# zeus<sup>®</sup> Knurling Tools



www.dieterle-tools.com





Knurling process	4
Tool characteristics	5
Tool selection	6
zeus form knurling tools	8
zeus form knurling tools RD1	9
zeus form knurling tools RD2	12
zeus form knurling tools RD3	16
zeus form knurling tools sets	18
zeus cut knurling tools	20
zeus cut knurling tools RF1	21
zeus cut knurling tools RF2	22
zeus cut knurling tool RF3	23
zeus cut knurling tools sets	24
zeus special tools and interfaces	26
zeus knurling wheels	34
Profiles and knurling pitches	35
Form knurling – non-cutting process	36
Cut knurling – cutting process	38
Special knurling wheels	39
Brunishing rolls	40
Features	41
Technology	42
Process characteristics	43
Wheel geometries	44
Conversion to inches	45
Material displacement – non-cutting forming	46
Reference values for cutting speed and feed rate	47
Optimization of knurling	48
Influencing factors	50
-	

# Our product range

offers tool solutions for the diverse applications of knurling technology. In addition to standard profiles, zeus knurling tools can also be used to manufacture conical, convex, concave and special profiles (e.g. bead knurling).

The example below shows the most important manufacturing applications.

	Application	Profile (DIN 82) Marking	Tool Examples	Knurling wheels/ marking rolls
	Cut knurling, axial	RGE30°	291	3 x AA
	Cut knurling, axial	RGE45°	241	1 x BL15° 1 x BR15°
	Cut knurling, axial	RAA	231	1 x BR30°
	Form knurling, radial	RKV	131	1 x KE
	Form knurling, radial	RKE	132	1 x KV
	Form knurling, radial	RGE45°	141	1 x BL45° 1 x BR45°
	Form knurling, radial + axial up to a shoulder	RAA	162	2 x AA
	Perl radial	RHE	131	1 x HV
	Form knurling, radial	RE	131	1 x C
	Form knurling, radial	RC	131	1 x E
	Form knurling radial	RKAA	311	1 x KAA
	Form knurling, axial	RAA-face	311	1 x AA
THE PARTY OF THE P	Form knurling	RKGV	311	1 x KGE
SELLO ZONE	Continuous roll marking	zeus	130	40 W
Whatimet acitor in	Spring return marking	hommel+keller.de	431	41 W
	The profiles with 45° are st but not defined in DIN 403	andard on Hommel+Keller and DIN 82.	r Präzisionswerkzeuç	ge GmbH

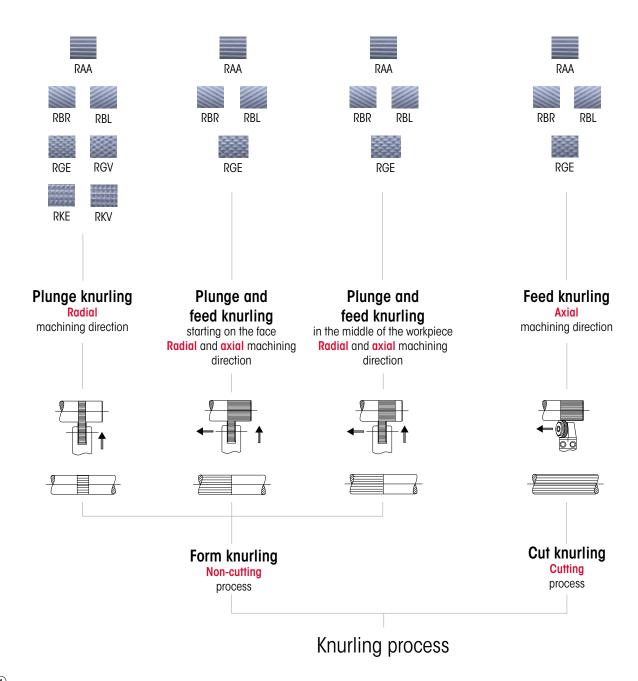
# Knurling process

Knurling technology is divided into two processes: form knurling and cut knurling. Both processes have their special applications and areas of utilisation.

A basic difference in the two marking technologies is the possible direction of machining and the capability of manufacturing knurling profiles on the workpiece.

For more details on manufacturing the individual profiles see the tool view.

# Possible knurling profiles on the workpiece



# Tool characteristics



# Different characteristics based on machine types and machine properties

Knurling tools for CNC lathes/ automatic lathes	Knurling tools for conventional lathes/ automatic lathes	Knurling tools for Swiss-type lathes/ automatic lathes	Knurling tools for axial machining
The knurling tools for CNC lathes/automatic lathes features an integrated centre height (centre height = top edge of shank). This makes it possible to use them in CNC lathes/automatic lathes without the capability of adjustment (fixed tool holder) of the centre height. In general, these knurling tool series are also suitable for conventional lathes/automatic lathes as long as the centre height can be adjusted on the machine.	Knurling tools from zeus for conventional machine types are designed so that the centre height must be adjusted by the tool holder in the machine. This results in a simplified design of these knurling tools.	In the case of knurling tools that are suitable for Swiss-type lathes/automatic lathes, the knurling wheel must not protrude beyond the front edge of the shank, in order to prevent collision with the guide bush.  Most knurling tools with a shank height of 10–16 mm are suitable for Swiss-type lathes/automatic lathes. In general, they can also be used in CNC lathes and conventional lathes/automatic lathes.	Knurling tools for axial machining of the workpiece can be clamped axially to the workpiece on all conventional and CNC lathes/automatic lathes with a tailstock. Machining takes place by means of a rotating workpiece in a stationary tool that is mounted in the tailpiece.  On rotary indexing machines, indexing tables and automatic transfer machines, a stationary workpiece is machined by means of an axially rotating tool.
The tool holder is not height adjustable. The centre height is integrated in the tool.	The tool holder is adjustable. The centre height of the tool must be adjusted.	Guide bush	
		Centre height is integrated  View X	
The zeus product range includes special versions for (R) right- and (L) left-oriented lathes/automatic lathes.  If the construction allows, zeus knurling tools are available in a modular (M) or universal (U) design. The (M) versions can be converted from counterclockwise to clockwise rotation by simply turning the knurling head. The (U) versions can be used for both clockwise and counterclockwise rotation without conversion.	Knurling tools from zeus for conventional machine types are designed for universal use and can therefore be used with both clockwise and counterclockwise rotation.	In the case of Swiss-type lathes/automatic lathes the knurling wheel should be positioned as close to the workpiece clamping as possible to allow machining of workpieces with small diameters. The knurling wheels of the zeus RD1 and RD2 series with shank dimensions of 10 x 10 to 16 x 16 are therefore offset instead of centred.	Machining possibilities:  • Tool is stationary  • Workpiece rotates  • Direction of rotation is universal  • Tool rotates  • Workpiece is stationary  • Direction of rotation is universal
L = left  R = right	L = left	L = left	

# Tool selection

# Symbols:

LD = Swiss-type lathes (CNC/conventional)
KD = Automatic-short-turning lathes/universal lathes/ turning/ milling centres (CNC/conventional)

MS = Multi-spindle lathes (CNC/conventional)

RT = Rotary indexing machines/indexing tables/
automatic transfer machines

X = Process is not possible with this application

▲ = Length of knurling is limited

\* = For cut knurling RBR/RBL possible only to a limited extent

# **Explanation of arrows:**

Knurl can be manufactured in radial direction (plunge knurling) Knurl can be manufactured only in axial direction (feed knurling)

