values, these tools are available in HSS-E, solid carbide or carbide-tipped (fig. 5). The tool material should be selected in accordance with the material to be machined.

Fig. 5: carbide-tipped machine reamer

Carbide reamers offer the following advantages:

- Higher cutting speeds and feed rates.
- Most economic machining of materials of over 1200 mm^2 tensile strength.
- The tool life is much higher than that of HSS-E reamers.

Reamers with special form
Reamers with special form and to special tolerances have recently become more and more common place. Their manufacture requires a great deal of know-how as well as the most modern and sophisticated tooling. We have all the machines and the knowledge to produce even the most complicated tools very economically. Leave the machining problems to us. To meet and overcome them is the daily task of our engineers. They are ready to assist you at all times, to find the best possible solution and, if necessary, to arrange for an obligation-free demonstration of our tools on your own machines.

A further distinctive feature of hand and machine reamers is the geometry of the cutting section, standardised under the following headings:

- straight-fluted reamers
- LH spiral reamers
- reamers with quick spiral (45°) left-hand flutes

Tools with right-hand spiral flutes are only applied in special cases. They produce, as do twist drills, a chip flow up the flutes, which often results in an unsatisfactory surface finish quality.

Reamers with straight flutes are suitable for the machining of blind holes. Here again the absence of chip space at the bottom of the hole means that swarf must be evacuated up the reamer flutes. For all other machining tasks, and particularly for interrupted holes (e.g. holes with keyways, intersecting holes and the like), reamers with left-hand spiral flutes are much more suitable. Chip removal is always in the direction of the feed and for this reason this flute geometry is used almost exclusively for through holes. Their application in blind holes is limited to tasks where reaming to the full depth is not required, so that sufficient space for the chip volume created is available.


Fig. 6: machine roughing reamer


Fig. 7: machine bottoming reamer

The 45° LH quick spiral reamer (fig. 6) has been well tried and tested in long-chipping materials. For absolutely straight and precisely located deep holes we recommend our machine bottoming reamers (fig. 7). Their bevel lead is face-cutting, i.e., they do not cut in conformity with the pre-drilled hole, but correct it truly to size. Machine bottoming reamers should always be applied with bushings.


Fig. 8: stepped carbide-tipped machine reamer

Accuracy in surface quality and form is tremendously improved by dividing the machining process into rough and finishing reaming. Stepped machine reamers (fig. 8) perform these two operations in one pass.

Badly worn taper pin reamers can be salvaged by resharpening of taper and reduction of circular land width.

Storage of reamers
Reamers are finishing tools and therefore very vulnerable. To avoid damage, individual storage and transport in our plastic sleeves is recommended. Tools reward careful treatment by producing excellent results and giving much higher operational life.

Blind hole or through hole
Straight-fluted reamers are gene-rally applied in blind holes as they, due to their cutting edge geometry, evacu-ate the chips from the hole against the direction of the feed. Spiral reamers are preferred for the application in through holes because the spiral evacuates the chips from the hole in direction of the feed.

Interrupted holes
Spiral reamers are preferred for the application in interrupted holes because the cutting edge geometry, in comparison to straight-fluted tools, possesses a lesser tendency of grabbing on the oblique hole. If the oblique hole is > 0.25 x D, spiral reamers can also be applied in blind holes.

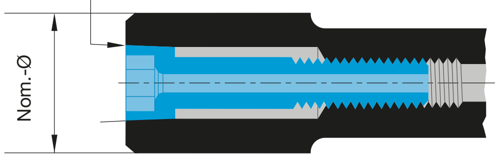
Stock removal allowance of the pre-drilled hole
In the event of the stock removal allowance of the pre-drilled hole exceeding the standard stock removal allowance (see table „Recommended stock allowance“ on page 15), a quick spiral reamer or a machine bridge reamer should be applied. It is possible to machine a considerably larger stock removal allowance with these tools, however, they should not be applied in blind holes due to the bevel lead length and the spiral angle.

Expanding reamers
Expanding reamers can only be expanded. Subsequently, if the resulting measurement is too large it is not possible to turn the screw back as the pretension of the tool would be lost. In most cases this leads to tool breakage. If the pre-tension has been taken from the tool, it requires re-adjusting and re-grinding.

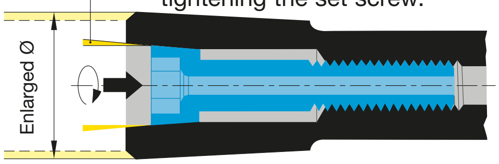
Positional accuracy of the hole
A machine bottoming reamer often provides the best solution when optimal positional accuracy is required, thanks to its special chamfer lead the ‘wander’ of the tool is minimal. In addition, machine bottoming reamers are often applied when the pre-drilled hole and the reamer are not on the same axis (slight misalignment).

Schematic depiction of expanding and of risk of tool breakage when re-turning set screw (excessive depiction)

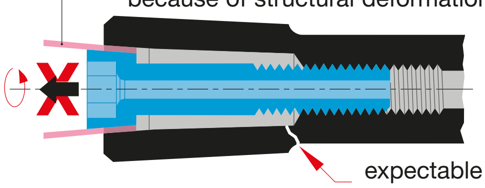
No distance between taper-shaped set screw and taper hole.



Expanding angle for Ø enlargement, resulting from tightening the set screw.



Un-screwing the set screw results in an overstretching and a lasting gap, red marked in the depiction. This leads to instability because of structural deformation.



expectable tool breakage by overstretching and un-screwing

Carbide reamer designs

Our carbide grades are applied in the following reamer types:
- Solid carbide NC machine reamers:
  Solid carbide
- Carbide machine reamers:
  ≤ Ø 9.50 mm solid carbide
  > Ø 9.50 mm carbide tipped
- Carbide expanding machine reamers:
  Carbide tipped

Expanding Reamers
Adjustment range

Expanding reamers can be adjusted by the following values according to the diameter range:
≥ Ø 12 mm by approx. 0.015 mm
≥ Ø 17 mm by approx. 0.020 mm
≥ Ø 24 mm by approx. 0.025 mm
≥ Ø 32 mm by approx. 0.030 mm

Attention:
Only expand reamer! Because of risk of breakage the pre-tension should never be relieved by turning the set screw anti-clockwise!

Expanding reamers
Adjustment range

Expanding reamers have an adjustment range of approx. 0.03 mm via a tapered adjustment screw.

Adjustable hand reamers
Adjustment range

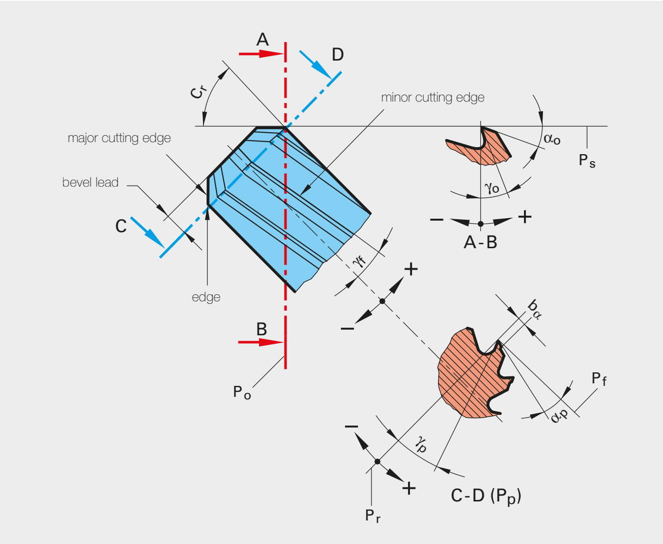
Adjustable hand reamers are ground to nominal size and not for holes with tolerance zone H7. The adjustment range is 1/100 of the nominal diameter, i.e. for Ø 10.00 mm approximately 0.1 mm. From Ø 6.50 mm adjustment is via lock nut.

Shell reamers
Taper bore

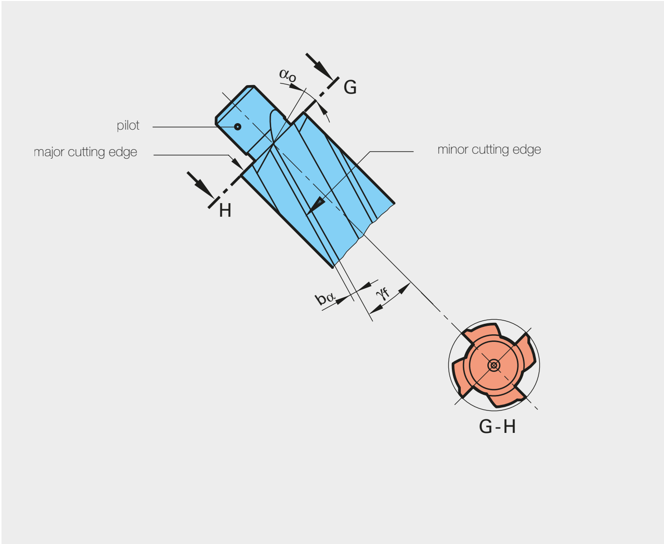
Shell reamers to DIN 219 have a taper bore with a taper 1:30 and a driving slot to DIN 138.

Definitions, dimensions and angles

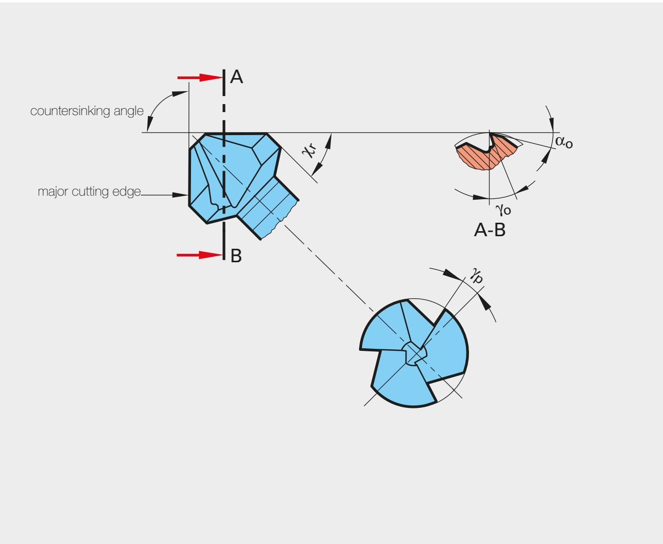
Reamers

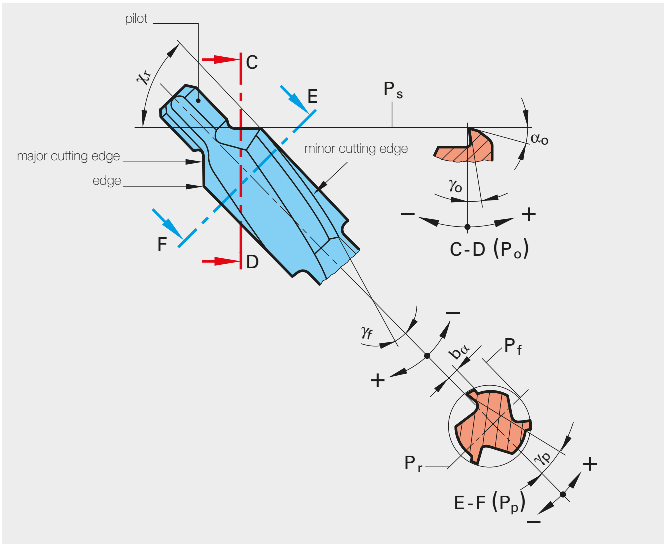


Counterbores



Countersinks





α_o = clearance angle
α_p = clearance angle of minor cutting edge
b_α = circular land width
γ_o = orthogonal rake angle
γ_f = helix angle
γ_p = back rake angle of minor cutting edge

χ_r = face setting angle
P_o = tool orthogonal plane
P_f = assumed operating plane
P_p = tool back plane
P_r = tool reference plane
P_s = tool cutting edge plane

Clamping systems GM 300

GÜHRING

Page

Clamping chucks / tool holders for straight tool shanks	TSG 3000 / shrink fit chucks / shrink fit extensions	Hydraulic chucks / HMC 3000 / reduction bushes
		
Characteristics	maximum concentricity; very slender non-interference; good rigidity; high clamping force; modular lenghtening; patented dampening screw ensures concentricity	high dampening with maximum concentricity; simple handling; flexible application thanks to reduction bushes also with GÜHROJET
Main application	drilling, countersinking, milling, reaming, universal and HSC applicatio	reaming, drilling, countersinking, HSC application, light milling
Main feature	accurate and universal; slender; high clamping force	simple handling
Concentricity	< 3µm	< 3µm
with 5xD	< 5µm	< 5µm
Clamping force	very high	very high
Rigidity	very high	high
Dampening	low	very high
Interference contour	small / minimal	medium
Handling	good	very good / very flexible
Actuation	shrink fit device e.g. GSS 2000 article no. 4742	hexagon key e.g. article no. 4912

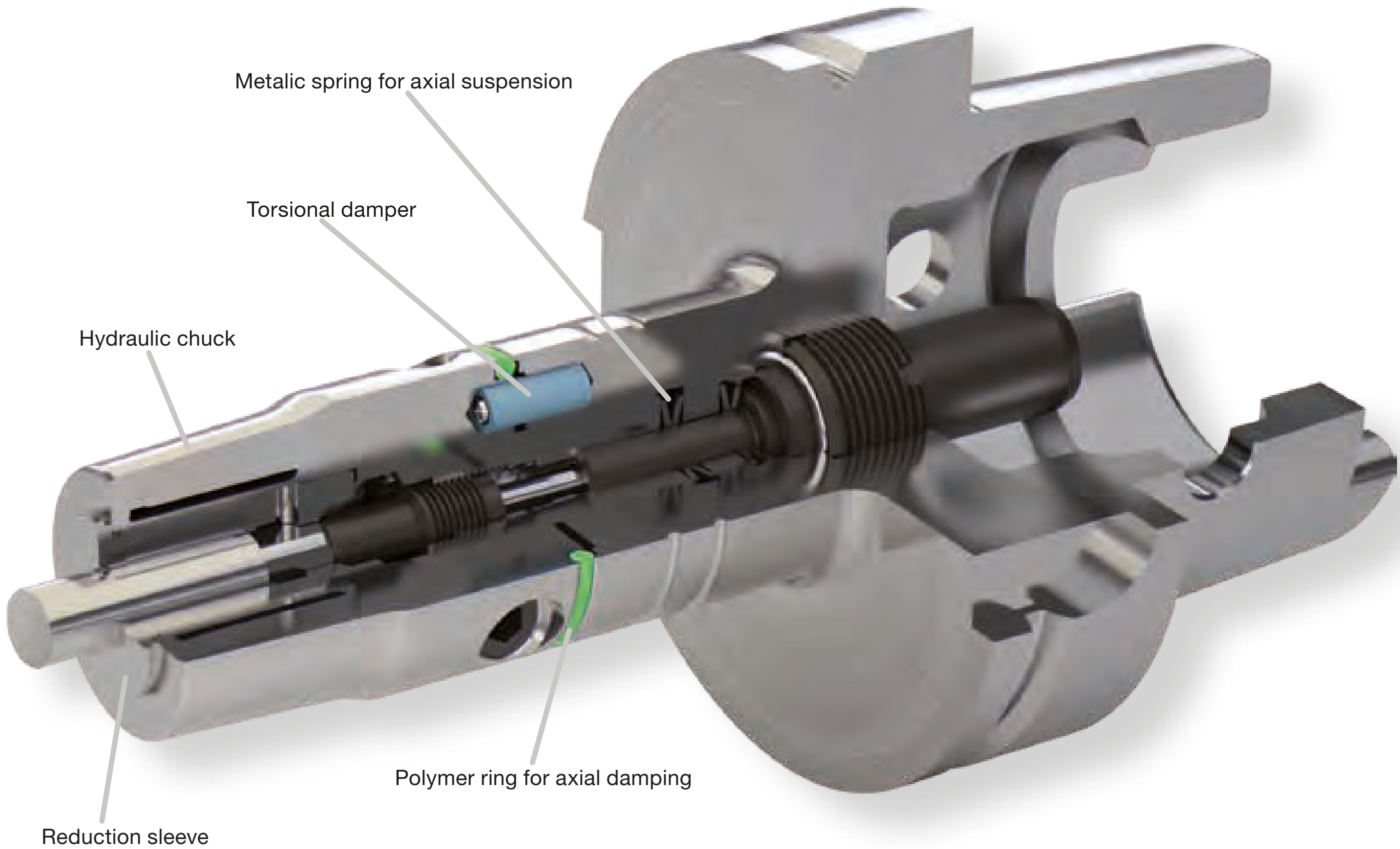
HPC precision power chucks / clamping sleeves	Straight shank holders "Weldon" / "Whistle-Notch"	Collet chucks ER
		
maximum clamping force and rigidity thanks to mechancal clamping transmission; high accuracy and balancing quality; flexible application thanks to clamping sleeves also with GÜHROJET	robust, cost-efficient clamping chuck for heavy machining in the lower speed and accuracy range	very flexible clamping chuck for various shank dimensions and tolerances; for lower level machining tasks
heavy HPC and fast accurate HSC milling, drilling, universal application	roughing, milling, drilling	light machining, centering, chamfering, drilling, threading; intermediate shank dimensions
highest clamping force and rigidity	simple operation; secure clamping	highly flexible
< 3µm	< 10µm	< 10µm
< 8µm	< 25µm	< 20µm
extremely high	very safe	medium
extremely high	very high	low
high	low	high
medium	large	large (mini = small)
very good / flexible	good	good
hexagon key / torque wrench e.g. article no. 4915 + 4916 type D	hexagon key torque: information at clamping screw article no. 4903	hook spanner max. torque: information at clamping screw article no. 4903

GÜHROSync

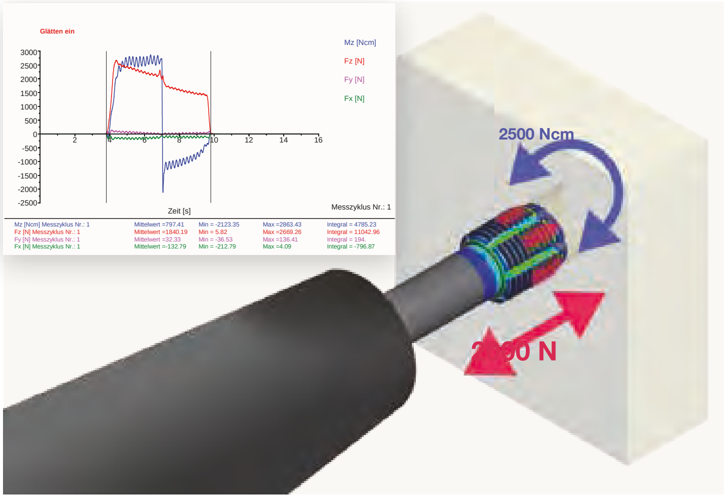
The easy way to the perfect thread

Intelligent design:
As well as the suspension and damping elements in the slender GÜHROSync chucks (for the reduction of axial and radial forces during the tapping process) there is also room for the supply set for MQL or conventional cooling lubrication and the length setting screw.

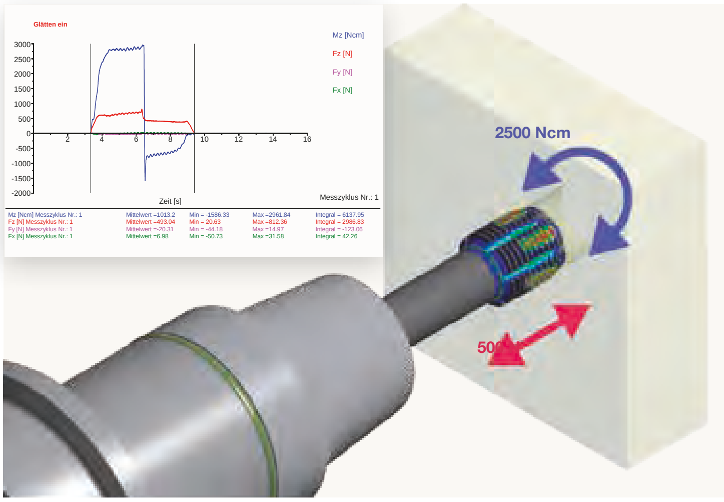
- **improved tool life**
- **improved thread quality**
- **greater process reliability**



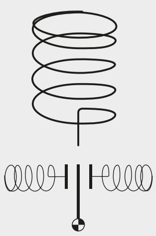
The optimal combination of long-life metal spring and polymer damping elements considerably reduces axial and radial forces.



Rigid chuck

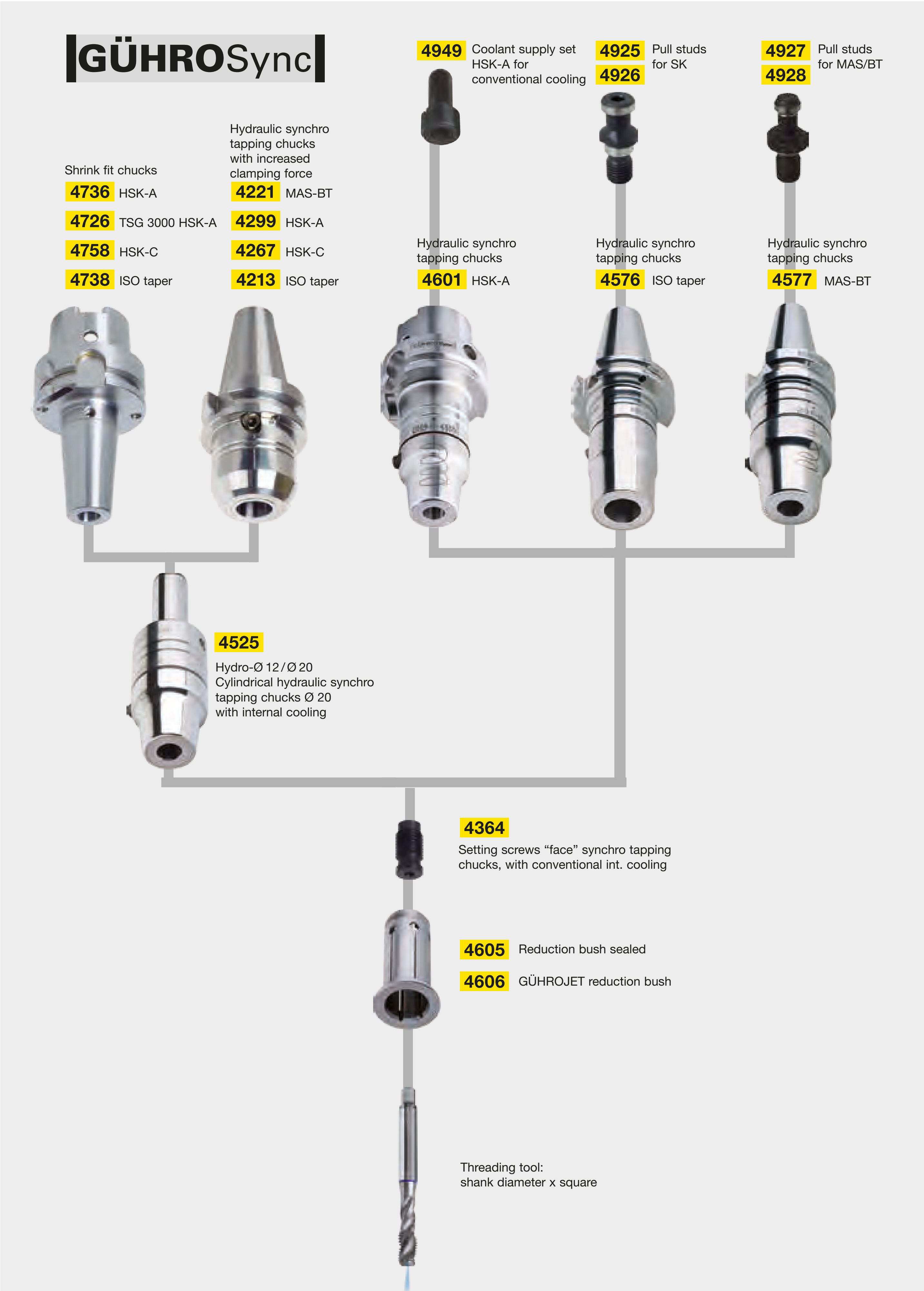


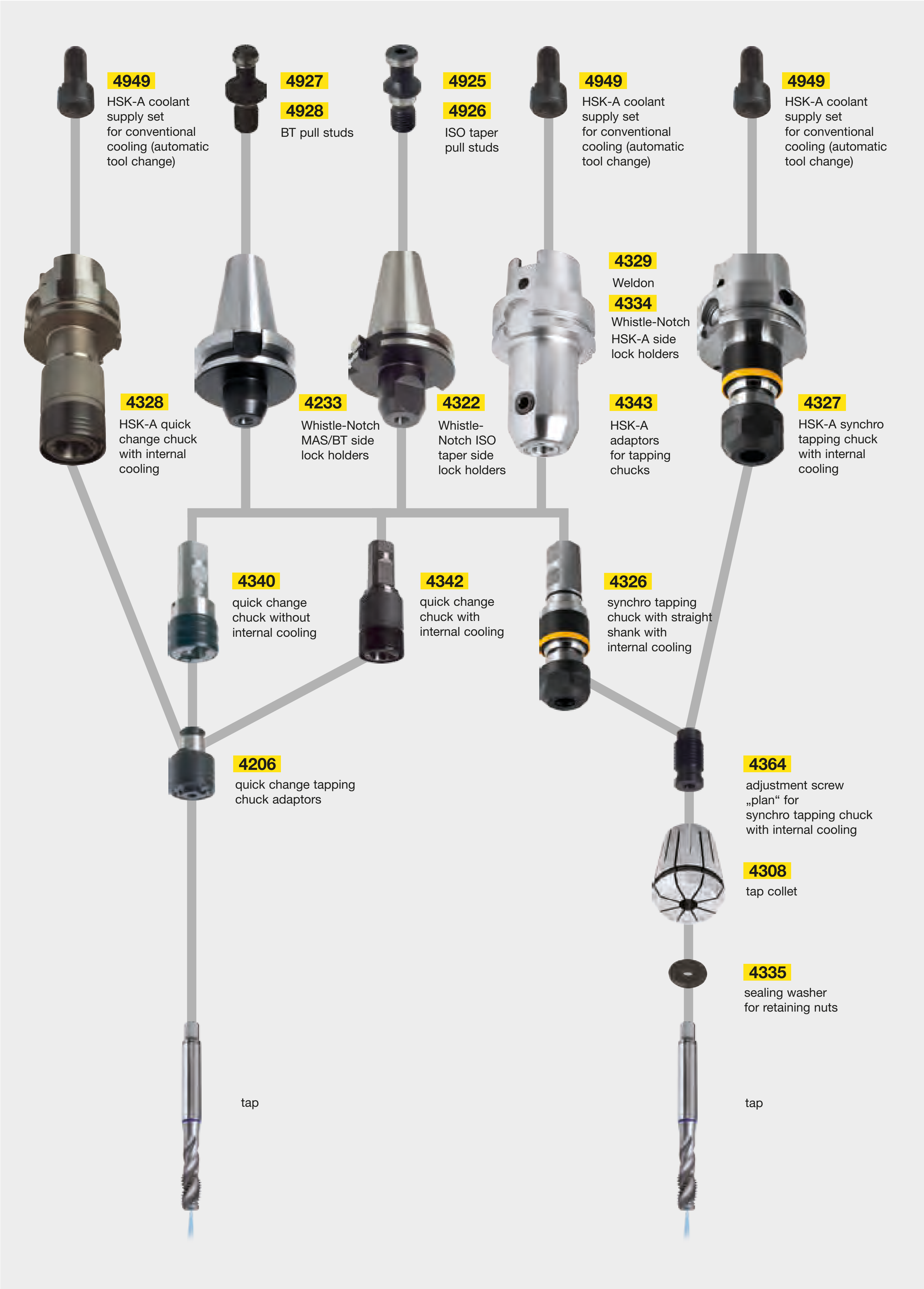
GÜHROSync



Made visible:

The spring symbol on the GÜHROSync displays the effect of axial and radial force.


GÜHROSync
4949 Coolant supply set HSK-A for conventional cooling
4925 4926 Pull studs for SK
4927 4928 Pull studs for MAS/BT
Shrink fit chucks
4736 HSK-A
4726 TSG 3000 HSK-A
4758 HSK-C
4738 ISO taper
Hydraulic synchro tapping chucks with increased clamping force
4221 MAS-BT
4299 HSK-A
4267 HSK-C
4213 ISO taper
Hydraulic synchro tapping chucks
4601 HSK-A
Hydraulic synchro tapping chucks
4576 ISO taper
Hydraulic synchro tapping chucks
4577 MAS-BT
4525
Hydro-Ø 12 / Ø 20
Cylindrical hydraulic synchro tapping chucks Ø 20 with internal cooling
4364
Setting screws “face” synchro tapping chucks, with conventional int. cooling
4605 Reduction bush sealed
4606 GÜHROJET reduction bush
Threading tool:
shank diameter x square


4949
HSK-A coolant supply set for conventional cooling (automatic tool change)
4927
4928
BT pull studs
4925
4926
ISO taper pull studs
4949
HSK-A coolant supply set for conventional cooling (automatic tool change)
4949
HSK-A coolant supply set for conventional cooling (automatic tool change)
4329
Weldon
4334
Whistle-Notch HSK-A side lock holders
4328
HSK-A quick change chuck with internal cooling
4233
Whistle-Notch MAS/BT side lock holders
4322
Whistle-Notch ISO taper side lock holders
4343
HSK-A adaptors for tapping chucks
4327
HSK-A synchro tapping chuck with internal cooling
4340
quick change chuck without internal cooling
4342
quick change chuck with internal cooling
4326
synchro tapping chuck with straight shank with internal cooling
4206
quick change tapping chuck adaptors
4364
adjustment screw „plan“ for synchro tapping chuck with internal cooling
4308
tap collet
4335
sealing washer for retaining nuts
tap
tap

MQL BY GÜHRING

Technology and advantages

- cost reduction due to reduced cleaning
- environment & health protection
- less cooling lubrication requirement – high coolant effect
- low process temperatures
- lower working temperature at tool point
- uninterrupted cooling lubricant supply
- direct response without losses
- high compatibility

1 MQL BY GÜHRING

Our products for the MQL 1-channel technology are identified by this symbol.

Visual feature of the 1-channel system is the gold coloured MQL length setting screw.

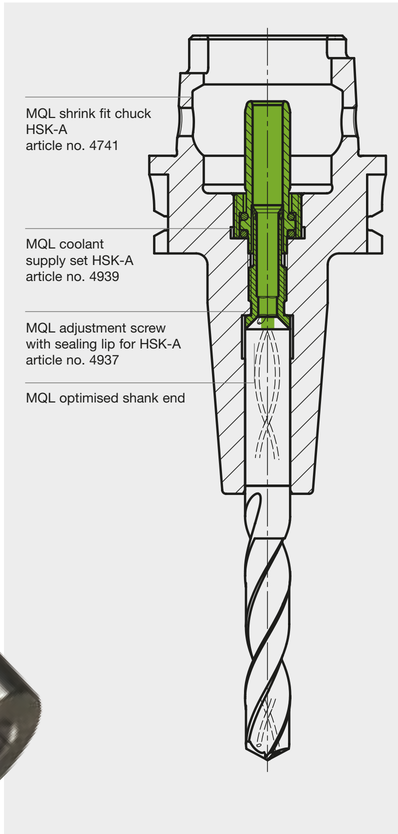
2 MQL BY GÜHRING

Our products for the MQL 2-channel technology are identified by this symbol.

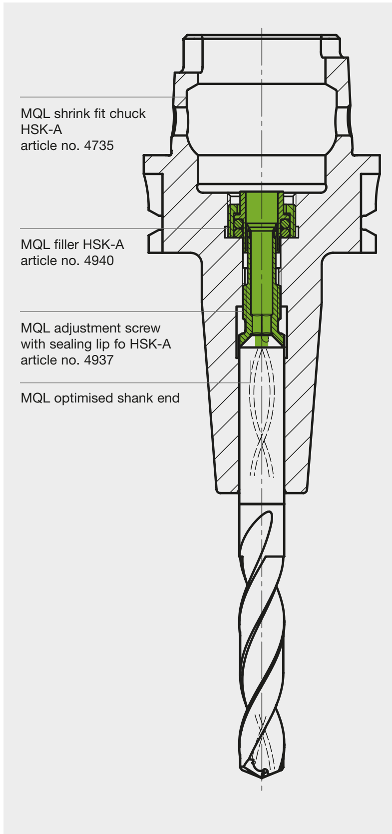
Visual feature of the 2-channel system is the black coloured MQL length setting screw.

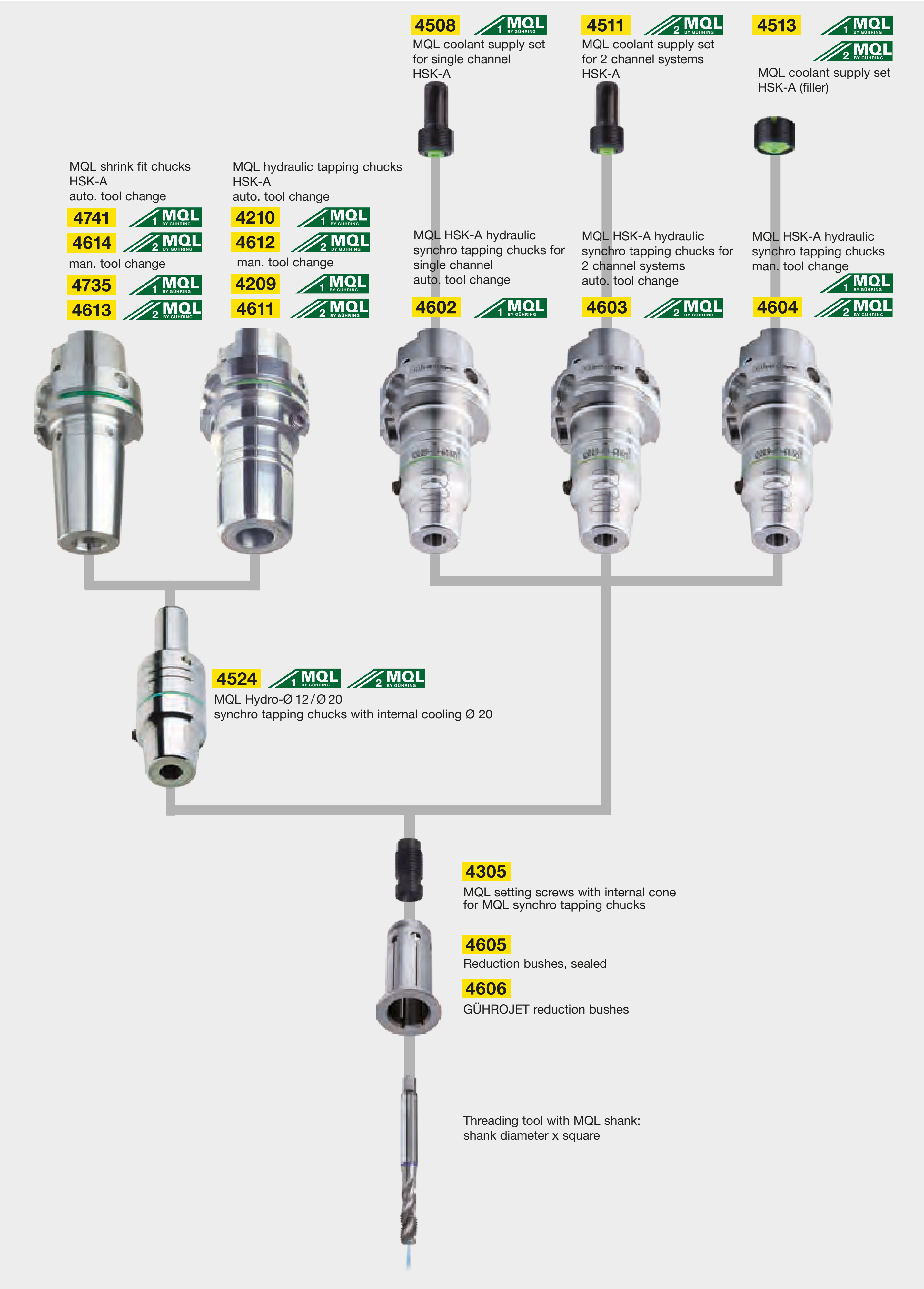
			HSK-A **for automatic tool change**	HSK-A **for manual tool change**
1 MQL BY GÜHRING	**Hydraulic chucks**		**4210**	**4209**
	Shrink fit chucks		**4741**	**4735**
	Synchro-chucks		**4330**	**4298**
2 MQL BY GÜHRING	**Hydraulic chucks**		**4612**	**4611**
	Shrink fit chucks		**4614**	**4613**
	Synchro-chucks		**4341**	**4298**

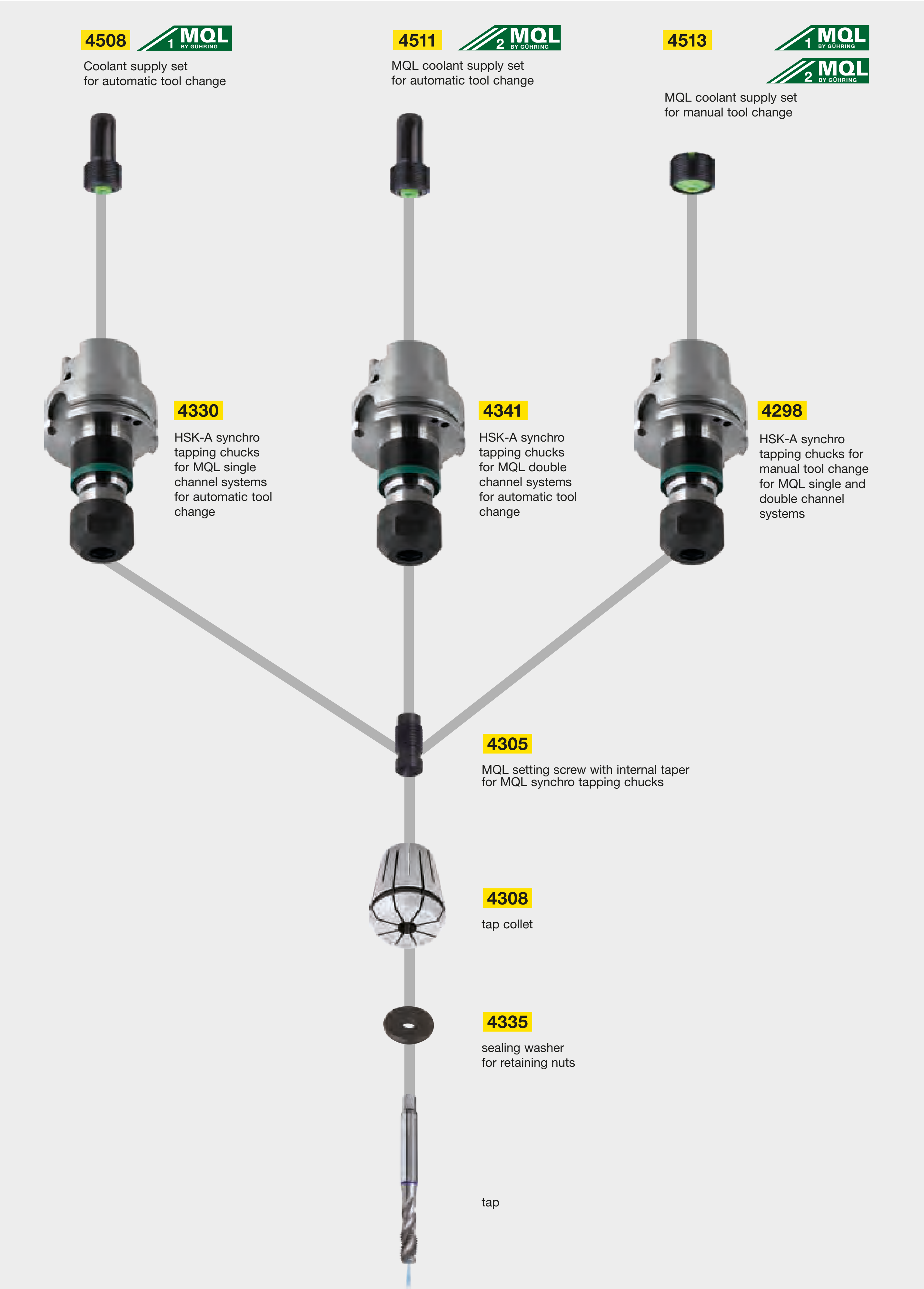
automatic tool change



manual tool change

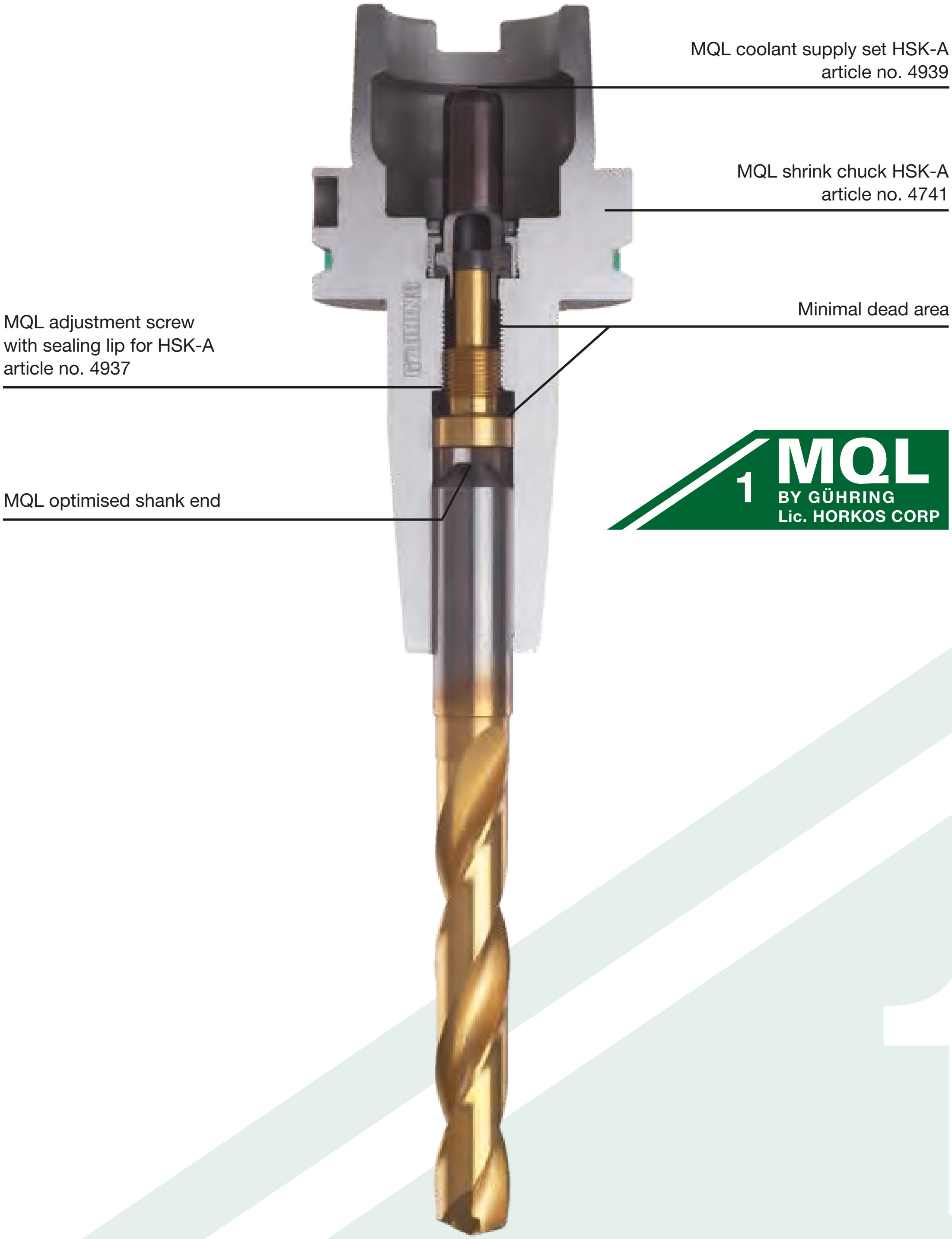



4508 1 MQL
MQL coolant supply set
for single channel
HSK-A
4511 2 MQL
MQL coolant supply set
for 2 channel systems
HSK-A
4513 1 MQL 2 MQL
MQL coolant supply set
HSK-A (filler)
MQL shrink fit chucks
HSK-A
auto. tool change
4741 1 MQL
4614 2 MQL
man. tool change
4735 1 MQL
4613 2 MQL
MQL hydraulic tapping chucks
HSK-A
auto. tool change
4210 1 MQL
4612 2 MQL
man. tool change
4209 1 MQL
4611 2 MQL
MQL HSK-A hydraulic
synchro tapping chucks for
single channel
auto. tool change
4602 1 MQL
MQL HSK-A hydraulic
synchro tapping chucks for
2 channel systems
auto. tool change
4603 2 MQL
MQL HSK-A hydraulic
synchro tapping chucks
man. tool change
4604 1 MQL 2 MQL
4524 1 MQL 2 MQL
MQL Hydro-Ø 12 / Ø 20
synchro tapping chucks with internal cooling Ø 20
4305
MQL setting screws with internal cone
for MQL synchro tapping chucks
4605
Reduction bushes, sealed
4606
GÜHROJET reduction bushes
Threading tool with MQL shank:
shank diameter x square


4508
1 MQL BY GÜHRING
Coolant supply set
for automatic tool change
4511
2 MQL BY GÜHRING
MQL coolant supply set
for automatic tool change
4513
1 MQL BY GÜHRING
2 MQL BY GÜHRING
MQL coolant supply set
for manual tool change
4330
HSK-A synchro tapping chucks for MQL single channel systems for automatic tool change
4341
HSK-A synchro tapping chucks for MQL double channel systems for automatic tool change
4298
HSK-A synchro tapping chucks for manual tool change for MQL single and double channel systems
4305
MQL setting screw with internal taper
for MQL synchro tapping chucks
4308
tap collet
4335
sealing washer
for retaining nuts
tap

Our products for the MQL 1-channel technology are identified by this symbol.

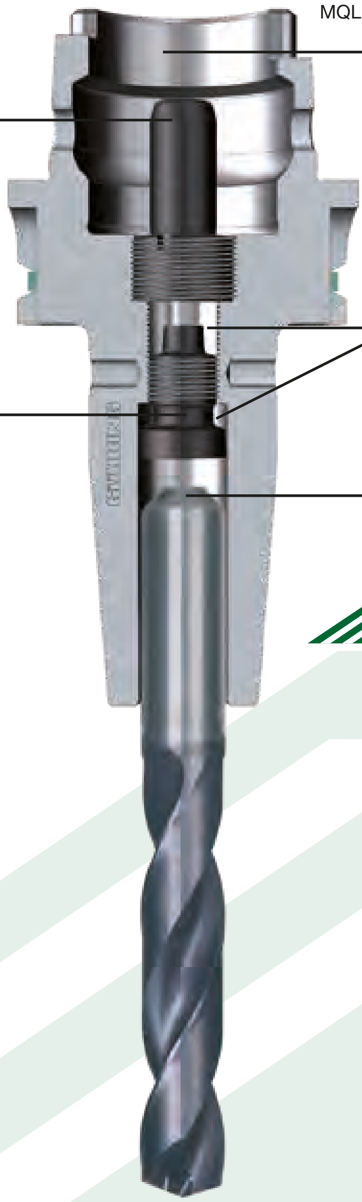
Visual feature of the 1-channel system is the gold coloured MQL length setting screw.



2 MQL BY GÜHRING

Our products for the MQL 2-channel technology are identified by this symbol.

Visual feature of the 2-channel system is the black coloured MQL length setting screw.