Knurl can be manufactured in both axial and radial direction



	Manufactur	ing process	Machine	Knurling on	Knurling starting	
Knurling profile (DIN 82)	Form knurling	Cut knurling	type	workpiece centre/ without plunge cut	at workpiece beginning	
RAA knurl	Mary Francis		LD	130/131/141/161	130/131/141/161/ 162▲/192▲/391	
	Knurling RAA Workpiece		KD	130/131/141/161	130/131/141/161/ 162▲/192▲/391	
	Knurling wheel AA		MS	130/131/141/161	130/131/141/161/ 162▲/192▲/391	
			RT	X	192 ▲ / 391	
		Workpiece Knurling wheel BL, swivelled 30°	LD		231	
		RAA Knurling	KD	Х	231	
		RAA Work-	MS	^	231	
		Knurling wheel BR, swivelled 30° piece	RT		X	
RBL left-hand knurl	Workpiece Knurling RBL		LD	130/131/141/161	130/131	
NDE TOTT HATTE KITATI	<u> </u>		KD	130/131/141/161	130/131	
	Knurling wheel BR		MS	130/131/141/161	130/131	
	Nitulling wheel bit		RT	X	130/131	
		Knurling wheel AA, swivelled 30°	LD		231*	
		Knurling RBL	KD	X	231*	
			MS		231*	
		Workpiece -	RT		X	
RBR right-hand knurl	Workpiece Knurling RBR		LD	130/131/141/161	130/131	
	<u> </u>		KD	130/131/141/161	130 / 131	
	Knurling wheel BL		MS	130/131/141/161	130 / 131	
	Nidilling wheel bi		RT		130 / 131	
		Knurling RBR	LD		231*	
		Workpiece	KD	X	231*	
		<b>←</b>	MS		231*	
		Knurling wheel AA, swivelled 30°/	RT		X	
RGE left/right-hand knurl/	Knurling RGE		LD	130/131/132/161		
raised points/30°	Workpiece		KD	130/131/132/161	X	
	Knurling wheel GV		MS	130/131/132/161		
			RT			
	Knurling wheel BR		LD	141/161	141/161/162/192	
	Knurling RGE		KD	141 / 161	141/161/162/192	
	Workpiece		MS	141 / 161	141/161/162/192 🛦	
	Knurling wheel BL	Knurling wheel AA,	RT		161/162/192 🛦	
		swivelled 30°	LD KD		241 / 291 🛦	
		M. Knurling RGE	MS	Х	241 / 291 ▲ 241 / 291 ▲	
		workpiece	RT		241 / 291 ▲	
		Knurling wheel AA, swivelled 30°	LD	130/131	∠7   ♣	
RGV left/right-hand knurl/	Knurling RGV		KD	130/131	RGV:	
lowered points/30°	Workpiece		MS	130/131	only plunge knurling	
	Knurling wheel GE		RT	100, 101	possible	
DIE I II	Knurling RKE		LD	130/131		
RKE cross knurl/	Kiluriling KKE		KD	130/131	RKE:	
raised points/90°	Workpiece		MS	130/131	only plunge knurling	
	Knurling wheel KV		RT	152, 101	possible	
DIO/ I!	Knurling RKV		LD	130/131		
RKV cross knurl/	Workpiece		KD	130/131	RKV:	
lowered points/90°	<del>                                    </del>		MS	130/131	only plunge knurling	
	Knurling wheel KE		RT	152, 101	possible	
	1	1	· · · · · · · · · · · · · · · · · · ·			



This matrix provides you with a selection of tool series that can be used for your application. You can use the table to define the profile, process and machine type.

Then you can choose the application based on the pictograms. Starting on page 9 you will find details of the products and tool features.















Knurling starting in centre of workpiece/after plunge cut	Knurling starting in centre of workpiece/without plunge cut	Knurling up to a shoulder	Knurling starting at workpiece beginning up to a shoulder	Conical knurling	Knurling on the front face	Knurling in a bore
130/131/141/161	130/131/141/161	132 / 142	132/142/162 ▲/192 ▲	311/312	311/312	330/332
130/131/141/161	130/131/141/161	132 / 142	132/142/162 ▲/192 ▲	311/312	311/312	330 / 332
130/131/141/161	130/131/141/161	132 / 142	132/142/162 ▲/192 ▲	311/312	311/312	330/332
<b>X</b> 231	Х	Х	162 ▲ / 192 ▲	Х	X	330/332
231 231 231	Х	Х	Х	Х	Х	Х
130 / 131 / 141 / 161	130/131/141/161	132 / 142	132/142/162 ▲/192 ▲	311/312	311/312	330/332
130/131/141/161	130 / 131 / 141 / 161	132 / 142	132/142/162 ▲/192 ▲	311/312	311/312	330/332
130/131/141/161	130/131/141/161	132 / 142	132/142/162 ▲/192 ▲	311/312	311/312	330/332
Х	Х	Х	162 ▲ / 192 ▲	Х	Х	Х
231* 231* 231* X	х	х	х	Х	х	х
130/131/141/161	130 / 131 / 141 / 161	132 / 142	132/142/162 ▲/192 ▲	311/312	311/312	330/332
130/131/141/161	130 / 131 / 141 / 161	132 / 142	132/142/162 ▲/192 ▲	311/312	311/312	330/332
130/131/141/161	130/131/141/161	132 / 142	132 / 142 / 162 ▲ / 192 ▲	311/312	311/312	330/332
			162 ▲ / 192 ▲			
231*						
231*		37		24	24	
231*	X	X	X	X	X	X
X						
		132	132			
	only plunge knurling	132	132	V		W
X	possible	132	132	X	X	X
		Х	162 ▲			
141 / 161	141/161	142	142 / 162 ▲ / 192 ▲	161 / 162		340/342
141 / 161	141/161	142	142/162 ▲/192 ▲	161 / 162	Х	340/342
141 / 161	141/161	142	142/162 ▲/192 ▲	161 / 162	Α	340/342
X	X	X	162 ▲ / 192 ▲	161 / 162		X
241						
241	Χ	X	Х	Х	Х	Х
241	A	Α	^	A	Α	A
X						
RGV:	RGV:	132	RGV:	311/312	311/312	330 / 332
only plunge knurling	only plunge knurling	132	only plunge knurling	311/312	311/312	330/332
possible	possible	132	possible	311/312	311/312	330 / 332
		X		311/312	Х	330 / 332
RKE:	RKE:	132	RKE:			330 / 332
only plunge knurling	only plunge knurling	132	only plunge knurling	Х	Х	330 / 332
possible	possible	132	possible			330 / 332
		X				330 / 332
RKV:	RKV:	132	RKV:			330 / 332
only plunge knurling	only plunge knurling	132	only plunge knurling	Х	X	330 / 332
possible	possible	132	possible			330 / 332
		X	<u> </u>			330 / 332



# Ideal for all knurling profiles



# Series 130



# Tool holder Designation Product series Shank size 16 x 16 mm For right and left use Design for knurling wheels 25x8x6 (Øxwidthxbore)

# Knurling profiles on DIN 82 workpiece:

# Plunge knurling



# Selection of knurling wheels:



### Feed knurling



# Selection of knurling wheels:

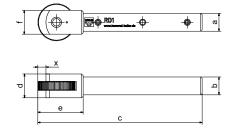


# Product features:

- Centre height must be adjusted
- Set screws in shank for clearance angle correction
- · Carbide pins

# TOOL VERSIONS:

Order ne	Order po Tool holder Wo		Dimension [mm]							Knurling wheels
Order no.	Designation	Ø [mm]	а	b	С	d	е	f	Х	(Ø x b x b) [mm]
31000759	130-10U150404-A	3-50	10	10	99	-	-	-	1.5/4	10/15 x 4 x 4
31000760	130-10U150604-A	3-50	10	10	99	14	19	-	1.5/4	10/15 x 6 x 4
31000762	130-12U150404-A	3-50	12	12	99	-	-	-	1.5/4	10/15 x 4 x 4
31000763	130-12U250606-A	8-200	12	12	110.5	16	30.5	16	3/5.5	20/25 x 6 x 6
31000764	130-12U250806-A	8-200	12	12	110.5	16	30.5	16	3/5.5	20/25 x 8 x 6
31000765	130-14U150604-A	3-50	14	14	99	-	_	_	1.5/4	10/15 x 6 x 4
31000766	130-14U250606-A	8-200	14	14	110.5	-	_	-	3/5.5	20/25 x 6 x 6
31000767	130-16U250806-A	8-200	16	16	110.5	_	_	-	3/5.5	20/25 x 8 x 6
31000768	130-20U251006-A	8-200	20	20	110.5	_	-	-	3/5.5	20/25 x 10 x 6



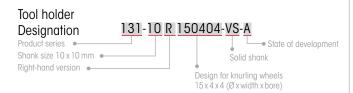




# Ideal for all knurling profiles, features exceptionally easy handling

# Series 131





# Knurling profiles on DIN 82 workpiece:

# Plunge knurling



### Selection of knurling wheels:

AA	BR	BL	GV	GE	KV	KE

### Feed knurling



# Selection of knurling wheels:



# Product features:

- All holders equipped with Click-Pin® system for fast retooling of the knurling wheels
- Set screws in shank for clearance angle correction
- Carbide pin
- Modular shank design: Shank size 10 x 10 mm optionally adaptable

### **TOOL VERSIONS:**

Order no.	Order no. Tool holder Working area					Dimension [mm]					
Designation	Ø [mm]	а	b	С	d	е		Х	` [mm] ´		
31002706	131-10R150404-VS-A	3-50	10	10	99	12	19	17.5	1.5/4	10/15 x 4 x 4	
31002707	131-12R150404-VS-A	3-50	12	12	99	12	19	19.5	1.5/4	10/15 x 4 x 4	
31002708	131-16R150404-VS-A	3-50	16	16	99	19	19	23.5	1.5/4	10/15 x 4 x 4	

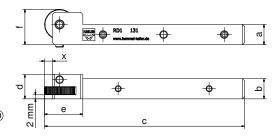
Other variants available on request

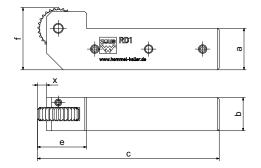
Left-hand version of all shank dimensions available on request

Order no.	Tool holder	Working area		Dimension [mm]					Knurling wheels (Ø x b x b)
	Designation	Ø[mm]	а	b	С	е	f	Х	`[mm] ´
31000714	131-20U250806-A-Z	8-200	20	20	109.5	29.5	32.5	3/5.5	20/25 x 8 x 6
31000715	131-25U250806-A-Z	8-200	25	20	109.5	29.5	37.5	3/5.5	20/25 x 8 x 6

# ADAPTER BRACKET FOR BASE SHANK 10 x 10 mm:

Order no.	Shank size [mm]
21BHR1653	12 x 12
21BHR1654	16 x 16

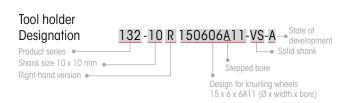












# Knurling profiles on DIN 82 workpiece:

# Plunge knurling



### Selection of knurling wheels:

		_				
AA	BR	BL	GV	GE	KV	KE

### Feed knurling



# Selection of knurling wheels:



# Product features:

- Knurling wheel fixed by means of carbide collar studs
- Set screws in shank for clearance angle correction
- Modular shank design: Shank size 10 x 10 mm optionally adaptable

# **TOOL VERSIONS:**

Order no.	Working area	Dimension [mm]						Knurling wheels (Ø x b x b)		
	Designation	Ø [mm]	а	b	С	d	е	f	Х	`[mm] ´
31002726	132-10R150606A11-VS-A	3-50	10	10	101	19	21	18	1.3	15 x 6 x 6A11
31002227	132-12R150606A11-VS-A	3-50	12	12	101	19	21	20	1.3	15 x 6 x 6A11
31002729	132-16R150606A11-VS-A	3-50	16	16	101	19	21	24	1.3	15 x 6 x 6A11

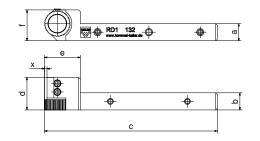
Other variants available on request

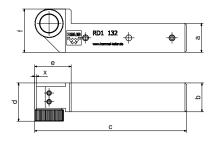
Left-hand version of all shank dimensions available on request

Order no.	Tool holder	Working area			Dime	nsion	[mm]			Knurling wheels (Ø x b x b)
	Designation	Ø [mm]	а	b	С	d	е		Х	`[mm] ´
31000742	132-20U200806A13-A	8-200	20	20	105.5	24	25.3	30	1.3	20 x 8 x 6A13
31000743	132-25U200806A13-A	8-200	25	20	105.5	24	25.3	30	1.3	20 x 8 x 6A13

# ADAPTER BRACKET FOR BASE SHANK 10 x 10 mm:

Order no.	Shank size [mm]
21BHR1653	12 x 12
21BHR1654	16 x 16









# Tool holder Designation Product series Shank size 10 x 10 mm Design for knurling wheels 10 x 4 x 4 (Ø x width x bore)

# Knurling profiles on DIN 82 workpiece:

Plunge/feed knurling



# Selection of knurling wheels:

2 x AA	2 x BR	2 x BL	1 x BL30°/	1 x BL45°/
			1 x BR30°	1 x BR45°

### Product features:

- Shank size 20 x 20 mm and 25 x 25 mm with Click-Pin® system for fast retooling of the knurling wheels
- Modular design: Tool can be used as right-hand and left-hand version
- · Knurling head with flexible centring
- Set screws in shank for clearance angle correction
- Carbide pins
- Modular shank design: Shank size 10 x 10 mm optionally adaptable

### **TOOL VERSIONS:**

Order no.	Tool holder	Working area			Dime	nsion [	mm]			Knurling wheels (Ø x b x b)
	Designation	Ø [mm]	а	b	С	d	е	f		`[mm] ´
31002702	141-10M100404-VS-A	3-25	10	10	105.5	12	25.5	21	1	10 x 4 x 4
31002703	141-12M100404-VS-A	3-25	12	12	105.5	12	25.5	22.5	1	10 x 4 x 4
31002658	141-16M150404-VS-A	6-60	16	16	119	16	39	33	1.5	15 x 4 x 4
31000741	141-16M150604-VS-A	6-60	16	16	119	16	39	33	1.5	15 x 6 x 4

# Other variants available on request

Order no.	Tool holder	Working area			Dime	nsion	[mm]			Knurling wheels (Ø x b x b)
	Designation	Ø [mm]	а	b	С	d	е	f	Х	`[mm] ´
31002704	141-20M200806-B	10-110	20	20	130	20	50	42	2.5	20 x 8 x 6
31002705	141-25M200806-B	10-110	25	20	130	20	50	46	2.5	20 x 8 x 6
31002721	141-25M250806-B	15-220	25	20	136	20	56	55	2.5	25 x 8 x 6

Tools of series 141 can be converted to series 142 and vice versa by replacing the knurling head, with a shank size of 16 x 16 mm or larger

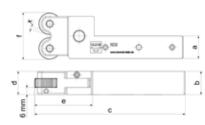
# ADAPTER BRACKET FOR BASE SHANK 10 x 10 mm:

Order no.	Shank size [mm]
21BHR1653	12 x 12
21BHR1654	16 x 16

# KNURLING HEADS 142:

Order no. Series 142	Shank size [mm]	Knurling wheels (Ø x w x b) [mm]
21BHR0532	16 x 16	15 x 6 x 6A11
21BHR0533	20 x 20	20 x 8 x 6A13











# Tool holder

Designation 142-20 M 200806A13-A

Product series State of development Stank size 20 x 20 mm Stepped bore

Design for knurling wheels 20 x 8 x 6 A13 (Ø x width x bore)

# Knurling profiles on DIN 82 workpiece:

Plunge/feed knurling



# Selection of knurling wheels

2 x AA	2 x BR	2 x BL	1 x BL30°/	1 x BL45°/
			1 x BR30°	1 x BR45°

### Product features:

- · Knurling wheels fixed by means of carbide collar studs
- Modular design: Tool can be used as right-hand and left-hand version.
   Retooling by simply turning the knurling head
- · Knurling head with flexible centring
- Set screws in shank for clearance angle correction

# **TOOL VERSIONS:**

	Tool holder	Working area			Dime	nsion	[mm]			Knurling wheels
Order no.	Designation	Ø [mm]	а	b	С	d	е	f	Х	(Ø x b x b) [mm]
31002801	142-10M150606A11-VS-A	3-40	10	10	110	19	30	30.4	1.5	15 x 6 x 6A11
31002803	142-12M150606A11-VS-A	3-40	12	12	110	19	30	30.4	1.5	15 x 6 x 6A11
31000751	142-16M150606A11-A	6-60	16	16	119	19	39	33	1.5	15 x 6 x 6A11

# Other variants available on request

	Tool holder	Working area			Dime	ension [	[mm]			Knurling wheels
Order no.	Designation	Ø [mm]	а	b	С	d			Х	(Ø x b x b) [mm]
31000752	142-20M200806A13-A	10-110	20	20	130	24	50	42	2.4	20 x 8 x 6A13
31000753	142-25M200806A13-A	10-110	25	20	130	24	50	46	2.4	20 x 8 x 6A13

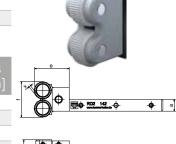
Tools of series 142 can be converted to series 141 and vice versa by replacing the knurling head, with a shank size of 16 x 16 mm or larger

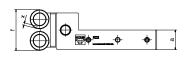
# ADAPTER BRACKET FOR BASE SHANK 10 x 10 mm:

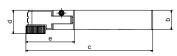
Order no.	Shank size [mm]
21BHR1653	12 x 12
21BHR1654	16 x 16

# KNURLING HEADS 141:

Order no. Series 141	Shank size [mm]	Knurling wheels (Ø x w x b) [mm]
21BHR1527	16 x 16	15 x 4 x 4
21BHR0529	16 x 16	15 x 6 x 4
21BHR1795	20 x 20	20 x 8 x 6
21BHR1796	25 x 20	25 x 8 x 6



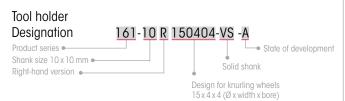




# Ideal for very small workpiece diameters, features gentle tangential profiling

# Series 161





# Knurling profiles on DIN 82 workpiece:

Plunge/feed knurling



# Selection of knurling wheels:

2 x AA	2 x BR	2 x BL	1 x BL30°/	1 x BL45°/
			1 x BR30°	1 x BR45°

### Product features:

- Knurl holder is easily adjustable to workpiece diameter by means of synchronous spindle
- Set screws in shank for clearance angle correction
- · Carbide pins with surface secured by set screw
- Modular shank design: Shank size 10 x 10 mm optionally adaptable

# **TOOL VERSIONS:**

Order no.	Tool holder	Working area				Knurling wheels (Ø x b x b)				
	Designation	Ø [mm]	а	b	С	d	е		Χ	[mm]
31002719	161-10R150404-VS-A	0-15	10	10	113.4	19.6	33.4	40	2.5	15 x 4 x 4
31002722	161-12R150404-VS-A	0-15	12	12	113.4	19.6	33.4	40	2.5	15 x 4 x 4
31002724	161-16R150404-VS-A	0-15	16	16	113.4	19.6	33.4	40	2.5	15 x 4 x 4