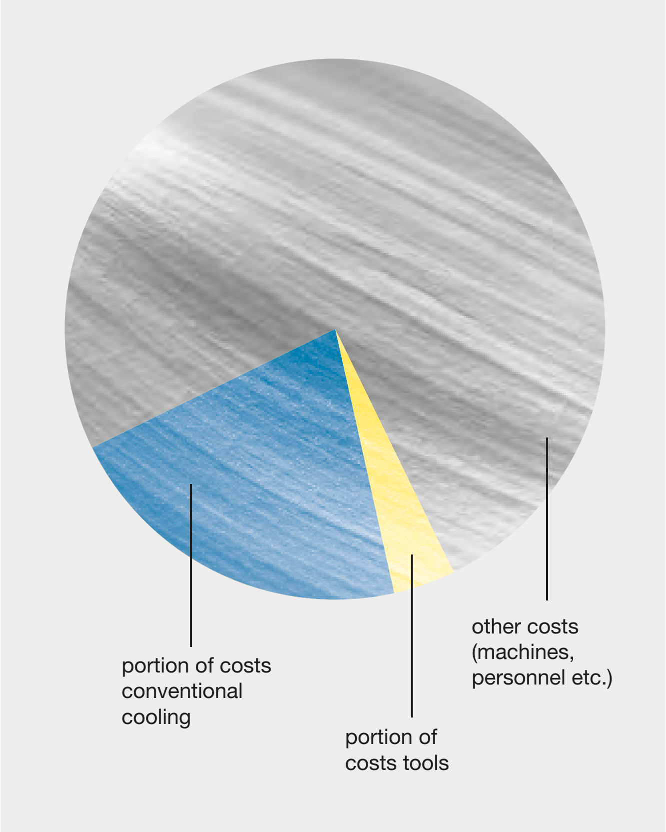
4:1

When selecting the tool holders please note: the ratio of cross-section A (mm2) of the supply pipe in the MQL 2-channel supply set to the sum of the cross-sections of the tool coolant duct exits should be maximum 4:1. This achieves quick reaction times when switching on the 2-channel MQL.

Introduction

Alongside the machine and tooling the costs for coolant are a considerable portion of the overall cost of the machining process. Therefore, a reduction in the cooling lubrication requirements offers a potential for cost savings.

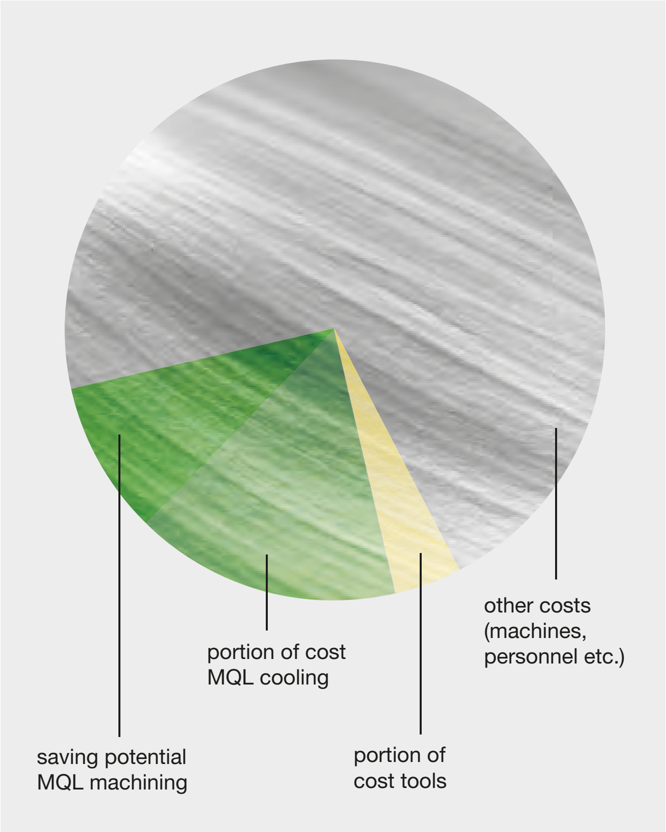
The reduction of cooling lubricants is not only cost saving but is also of benefit to the environment and health protection. Gühring is one of the pioneers in the research and development of MQL that began in the mid 1990's.



The aim of MQL machining

The acquisition of a new MQL cooling lubricant system is significantly less expensive than conventional cooling!

- reduction of thermal stresses at the tool point
- less tool wear
- effective chip evacuation from deep holes
- reduction of cooling lubricant requirement
- high cooling and lubrication effect especially in deep holes
- lowering the resulting costs such as:
  - component cleaning costs
  - cooling lubricant disposal costs
  - swarf disposal costs
- environment and health protection



The development of present-day MQL systems

Thanks to the research in MQL machining Gühring created the pre-condition for a practical MQL technology. From the clamping set to the tool's cutting edge all the components were integrated in the development – the result was the first MQL supply system.

Features:
- modular constructed and standardised system
- MQL and conventional clamping set are freely interchangeable thanks to an identical spindle contour
- hydraulic, shrink fit and synchro chucks are all designed for the MQL clamping set

Gühring's current MQL system

By incorporating the MQL length adjustment screw to Gühring's first MQL supply system in 2007, the original drawback was eliminated. There is, therefore, currently a MQL supply system available to the customer that optimally meets the requirements of the present-day production process.

Features of the first Gühring MQL supply system:
- no lubricant delays
- special MQL coolant supply unit
- MQL suitable tool shank end
- tapered length setting screw

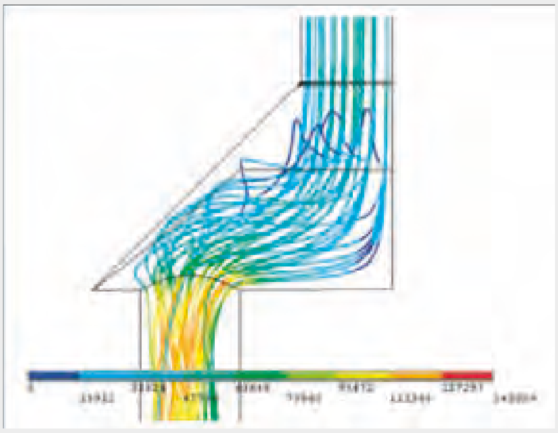
The user, therefore, benefits from a standardised system and a clearly reduced stock keeping thanks to compatible components.

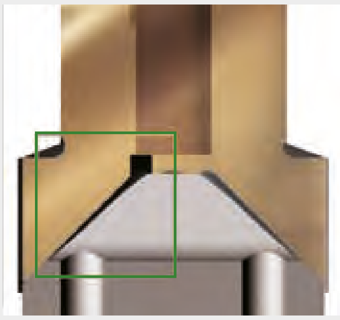
Optimally formed shank end!
For a secure MQL supply

The supply of these extremely low coolant quantities directly to the effective area is of utmost importance. Hereby, the geometric design of the shank end plays a significant role! The Gühring developed conical shank end optimally satisfies the relevant MQL conditions.

Advantages of the tapered shank end:
- no lubricant delays
- minimal dead area
- simple operation
- cost-efficient production

Flow pattern with low vortex formation





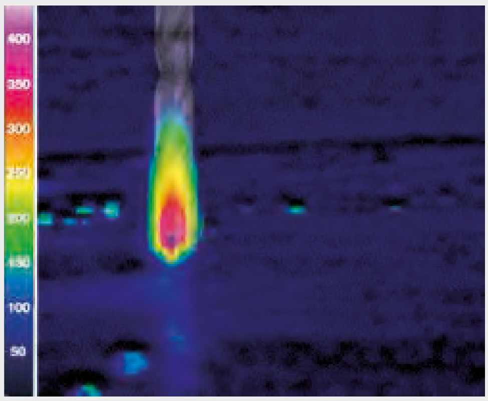
Flow conditions in the coolant duct connection slot at the point of the tapered transition

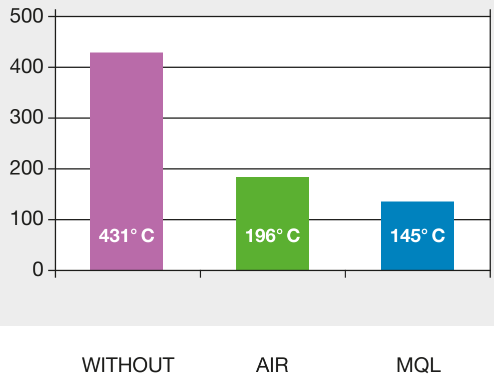
---

Keeping a cool point

With MQL the process temperature can be considerably reduced in comparison to dry machining resulting in longer tool life and an increased process reliability.

Thermographic examination at Gühring: Comparison of tool temperatures





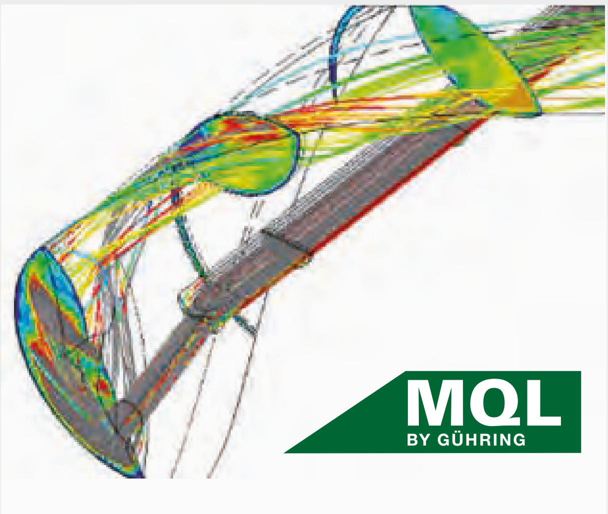
The best form for MQL!

Optimal MQL machining results thanks to the optimised tool geometry of RT 100 T!

1. Flute cross section:
The flute geometry of Gühring MQL tools ensures short chips that are optimally evacuated from deep holes.

2. Maximum coolant duct cross-section:
The cooling lubricant supply as well as the chip evacuation have been optimised through the tool' maximum coolant duct cross-section.

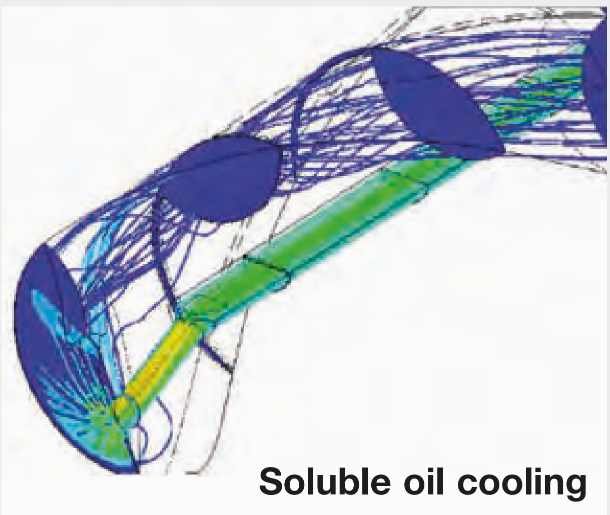
Flow speed comparison



The flow speed
in the flute with MQL is 30.4 m/s.

The volume with MQL
is 6.960 l/h (std.litres air/h).

Tool Ø = 11.7 mm
Pressure at pump = 6 bar
Pressure at tool = 4 bar



The flow speed
In the flute with soluble oil is 3.5 m/s.

The volume with soluble oil
is 600 l/h (std.litres air/h).

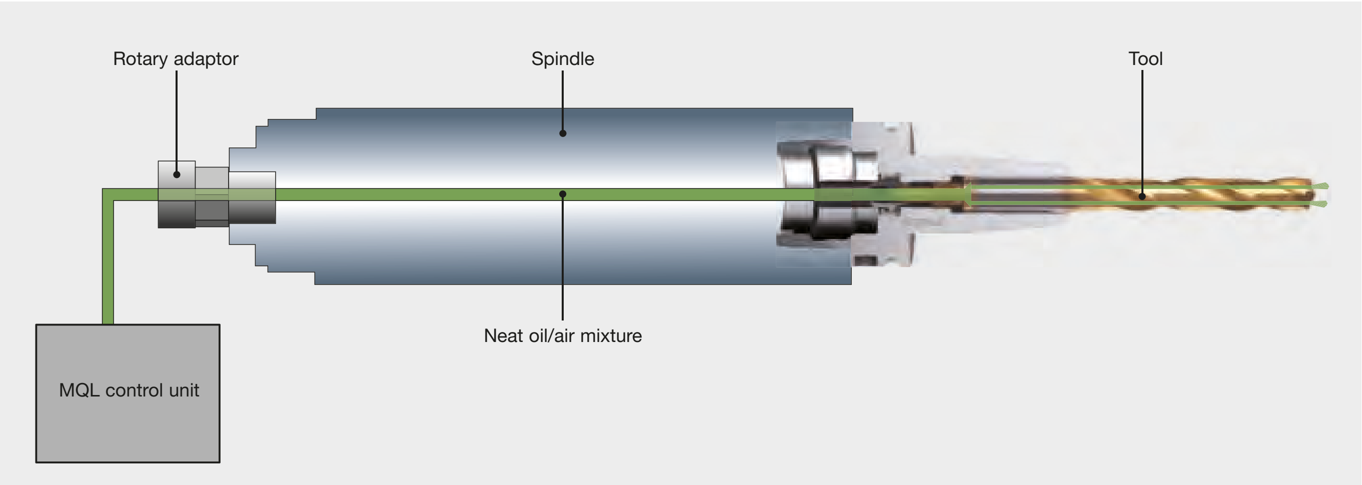
Tool Ø = 11.7 mm
Pressure at pump = 60 bar
Pressure at tool = 31 bar

MQL system types

The provision of the MQL medium to the tool can be achieved in two ways: the aerosol mixture can be prepared outside the machine and conveyed to the machining location (1-channel system) or compressed air and MQL medium are conveyed separately to the mixing chamber where they are then mixed together (2-channel system). The aerosol feed to the machining location is achieved via a suitable minimal quantity lubrication rotary adaptor (preferably with axial flowthrough), the spindle, the clamping system and finally the cutting tool. Unavoidable cross-section modifications should be as streamlined as possible.

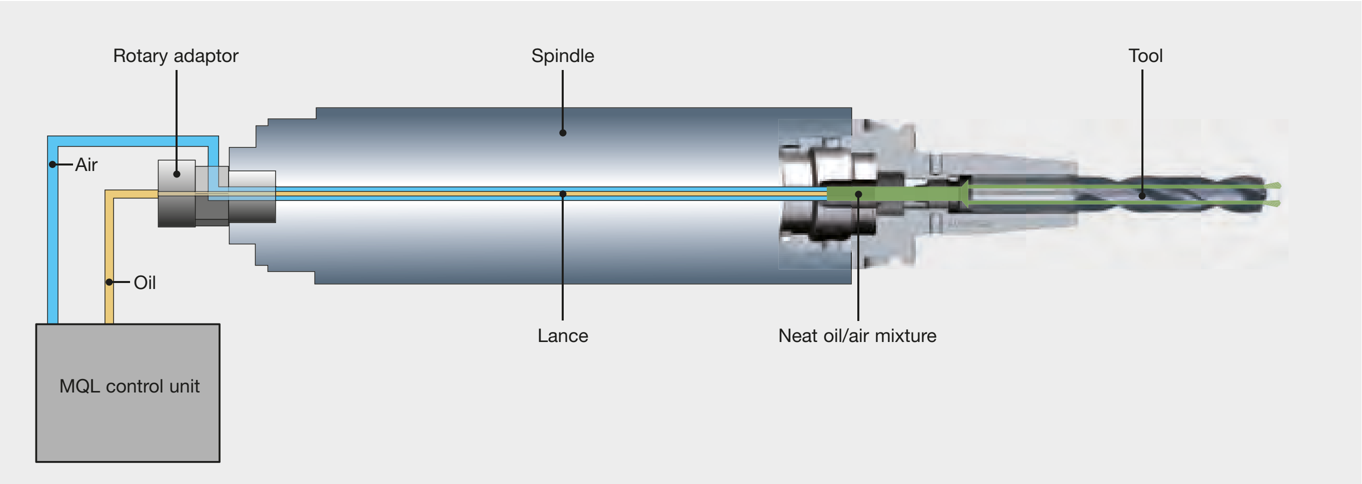
1-channel MQL system

With a 1-channel MQL system, a lubricating aerosol is created in a separate MQL unit attached to the machine tool. Special nozzle systems inside a pressurised container create a lubricating aerosol via a regulated compressed air feed, its neat oil content adjustable and then maintained within the physical limits by the MQL control.



The 2-channel MQL system

With a 2-channel system the neat oil reaches the rotary adaptor from the unit via a ring line and a as short as possible stub line. In it is incorporated a quick valve that regulates minute quantities of neat oil. The neat oil is transported into the tool holder via a lance attached in the spindle. The second channel of the rotary adaptor is used for the air supply to the tool holder. Only at this point the air is mixed with the neat oil. To achieve this, the tool holder possesses a pressed-in pipe nozzle in which the mixing chamber is located. Neat oil and air can be mixed with this system in more or less any quantities. The route from the mixing chamber to the point of destination is only minimal resulting in a rapid response time and allowing a very quick alteration of the volume of neat oil.



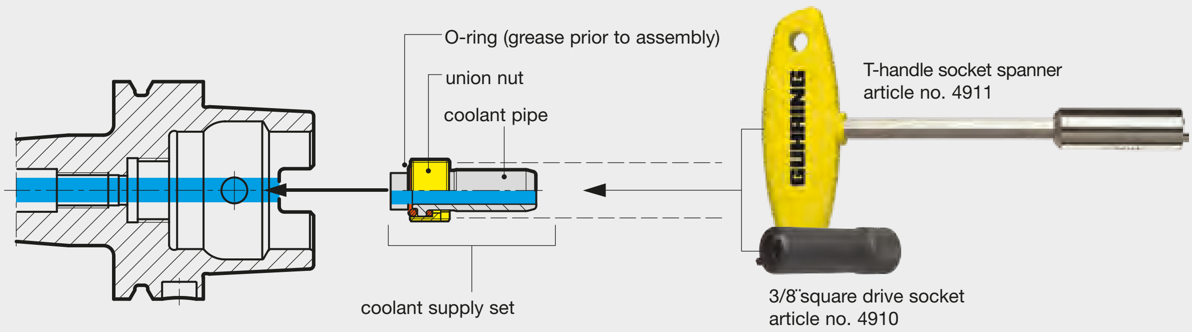
installation Instructions

1. The HSK holder must be clean, free of swarf and undamaged.
2. Grease the O-rings prior to assembly.
3. Centrally insert the complete coolant supply set (coolant pipe, union nut and 2 O-rings) in the HSK with the assistance of the socket spanner. When inserting the MQL coolant supply unit, it is paramount to ensure that the MQL pipe is inserted centrally and undamaged into the MQL length setting screw (do not kink).
4. Screw in the coolant supply set/coolant supply unit and tighten (see table for torque figures)
5. Check coolant pipe for radial mobility.

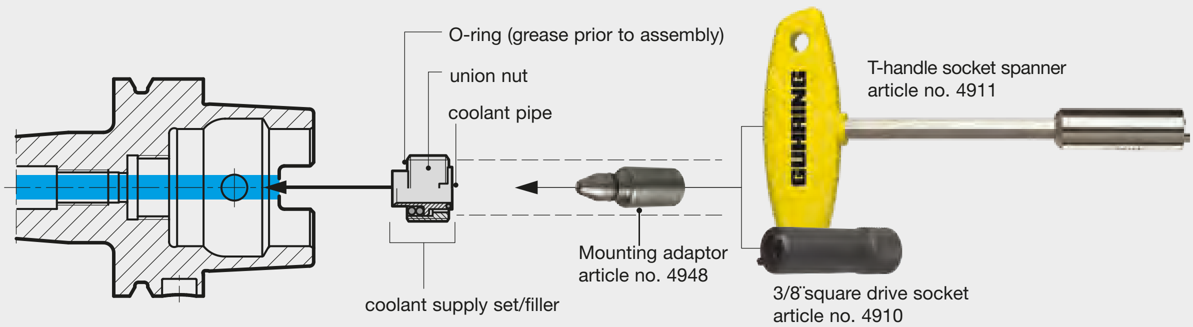
Torque figures

for HSK	MA Nm
32	7
40	11
50	15
63	20
80	25
100	30

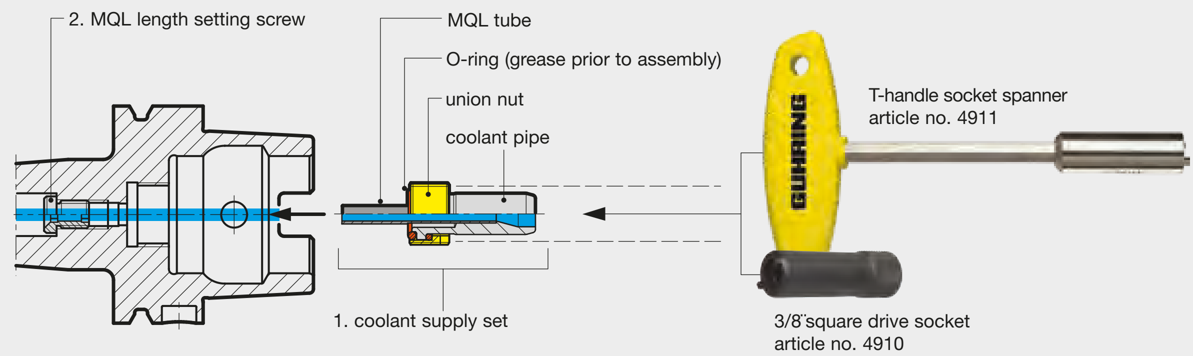
Installation of MQL coolant supply set article no. 4939



Installation of MQL coolant supply set filler article no. 4940



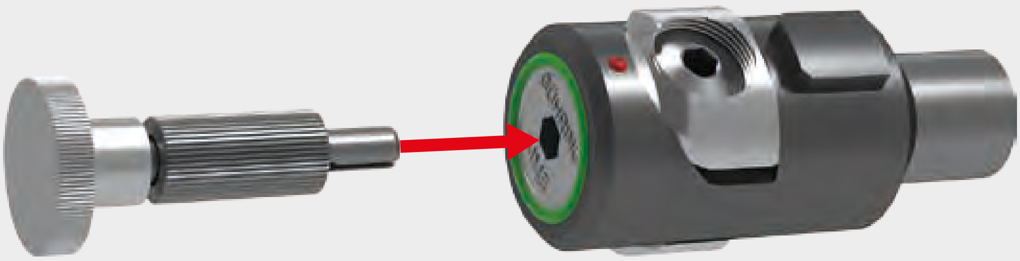
Installation of MQL coolant supply unit article no. 4623/4924



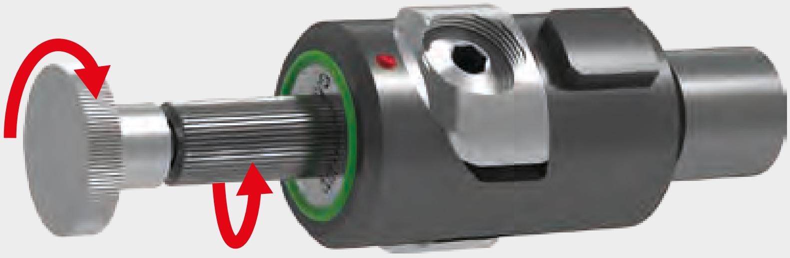
Assembly instructions

Product information
for assembly and disassembly of ejectors of MQL clamping sets, article no. 4930,
and M contour clamping sets, article no. 4615

①



②



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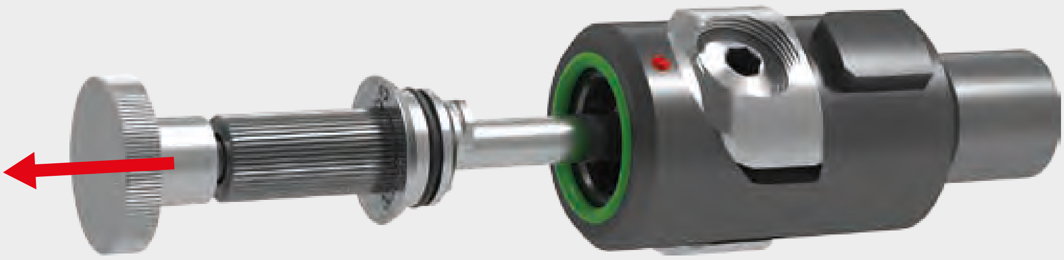


MQL-Check 3001

Measurement directly at tool tip

In particular with minimum quantity lubrication it is very essential that very little quantities of lubrication are perfectly applied on the tool's cutting edge.
Deficient supply or long response times may have fatal consequences, which are premature wear, lower processing quality or even tool breakages. If the quantity of lubrication is too high, this may lead to a cost-intensive and needless lubricant consumption and extra cleaning effort on components or/and machines.
The MQL Check 3001 is a measuring device provided by Gühring which is easy in operation and which allows fast and reliable checking of the lubrication quantity directly at the tool's tip.