ı	Order no.	Tool holder	Working area				Knurling wheels (Ø x b x b)					
		Designation	Ø [mm]	а	b	С	d	е		xa		`[mm] ´
	31002127	161-20M250806	3.5-65	20	25	164.8	28.4	92.8	103	33.5	1.5	20 x 8 x 6
	31002127	101-20101250600	0-65	20	25	167.3	28.4	95.3	103	33.5	4	25 x 8 x 6

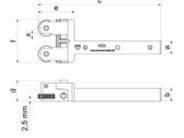
Other variants available on request Left-hand version of all shank dimensions available on request

# ADAPTER BRACKET FOR BASE SHANK 10 x 10 mm:

Order no.	Shank size [mm]
21BHR1653	12 x 12
21BHR1654	16 x 16

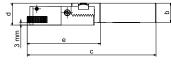
# JAWS:

Order no. Series 162	Shank size [mm]
21BHR1673	10 x 10/12 x 12/16 x 16
21BHR1214	20 x 25





\*



•

141/1/8



21BHR1214

21BHR1673





# Tool holder Designation Product series Shank size 10 x 10 mm Right-hand version Right-hand version Tool holder 150606A11-VS-A State of development development Stepped bore Design for knurling wheels 15 x 6 x 6A11 (Ø x width x bore)

# Knurling profiles on DIN 82 workpiece:

Plunge/feed knurling



# Selection of knurling wheels:

2 x AA	2 x BR	2 x BL	1 x BL30°/	1 x BL45°/
			1 x BR30°	1 x BR45°

### Product features:

- · Knurling wheels fixed by means of carbide collar studs
- Knurl holder is easily adjustable to workpiece diameter by means of synchronous spindle
- Set screws in shank for clearance angle correction
- Modular shank design: Shank size 10 x 10 mm optionally adaptable

# **TOOL VERSIONS:**

Order no.	Tool holder	Working area			Knurling wheels (Ø x b x b)					
	Designation	Ø [mm]	а	b	С	d	е	f	Х	[mm]
31002713	162-10R150606A11-VS-A	0-15	10	10	113.4	20.6	33.4	40	2.5	15 x 6 x 6A11
31002714	162-12R150606A11-VS-A	0-15	12	12	113.4	20.6	33.4	40	2.5	15 x 6 x 6A11
31002715	162-16R150606A11-VS-A	0-15	16	16	113.4	20.6	33.4	40	2.5	15 x 6 x 6A11

Order no.	Tool holder	Working area	Dimension [mm]						Knurling wheels (Ø x b x b)		
	Designation	Ø [mm]	а	b	С	d	е	f	xa	Х	`[mm] ´
31002128	162-20M200806A13	3 5-65	20	25	164.8	28 4	92.8	103	33.5	1.5	20 x 8 x 6A13

21BHR1213

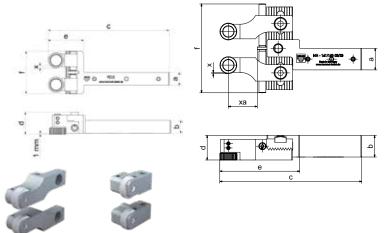
Other variants available on request

Left-hand version of all shank dimensions available on request

# ADAPTER BRACKET FOR BASE SHANK 10 x 10 mm:

Order no.	Shank size [mm]
21BHR1653	12 x 12
21BHR1654	16 x 16

Order no. Series 161	Shank size [mm]
21BHR1672	10 x 10/12 x 12/16 x 16
21BHR1213	20 x 25





# Tool holder Designation Product series Shank size Ø 12 Modular Modular Modular

# Knurling profiles on DIN 82 workpiece:

# Feed knurling



# Selection of knurling wheels:

3 x AA	3 x BR	3 x BL	1 x BL30°/ 2 x BR30°//	1 x BL45°/ 2 x BR45°//
			1 x BR30° / 2 x BL30°	

### Product features:

- Easy and precise fine adjustment
- Modular exchangeable knurl holder jaws for conversion to knurling up to a shoulder (192) or a cut knurling tool (291)
- Carbide pins

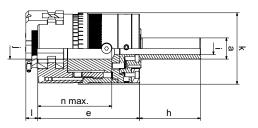
# **TOOL VERSIONS:**

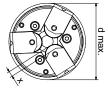
		Order no Tool holder Working area					Dimension [mm]								
	Order no.	Designation	Ø [mm]	a Ø	d max.Ø		h	i Ø	j Ø	k Ø	ı	n max.	x Ø	(Ø x b x b) [mm]	
	31001902	191-12M150404-B	2-13.5	12	57	78	45	9	16	54	9	56	1.5	10 x 4 x 4	
			3-8.5	12	57	78	45	9	16	54	9	56	4	15 x 4 x 4	

Other shank variants available on request

 $d = \text{for max. workpiece } \varnothing$ 

 $n = \max$ . workpiece length (with  $\emptyset$ )





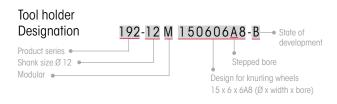
Order no.	Order no.
Form knurling up to a shoulder	Cut knurling
21BHR1128	21BHR1127











# Knurling profiles on DIN 82 workpiece:

# Feed knurling



# Selection of knurling wheels:

3 x AA	3 x BR	3 x BL	1 x BL30°/2 x BR30°//	1 x BL45°/ 2 x BR45°//
			1 x BR30° / 2 x BL30°	1 x BR45° / 2 x BL45°

### Product features:

- Easy and precise fine adjustment
- Modular exchangeable knurl holder jaws for conversion to a form knurling tool (191) or a cut knurling tool (291)
- Carbide collar studs

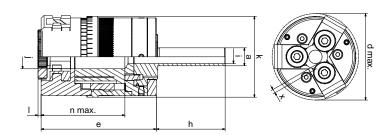
# **TOOL VERSIONS:**

	Tool holder	Working area				Diı	mensio	on [mm	1]				Knurling wheels
Order no.	Designation	Ø [mm]	a Ø	d max.Ø	е	h	i Ø	j Ø	k Ø	ı	n max.	χ	(Ø x b x b) [mm]
31001948	192-12M150606A8-B	3-12	12	57	78	45	9	16	54	2	56	2.5	15 x 6 x 6A8

Other shank variants available on request

 $d = for max. workpiece \emptyset$ 

n = max. workpiece length (with  $\emptyset$ )



Order no.	Order no.
Form knurling	Cut knurling
21BHR1096	21BHR1127





# Maximum flexibility in combination – the perfect standard equipment

# Set 100-12



# SET consisting of:

- 1 x tool: 131
- 3 x knurling wheel: 15 x 4 x 4 mm
- 3 x profile: AA
- Pitches: 0.5/0.6/0.8 mm



- 1 x tool: 141
- 12 x knurling wheel: 10 x 4 x 4 mm
- 6 x profile: AA
- 3 x profile: BL30°
- 3 x profile: BR30°
- Pitches: 0.5/0.6/0.8 mm

# Knurling profiles on DIN 82 workpiece for tool 131: Plunge/feed knurling



Selection of knurling wheels:



# Knurling profiles on DIN 82 workpiece for tool 141:

Plunge/feed knurling



# Selection of knurling wheels:



# **TOOL VERSIONS:**

Order no. Set	Order no. Holder	Tool holder Designation	Working area Ø [mm]	Dimension [mm]	Knurling wheels (Ø x b x b) [mm]
31002691	31002707	131-12R150404-VS-A	3-50	see page 10	10/15 x 4 x 4
31002091	31002703	141-12M100404-VS-A	3-25	see page 12	10 x 4 x 4

# Set 100-16



- 1 x tool: 131
- 3 x knurling wheel: 15 x 4 x 4 mm
- 3 x profile: AA
- Pitches: 0.6/0.8/1.0 mm

# Knurling profiles on DIN 82 workpiece for tool 131:

Plunge/feed knurling

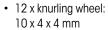












- 6 x profile: AA
- 3 x profile: BL30°
- 3 x profile: BR30°
- Pitches: 0.6/0.8/1.0 mm

# Knurling profiles on DIN 82 workpiece for tool 141:

Plunge/feed knurling





# Selection of knurling wheels:

# **TOOL VERSIONS:**

Order no. Set	Order no. Holder	Tool holder Designation	Working area Ø [mm]	Dimension [mm]	Knurling wheels (Ø x b x b) [mm]
31002694	31002708	131-16R150404-VS-A	3-50	see page 10	10/15 x 4 x 4
31002094	31002658	141-16M150404-VS-A	6-60	see page 12	15 x 4 x 4

# Form knurling tools $\operatorname{SETS}$



# Set 100-20



# SET consisting of:

- 1 x tool: 131
- 3 x knurling wheel: 20 x 8 x 6 mm
- 3 x profile: AA
- Pitches: 0.8/1.0/1.5 mm



- 1 x tool: 141
- 12 x knurling wheel: 20 x 8 x 6 mm
- 6 x profile: AA
- 3 x profile: BL30°
- 3 x profile: BR30°
- Pitches: 0.8/1.0/1.5 mm

# Knurling profiles on DIN 82 workpiece for tool 131: Plunge/feed knurling







### Selection of knurling wheels:

AA BR BL

# Knurling profiles on DIN 82 workpiece for tool 141:

Plunge/feed knurling







Selection of knurling wheels:



# **TOOL VERSIONS:**

Order no. Set	Order no. Holder	Tool holder Designation	Working area Ø [mm]	Dimension [mm]	Knurling wheels (Ø x b x b) [mm]
21002405	31000714	131-20U250806-A-Z	8-200	see page 10	20/25 x 8 x 6
31002695	31002704	141-20M200806-B	10-110	see page 12	20 x 8 x 6

# Set 100-25



- 1 x tool: 131
- 3 x knurling wheel: 20 x 8 x 6 mm
- 3 x profile: AA
- Pitches: 0.8/1.0/1.5 mm



- 1 x tool: 141
- 12 x knurling wheel: 20 x 8 x 6 mm
- 6 x profile: AA
- 3 x profile: BL30°
- 3 x profile: BR30°
- Pitches: 0.8/1.0/1.5 mm

# Knurling profiles on DIN 82 workpiece for tool 131:









# Selection of knurling wheels:

AA BR BL

# Knurling profiles on DIN 82 workpiece for tool 141:

Plunge/feed knurling







RGE30°

# Selection of knurling wheels:

# **TOOL VERSIONS:**

Order no. Set	Order no. Holder	Tool holder Designation	Working area Ø [mm]	Dimension [mm]	Knurling wheels (Ø x b x b) [mm]
31002696	31000715	131-25U250806-A-Z	8-200	see page 10	20/25 x 8 x 6
31002090	31002705	141-25M200806-B	10-110	see page 12	20 x 8 x 6



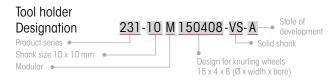
Perfect efficiency due to modular design, convincing process reliability due to sturdy construction



# Series 231







# Knurling profiles on DIN 82 workpiece:

# Feed knurling



# Selection of knurling wheels:

1 x BR30° (right-hand use)	1 x AA (left-hand use)	1 x AA (right-hand use)
$1~{ m x~BL}30^\circ$ (left-hand use)	$1~x~BR15^{\circ}$ (left-hand use)	$1~x~BL15^\circ$ (right-hand use)

### Product features:

- Scaling and positioning aids
- Adjusting spindle for fine adjustment of the knurl profile
- Set screws in shank for clearance angle correction
- · Coated carbide bearing bushes for improved antifrictional property
- Modular shank design: Shank size 10 x 10 mm optionally adaptable

# **TOOL VERSIONS:**

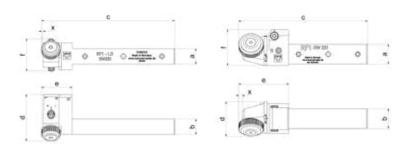
Order no.	Tool holder	Working area			Dime	nsion [	[mm]			Knurling wheels (Ø x w x b)
	Designation	Ø [mm]	а	b	С	d	е	f		[mm]
31002739	231-10M150408-VS-A	3-50	10	10	103.5	36.2	23.9	25.3	1.4	15 x 4 x 8
31002740	231-12M150408-VS-A	3-50	12	12	103.5	36.2	23.9	25.3	1.4	15 x 4 x 8
31002741	231-16M150408-VS-A	3-50	16	16	103.5	36.2	23.9	29.3	1.4	15 x 4 x 8

Order no.	Tool holder	Working area			Dime	nsion [	[mm]			Knurling wheels (Ø x w x b)
31431 1131	Designation	Ø [mm]	а	b	С	d	е	f	Χ	[mm]
31002652	231-20M250608-B	10-300	20	20	130.8	35	50.8	36.5	3.7	25 x 6 x 8
31002445	231-25M250608-B	10-300	25	25	130.8	35	50.8	40	3.7	25 x 6 x 8

Other variants available on request

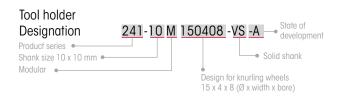
# ADAPTER BRACKET FOR BASE SHANK 10 x 10 mm:

Order no.	Shank size [mm]
21BHR1653	12 x 12
21BHR1654	16 x 16









# Knurling profiles on DIN 82 workpiece:

Feed knurling



Selection of knurling wheels:

# Product features:

- Modular design: Tool can be used as right-hand and left-hand version.
   Retooling by simply turning the cut knurling head
- Conversion to alternative full shank dimensions is possible
- Modular shank design: Shank size 10 x 10 mm optionally adaptable
- Fine adjustment of centre height of the cut knurling head
- Fine adjustment of the clearance angle by means of synchronous adjustment spindle
- Coated carbide bearing bushes for improved antifrictional property
- Vertical height adjustment for use of shank size 20 mm on 25 mm (version 241-20M250608-A1)

### **TOOL VERSIONS:**

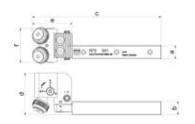
Order no.	Tool holder	Working area Ø[mm]	Dimension [mm]					Knurling wheels (Ø x w x b)	
	Designation		а	b	С	d		f	` [mm] ´
31001926	241-10M150408-VS-A	3-50	10	10	116	36.7	36	31	15 x 4 x 8
31001901	241-12M150408-VS-A	3-50	12	12	116	37.7	36	31	15 x 4 x 8
31001945	241-16M150408-VS-A	3-50	16	16	116	39.7	36	31	15 x 4 x 8

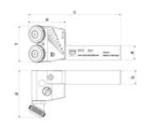
Other variants available on request

Order no.	Tool holder	Working area	Dimension [mm]						Knurling wheels (Ø x w x b)
	Designation	Ø [mm]	а	b	С	d	е	f	[mm]
31000804	241-20M150408-A	3-50	20	20	116	44.7	36	35.6	15 x 4 x 8
31000666	241-20M250608-A1	10-250	20	20	133.3	68	53.3	53	25 x 6 x 8
31001899	241-25M250608-A1	10-250	25	20	133.3	68	53.3	53	25 x 6 x 8

# ADAPTER BRACKET FOR BASE SHANK 10 x 10 mm:

Order no.	Shank size [mm]
21BHR1653	12 x 12
21BHR1654	16 x 16









# Knurling profiles on DIN 82 workpiece:

Feed knurling







# Selection of knurling wheels:

1 x BL15°/2 x BR15° oder

### Product features:

- Easy and precise fine adjustment
- Modular exchangeable knurl holder jaws for conversion to a form knurling tool 191/192 (knurling up to a shoulder)
- · Coated carbide bearing bushes for improved antifrictional property

### Tool holder 291-12 M 100306-B Designation State of Product series • development Shank size Ø 12 • Design for knurling wheels 10 x 3 x 6 (Ø x width x bore) Modular •-

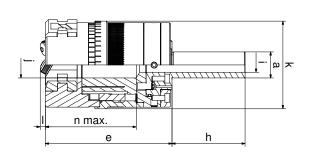
# **TOOL VERSIONS:**

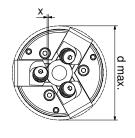
	Tool holder	Working area			Dimension [mm]						Knurling wheels		
Order no.	Order no. Designation	Ø [mm]	a Ø	d max.Ø		$\begin{array}{c ccccccccccccccccccccccccccccccccccc$			x Ø	(Ø x w x b) [mm]			
31001946	291-12M100306-B	3.5-13.5	12	57	78	45	9	16	54	3	56	1	10 x 3 x 6

Other variants available on request

 $d = \text{for max. workpiece } \varnothing$ 

n = max. workpiece length (with  $\emptyset$ i)





Order no.	Order no.
Form knurling	Cut knurling up to a shoulder
21BHR1096	21BHR1128





# $\hbox{Cut knurling tools $SETS}$

# Set 200-12



# SET consisting of:

- 1 x tool: 231
- 6 x knurling wheel: 15 x 4 x 8 mm
- 3 x profile: BL30°
- 3 x profile: BR30°
- Pitches: 0.5/0.6/0.8 mm



- 1 x tool: 241
- 6 x knurling wheel: 15 x 4 x 8 mm
- 6 x profile: AA
- Pitches: 0.5/0.6/0.8 mm

# Knurling profiles on DIN 82 workpiece for tool 231: Feed knurling



### Selection of knurling wheels:

1 x BR30° (right-hand use) 1 x BL30° (left-hand use)	1 X AA (left-hand use)	1 x AA (right-hand use)

# Knurling profiles on DIN 82 workpiece for tool 241: Feed knurling



RGE30°

Selection of knurling wheels:

 $2 \times AA$ 

# **TOOL VERSIONS:**

Order no. Set	Order no. Holder	Tool holder Designation	Working area Ø [mm]	Dimension [mm]	Knurling wheels (Ø x b x b) [mm]
21002407	31002740	231-12M150408-VS-A	3-50	see page 21	15 x 4 x 8
31002697	31001901	241-12M150408-VS-A	3-50	see page 22	15 x 4 x 8