The MQL Check 3001 is fastened inside the machine via magnet points before the zero point of the plunging depth is determined via the tool's tip. After the tool has been positioned in the measuring device and the start command has been transmitted via the software, MQL supply can be started. The measuring device sends the collected data to the respective software on PC/laptop via bluetooth.

Advantages of MQL-Check 3001

- simple, quick measurements of the coolant volume directly at the tool point
- reproduceable and at any time comparable measuring data
- it also comes with a master tool for cross-checking the MQL test stand → in order to check the function of the MQL device, machine, spindle, tool holder and tool
- a workshop suitable system, wireless operation - in terms of power supply as well as data transfer

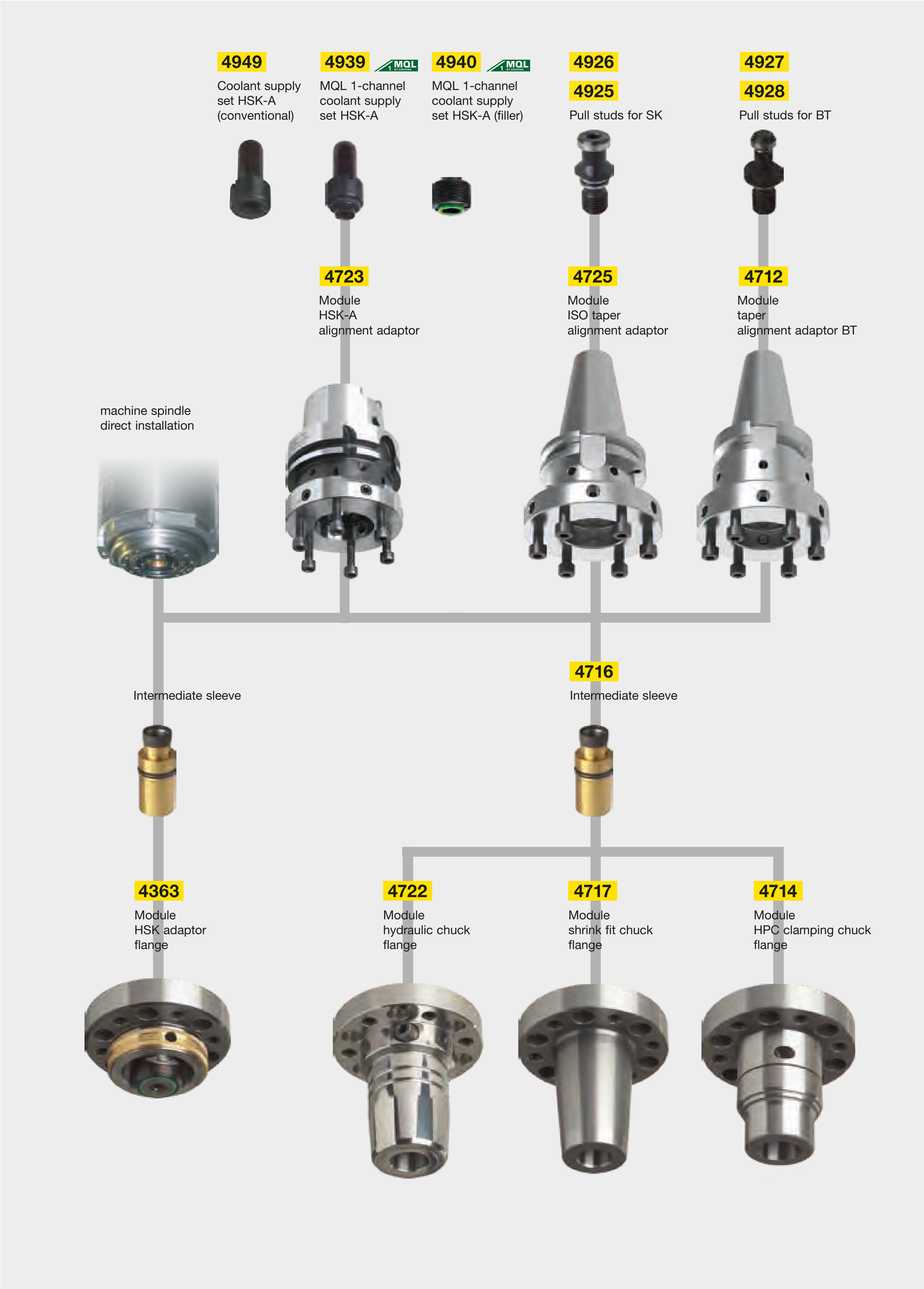
Note:
Only tools with axial coolant duct exits can be checked by means of the MQL Check 3001

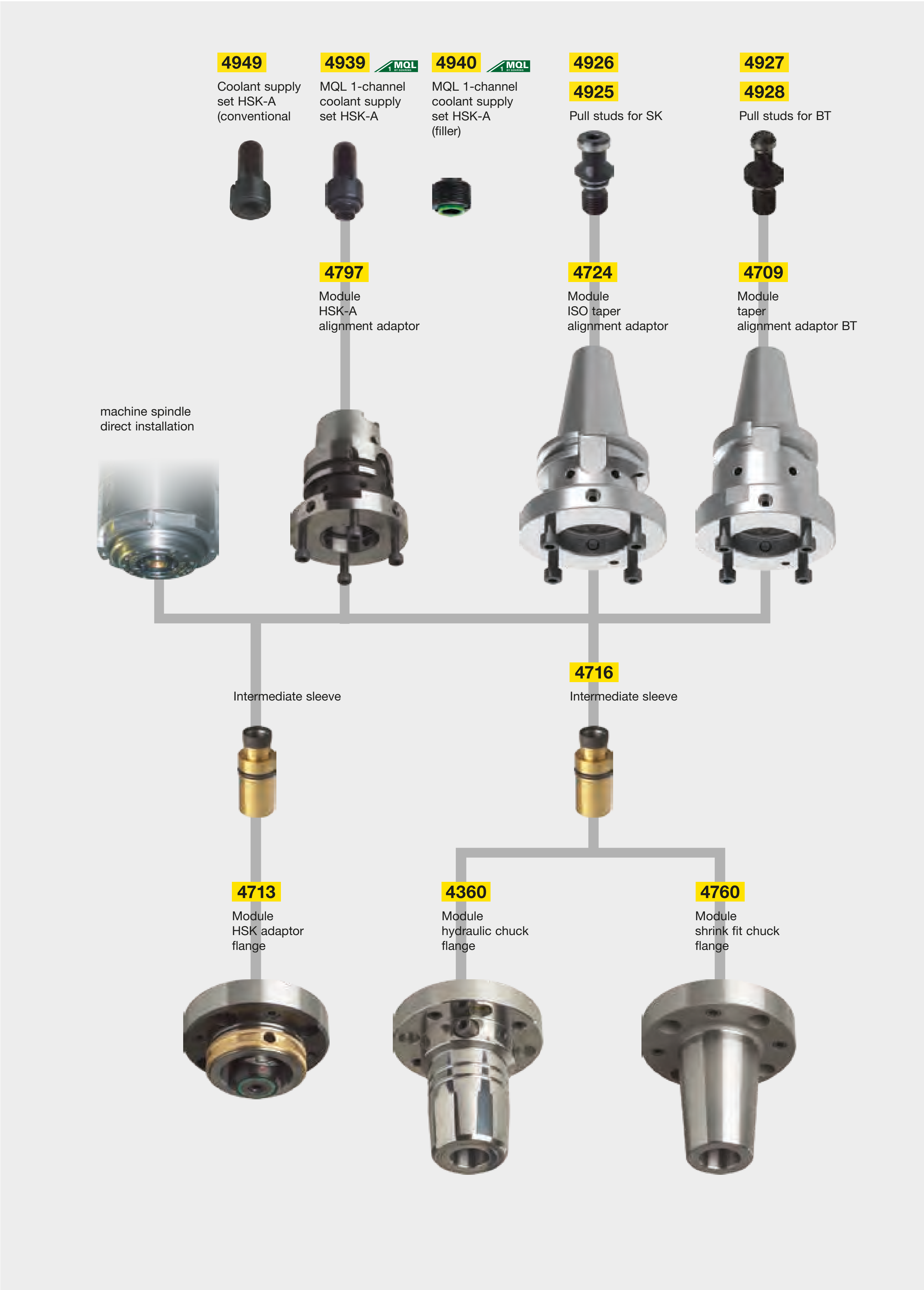
Technical Data

Measuring range	10 to 160 ml/h
Tool diameter range	3 to 21.5 mm
Measuring position	0 to 90° (vertical and horizontal machining)
Radio range	approx. 50 m (at optimal conditions)

MQL-Check 3001 consists of:

- Measuring device incl. bluetooth sender and magnet foot for fastening during horizontal processing
- Software for measured data logging
- 10 measuring filter
- Battery + power pack


4949
Coolant supply set HSK-A (conventional)
4939 MQL
MQL 1-channel coolant supply set HSK-A
4940 MQL
MQL 1-channel coolant supply set HSK-A (filler)
4926
4925
Pull studs for SK
4927
4928
Pull studs for BT
4723
Module HSK-A alignment adaptor
4725
Module ISO taper alignment adaptor
4712
Module taper alignment adaptor BT
machine spindle direct installation
Intermediate sleeve
4716
Intermediate sleeve
4363
Module HSK adaptor flange
4722
Module hydraulic chuck flange
4717
Module shrink fit chuck flange
4714
Module HPC clamping chuck flange


4949
Coolant supply set HSK-A (conventional
4939 MQL
MQL 1-channel coolant supply set HSK-A
4940 MQL
MQL 1-channel coolant supply set HSK-A (filler)
4926
4925
Pull studs for SK
4927
4928
Pull studs for BT
4797
Module HSK-A alignment adaptor
4724
Module ISO taper alignment adaptor
4709
Module taper alignment adaptor BT
machine spindle direct installation
Intermediate sleeve
4716
Intermediate sleeve
4713
Module HSK adaptor flange
4360
Module hydraulic chuck flange
4760
Module shrink fit chuck flange

4-point clamping technology for MQL

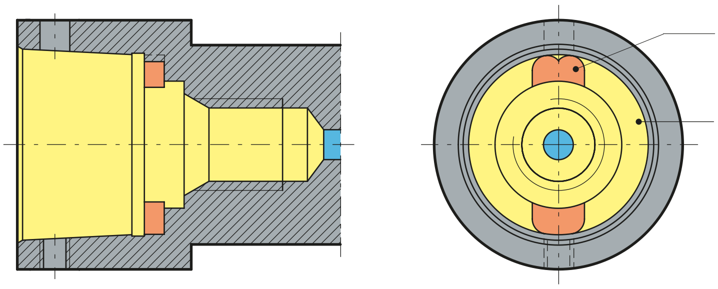
Technical information and advantages

Our 4-point clamping system is suitable for radial manual clamping. Primarily designed for installation in spindles (short drilling spindles. multiple-spindle drilling heads).

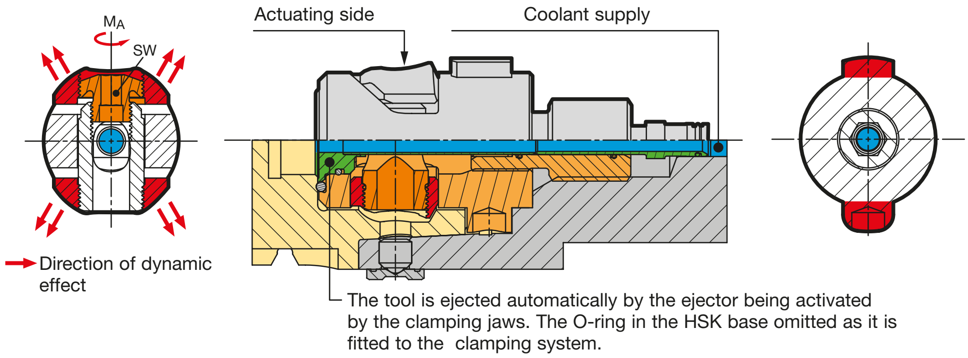
Advantages:

- simple and hence more economic spindle manufacture
- short. small diameter spindles with constricted spindle bearing spacing
- suitable for a pressure up to 160 bar (for conventional internal cooling)
- fast response time thanks to uninterupted MQL supply
- compatible installation contour and application of our 4-point clamping set for conventional cooling
- fixed installation through screwed joint, prebalanced, good rotation symmetry, therefore high-speed capability

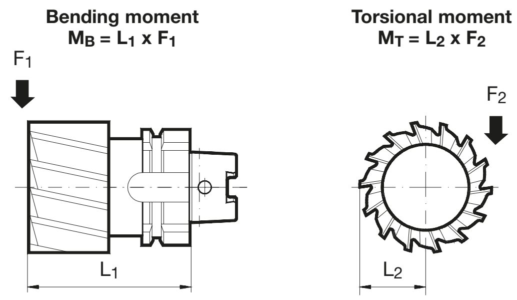
Internal contour of spindle



Installation and principle of operation



Bending. torsional and tightening moment for 4-point clamping sets for MQL



① We recommend M_A max. for rough machining and milling operations. For drilling and reaming operations a lower deviation of M_A max. up to 30% is permissible. Please check the torque with a torque wrench.
② Depending on temperature and lubricating conditions these values can be up to 15% lower.
③ Due to the screwed connection. M_T max. can be lower with adaptors.

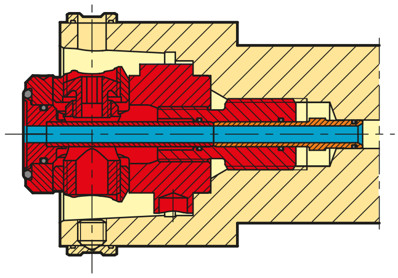
HSK-C	**max.** torque M_A [Nm] ①	Key size	**max.** drawing force [kN] ②	**max.** linear bending moment M_B [Nm] ②	**max.** transferrable torsional moment M_T [Nm] ② ③
32	3.0	2.5	8.5	72	105
40	6.0	3.0	12.5	135	180
50	12.0	4.0	24.0	330	390
63	24.0	5.0	32.0	570	680
80	40.0	6.0	45.0	1000	1570
100	60.0	8.0	53.0	1620	4200

General notes: Our manual clamping sets must not be operated with motor-driven tools (impulse screwdriver or similar). The hexagonal key should not exceed the key size over its entire length, this largely prevents excessive torque being transferred. We recommend the T-handle hexagonal key, article no. 4912.
For accurate setting of the maximum torque and achieving the maximum interface rigidity, we recommend the application of a torque wrench, article no. 4915 with hexagonal sockets, article no. 4916. Production drawings of the spindle contour to suit direct installation are available on request, including .dxf.

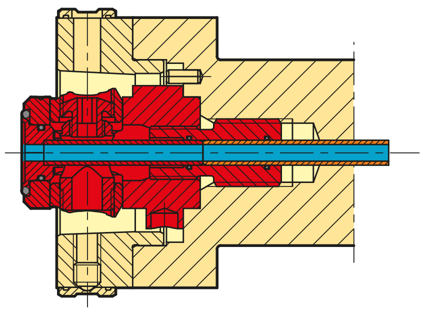
MQL BY GÜHRING

MQL 4-point clamping set connection dimensions for new designs

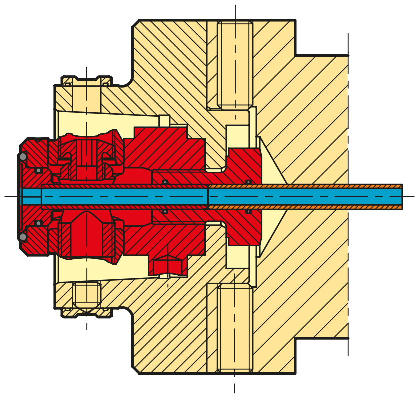
Direct installation in spindle with MQL adaptor



Short spindle adaptor with MQL supply pipe



Adaptor (in front) with MQL supply pipe



The 4-point clamping technology for conventional cooling

Technical information and advantages

Conventional 4-point clamping sets offer enormous clamping force and optimal cooling lubricant supply. They are suitable for radial manual HSK tool clamping.

Advantages:

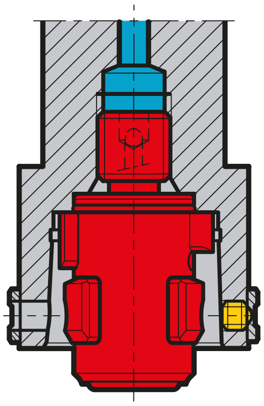
- simple and hence more economic spindle manufacture
- short, small diameter spindles with constricted spindle bearing spacing
- suitable for a pressure up to 80 bar

General notes: Our manual clamping sets must not be operated with motor-driven tools (impulse screwdriver or similar). The hexagonal key should not exceed the key size over its entire length. this largely prevents excessive torque being transferred. We recommend the T-handle hexagonal key, article no. 4912. For accurate setting of the maximum torque and achieving the maximum interface rigidity. we recommend the application of a torque wrench, article no. 4915 with hexagonal sockets, article no. 4916. Removal of the locking ring is made by releasing the pressure ball screw. This is achieved with the use of an Allen key inserted through the opposite access hole and through the hollow threaded spindle and turned anticlockwise. Once released. the locking ring will slide axially off. Production drawings of the spindle contour to suit direct installation are available on request, including .dxf.

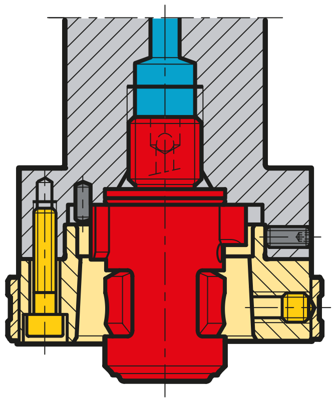
Application examples

Spindle interface

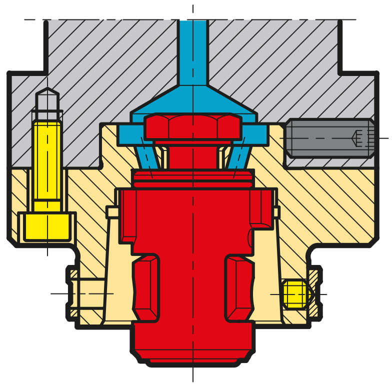
Direct installation in spindle



Spindle adaptor (integrated)

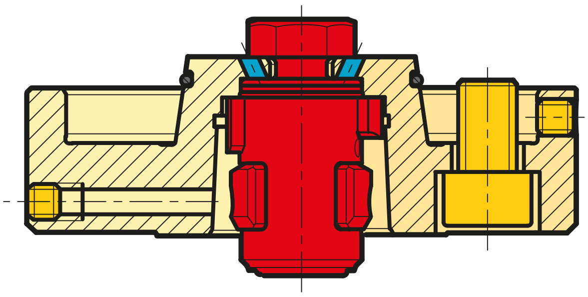


Spindle adaptor (in front)

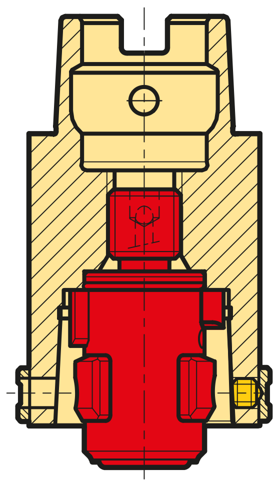


Adaptor

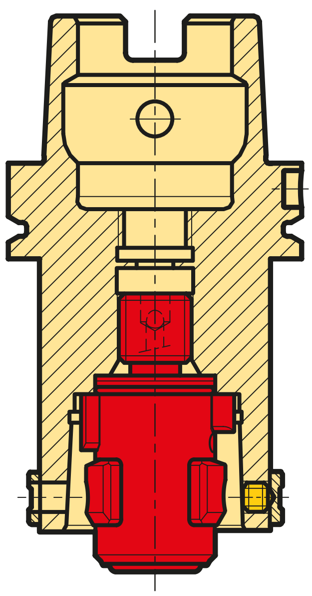
Basic adaptor for ISO taper spindles



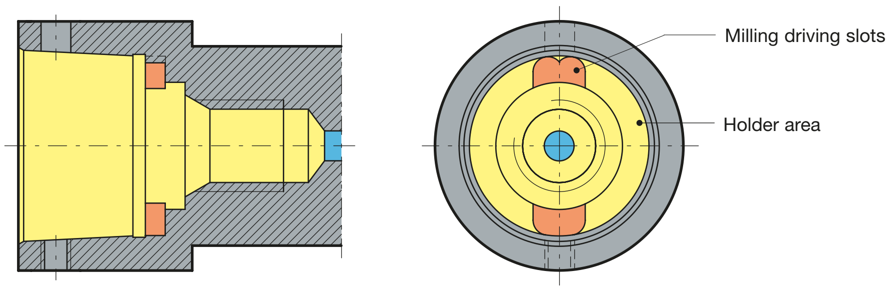
HSK-C extension



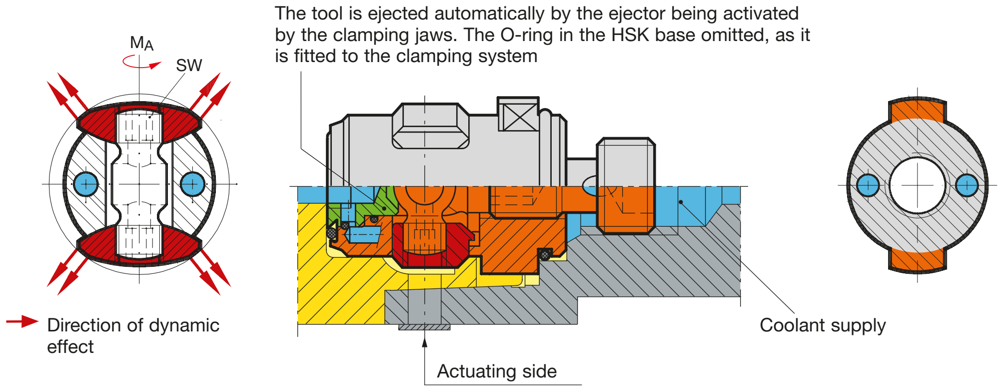
HSK-A reduction



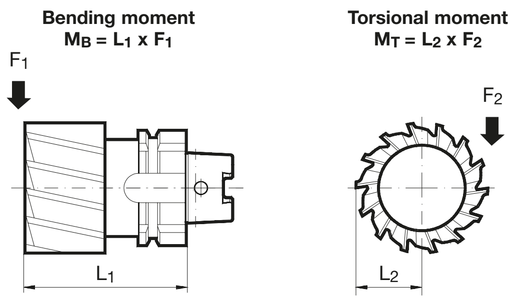
Internal contour of spindle



Installation and principle of operation



Bending torsional and tightening moment for 4-point clamping sets for conventional cooling



① We recommend M_A max. for rough machining and milling operations. For drilling and reaming operations a lower deviation of M_A max. up to 30% is permissible. Please check the torque with a torque wrench.
② Depending on temperature and lubricating conditions these values can be up to 15% lower.
③ Due to the screwed connection. M_T max. can be lower with adaptors.

HSK-C	**max.** torque M_A [Nm] ①	Key size	**max.** drawing force [kN] ②	**max.** linear bending moment M_B [Nm] ②	**max.** transferrable torsional moment M_T [Nm] ② ③
25	1.5	2.5	4.5	30	30
32	3.0	2.5	7.0	60	100
40	6.0	3.0	12.0	130	170
50	14.0	4.0	20.0	280	350
63	27.0	5.0	28.0	500	640
80	54.0	6.0	40.0	900	1330

PowerClamp

Technical information and advantages

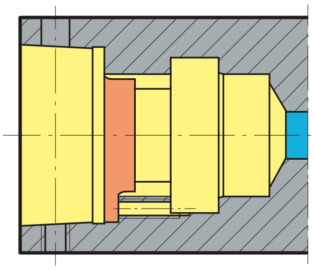
Gühring's PowerClamp system is designed for universal applications in transfer lines, machining centres, turning centres and setting equipment.

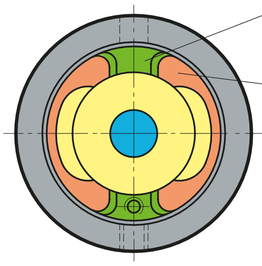
Due to high pull forces the PowerClamp is suitable for low-speed operations in heavy machining.

Advantages:

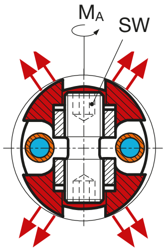
- simple assembly thanks to uncomplicated spindle contour
- few moving components, therefore optimal force transmission
- high clamping force, therefore excellent bending resistance
- secure ejector function
- internal coolant supply
- coolant sealing from p > 6 bar to max. 80 bar

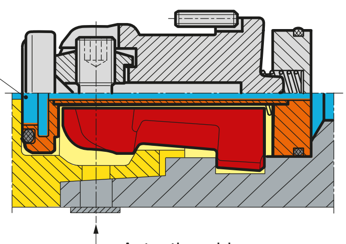
Internal contour of spindle

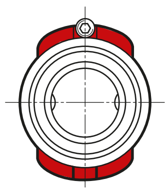




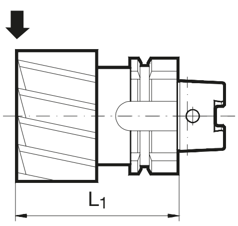
Installation and principle of operation

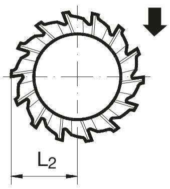






Bending torsional and tightening moment for PowerClamp





① We recommend M_A max. for rough machining and milling operations. For drilling and reaming operations a lower deviation of M_A max. up to 30% is permissible. Please check the torque with a torque wrench.
② Depending on temperature and lubricating conditions these values can be up to 15% lower.
③ Due to the screwed connection. M_T max. can be lower with adaptors.

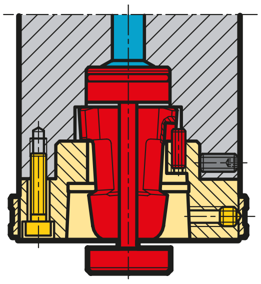
HSK-C	**max.** torque M_A [Nm] ①	Key size	**max.** drawing force [kN] ②	**max.** linear bending moment M_B [Nm] ②	**max.** transferrable torsional moment M_T [Nm] ② ③
25	1.5	2.0	5	45	50
32	2.5	2.5	8	74	120
40	6.0	3.0	18	213	360
50	10.0	4.0	27	431	1000
63	15.0	5.0	35	703	1300
80	25.0	6.0	50	1100	2800
100	50.0	8.0	60	1620	4800

General notes: Our manual clamping sets must not be operated with motor-driven tools (impulse screwdriver or similar). The hexagonal key should not exceed the key size over its entire length. this largely prevents excessive torque being transferred. We recommend the T-handle hexagonal key, article no. 4912. For accurate setting of the maximum torque and achieving the maximum interface rigidity. we recommend the application of a torque wrench, article no. 4915 with hexagonal sockets, article no. 4916. Production drawings of the spindle contour to suit direct installation are available on request, including .dxf.

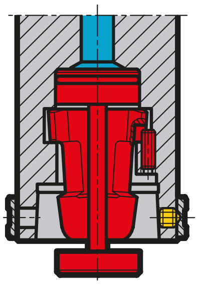
Application examples

Spindle interface

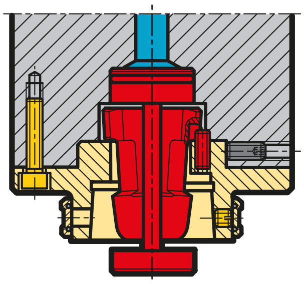
integrated spindle adaptor



Direct installation in spindle

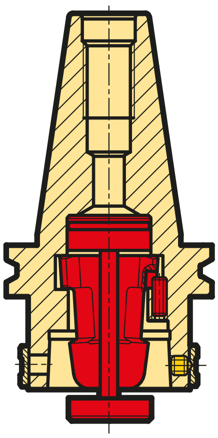


Spindle adaptor (in front)

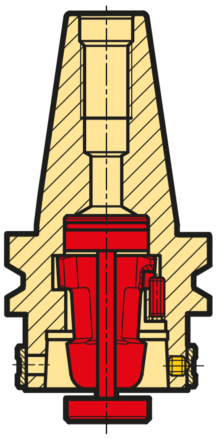


Adaptor

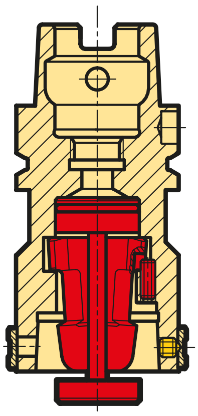
DIN ISO 7388-1 form AD



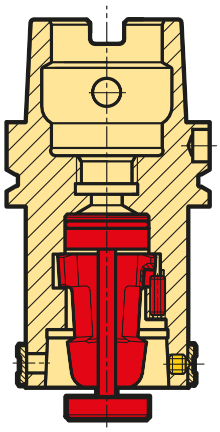
MAS/BT



HSK-A extention

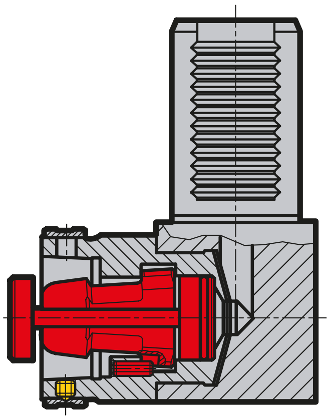


HSK-A reduction

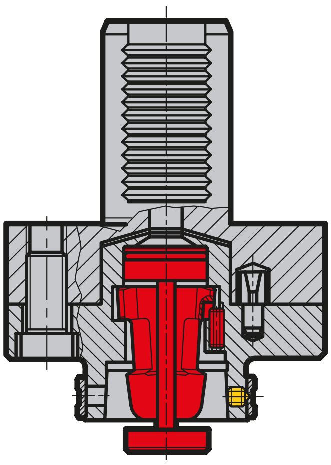


Tool holder for turning centers

adaptor (in front) on VDI angle holder



adaptor (in front) on VDI vertical holder



Technical information and advantages

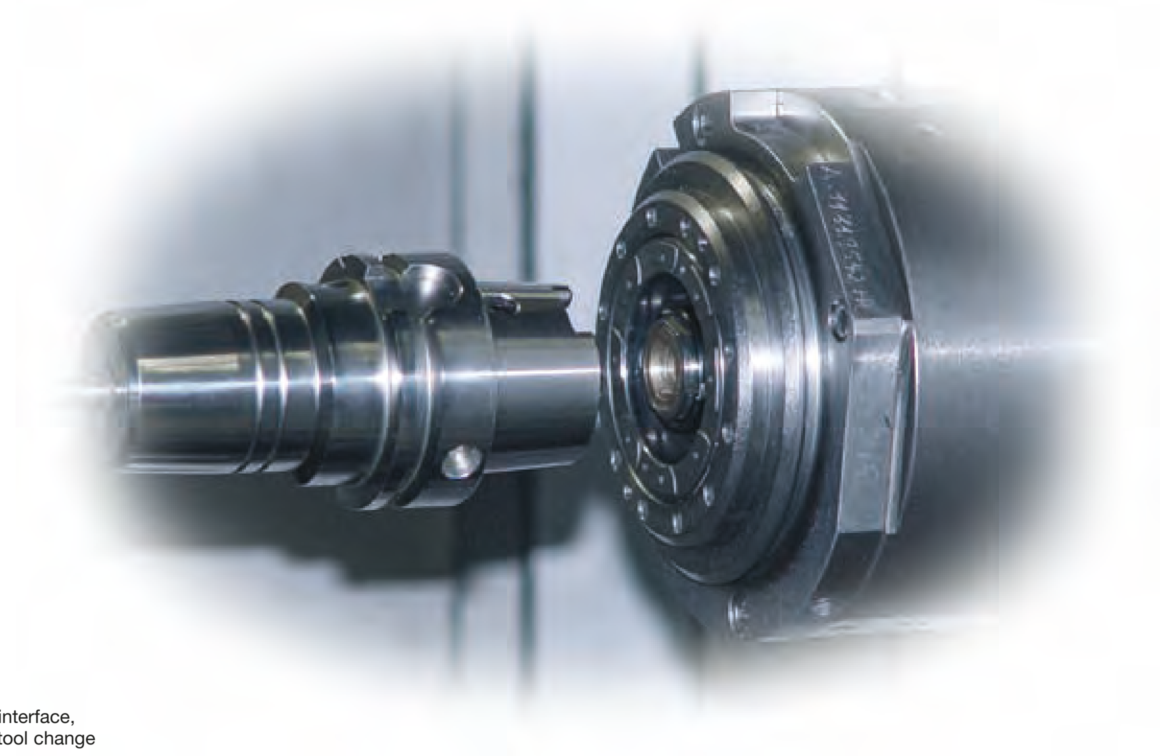


Fig. 1:
HSK-A 63 interface,
automatic tool change

Our modular tooling system GM 300 has been developed for the application of rotating and stationary tools. 1987 we devloped the GM 300 coupling. Standardisation for this interface (DIN 69893) was obtained in1991. Since 12/2001 the HSK interface is also standard to ISO 12164-1/-2. The unique design of the clamping method offers not only an ideal interface for manual clamping within the tooling system, but also an ideal interface for automatic clamping directly to the machine spindle (fig. 1) or tool holder.

Characteristic feature:
Tapered holow shank (HSK) with axial plane clamping mechanism according to DIN 69893. The most important advantages are as follows:

- **High static and dynamic rigidity**

The radial and axial forces generated in the tool shank provide the clamping forse necessary for extreme rigidity (fig. 2). Recommended values for the GM-300 module for manual clamping.

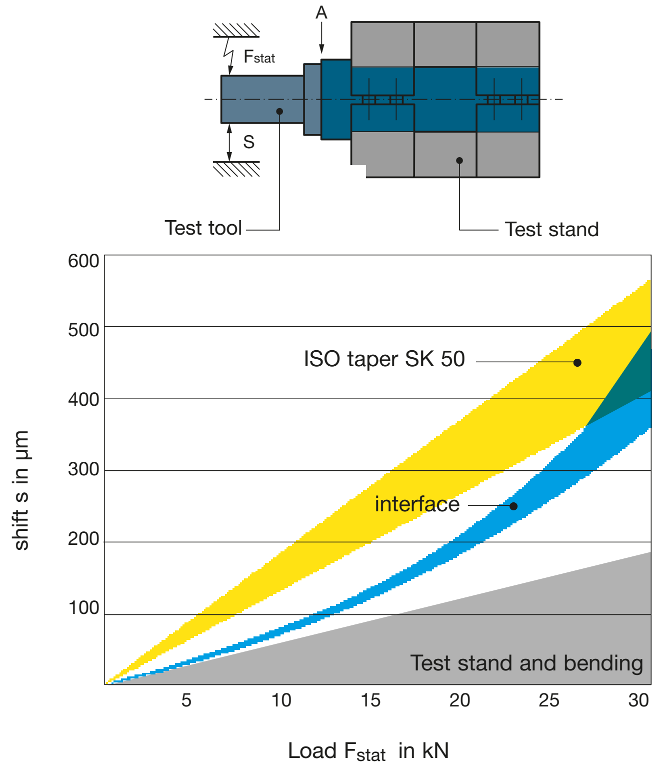


Fig. 2
Static deflection: Comparison between ISO taper 50 and automatic interface HSK-A 100 (A)

ISO taper DIN 2080 DIN ISO 7388-1	HSK form A/C/(E) DIN 69893 part 1	HSK form B/D/(F) DIN 69893 part 2
–	HSK 40	HSK 50
SK30	HSK 50	HSK 63
SK40	HSK 63	HSK 80
SK45	HSK 80	HSK 100
SK50	HSK 100	HSK 125

Association between ISO taper - hollow taper shank

Technical information and advantages

• High torque transmission and defined radial positioning

The wedging effect between the hollow taper shank and the holder or spindle causes a friction contact over the full taper surface and the plane supporting face (fig. 3). Two keys engage with the shank end of the tool holder and provide form-closed, radial positioning, thereby excluding any possible setting errors.

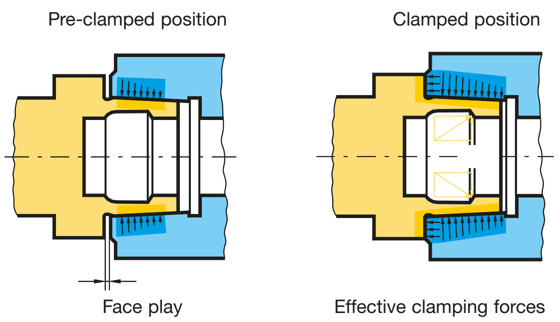
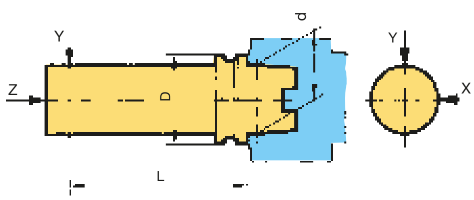


Fig. 3
Prestressing and frictional forces of hollow taper shank at the interface.

• High tool change accuracy and repeatability

The circular form engagement of the clamping claws within the hollow tool shqank provides a totally tight connection between the shank and spindle or holder respectively (fig. 3 and 4).



HSK-size D	d mm	L mm	X mm	Y mm	Z mm
32	24	50	0.002	0.002	0.002
40	30	60	0.002	0.002	0.002
50	38	75	0.002	0.002	0.002
63	48	100	0.002	0.002	0.002
100	75	150	0.002	0.002	0.002

Fig. 4
Radial and axial repeatability of interface for manual and automatic clamping

• High speed machining performance

The higher the number of revolutions the better, as this increases both the power and effectiveness of the locking of the clamping mechanism. The direct initial stress between the hollow taper shank and the spindle holder compensates for the spindle expansion generated by the centrifugal force so that there is absolutely no radial play (fig. 3). The plane clamping position prevents any slipping in the axial direction.

• Short tool changing time

Efficient tool change due to a short shank length (approx. 1/3 of the conventional ISO taper) and light weight (approx. 50% of the ISO taper).

• Simple, cost-efficient shank design

No moving components at the tool shank means no wearing parts.

• Insensitive to foreign matter

The uninterrupted design of the ring-shaped axial plane clamping simplifies the cleaning of the coupling. During automatic tool change compressed air provides ideal cleaning in the interface.

• Coding and identification

To allow for the attachment of common identification systems, a hole of 10 mm dia. and 4.5 mm depth is provided for the data media (coding chips) in the vicinity of the collar.

• Standardising of interface

The hollow taper shanks by GÜHRING are conform with ISO 12164-1/DIN 698936. Version form „E“ with access hole in taper for manual clamping.

• Coolant feed

The tools for automatic clamping, HSK-A and E, are designed for a central coolant feed by means of a duct. Tools with manual change behind the GM 300 interface also operate with a central coolant feed. The clamping elements are entirely sealed against the entry of coolant so that fouling is prevented.

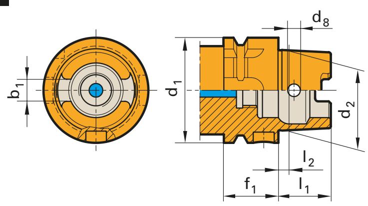
• Installation of the coolant supply set

Coolant supply sets are to be ordered separately for all GM 300 modules. The installation of the coolant duct must be carried out by the user.

General overview of HSK shanks ISO 12164-1/DIN 69893

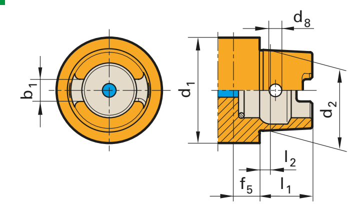
Form A ISO 12164-1/DIN 69893-1

HSK-sizes 25…160



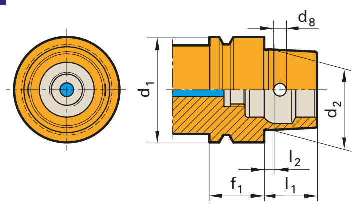
Form C ISO 12164-1/DIN 69893-1

HSK-sizes 25…160



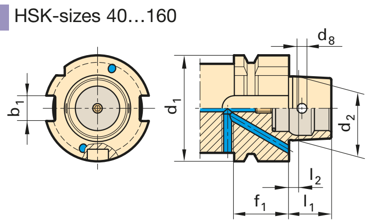
Form E DIN 69893-5

HSK-sizes 20…63



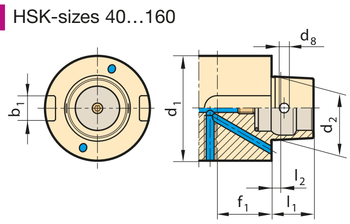
Form B DIN 69893-2

HSK-sizes 40…160



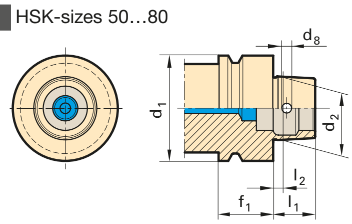
Form D DIN 69893-2

HSK-sizes 40…160



Form F DIN 69893-6

HSK-sizes 50…80



HSK for automatic tool change with gripper groove and index notch. Manual operation is via access hole in taper. Form B relies on driving dogs on the joint face as shank isn't slotted. Torque is transmitted through highly accurate connnection.

HSK for manual tool change. Operation is via access hole in taper. Form D relies on driving dogs on the joint face as shank isn't slotted. Torque is transmitted through highly accurate connnection.

HSK for automatic tool change. Torque is transmitted through highly accurate connnection. Version with access hole acc. to DIN 69893-1 by arrangement. HSK-E/F by Gühring are supplied with access holes.

HSK form A C E

Nominal Ø d_1 mm	Form	d_2 mm	l_1 mm	l_2 mm	f_1 mm	f_5 mm	d_8 mm	b_1 mm
20		15.203	10	2.0	8	-	-	-
25		19.006	13	2.5	10	-	-	-
32	E	24.007	16	3.2	20	10.0	4.0	7.05
40		30.007	20	4.0	20	10.0	4.6	8.05
50		38.009	25	5.0	26	12.5	6.0	10.54
63		48.010	32	6.3	26	12.5	7.5	12.54
80		60.012	40	8.0	26	16.0	8.5	16.04
100	A C	75.013	50	10.0	29	16.0	12.0	20.02
125		95.016	63	12.5	29	-	-	25.02
160		120.016	90	16.0	31	-	-	30.02

HSK form B F

Nominal Ø d_1 mm	Form	d_2 mm	l_1 mm	l_2 mm	f_1 mm	d_8 mm	b_1 mm
25		-	-	-	-	-	-
32		-	-	-	-	-	-
40		24.007	16	3.2	20	4.0	10
50		30.007	20	4.0	26	4.6	12
63	F	38.009	25	5.0	26	6.0	16
80	B	48.010	32	6.3	26	7.5	18
100		60.012	40	8.0	29	8.5	20
125		75.013	50	10.0	29	12.0	25
160		95.016	63	12.5	31	12.0	32

Because the rotational speed is the largest influencing factor together with the limits regarding the spindle or spindle bearing interface, the following r.p.m. limits for HSK interfaces have been recommended as guidelines within the HSK standards:

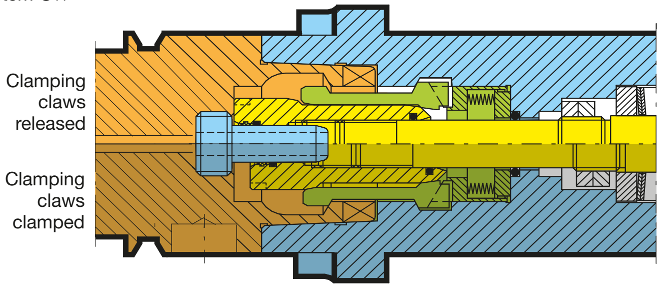
HSK-A/C 25	to 60.000 rev./min
HSK-A/C 32	to 50.000 rev./min
HSK-A/C 40	to 42.000 rev./min
HSK-A/C 50	to 30.000 rev./min
HSK-A/C 63	to 25.000 rev./min
HSK-A/C 80	to 20.000 rev./min
HSK-A/C 100	to 16.000 rev./min

The automatic tool clamping

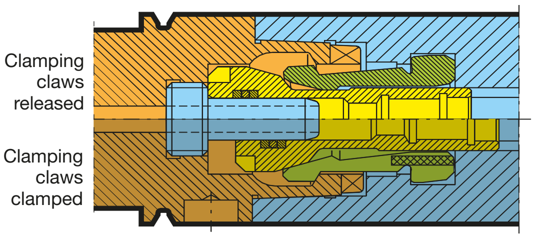
For the automatic interface the forces are introduced axially via a draw bar. A clamping taper simultaneously causes a radial movement of the clamping segments which, in turn, engage with the clamping shoulder of the tool shank and lock the coupling absolutely play-free. The clamping mechanism increases the draw-in force on the plane face by a factor of 3.5. General application in machining centers and turning centres using an automatic tool changing method. Such clamping systems are currently being offered by Messrs. Ott, Ortlieb, Berg and Röhm (fig. 6).

Fig. 6
Spindle interfaces with clamping devices

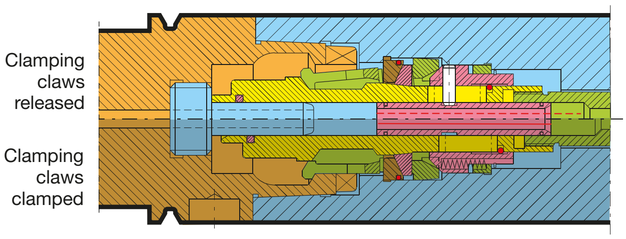
System Ott



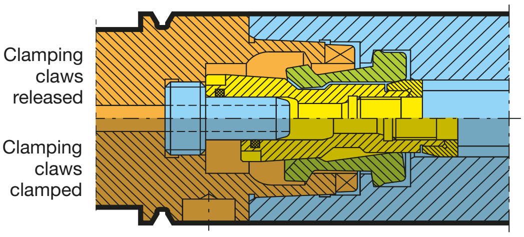
System Ortlieb (licence Fa. Gühring)



System Berg (licence Fa. Gühring)



System Röhm (licence Fa. Gühring)



Term definitions of HSK-A interface for automatic tooling systems

① Gripper groove: circular groove

② Index notch: sickle-shaped notch across gripper groove

③ Keyway on collar: index notch or for attachment in tool magazine or grippers. With HSK-B/D also provides form closed torque transmission to spindle

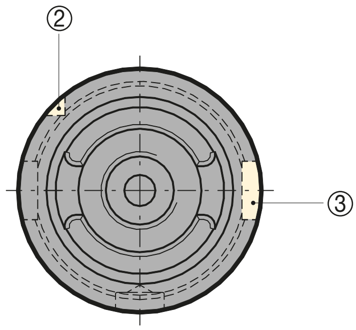
④ Coding/identification: bore in collar for attachment of identification system (coding chip)

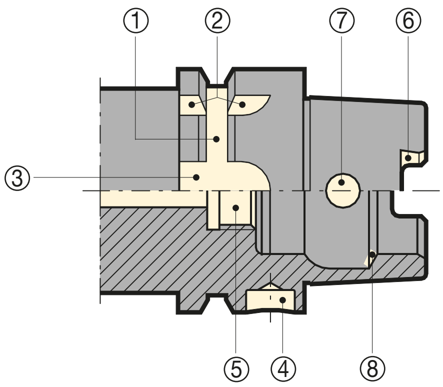
⑤ Thread for coolant: for attachment of coolant supply set

⑥ Keyway on taper shank: form closed torque transmission to spindle

⑦ Radial bore in taper shank: necessary for manual clamping systems

⑧ Clamping shoulder: circular chamfer for drawing in the tool





Note:
We like to point out, that HSK-A can be used alternatively to HSK-C with manual clamping systems e.g. 4-point clamping set or PowerClamp. The only difference is the overall length, which is slightly longer. That is why we have decided to have certain tool holders only as form C as standard.