# Set 200-16



# SET consisting of:

- 1 x tool: 231
- 6 x knurling wheel: 15 x 4 x 8 mm
- 3 x profile: BL30°
- 3 x profile: BR30°
- Pitches: 0.6/0.8/1.0 mm
- 1 x tool: 241
- 6 x knurling wheel: 15 x 4 x 8 mm
- 6 x profile: AA
- Pitches: 0.6/0.8/1.0 mm

# Knurling profiles on DIN 82 workpiece for tool 231: Feed knurling



# Selection of knurling wheels:

1 x BR30° (right-hand use)	1 x AA (left-hand use)	1 X AA (right-hand use)
1 x BL30° (left-hand use)		

# Knurling profiles on DIN 82 workpiece for tool 241:

# Feed knurling



# Selection of knurling wheels:

2 x AA

# **TOOL VERSIONS:**

Order no. Set	Order no. Holder	Tool holder Designation	Working area Ø [mm]	Dimension [mm]	Knurling wheels (Ø x b x b) [mm]
31002698	31002741	231-16M150408-VS-A	3-50	see page 21	15 x 4 x 8
31002090	31001945	241-16M150408-VS-A	3-50	see page 22	15 x 4 x 8



# Set 200-20



# $000_{-20}$ SET consisting of:

- 1 x tool: 231
- 6 x knurling wheel: 25 x 6 x 8 mm
- 3 x profile: BL30°
- 3 x profile: BR30°
- Pitches: 0.8/1.0/1.5 mm
- 1 x tool: 241
- 6 x knurling wheel: 25 x 6 x 8 mm
- 6 x profile: AA
- Pitches: 0.8/1.0/1.5 mm

# Knurling profiles on DIN 82 workpiece for tool 231: Feed knurling



# Selection of knurling wheels:

1 x BR30° (right-hand use) 1 x BL30° (left-hand use)	1 x AA (left-hand use)	1 x AA (right-hand use)
1 A DEGG (Ich Halla acc)		

# Knurling profiles on DIN 82 workpiece for tool 241: Feed knurling



RGE30

Selection of knurling wheels:

2 x AA

# **TOOL VERSIONS:**

Order no. Set	Order no. Holder	Tool holder Designation	Working area Ø [mm]	Dimension [mm]	Knurling wheels (Ø x b x b) [mm]
21002400	31002652	231-20M250608-B	10-300	see page 21	25 x 6 x 8
31002699	31000666	241-20M250608-A1	10-250	see page 22	25 x 6 x 8

# Set 200-25



# SET consisting of:

- 1 x tool: 231
- 6 x knurling wheel: 25 x 6 x 8 mm
- 3 x profile: BL30°
- 3 x profile: BR30°
- Pitches: 0.8/1.0/1.5 mm
- 1 x tool: 241
- 6 x knurling wheel: 25 x 6 x 8 mm
- 6 x profile: AA
- Pitches: 0.8/1.0/1.5 mm

# Knurling profiles on DIN 82 workpiece for tool 231:



# Selection of knurling wheels:

$1~x~BR30^{\circ}$ (right-hand use) $1~x~BL30^{\circ}$ (left-hand use)	1 x AA (left-hand use)	1 x AA (right-hand use)
--	------------------------	-------------------------

# Knurling profiles on DIN 82 workpiece for tool 241:

# Feed knurling



# Selection of knurling wheels:

2 x AA

# **TOOL VERSIONS:**

Order no. Set	Order no. Holder	Tool holder Designation	Working area Ø [mm]	Dimension [mm]	Knurling wheels (Ø x b x b) [mm]
21002700	31002445	231-25M250608-B	10-300	see page 21	25 x 6 x 8
31002700	31001899	241-25M250608-A1	10-250	see page 22	25 x 6 x 8







Ø 25 mm



Ø 30 mm

# Knurling profiles on DIN 82 workpiece:

# Feed knurling



Selection of knurling wheels:	
3 x AA 2 x BL30°/ 1 x BR30°	2 x BL45°/ 1 x BR45°

### Product features:

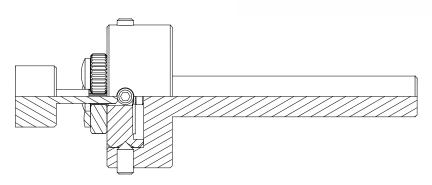
- No lateral contact pressures minimum load on the workpiece
- Custom production designed for workpiece diameter and pitch
- Dimensions correspond to standard for thread-cutting dies
- For use in standardised thread-cutting die holders
- Base shanks are not included in scope of delivery, but are available on request

# Available sizes:

- Ø 25 mm
- Ø 30 mm
- Ø 38 mm
- Ø 45 mm
- Ø 55 mm







# Special tools

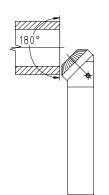
# Series 311-xx°

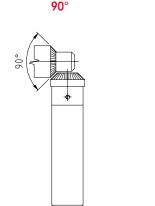
Conical knurling Face knurling

Conical/inner/face knurling up to a shoulder









# Knurling profiles on DIN 82 workpiece:

Plunge knurling

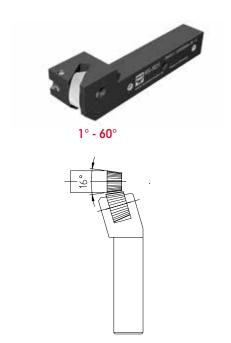


Selection of knurling wheels:



# Series 312-xx°

Conical knurling



# Knurling profiles on DIN 82 workpiece:

Plunge knurling



# Selection of knurling wheels:



# Special tools



# Series 330

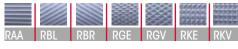
Knurling within a bore





# Knurling profiles on DIN 82 workpiece:

Plunge knurling



### Selection of knurling wheels:

AA BR BL GV GE KV KE		•				
	AA	BL	GV	GE	KV	KE

# Feed knurling

ΡΔΔ	DRI	DRD

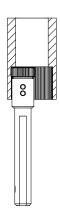
# Selection of knurling wheels:



# Series 332

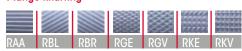
Knurling within a bore up to a shoulder





# Knurling profiles on DIN 82 workpiece:

### Plunge knurling



# Selection of knurling wheels:

AA	BR	BI	GV	GF	KV	KF
, , ,	DIV	25	0.1	OL.	10.0	

# Feed knurling



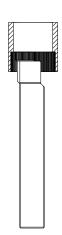
# Selection of knurling wheels:

AA BR BL

# Series 342

Knurling within a bore up to a shoulder





# Knurling profiles on DIN 82 workpiece:

# Plunge knurling



# Selection of knurling wheels:

|--|

### Feed knurling

RAA	RBL	RBR	RGE30°	RGE45°

### Selection of knurling wheels:

concomen or minimized							
AA	BR		1 x BL30°/ 1 x BR30°	1 x BL45° / 1 x BR45°			

# Special interfaces

# SK



### Characteristics:

- Standardised to DIN 69871 with retention knob
- Torque transmission by means of the friction contact of the taper with low strain
- For larger torques and sudden loads, driving keys are primarily responsible for the transmission
- The driving keys are arranged asymmetrically on the spindle face for clear orientation for the tool
- Easy production
- Self-centring due to steep taper
- High speeds can expand the spindle cone and the resulting centrifugal force can cause axial distortion of the tool
- The centrifugal force distortion reduces the contact surfaces and therefore the frictional transmission of torques

# HSK/HSK-C



# Characteristics:

- Standardised to DIN 69893
- · No retention nob
- Smaller (ca. 30%) and lighter (ca. 50%) than the steep taper (SK)
- Faster and easier tool change
- Rigidity 5 to 7 times higher than with steep taper holders due to support on the tool holder over the collar
- Force-closing due to the taper and contact surface
- Form-closing by means of drive slots
- Excellent change accuracy (3 µm)
- Face contact on collar ensures axial wobble accuracy
- Close taper tolerance minimises radial run-out
- HSK-C has a shorter shank with a flatter taper angle

# Special interfaces



# CAPTO® (Sandvik)



# **Characteristics:**

- Transmission of high torques
- · High bending strength
- Central supply of high-pressure cooling lubricant from the machine to the cutting edge
- Balanced and concentric
- Self-centring
- · Flexible due to high level of modularity
- · High basic stability and accuracy
- Reduced setup time

# VDI



# Characteristics:

- Universal tool system for all production areas
- Tool change within seconds
- Form-closing for reliable torque transmission
- Very short design
- Internal coolant supply is possible
- Presetting of tools outside the machine
- Tool holders in different sizes
- · High rigidity

# GRAF holding systems



# Characteristics:

- Tool change within seconds
- Very short design
- Presetting of tools outside the machine
- Tool holders in different sizes
- · High rigidity

# Special tools

# Series 161-S

Integrated turret holder Expanded work area



# Knurling profiles on DIN 82 workpiece:

# Plunge knurling









# Selection of knurling wheels:

1 x BL30°

### Product features:

- · Flexible work area
- · Extremely stable design
- · Direct machine connection
- Conical application
- · Carbide pins