The manual tool clamping

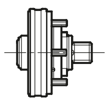
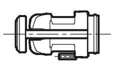
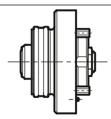
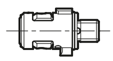
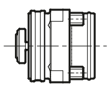
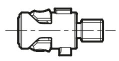
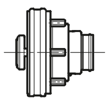
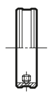
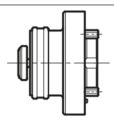
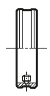
Operating instructions for manual tool clamping

- Do not exceed the maximum torque figures for the clamping screw of the 4-point clamping set and the PowerClamp system.
- The thread of the clamping screw of the manual clamping set is supplied pre-greased. Following pro-longed operating periods it may be necessary grease otherwise the require clamping force cannot be obtained.
- At tool changing the plane surface and spindle has to be cleaned. Dirt will restrain the perfect function of the tool system. The inner taper of the spindle can be cleaned with cleaning unit, article no. 4914.
- The spindle should be sealed with a plug, article no. 4985, when running without tool to prevent impurities in the clamping sets and HSK tool systems.

Exemplary interface design

Spindle connection dimensions see page 276/277

Detailed drawings of the spindle connection contours are available on request for the following:

Article no. **4385** Short HSK adaptor		Article no. **4554** PowerClamp clamping set	
Article no. **4386** HSK adaptor (in front)		Article no. **4958** 4-point clamping set	
Article no. **4582** HSK adaptor (in front) for turning centres		Article no. **4930** MQL 4-point clamping set	
Article no. **4584** HSK adaptors (integrated axial plane)		Article no. **4953** Brass collar	
Article no. **4586** HSK adaptor (in front)		Article no. **4953** Brass collar	

Technical information and advantages

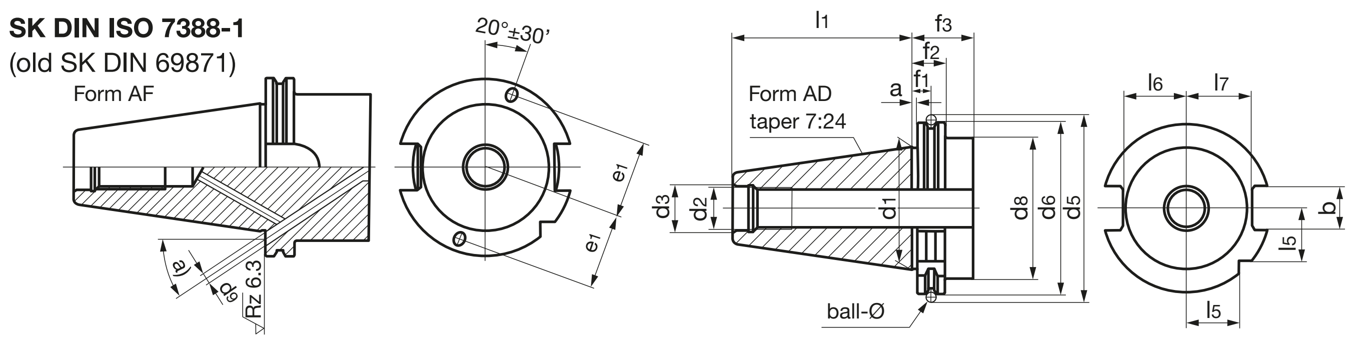
Gühring has considerably expanded its ISO taper and MAS-BT tool holder program. Naturally, the tool holders are of the usual high Gühring quality. This means: ISO taper and MAS-BT tool holders are produced in a special, alloyed case hardened steel with a minimum tensile strength at the core of 900 N/mm2, hardened in a low distortion hardening process to HRC 58 at a case hardening depth of 0.8 to 1.0 mm. For reasons of longevity, the surface of the tool holder is subjected to an abrasive blasting process and protected against corrosion.

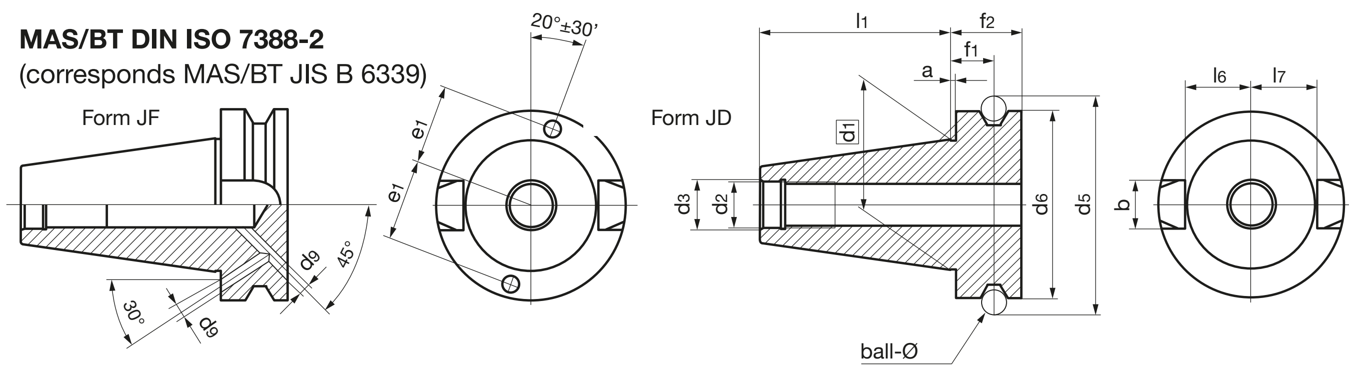
Quality through precision
Gühring's demand for highest precision also applies to tool holders. Therefore, ISO taper and MAS-BT chucks are precision ground: in the vicinity of the ISO taper to Ra ≤ 0.2, at the holder face to Ra ≤ 0.4. The taper tolerance is better than AT 3 with a measuring accuracy of ≤ 1µm.
Detailed information regarding the form and positional tolerances can be found for the individual tool holders on the respective pages in the catalogue. The tolerances of the holder bore and the spigot are approximately 2/3 of the DIN tolerance.

Balancing
Tool holders suitable for increased speeds are generally pre-balanced. For this purpose, we have determined the imbalance and entered the balancing areas as well as balancing bores on the drawings. This levels out the imbalance to a large extent and up to approximately 8000 rev./min precision balancing is unnecessary. For higher revolutions, the pre-balanced tool holders must be precision balanced to G 6.3 or G 2.5 respectively.

Type AD/AF
ISO taper tool holders generally produced are type AD/AF. Supplied is type AD, the coolant bores at the collar are sealed with screws.

General dimensions and tolerances
The following dimensions apply to our ISO taper and MAS-BT tool holders:





ISO taper	a mm	ball-Ø mm	b mm	d_1 mm	d_2 mm	d_3 mm	d_5 mm	d_6 mm	d_8 mm	d_9 mm	e_1 mm	f_1 mm	f_2 mm	f_3 mm	l_1 mm	l_5 mm	l_6 mm	l_7 mm
SK30	3.2	7	16.1	31.75	M12	13	59.3	50.00	45	4	21	11.1	19.1	35	47.80	15.00	16.4	19.0
SK40	3.2	7	16.1	44.45	M16	17	72.3	63.55	50	4	27	11.1	19.1	35	68.40	18.5	22.8	25.0
SK50	3.2	7	25.7	69.85	M24	25	107.25	97.50	80	6	42	11.1	19.1	35	101.75	30.0	35.5	37.7
BT30	2.0	8	16.1	31.75	M12	12.5	56.03	46.00	–	–	–	13.6	22.0	–	48.40	–	16.3	16.3
BT40	2.0	10	16.1	44.45	M16	17	75.56	63.00	–	4	27	16.6	27.0	–	65.4	–	22.6	22.6
BT50	3.0	15	25.7	69.85	M24	25	118.89	100.00	–	5.4	42	23.2	38.0	–	101.8	–	35.4	35.4

Imbalance

An imbalance produces a centrifugal force during the rotation of the spindle impeding the smooth running of the tool. This imbalance influences the working process and the life span of the spindle bearings.

The centrifugal force F increases linear with the imbalance U and squared with the number of revolutions according to the formula below.

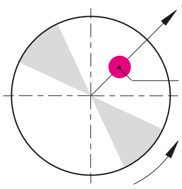
Counter balancing

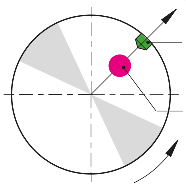
To compensate for unwanted centrifugal forces, the symmetrical distribution of mass must be restored with the aim of eliminating any centrifugal forces influencing the spindle bearing. Tool holders generally have compensation holes or areas which assist in directing the total amount of all centrifugal forces influencing the axis towards zero (see DIN ISO 21940-11).

Eccentricity of center of gravity

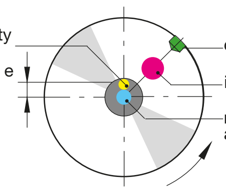
The imbalance of a spindle causes its center of gravity to deviate a certain distance from the rotating axis in direction of the imbalance. This distance is called rest-eccentricity e or eccentricity of center of gravity. The heavier the weight of the balance body mass m, the greater the rest-imbalance U permissible.

$$c = U \cdot \omega^2$$





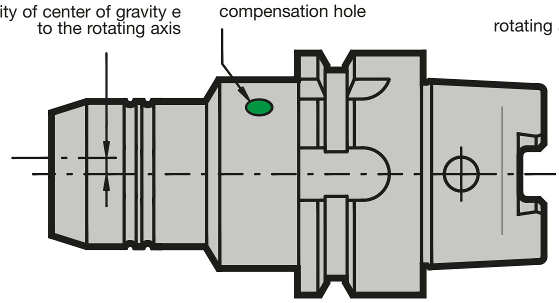
$$e = \frac{U}{m}$$



Calculation imbalance

Imbalance is a measure, specifying how much unsymmetrical distributed ass deviates radially from the rotating axis.

Imbalance is measured in gmm. The measure of distance e determines the distance of the center of gravity of an element to the rotating axis. Imbalance is calculated as follows:



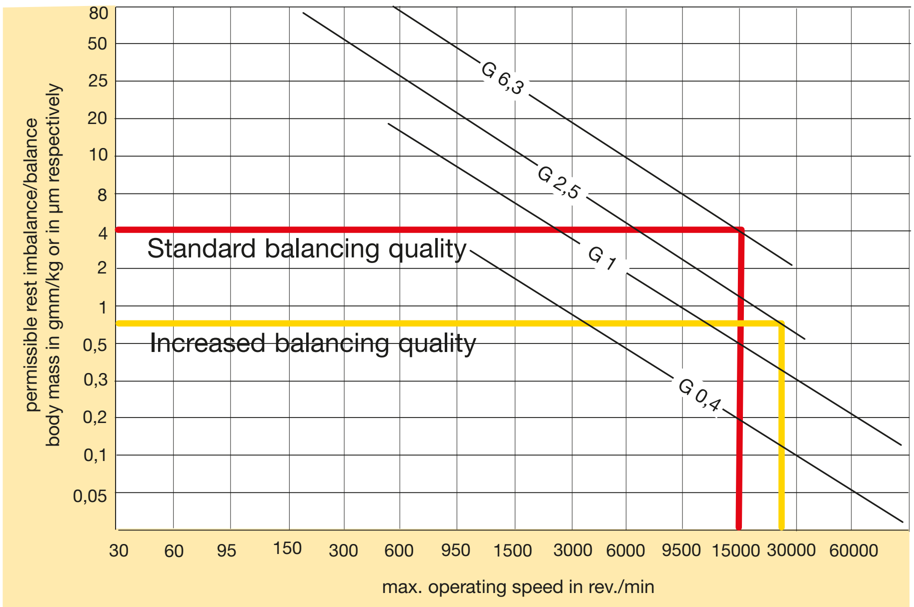
$$U = m \cdot e$$

c = centrifugal force
U = imbalance in gmm
e = eccentricity of center of gravity in µm
m = mass in kg
s = speed min-1
ω = angular velocity ($\omega = 2 \cdot \pi \cdot n$)

Balancing limits

In accordance with DIN ISO 21940-11 the balance grade is denoted with G as well as the units gmm/kg or µm respectively and is relative to the number of revolutions. At a speed of 15.000 rev./min and a weight of 1 kg, G6.3 corresponds with a permissible center deviation between rotational axis and center of gravity axis of the spindle of 4 µm.
At twice the speed of 30,000 rev./min it would be 2 µm. If the tool holder was only half the weight, i.e. 0.5 kg, the permissible counter balancing tolerance is also halved.
Aim of counter balancing is to find a compromise between the technically feasible and the econnomically efficient. Because the radial interchange accuracy for a brand-new HSK holder can be 2 to 3 µm and for an ISO taper shank holder can be 5 to 10 µm, it means an initial quality limit of G2.5 or G6.3 respectively at 10,000 rev./min.
The following diagram shows the quality grades to DIN ISO 21940-11, i.e. the permissible rest imbalance in relation to the balance body mass for different counter balance qualities G relative to the maximum operating speed.

Balancing machine



Gühring tool holders are balanced to G6.3/15,000 rev./min. As an option, i.e. when specified by the machine tool manufacturer, it is possible to precision balance including balancing protocol to a rest imbalance of 0.3 gmm.

Calculation the balancing grade total of the assembled system:

Spindle - tool holder - tool

Illustration of balancing grade total

$IB_{total} = IB_{Spindle} + IB_{tool\ holder} + IB_{tool}$

Example:

$IB_{total} = IB_{Spindle\ (G\ 0.4)} + IB_{tool\ holder\ (G2.5)} + IB_{tool\ (G6.3)}$

Calculation of rest imbalance

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

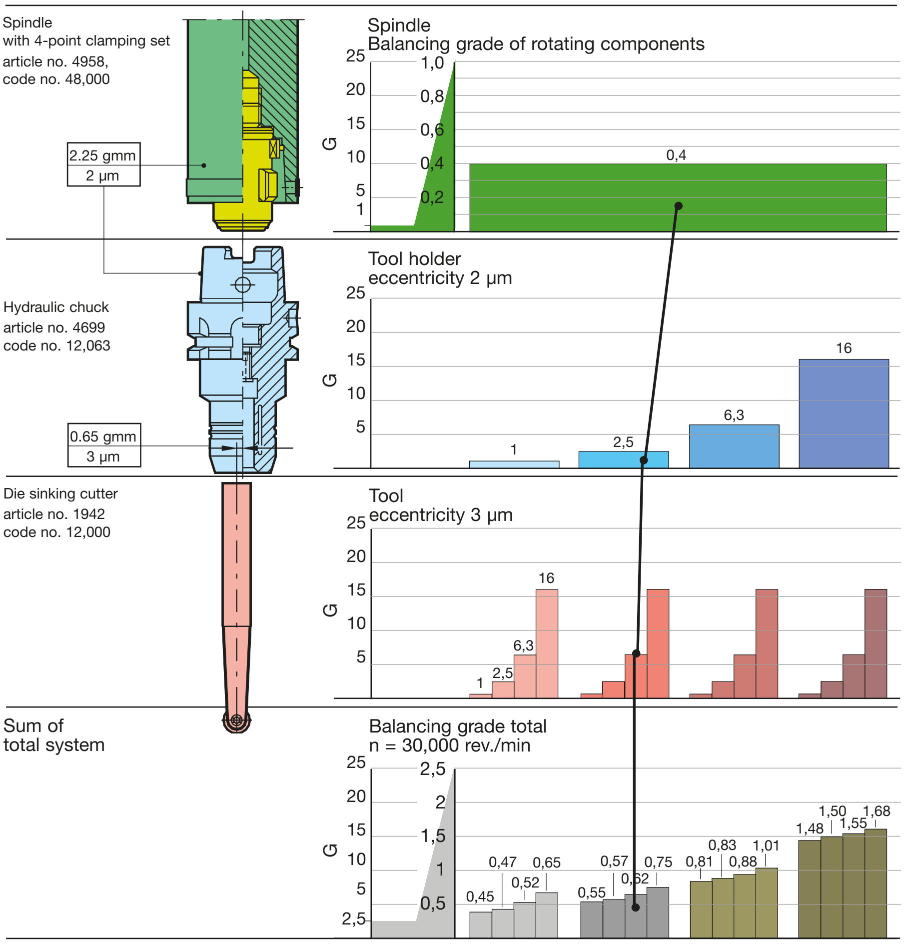
		m in g	U in gmm
IB Spindle	$= \frac{0{,}4 \cdot 60}{2 \cdot \pi \cdot 30.000} \cdot$	15.000 =	1,910
IB tool holder	$= \frac{2{,}5 \cdot 60}{2 \cdot \pi \cdot 30.000} \cdot$	1125 =	0,895
IB tool	$= \frac{6{,}3 \cdot 60}{2 \cdot \pi \cdot 30.000} \cdot$	215 =	0,431
	m total in g:	16.340	
	IB total in gmm:		3.236

Balancing grade conversion of the total system

$$G = IB_{total} \cdot 2 \cdot \pi \cdot \frac{n}{60 \cdot m_{total}}$$

Example:

$$G = 3{,}236\ gmm \cdot 2 \cdot \pi \cdot \frac{30.000 \cdot \frac{U}{min}}{60\ s \cdot 16340\ g} = 0{,}62$$



Technical information and advantages

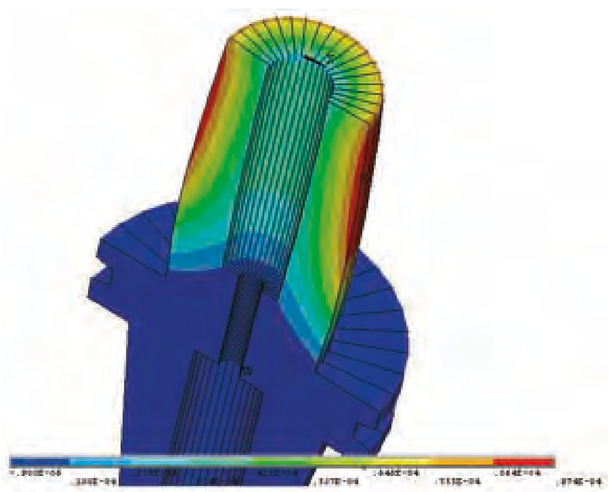
Gühring's shrink fit chucks ensure an optimal connection between shrink fit chuck and shank tool.
While some manufacturers use conventional case hardened steel, Gühring applies a special, application orientated tool steel. The result is an increased expansion rate as well as improved temperature adaptability. There is no limit to the number of shrink fit insertion or withdrawal operations.

Advantages:
- short shrink fit times
- maximum clamping force
- shrink fit chucks available for tool shank diameters from 3 mm to 32 mm
- longevity

These advantages are of particular interest in the field of HSC milling, difficult and rough cutting operations, drilling, reaming and internal grinding operations as well as for woodworking.

Convincing characteristics:
- excellent concentricity
- extreme clamping force and rigidity
- improved tool life
- insignificant imbalance through rotation symmetry
- economic efficiency

A gripping principle
When shrink fitting tools in shrink fit chucks, the decisive factors for ensuring the safe clamping of the tool in the tool holder are solely the heating and cooling of the tool holder. The heating process expands the shrink fit chuck enabling a tool to be inserted or withdrawn respectively. During the cooling process it contracts again and clamps the inserted tool with maximum clamping force.
Because the shrink fit chucks can become extremely hot in localised areas during the heating process and the tools shrink fitted for insertion or withdrawal respectively possess very sharp cutting edges, it is paramount that the operator wears Kevlar gloves during the shrink fit operation to prevent burns and cuts to the hands.



Shrink fit extensions: Increase performance
Shrink fit extensions increase the scope of a tool's performance and reduce tool surface imperfections. As with shrink fit chucks, the tool is clamped in the shrink fit extension and ideally in an hydraulic chuck. Naturally, shrink fit extensions can also be clamped in shrink fit chucks.

Perfect team: Gühring shrink fit chucks and shrink fit systems
For the shrink fitting for withdrawal and insertion of tools in our shrink fit chucks we offer various shrink fit systems to satisfy individual customer requirements: From high-tech solutions with integrated, highly accurate length pre-setting and special shrink fit systems for extra long tools to the multi-faceted GSS 2000 with various equipment options:

- GSS 5000
- GSS 3001
- HSV 2000
- GSS 2000

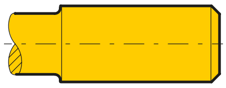
Technical information and advantages

Clamping standard tool shanks to DIN 6535 in hydraulic chucks

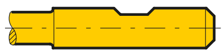
Direct clamping
of tool preferred
run-out ≤ 0.003 mm

Form HA Ø 6 ... 20 mm

Form HA Ø 25 ... 32 mm

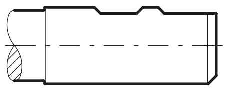


Form HB Ø 6 ... 20 mm

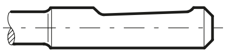


Clamping of tool shank
only with reduction bushes
run-out ≤ 0.005 mm

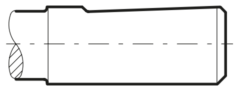
Form HB Ø 25 ... 32 mm



Form HE Ø 6 ... 20 mm



Form HE Ø 25 ... 32 mm



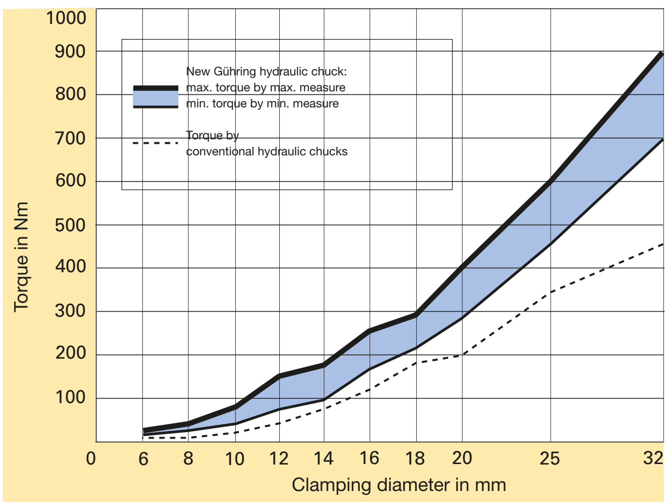
General notes:
Our hydraulic chucks must not be operated with motor-driven tools (impulse screwdrivers or similar). The hexagonal key should not exceed the key size over its entire length, this largely prevents excessive torque being transferred. We recommend the hexagon clamping key, article no. 4912. A tightening moment of 10 Nm must not be exceeded.

Gühring Hydraulic chucks with increased clamping force

Hydraulic chucks are suitable for clamping rotary symmetrical tools or workpieces. Straight shank tools without drive flats may be clamped up to Ø 32 mm, but also shanks according to DIN 6535 form HA and HB up to Ø 20 mm without reduction bushes. The given values in the table below are not to be exceeded. If the inserted length is less than the given minimum insertion depth or other tool shanks than specified above are applied, lower accuracy and breakage may occur!

Above all it is the high revolutions with High-Speed-Cutting operations that puts special demands on the tool holder. The clamping of the tool in a hydraulic chuck is, therefore, especially significant. Gühring has developed a hydraulic chuck that offers reliable and powerful clamping with higher torque figures, guaranteeing excellent tool clamping in the tool holder.

Combined with precise concentricity (max. 3 µm deviation from concentricity), a very fast and simple tool change as well as the vibration cushioning effect of the pressure chamber, the new hydraulic chuck can tackle the most demanding of machining tasks. The result is optimal tool life and excellent surface qualities or dimensional accuracy of the workpiece respectively.

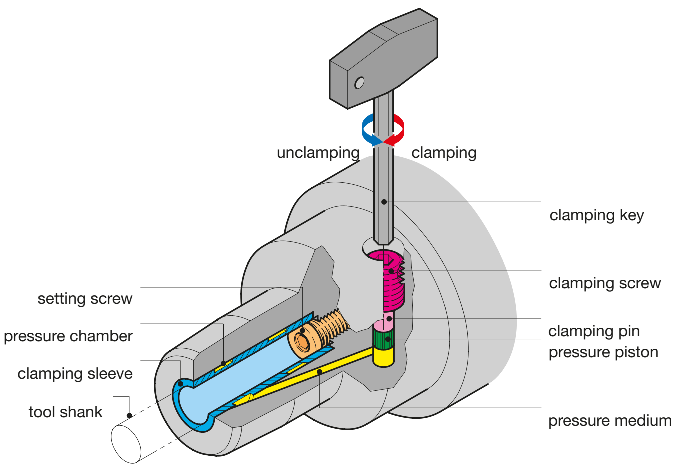


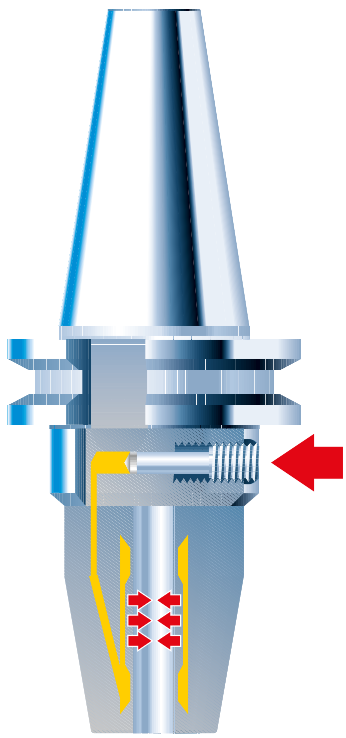
Considerably higher:
The clamping force of Gühring's new HSK-A hydraulic chuck in comparison to conventional chucks.

Technical information and advantages

Modern machining processes place heavy demands on tool holding. Hydraulic chucks provide excellent clamping characteristics combined with precise concentricity. Furthermore, they enable a simple and fast tool change, with the assistance of a special extraction key.
Turning the pressure screw generates sufficient pressure in the pressure chamber resulting in an elastic deformation of the clamping bush, providing powerful tool clamping and precise concentricity. A safe and powerful fit is guaranteed. If reduction bushes are applied that are able to hold varying tool diameters, the tool application may be extended without problem. If such bushes are not applied, it is essential to observe the minimum clamping length!

A summary of the advantages:
- precise tool clamping with a maximum 3 µm deviation from concentricity
- transmission of high torque through (excellent clamping) optimised bush clamping system
- high speed compatibility (no centrifugal forces from clamping segments)
- precise concentricity, therefore excellent surface qualities and dimensional accuracy of the workpiece
- rapid tool change thanks to simple operation of the clamping screw
- optimal tool life
- hydraulic cushioning has vibration absorbing effect



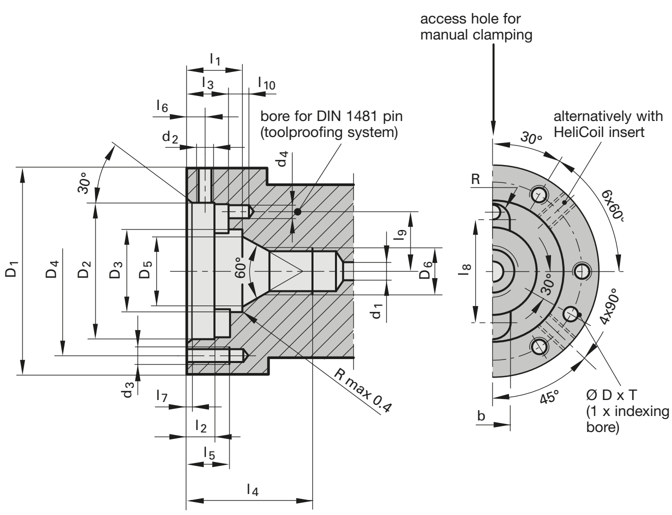


Convincing operation: the pressure medium is compressed via a screw and ensures safe positioning of the tool.

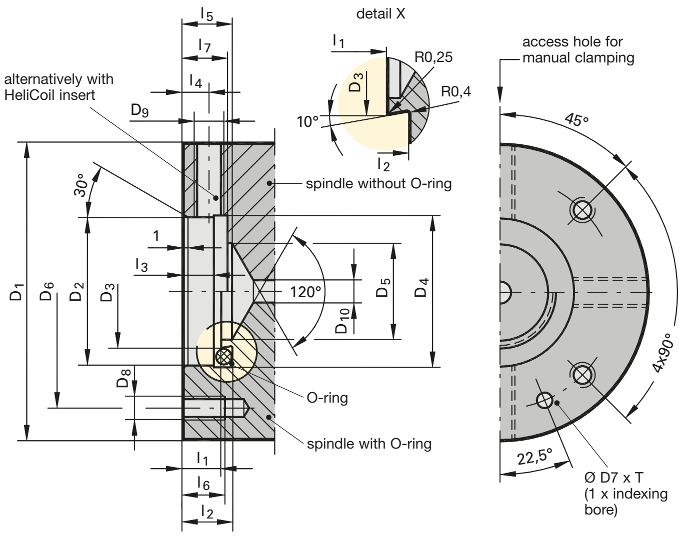
for shank-Ø in mm	**max. r.p.m. in 1/min**	max. transferable torque in Nm	min. insertion depth in mm	max. adjustment l_3 mm	max. rad. force F on chuck with 50 mm from the nose in N	operating temperature in °C	max. coolant pressure in bar
3 h6	50 000	2.5	27	7	25	20 - 50	80
4 h6	50 000	6	27	7	40	20 - 50	80
5 h6	50 000	10	27	7	65	20 - 50	80
6 h6	50 000	16	27	10	225	20 - 50	80
8 h6	50 000	26	27	10	370	20 - 50	80
10 h6	50 000	50	31	10	540	20 - 50	80
12 h6	50 000	82	36	10	650	20 - 50	80
14 h6	50 000	125	36	10	900	20 - 50	80
16 h6	50 000	190	39	10	1410	20 - 50	80
18 h6	50 000	275	39	10	1580	20 - 50	80
20 h6	50 000	310	41	10	1860	20 - 50	80
25 h6	25 000	520	47	10	4400	20 - 50	80
32 h6	25 000	770	51	10	6500	20 - 50	80

Detailed production drawing on request

Short spindle adaptor (integr.) art. no. 4385



HSK adaptor (in front) art. no. 4386/4586



Short spindle adaptor (integr.) art. no. 4385

for HSK/Code no.	D1	D2	D3	D4	D5	D6	d_1	d_2	d_3	d_4
32 24,000	40	27.0	16.7	32.0	12.5	M 10	4.0	M 3	M 3	2
40 30,000	50	33.5	20.6	40.5	16.0	M 12	5.0	M 4	M 4	3
50 38,000	63	42.0	25.5	52.0	20.0	M 16	6.0	M 5	M 5	4
63 48,000	80	55.0	33.0	66.0	25.0	M 20	8.0	M 6	M 6	4
80 60,000	100	68.0	41.0	82.0	32.0	M 24	10.2	M 8	M 8	5

Short spindle adaptor (integr.) art. no. 4385 continuation

for HSK/Code no.	clamping depth l_1	l_2	l_3	l_4	l_5	l_6	l_7	l_8	l_9	l_{10}	b	R	D	T	locating pin DIN 1481
32 24,000	9.0	4.0	6.5	22	10	2.5	0.6	20.5	11.5	3.5	7.0	3.0	3.5	3.0	2 x 6
40 30,000	12.0	5.5	8.7	30	11	3.5	0.6	25.0	14.5	5.0	8.0	4.0	4.0	3.5	3 x 8
50 38,000	16.0	8.0	12.0	36	12	5.0	0.8	31.5	18.3	6.0	10.5	5.0	4.0	3.5	4 x 10
63 48,000	20.0	10.0	15.0	48	15	6.0	1.0	41.0	22.5	5.0	12.5	6.0	4.0	3.5	4 x 10
80 60,000	25.6	13.0	19.3	60	14	7.5	1.0	50.0	28.0	6.0	16.0	7.5	5.0	4.5	5 x 12

HSK adaptor (in front) art. no. 4386

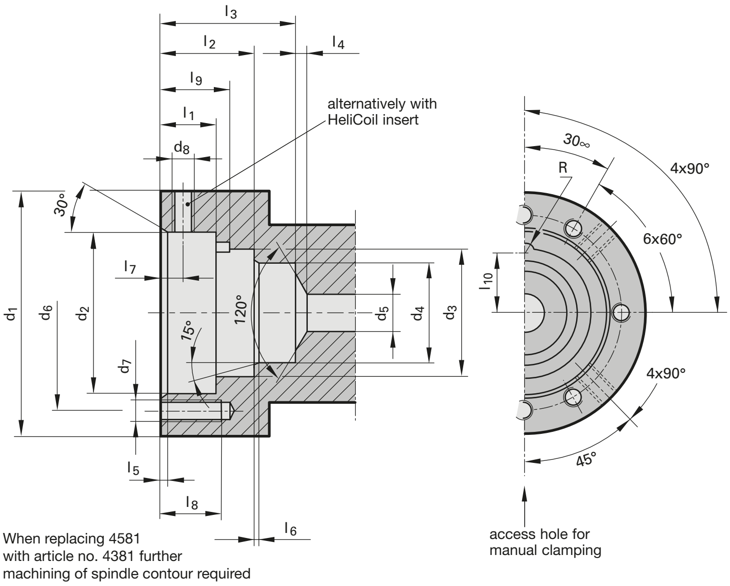
for HSK/Code no.	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	l_1	l_2	l_3	l_4	l_5	l_6	l_7	T	0-ring
25 19,000	45	23	16.5	24	–	35	–	M5	M5	3.2	8.2	9.5	6.2	4.5	–	14	9	–	16x2
32 24,000	60	30	23.5	31	–	44	5	M5	M8x1	4.0	10.3	12.4	8.3	7.0	–	11	12	3.5	23x3
40 30,000	70	35	28.5	36	22	53	5	M6	M8x1	5.0	10.3	12.4	8.3	7.0	12	14	12	3.5	28x3
50 38,000	80	40	30.5	41	26	63	5	M6	M8x1	6.0	10.3	13.3	8.3	7.0	12	14	12	3.5	30x4
63 48,000	100	50	38.5	51	34	79	5	M8	M10x1	8.0	12.3	16.1	10.3	8.0	15	15	14	3.5	38x5
80 60,000	117	60	47.5	61	38	96	6	M8	M10x1	10.2	12.3	16.1	10.3	8.0	20	15	14	4.5	47x5

HSK adaptor (in front) art. no. 4586

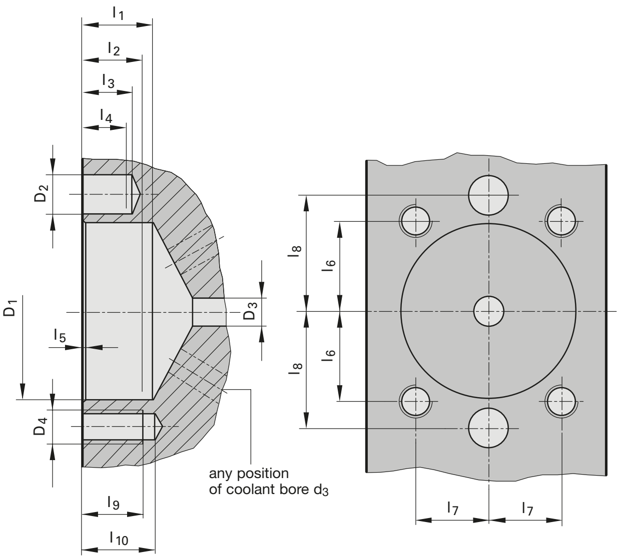
for HSK/Code no.	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	l_1	l_2	l_3	l_4	l_5	l_6	l_7	T	0-ring
40 30,000	70	35	28.5	36	22	53	5	M6	M8x1	5.0	10.3	12.4	8.3	7.0	12	14	12	3.5	28x3
50 38,000	80	40	30.5	41	26	63	5	M6	M8x1	6.0	10.3	13.3	8.3	7.0	12	14	12	3.5	30x4
63 48,000	100	50	38.5	51	34	79	5	M8	M10x1	8.0	12.3	16.1	10.3	8.0	15	15	14	3.5	38x5
80 60,000	117	60	47.5	61	38	96	6	M8	M10x1	10.2	12.3	16.1	10.3	8.0	20	15	14	4.5	47x5
100 75,000	140	80	65.0	81	53	119	6	M10	M10x1	12.0	12.3	16.1	10.3	8.0	20	18	14	4.5	45x5

Detailed production drawing on request

HSK adaptor (in front) art. no. 4581/4584



HSK adaptor (in front) art. no. 4582



HSK adaptor (in front) art. no. 4581

for HSK/Code no.	d_1	d_2	d_3	d_4	d_5	d_6	d_7	d_8	l_1	l_2	l_3	l_4	l_5	l_6	l_7	l_8
25 19,000	45	23	-	-	5	35	M5	M4	6.8	-	-	1.5	1	-	3.5	min.8
32 24,000	55	28	21.12	17	6.4	43.5	M6	M4	6	9.75	16.75	2	1	0.6	3.5	11
40 30,000	63	36	26.4	21	8	51.5	M6	M4	7	11.3	19.9	2.5	1	1	4	12
50 38,000	80	46	33	26	10	65	M8	M5	9	14.7	25.5	3	1.5	1	5	12
63 48,000	100	56	42.5	34	16	81.5	M10	M6	12	17.8	30	3.5	1.5	1	6	16
80 60,000	125	66	52.8	42	16	103	M12	M8	14	22.7	39.8	4	2	1.5	8	16
100 75,000	160	86	66	53	20	130	M16	M10	16	27.4	49	4.5	2	2	10	16

HSK adaptor (in front) art. no. 4584

for HSK/Code no.	d_1	d_2	d_3	d_4	d_5	d_6	d_7	d_8	l_1	l_2	l_3	l_4	l_5	l_6	l_7	l_8	l_9	l_{10}	R
32 24,000	40	27.0	21.12	17	6.4	32.0	M 3	M 4	8.8	14.80	21.75	2.0	1.0	0.6	3.5	10.0	11.9	10.10	2.0
40 30,000	50	33.5	26.40	21	8.0	40.5	M 4	M 4	11.0	18.85	27.40	2.5	1.0	1.0	4.0	12.0	13.9	12.40	2.0
50 38,000	63	42.0	33.00	26	10.0	52.0	M 5	M 5	15.0	24.75	35.50	3.0	1.5	1.0	5.0	12.0	18.4	15.50	2.5
63 48,000	80	55.0	42.50	34	16.0	66.0	M 6	M 6	17.9	30.35	42.50	3.5	1.5	1.0	6.0	16.0	23.9	20.00	3.0
80 60,000	100	68.0	52.80	42	16.0	82.0	M 8	M 8	24.3	40.25	57.30	4.0	2.0	1.5	8.0	16.0	32.9	24.80	3.5
100 75,000	125	88.0	66.00	53	20.0	106.0	M10	M10	34.4	54.45	76.00	4.5	1.5	2.0	10.0	16.0	42.4	31.40	4.5

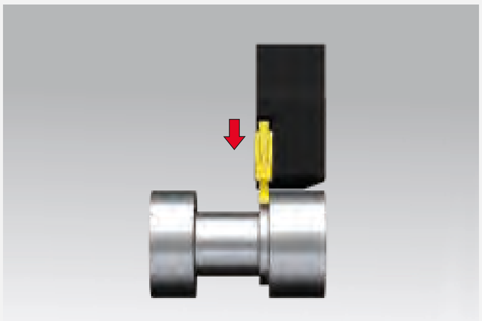
HSK adaptor (in front) art. no. 4582

for HSK/Code no.	d_1	d_2	d_3	d_4	l_1	l_2	l_3	l_4	l_5	l_6	l_7	l_8	l_9	l_{10}
50 38,000	50	7.95	10	M10	20.55	20	15	11	1	27.44	19.22	33.5	20	25
63 48,000	63	14.00	10	M12	25.00	21	18	16	1	31.70	26.00	41.0	22	26

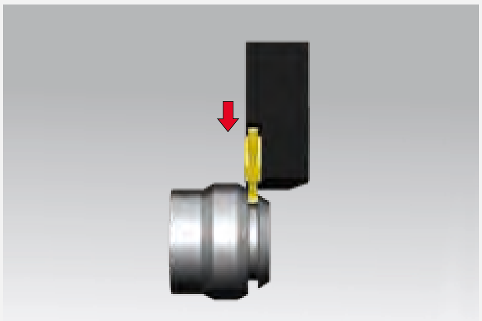
Grooving tools

GÜHRING

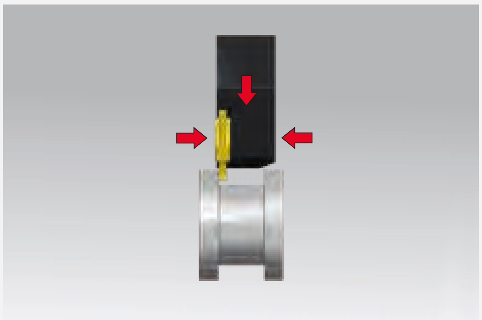
General machining tips



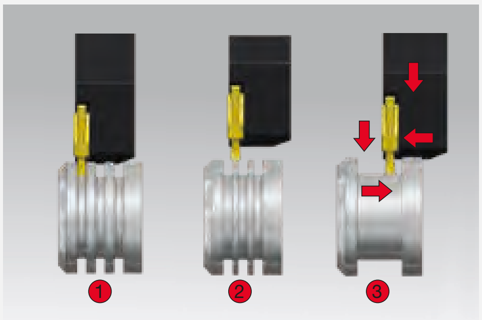
Width of machining should be min. 70%
of the width of the cutting edge



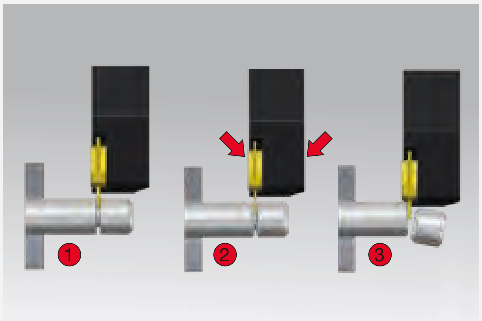
Reduce feed by 20 – 50% when grooving
on inclined faces



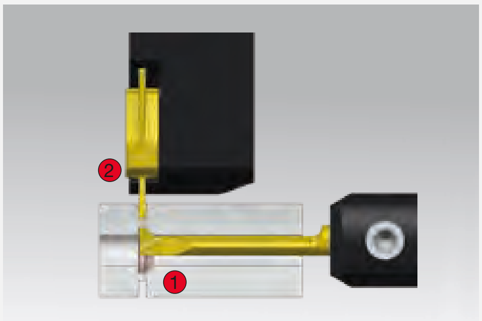
Recessing
- radial stroke
- turning in axial direction
- leave axial and radial stock for finishing



Our hint for clever recessing:
1 – (pre)-grooving „comb“
2 – removing remaining webs
width of the webs max: width of insert b – 2 x r
3 - finishing



Our hint for clever parting:
1 – (pre)-grooving
2 – chamfering
3 - parting off



Our hint for clever parting with bore in centre:
1 – (pre)-grooving with tool type GV104
2 – parting off with tool type GZ305

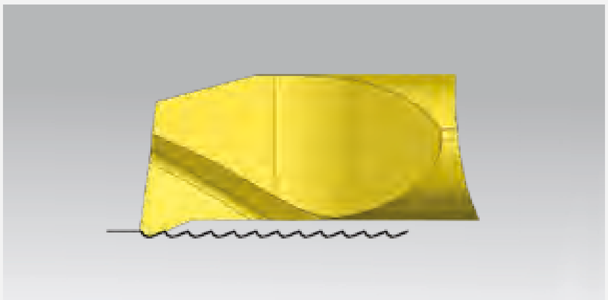
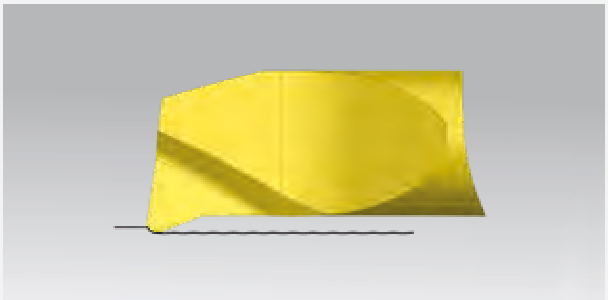
General application hints

Solution

Subject		Feed	Feed at centre	Cutting speed	RH/LH edge orientation	Corner radius	Wiper	Width of groove	Tool clamping	Workpiece clamping	Tool overhang	Centre height of cutting edge	Coolant
Related to wear	Edge chipping	⬇	⬇			⬆			🔍	🔍	🔍	🔍	
	Build up edge			⬆									👍
	Flank wear	🔍	⇩	⬇		⬆						🔍	👍
	Plastic deformation	⇩	⇧	⬇		⬆							👍
Related to the component	Vibrations	⇧		⇩		⇩		⬇	🔍	🔍	⇩	🔍	
	Burrs		⬇		👍	⬇						🔍	👍
	Surface	⬇	⇩	⇧		⇧	👍	⇧	🔍	🔍	⇩	🔍	👍
	Long chips (no chip breakage)	⬆		⇧									👍
	(too) short chips, compressed chips	⬇											

- ⬇ decrease values (large impact)
- ⬆ increase values (large impact)
- ⇩ decrease values (low impact)
- ⇧ increase values (low impact)
- 🔍 check
- 👍 apply

Application hints for the cutting insert GJ104/106/108 with wiper geometry

Without wiper geometry	With wiper geometry
	

The wiper geometry offers multiple options

- You retain the feed rate of the cutting insert without wiper geometry and achieve a considerably better surface finish.
- You increase the feed rate taking the entire process (material, chip formation, stability) into consideration and achieve the following improvements:
- reduced machining time
- therefore reduced engagement of the tool, improving tool life
- improved chip formation/chip breakage
- thicker chip enables better heat dissipation

Please note the following carefully!
The cutting insert/holder must be positioned axially parallel to optimize the wiper.
This is the only way the wiper geometry can achieve its desired effect to improve the surface finish.

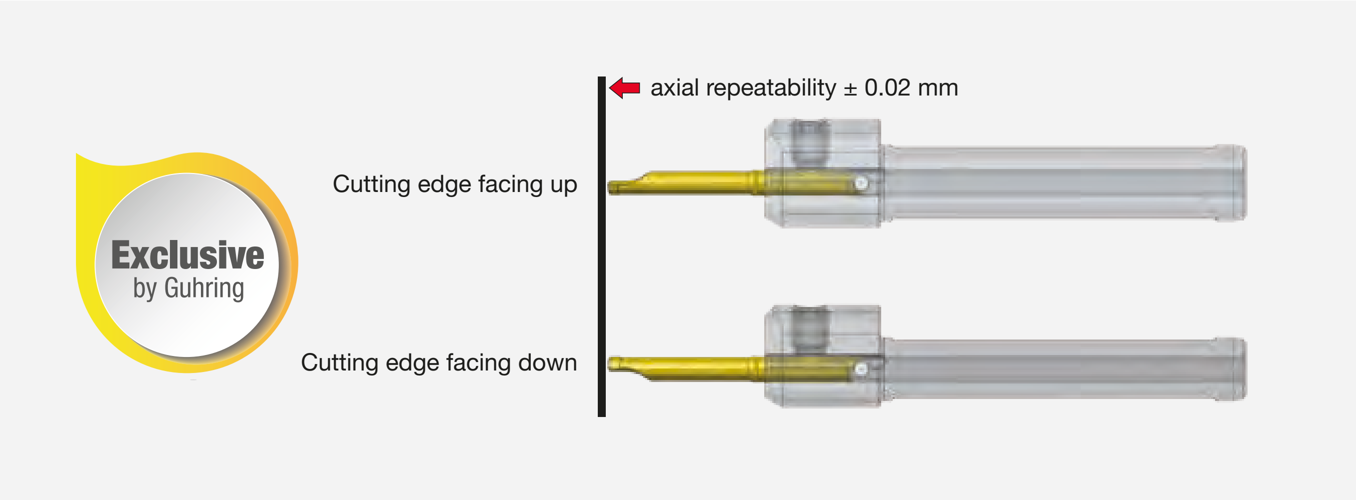
General formulas to determine the surface finish quality

$R_{th} = f^2 / 8 \cdot r$	$r = f^2 / 8 \cdot R_{th}$	$f = \sqrt{8 \cdot r \cdot R_{th}}$

Application example

Application: Boring out Ø 4 mm		Tool selection		Customer benefit
Component:	Sleeve	System:	104	Rz 5-8 ųm was achieved with a cutting insert without wiper. With a wiper cutting insert Rz values could be improved to 2-4 ųm. In the 2nd step vc was increased to 130 m/min. This resulted in a further surface finish improvement.
Material:	42CrMo4	Holder:	GB104.0016.075.00.15.N.IK	
	1.7225	Insert:	GJ104.2337.020.17.40.R	
Machine:	Spinner		TiAln nanoA	
Cooling:	20 bar			
Operat. step:	Finishing			
vc:	90 m/min			
f:	0.08 mm			
ap:	0.15			
Groov. depth:	-			

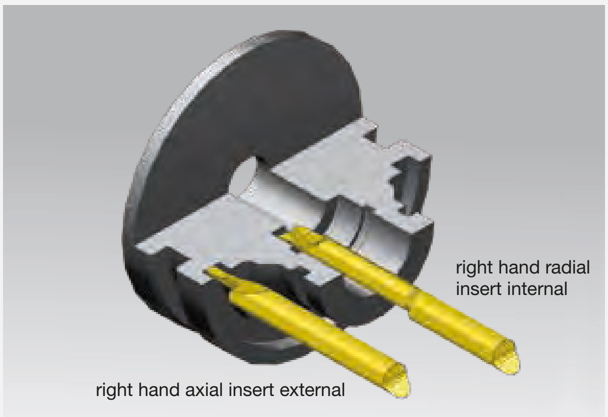
System 104/106/108/110
Positioning and clamping



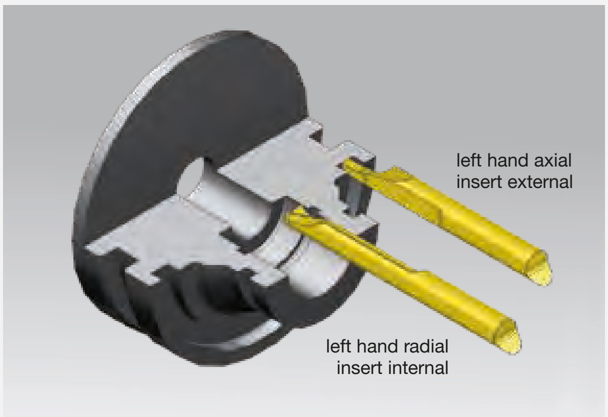
Guhring´s system 104/106/108/110 is unique in terms of insert positioning and clamping: The position between cutting edge facing up and cutting edge facing down can be changed by keeping the same length position without loosening the holder.