### Working area:

• Ø 0 – 15 mm

# Series 161-S

Conical knurling Adjustable jaws 4-12°



# Knurling profiles on DIN 82 workpiece:

Plunge/feed knurling













# Selection of knurling wheels:

2 x AA | 2 x BR 2 x BL

### Product features:

- Adjustable jaws 4-12°
- Star turret holder
- Flexible work area conical surfaces
- Reduced strain on workpiece and machine
- Knurling head with flexible centring
- Modular shank design
- · Carbide pin

### Working area:

• Ø8-36 mm

# Series 161-S

Knurling wheels in special size/form



# Knurling profiles on DIN 82 workpiece:

Plunge/feed knurling









# Selection of knurling wheels:

### Product features:

- HSK holder
- No lateral contact pressure reduced load
- Centre height adjustable due to synchronous spindle
- · Carbide pins

# Working area:

• Ø 0-20 mm

# Special tools



# Series 142-S

Special Capto® holder



# Knurling profiles on DIN 82 workpiece:

Plunge/feed knurling









# Selection of knurling wheels:

1 x BL30°

### Product features:

- Knurling up to a shoulder
- · Capto holder
- · Knurling head with flexible centring
- Modularity application independent
- · Carbide pins

### Working area:

- Ø 3 40 mm
- Ø 6 60 mm
- Ø 10 110 mm

# Series 192-S

Special HSK 32 holder



# Knurling profiles on DIN 82 workpiece:

### Feed knurling









# Selection of knurling wheels:

2 x AA | 2 x (1 x) BL30°/

# Product features:

- Knurling up to a shoulder
- · HSK holder
- No lateral contact pressure reduced load
- Modular exchangeable knurl holder jaws
- Suitable for very small workpieces
- Exchangeable shank
- Easy and precise fine adjustment (synchronous)
- · Carbide pins/bearing bolts

### Working area:

• Ø4-30 mm

# Form knurling/ marking

Special facing slide head holder



# Knurling profiles on DIN 82 workpiece:

Plunge/feed knurling









# Selection of knurling wheels:

1 x AA 1 x BR 1 x BL

### Product features:

- Holder for facing slide head
- Special width for custom applications (knurling wheel/marking roll)
- · Carbide pins

# Working area:

· Dependent on facing slide head

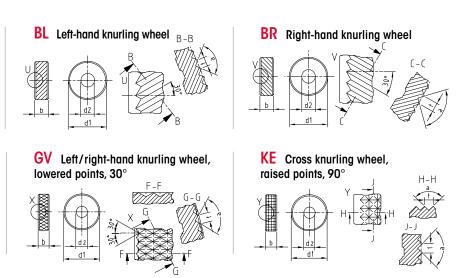


# Profiles and knurling pitches



DIN 403 describes and specified the knurling profile on the knurling wheel. DIN 403 defines knurling forms AA, BL, BR, GE, GV, KE and KV. Knurling wheels that deviate from DIN 403 are considered special knurling tools and are custom manufactured by Hommel+Keller based on customer drawings.

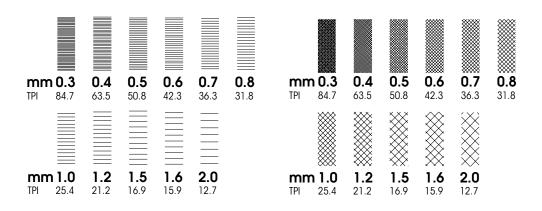
# GE Left/right-hand knurling wheel, raised points, 30° KV Cross knurling wheel, lowered points, 90° K-K Cross knurling wheel, lowered points, 90°



The knurling profile on the knurling wheel according to DIN 403 is based on the desired knurling profile on the workpiece (DIN 82) and the tool holder that is used.

The knurling pitch p refers to the distance between tooth crests. The pitches = 0.5/0.6/0.8/1.0/1.2/1.6 are standardised according to DIN 403. The Hommel+Keller product spectrum includes other pitches as well. They are listed below in mm and TPI. Other pitches are available as custom manufactured versions.

# Standard pitches from Hommel+Keller



# Form knurling – non-cutting process











BR45°

# Knurling wheels, milled, with 45° chamfer – PM

Standard	Profile		Dimension [mm]			Pitches												
variants			Ø	Width	Bore	[mm]												
No. 11			10	4	4	0												
No. 11			15	4	4	0												
No. 11			15	6	4	0												
No. 11			15	6	6A8													
No. 11			15	6	6A11													
No. 11		Α	20	6	6	0												
No. 11	_ A	А	20	8	6	•												
No. 11			20	8	6A13													
No. 11			20	10	6													
No. 11		25	6	6														
No. 11		25	8	6														
No. 11			25	10	6													
No. 11			10	4	4	0												
No. 11	BL	30°	15	4	4													
No. 11		DL	BL	BL	DL	DL	DL	DL	DL	DL	DL	DL	DL	30	20	6	6	
No. 11				20	8	6	•											
No. 11			10	4	4													
No. 11	BL	45°	15	4	4													
No. 11			20	8	6													
No. 11			10	4	4	0												
No. 11	BR	30°	15	4	4													
No. 11	DK	30	20	6	6													
No. 11			20	8	6													
No. 11			10	4	4													
No. 11	BR	45°	15	4	4													
No. 11			20	8	6													

# Standard pitches/profile angle 90°

- 0.3/0.4/0.5/0.6/0.7/0.8/1.0/1.2/1.5/1.6/2.0
- 0.3/0.4/0.5/0.6/0.7/0.8/1.0/1.2/1.5
- **0.5/0.6/0.8/1.0/1.2/1.5/1.6/2.0**
- 0.5/0.6/0.8/1.0/1.2/1.5
- 0.5/0.6/0.8/1.0
- On request

Other variants available on request

# **Variants**

# Knurling wheel variants (PM)

No.	Version
13	milled, without chamfer
30	ground with 45° chamfer
32	ground, without chamfer
95	milled, with 60° chamfer

# Knurling wheel variants (HSS)

No.	Version
10	milled, with 45° chamfer
12	milled, without chamfer
94	milled, with 60° chamfer

# Knurling wheel variants (HM)

No.	Version
50	ground with 45° chamfer
52	ground, without chamfer

# Form knurling with 60° chamfer

When forming knurling profiles with a larger pitch in the axial machining direction it can be advantageous to apply a  $60^{\circ}$  chamfer to the knurling wheel. The flatter chamfer achieves a better material flow.

Wheel geometries - see "Technology", page 44

# Form knurling – non-cutting process









GE30°

Knurling wheels, milled, with 45° chamfer - PM

Ctandard variants	Profile		Dime		mension [mm]		Pitches
Standard variants	PIC		Ø	Width	Bore	[mm]	
No. 11			15	4	4	<b>*</b>	
No. 11	GE	30°	15	6	4	•	
No. 11	GE	30	20	6	6	<b>*</b>	
No. 11			20	8	6		
No. 11	GE	45°	20	8	6		
No. 11	K	Œ	$\square$	$\square$	$\square$	☑	

### **Variants**

## Knurling wheel variants (PM)

No.	Version
13	milled, without chamfer
30	ground with 45° chamfer
32	ground, without chamfer

### Knurling wheel variants (HSS)

No.	Version
10	milled, with 45° chamfer
12	milled, without chamfer

### Knurling wheel variants (HM)

No.	Version
50	ground with 45° chamfer
52	ground, without chamfer
52	ground, without chamfer





GV30°

01/450

W/

# Standard pitches/profile angle $90^{\circ}$

- 0.3/0.4/0.5/0.6/0.7/0.8/1.0/1.2/1.5/1.6/2.0
- 0.3/0.4/0.5/0.6/0.7/0.8/1.0/1.2/1.5
- **0.5/0.6/0.8/1.0/1.2/1.5/1.6/2.0**
- 0.5/0.6/0.8/1.0/1.2/1.5
- 0.5/0.6/0.8/1.0
- On request

Other variants available on request

# Knurling wheels, formed, with 45° chamfer – PM

Standard variants	Profile		Dimension [mm]			Pitches
Sidiladia validilis	PIC		Ø	Width	Bore	[mm]
No. 21			15	4	4	•
No. 21	GV	30°	15	6	4	<b>*</b>
No. 21	GV	30	20	6	6	<b>*</b>
No. 21			20	8	6	
No. 21	GV	45°	20	8	6	•
No. 21	K	V	$\square$	Ø	$\square$	$\square$

## **Variants**

Knurling wheel variants (PM)