Definition of the cutting edge position

Main spindle clockwise



Main spindle counter clockwise

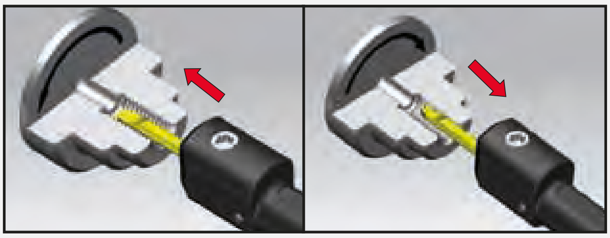


Internal threading
System GG104/GG106/GG108

		Recommended number of cuts with internal threading						
Pitch/P		**Steel materials (tensile strength in N/mm²)**			**Stainless steel**	**Cast iron**	**Heat-resistant alloys**	**Aluminium**
mm	Gg/“	400-700	700-1150	> 1150				
0.3		3	4	5	5	3	5	3
0.5	48	5	6	8	8	5	8	5
0.8	32	7	8	9	9	7	9	7
1	24	8	9	10	10	8	10	8
1.25	19	10	11	12	12	10	12	10
1.5	16	12	13	15	15	12	15	12
1.75	14	14	15	18	18	14	18	14
2	11	16	17	20	20	16	20	16
3	8	22	24	30	30	22	30	22

Feed direction internal threading

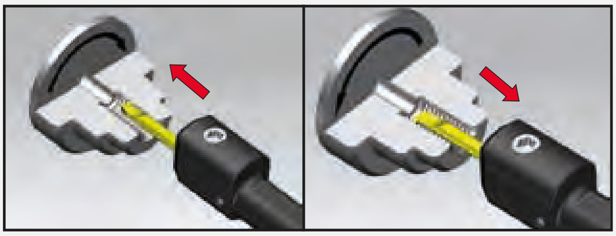
Right-hand thread



Insert: Right-hand design
Direction of rotation: Clockwise
M3 turning from outside in

Insert: Left-hand design
Direction of rotation: Anticlockwise
M4 turning from inside out

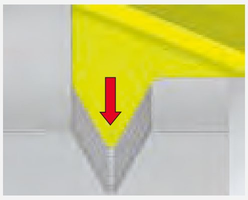
Left-hand thread



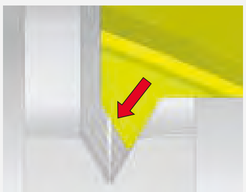
Insert: Left-hand design
Direction of rotation: Anticlockwise
M4 turning from outside in

Insert: Right-hand design
Direction of rotation: Clockwise
M3 turning from inside out

Feed process



Radial feed
- Both cutting edges engaged at the same time
- High cutting pressure and thermal load
- Especially suitable for the machining of short-chipping materials
- For the production of threads with a small pitch and small thread depth as well as multiple start depths to prevent pitch errors



One-sided flank in-feed
- Only one cutting edge engaged
- Lower cutting pressure and thermal load
- Especially suitable for the machining of long-chipping materials
- Achieving a higher surface finish quality at the respective thread flank

Reciprocal flank in-feed
- Both cutting edges alternately engaged
- Lower cutting pressure and thermal load
- Especially suitable for the machining of long-chipping materials
- Achieving a higher surface finish quality at the flanks

Internal threading
System GG104/GG106/GG108

Pre-drill-diameters for metrical threads						
Regular pitch thread				Fine pitch thread		
Nominal-Ø	Pitch mm	Pre-drill-Ø* full profile mm	Pre-drill-Ø partial profile mm	Nominal-Ø	Pitch mm	Tapp. size hole Ø partial profile mm
M 2	0.40	1.50	1.60	M 2	0.20	1.80
M 2.5	0.45	1.85	2.05	M 2.5	0.35	2.15
M 3	0.50	2.40	2.50	M 3	0.35	2.65
M 4	0.7	3.10	3.30	M 3.5	0.35	3.15
M 4.5	0.75		3.75	M 4	0.50	3.50
M 5	0.80	4.00	4.20	M 4.5	0.50	4.00
M 6	1.00		5.00	M 5	0.50	4.50
M 8	1.25		6.80	M 5.5	0.50	5.00
M 10	1.5		8.5	M 6	0.75	5.25
M 12	1.75		10.25			

*max. allowance (ap) in core diameter = 0.2 mm

Application example

Application: Internal thread		Tool selection		Customer benefit
Component:	Threaded sleeve	System:	106	Guhring's cutting insert leads to considerably less manual re-working. The customer saves time and money.
Material:	TiAl 6 V 4	Holder:	GB106.0016.090.00.22.N.IK	
	3.7165	Insert:	GG106.TM08.125.22.68.R	
Machine:	Mazak Nexus 200			
Cooling:	12 bar			
Operat.step:	Threading			
vc:	25 m/min			
f:	Pitch			
ap:				
Groov. depth:				

Broaching
System GN104 and GN106

General hints

Please align the tool accurately.
The alignment surface on the tool holder GB104/106 is a great help.

Application instructions

- With blind holes a run-out groove / undercut or cross hole must be at the groove end to allow chip evacuation
- As a general rule the delivery of coolant (soluble or neat oil) helps the broaching process. It allows chips to be flushed out of the hole as well as increasing the surface finish quality of the slot and tool life.
- On the return stroke the tool must travel completely out of the slot.
- Pay attention to the feed Ø when programming the first stroke (load on the cutting corners).

Calculating the feed diameter Ø d1 for the first stroke

Example: Hole-Ø: 8 mm
Groove width: 5 mm
Safety distance between cutting corners and workpiece-Ø: 0,15 mm

r = radius workpiece (hole-Ø 8/2) = 4
b = Cutting edge / 2 (5/2) = 2,5

Feed radius = $\sqrt{r^2 - b^2}$ - safety distance

Feed radius = $\sqrt{4^2 - 2{,}5^2}$ - 0,15 = 2,97

Feed diameter Ø d1 = 2.97 x 2 = Ø 5.94

The feed diameter for the first stroke in the machining example above is Ø 5.94

Feed and feed rate

- The feed per stroke is dependent on the tensile strength of the material to be machined.
- The feed rate when broaching corresponds to the cutting speed and is controlled by the Z-axis of the machine.
- Achievable speeds are partly limited by the machine conditions.

	Tensile strength (N/mm²)					
	300	**400**	**600**	**800**	**1000**	**1200**
Feed rate (mm/min)	10000	8000	7000	6000	5000	4000
Feed per stroke (mm)	0.1	0.08	0.07	0.06	0.05	0.04

* Values are for guidance only. The machine condition, rigidity of component clamping as well as the workpiece material influence the cutting parameters.

Broaching
System GN104 and GN106

Sequence of machining

Broaching square profile:
- The broaching inserts generate a 90° corner
- The component must be repositioned 4 times each 90° to complete the square profile

Broaching hexagon profile:
- The broaching inserts generate a 60° corner
- The component must be repositioned 6 times each 60° to complete the hexagon profile

Broaching Torx profile:
- The broaching inserts generate one section of the torx profile
- The component must be repositioned 6 times each 60° to complete the torx profile

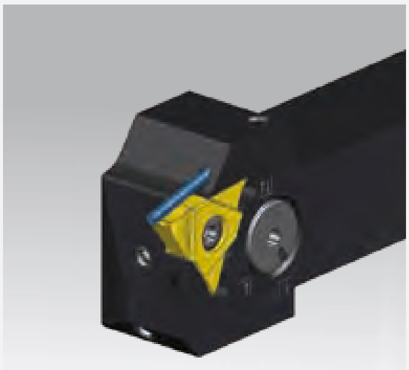
Application example

Application: Hexagon broaching		Tool selection		Customer benefit
Component:	Sleeve	System:	106 Special tool	The current process required a high amount of manual rework. Also the tool life was low. With the Guhring tool the customer achieves a very good surface with high tool life. Also there is no more manual rework required.
Material:	X 10 CrNiS 18 9	Holder:	GB106.0025.075.00.22.S.IK	
	1.4305	Insert:	Special insert	
Machine:	Spinner TC 65		TiAlN nanoA	
Cooling:	20 bar			
Operat. step:	Semifinishing & fnishing			
vc:	-			
f:	3200 mm			
ap:	0,06			
Groov. depth:	SW 9.3 (special)			

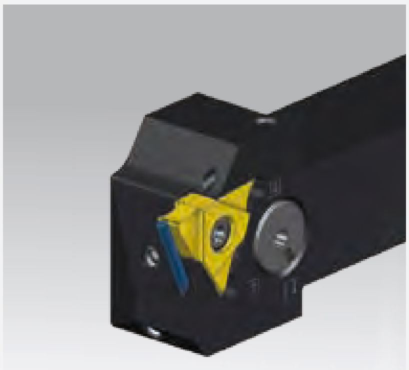
Application hints for holder GH305...EST with adjustable coolant supply

Exklusiv bei Gühring

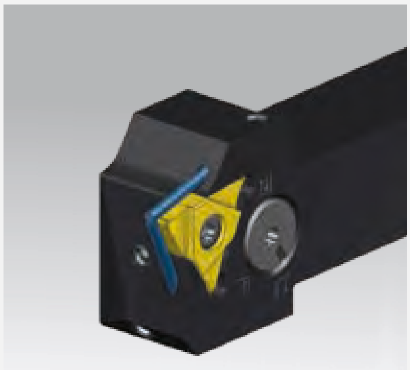
The adjustable valve directs the coolant to the cutting edge as follows:



Coolant supply directed to the rake face



Coolant supply directed to the clearance face



Coolant supply directed to both spots

The GH305 . . . EST is Guhring´s patent pending grooving holder with internal coolant.

What makes it worth the effort?

- You can optimally provide your process with coolant even at low coolant pressure:
  - first choice is the coolant supply to the rake face
  - if chips interfere or prevent coolant delivery, the temperature can be effectively controlled by cooling the clearance face.
- With high coolant pressure we recommend cooling from both coolant holes:
  - cooling the rake face can positively influence chip fracture
  - clerance face coolant additionally maintains the temperature of the cutting edge

Application example

Application: External grooving radial		Tool selection		Customer benefit
Component:	Piston	System:	305	Guhring´s precision ground insert offers more tool life than the just sintered product of the competitor. Additionally the customer reported better chip formation as well as improved surface quality.
Material:	17 CrNiM0 6	Holder:	GH305.2020.125.00.04.R.IK.EST	
	1.6587	Insert:	GE305.0200.020.BA.04.N	
Machine:	Mazak Quick Turn Smart 200			
Cooling:	20 bar			
Operat. step:	groov. 58 HRC, 0.8mm case d.			
vc:	40 m/min			
f:	0.06 mm			
ap:				
Groov. depth:	3 mm			

Conversion Table Inch-Millimeter from 1/64 to 11 63/64

Size (Inch)	mm	Part of Inch (decimal))
-	0.10	0.0039
97	0.15	0.0059
96	0.16	0.0063
95	0.17	0.0067
94	0.18	0.0071
93	0.19	0.0075
92	0.20	0.0079
91	0.21	0.0083
90	0.22	0.0087
89	0.23	0.0091
88	0.24	0.0095
-	0.25	0.0098
87	0.25	0.0100
	0.26	0.0102
86	0.27	0.0105
	0.27	0.0106
85	0.28	0.0110
	0.29	0.0114
84	0.29	0.0115
-	0.30	0.0118
83	0.30	0.0120
82	0.32	0.0125
	0.32	0.0126
81	0.33	0.0130
80	0.34	0.0135
79	0.37	0.0145
1/64	0.40	0.0156
78	0.41	0.0160
77	0.46	0.0180
-	0.50	0.0197
76	0.51	0.0200
75	0.53	0.0210
74	0.57	0.0225
-	0.60	0.0236
73	0.61	0.0240
72	0.64	0.0250
71	0.66	0.0260
-	0.70	0.0276
70	0.71	0.0280
69	0.74	0.0292
-	0.75	0.0295
68	0.79	0.0310
1/32	0.79	0.0313
-	0.80	0.0315
67	0.81	0.0320
66	0.84	0.0330
65	0.89	0.0350
-	0.90	0.0354
64	0.91	0.0360
63	0.94	0.0370
62	0.97	0.0380
61	0.99	0.0390
-	1.00	0.0394
60	1.02	0.0400
59	1.04	0.0410
58	1.07	0.0420
57	1.09	0.0430
56	1.18	0.0465
3/64	1.19	0.0469
	1.20	0.0472
	1.25	0.0492
	1.30	0.0512
55	1.32	0.0520
54	1.40	0.0550
	1.45	0.0571
	1.50	0.0591
53	1.51	0.0595
	1.55	0.0610
1/16	1.59	0.0625
	1.60	0.0630
52	1.61	0.0635
	1.65	0.0650

Size (Inch)	mm	Part of Inch (decimal))
51	1.70	0.0670
	1.75	0.0689
50	1.78	0.0700
	1.80	0.0709
49	1.85	0.0730
	1.90	0.0748
48	1.93	0.0760
	1.95	0.0768
5/64	1.98	0.0781
47	1.99	0.0785
-	2.00	0.0787
	2.05	0.0807
46	2.06	0.0810
45	2.08	0.0820
	2.15	0.0846
44	2.18	0.0860
43	2.26	0.0890
42	2.37	0.0935
3/32	2.38	0.0938
41	2.44	0.0960
40	2.50	0.0980
39	2.53	0.0995
38	2.58	0.1015
37	2.64	0.1040
36	2.71	0.1065
7/64	2.78	0.1094
35	2.79	0.11
34	2.82	0.111
33	2.87	0.113
	2.90	0.1142
32	2.95	0.116
-	3.00	0.1181
31	3.05	0.12
1/8	3.18	0.125
30	3.26	0.1285
	3.30	0.1299
29	3.45	0.136
	3.50	0.1378
28	3.57	0.1405
9/64	3.57	0.1406
27	3.66	0.144
26	3.73	0.147
	3.75	0.1476
25	3.80	0.1495
24	3.86	0.152
23	3.91	0.154
5/32	3.97	0.1562
22	3.99	0.157
-	4.00	0.1575
21	4.04	0.159
20	4.09	0.161
	4.20	0.1654
19	4.22	0.166
18	4.31	0.1695
11/64	4.37	0.1719
17	4.39	0.173
16	4.50	0.177
15	4.57	0.18
14	4.62	0.182
13	4.70	0.185
3/16	4.76	0.1875
12	4.80	0.189
11	4.85	0.191
10	4.91	0.1935
9	4.98	0.196
-	5.00	0.1968
8	5.05	0.199
7	5.11	0.2010
13/64	5.16	0.2031
6	5.18	0.2040
5	5.22	0.2055
	5.25	0.2067

Size (Inch)	mm	Part of Inch (decimal))
4	5.31	0.2090
3	5.41	0.213
	5.50	0.2165
7/32	5.56	0.2188
2	5.61	0.221
1	5.79	0.228
A	5.94	0.234
15/64	5.95	0.2344
-	6.00	0.2362
B	6.05	0.238
C	6.15	0.242
D	6.25	0.246
1/4	6.35	0.25
E	6.35	0.25
	6.50	0.2559
F	6.53	0.257
G	6.63	0.261
17/64	6.75	0.2656
	6.75	0.2657
H	6.76	0.266
I	6.91	0.272
-	7.00	0.2756
J	7.04	0.2772
K	7.14	0.281
9/32	7.14	0.2812
L	7.37	0.29
M	7.49	0.2949
	7.50	0.2953
19/64	7.54	0.2969
N	7.67	0.3020
	7.75	0.3051
5/16	7.94	0.3125
-	8.00	0.315
O	8.03	0.316
P	8.20	0.323
21/64	8.33	0.3281
Q	8.43	0.332
	8.50	0.3346
R	8.61	0.339
11/32	8.73	0.3438
	8.75	0.3445
S	8.84	0.348
-	9.00	0.3543
T	9.09	0.358
23/64	9.13	0.3594
U	9.35	0.368
	9.50	0.374
3/8	9.53	0.375
V	9.56	0.377
W	9.80	0.386
25/64	9.92	0.3906
-	10.00	0.3937
X	10.08	0.397
Y	10.26	0.4040
13/32	10.32	0.4062
Z	10.49	0.413
	10.50	0.4134
27/64	10.72	0.4219
-	11.00	0.4331
7/16	11.11	0.4375
	11.50	0.4528
29/64	11.51	0.4531
15/32	11.91	0.4688
-	12.00	0.4724
31/64	12.30	0.4844
	12.50	0.4921
1/2	12.70	0.50
-	13.00	0.5118
33/64	13.10	0.5156
17/32	13.49	0.5312
	13.50	0.5315
35/64	13.89	0.5469

Size (Inch)	mm	Part of Inch (decimal))
-	14.00	0.5512
9/16	14.29	0.5625
	14.50	0.5709
37/64	14.68	0.5781
-	15.00	0.5906
19/32	15.08	0.5938
39/64	15.48	0.6094
	15.50	0.6102
5/8	15.88	0.625
-	16.00	0.6299
41/64	16.27	0.6406
	16.50	0.6496
21/32	16.67	0.6562
-	17.00	0.6693
43/64	17.07	0.6719
11/16	17.46	0.6875
	17.50	0.689
45/64	17.86	0.7031
-	18.00	0.7087
23/32	18.26	0.7188
	18.50	0.7283
47/64	18.65	0.7344
-	19.00	0.748
3/4	19.05	0.75
49/64	19.45	0.7656
	19.50	0.7677
25/32	19.84	0.7812
-	20.00	0.7874
51/64	20.24	0.7969
	20.50	0.8071
13/16	20.64	0.8125
-	21.00	0.8268
53/64	21.03	0.8281
27/32	21.43	0.8438
	21.50	0.8465
55/64	21.84	0.8594
-	22.00	0.8661
7/8	22.23	0.875
	22.50	0.8858
57/64	22.62	0.8906
-	23.00	0.9055
29/32	23.02	0.9062
59/64	23.42	0.9219
	23.50	0.9252
15/16	23.81	0.9375
-	24.00	0.9449
61/64	24.21	0.9531
	24.50	0.9646
31/32	24.61	0.9688
-	25.00	0.9843
63/64	25.00	0.9844
1	25.40	1.00

Conversion Table TPI-Millimeter

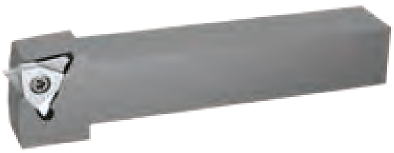
Number of pitches per inch	pitch inch	pitch mm
127	0,00787	0,200
120	0,00833	0,212
112	0,00893	0,227
101,6	0,00984	0,250
100	0,01000	0,254
96	0,01042	0,265
90	0,01111	0,282
84,67	0,01181	0,300
80	0,01250	0,318
72,57	0,01378	0,350
72	0,01389	0,353
64	0,01563	0,397
63,5	0,01575	0,400
60	0,01667	0,423
56,44	0,01772	0,450
56	0,01786	0,454
50,8	0,01969	0,500
48	0,02083	0,529

Number of pitches per inch	pitch inch	pitch mm
44	0,02273	0,577
42,33	0,02362	0,600
40	0,02500	0,635
36,29	0,02756	0,700
36	0,02778	0,706
34	0,02941	0,747
33,87	0,02952	0,750
32	0,03125	0,794
31,75	0,03150	0,800
30	0,03333	0,847
28,22	0,03544	0,900
28	0,03571	0,907
27	0,03704	0,941
26	0,03846	0,977
25,4	0,03937	1,000
24	0,04167	1,058
22	0,04545	1,155
20,32	0,04921	1,250

Number of pitches per inch	pitch inch	pitch mm
20	0,05000	1,270
19	0,05263	1,337
18	0,05556	1,411
16,93	0,05907	1,500
16	0,06250	1,588
14,51	0,06892	1,751
14	0,07143	1,814
13	0,07692	1,954
12,7	0,07874	2,000
12	0,08333	2,117
11,50	0,08696	2,209
11	0,09091	2,309
10,16	0,09843	2,500
10	0,10000	2,540
9	0,11111	2,822
8,47	0,11806	2,999
8	0,12500	3,175
7,26	0,13774	3,499

Number of pitches per inch	pitch inch	pitch mm
7	0,14286	3,629
6,35	0,15748	4,000
6	0,16667	4,233
5,64	0,17730	4,504
5,08	0,19685	5,000
5	0,20000	5,080
4,62	0,21645	5,498
4,5	0,22222	5,644
4,23	0,23641	6,005
4	0,25000	6,350
3	0,33333	8,467
2	0,50000	12,700

Application examples



External radial grooving

Application: External radial grooving		Tool selection		Customer benefit
Component:	Shaft	System:	305	Instantly, Guhring's insert with three cutting edges convinced with good chip evacuation and longer tool life.
Material:	C60	Holder:	GH305.2020.125.00.04.R	
	1.0601	Insert:	GE305.0130.000.BA.04.N	
Machine:	Gildemeister CTX410			
Cooling:	External cooling, 10 bar			
Oper. step:	Grooving to 1.4 mm			
vc:	100 m/min			
f:	0.15 mm			
ap:				
Groov. depth:	0.7 mm			

External radial grooving

Application: External radial grooving		Tool selection		Customer benefit
Component:	Shaft	System:	305	The change from external cooling to a Guhring holder with internal cooling resulted in a considerably longer tool life. There is one tool change less per shift and 25 more components can be manufactured per shift.
Material:	Ck50	Holder:	GH305.2020.125.00.04.R.IK	
	1.1206	Insert:	Special grooving insert b 2.72 mm	
Machine:	Gildemeister CTX420			
Cooling:	10 bar			
Oper. step:	Grooving to b 2.72 mm			
vc:	10 m/min			
f:	0.08 mm			
ap:				
Groov. depth:	1.3 mm			

Axial grooving

Application: Axial grooving		Tool selection		Customer benefit
Component:	Adapter sleeve	System:	106	Under the same application conditions, the Guhring tool instantly achieves 50% more components. Therefore, there is much improvement potential in this application in order to increase cutting speed and feed rate to save time.
Material:	16 MnCr 5	Holder:	GB106.0020.040.00.22.N.IK.CIT	
	1.7139	Insert:	GA106.0200.015.17.60.R	
Machine:	Citizen A20			
Cooling:	Neat oil, 80 bar			
Oper. step:	Semi-finishing			
vc:	100 m/min			
f:	0.02 mm			
ap:	D1 7.5 mm/D2 12.6 mm			
Groov. depth:	2.9 mm			

2024

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