No.	Version
23	formed, without chamfer

### Knurling wheel variants (HSS)

No.	Version
20	formed, with 45° chamfer
22	formed, without chamfer

# Cut knurling – cutting process











Knurling wheels, milled, without chamfer – PM

Standard	Profile			Pitches		
variants			Ø	Width	Bore	[mm]
No. 16			8.9	2.5	4	0
No. 16			10	3	6	0
No. 16	AA		14.5	3	5	
No. 16	_ A	A	15	4	8	0
No. 16			21.5	5	8	
No. 16			25	6	8	
No. 16			10	3	6	<b>♦</b>
No. 16	BL	15°	15	4	8	
No. 16	DL	15	21.5	5	8	
No. 16			25	6	8	
No. 16			10	3	6	<b>•</b>
No. 16		30°	14.5	3	5	•
No. 16	BL		15	4	8	0
No. 16			21.5	5	8	
No. 16			25	6	8	
No. 16			10	3	6	•
No. 16	BR	15°	15	4	8	
No. 16	DIX	15	21.5	5	8	
No. 16			25	6	8	
No. 16			10	3	6	•
No. 16			14.5	3	5	<b>•</b>
No. 16	BR	30°	15	4	8	0
No. 16			21.5	5	8	
No. 16			25	6	8	

# Standard pitches/profile angle $90^{\circ}$

0.5/0.4/0.5/0.0/0.//0.0/1.0/1.2/1.5/1.0/2	•	0.3/0.4/0.5/0.6/0.7/0.8/1.0/1.2/1.5/1.6/2.	0
---	---	--	---

0.3/0.4/0.5/0.6/0.7/0.8/1.0/1.2/1.5

**0.5/0.6/0.7/0.8/1.0/1.2/1.5/2.0** 

0.5/0.6/0.8/1.0/1.2/1.5

◆ 0.5/0.6/0.8/1.0

On request

Other variants available on request

## **Variants**

Knurling wheel variants (PM)

N°	Version
18	milled, with 10° chamfer
35	ground, without chamfer
37	ground with 10° chamfer

Knurling wheel variants (HSS)

N°	Version
15	milled, without chamfer
17	milled, with 10° chamfer

Knurling wheel variants (HM)

N°	Version
55	ground, without chamfer
57	ground with 10° chamfer

# Form knurling – with 10° chamfer

When cutting knurling profiles with a larger pitch in the axial machining direction it can be advantageous to apply a 10° chamfer to the knurling wheel.

For wheel geometries, see "Technology" on page 44

# Special knurling wheels







Bead knurl - No. 60

Note: Please indicate the bead diameter when ordering.



# Conical knurling wheels - No. 70

Note: The completeness of the teeth on the workpiece is always dependent on the width/pitch of the knurling wheel.







\* Only radiuses > 3 mm are possible.







Concave and convex knurling wheels - No. 80

In the DL, DR, FL and FR versions the spiral angle must not exceed 20°.







Nr. 93

Special knurling wheels - No. 90/92/93

Note: The picture of knurling wheel no. 90 is provided as an example. It represents all special forms not covered by no. 92 (single stepped) and no. 93 (double stepped).

# Burnishing rolls





•

zeus burnishing rolls can be used in standard zeus form knurling tools. On request, we can develop and produce a custom holding system.

Use in this tool system is suitable for machining cylindrical workpieces, bores, end faces, conical workpieces and for convex and concave outer contours.

## **Applications:**

zeus burnishing rolls are used primarily for roller-burnishing and supporting round material during machining on lathes.

## **Advantages:**

- Burnished workpieces exhibit low friction and increased resistance to corrosion after machining
- Reworking, such as grinding, honing and lapping can be replaced by simple roller-burnishing machining
- When used as support rolls, they reduce wear on the bearings and clamping devices and minimise the pressure on the workpiece

### Result:

- Improved surface quality
- Increased dimensional stability
- Increased hardness of surfaces

## Burnishing roll type RRA – cylindrical

	D	imension [mn	n]		Version	
Туре	Ø	Width	Bore	N° 04 polished, Rz 4 µm	N° 05 ground, Rz 2−3 µm	N° O6 ground & polished, Rz 1 µm
	10	4	4	✓	✓	✓
RRA	15	4	4	✓	✓	<b>✓</b>
KKA	20	8	6	✓	✓	✓
	25	8	6	✓	✓	<b>√</b>

# Burnishing roll type RRE - convex

	D	imension [mr	n]			Version	
Туре	Ø	Width	Bore	R	N° 04 polished, Rz 4 μm	N° 05 ground, Rz 2−3 µm	N° 06 ground & polished, Rz 1 µm
	10	4	4	2	✓	✓	<b>√</b>
RRE	15	4	4	2	✓	✓	✓
KKE	20	8	6	6	✓	✓	✓
	25	8	6	6	<b>✓</b>	<b>✓</b>	✓

# **Features**





### **Advantages:**

- Longer tool life
- Reduction of tool costs
- Reduction of set-up costs

In addition to the standard variants of powder metal, HSS, and carbide versions are also available on request.

# zeus Premium materials

As your supplier of premium tool products we insist on materials that allow machining of hard-to-machine and pressure resistant materials. All knurling wheels in the standard zeus product line are therefore made of power metal.

The material features high hot hardness and compression strength, as well as durability and resistance to wear.

# Surface treatment

Suitable treatment based on your individual application can have a positive effect on the life of the knurling wheel. We offer different treatment processes.

# TENIFER® salt-bath nitriding heat treatment

Treatment of the knurling wheel in a salt bath based on the TENIFER® process increases the resistance to wear and the fatigue strength. The salt-bath nitrocarburising process achieves a high case hardness.



## **PVD** coatings

Suitable PVD coating of the knurling wheels offers the user additional possibilities for increasing tool life. These variants are available on request. PVD coatings are suitable primarily for cut knurling applications.



## Polished knurling wheels

The use of finely polished knurling wheels can be effective for machining of adhesive materials that require optimal chip sliding. This process achieves very smooth surfaces, with a low coefficient of friction. Edge radiusing on the tooth flanks prevents built-up edges from forming and therefore premature tooth breakage.



# Technology

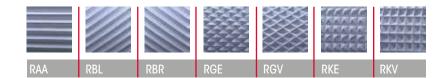


# Process characteristics



# Form knurling

Knurl profiles on DIN 82 workpiece



## **Application:**

- Non-cutting forming
- Processing of workpieces suitable for cold forming
- All knurling forms and profiles can be manufactured
- Suitable for face and knurling within a bore
- Knurling up to a shoulder is possible
- Tool can be started at any location on the workpiece

## **Handling:**

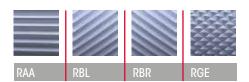
- Only minimal preparation of workpiece required
- Very easy handling of tool (short setup times)

#### **Features:**

- Material displacement increases the outer diameter of the workpiece
- The surface is compacted
- Form knurling of small diameters is possible only to a limited extent

# Cut knurling

Knurl profiles on DIN 82 workpiece



## **Application:**

- Alternative cutting process
- Material removal at axial feed drive
- Machining of thin-walled, soft and hard-to-machine materials is possible
- Only cylindrical workpieces can be machined in axial direction
- Machining of small diameters is possible
- Maximum precision and surface quality, therefore suitable primarily for visible knurling
- A plunge cut is necessary for applying the tool in the middle area of the workpiece
- Knurling up to a shoulder is not possible

## Handling:

- Requires precise tool adjustment and fine adjustment
- Requires precise preparation of the workpiece

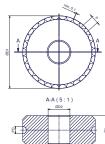
#### **Features:**

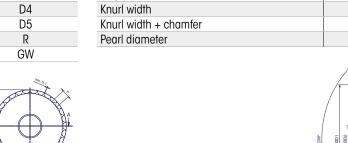
- Minimal change in the outer diameter
- Minimal surface compaction
- Lower strain on machine than in form knurling
- Minimum pressure on the workpiece and machine

# Wheel geometries

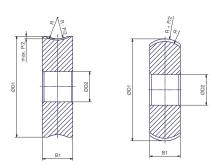
Designation	Abbreviation
Outer diameter	D1
Bore diameter	D2
Width	B1
Pitch	р
Stepped diameter	D3
Stepped diameter	D4
Collar stud bore diameter	D5
Radius	R
Total angle	GW

Designation	Abbreviation
Smallest diameter	Da
Average diameter	Dm
Bore depth	T1
Step width	B2
Step width	В3
Knurl width	RB
Knurl width + chamfer	RBF
Pearl diameter	PD

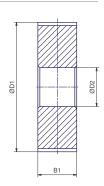




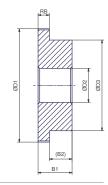
Bead knurl - No. 60



Conical knurling wheels - No. 70

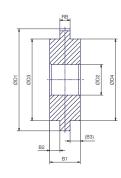


Concave/convex knurling wheels - No. 80

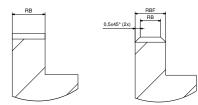


Special knurling wheels - No. 90

Special knurling wheels - No. 93



Special knurling wheels - No. 92

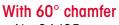


# **Knurl width** and chamfer

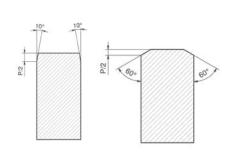
The knurl width (=RB) on the knurling wheel is always defined without the chamfer.

The knurl width on the workpiece is defined by the knurl width + chamfer (=RBF) on the knurling wheel.

With 10° chamfer - No. 17/18



- No. 94/95



# Conversion to inches



# Knurling based on CP (TPI) and DP

# ■ CP (TPI) = Circular Pitch (Teeth Per Inch)

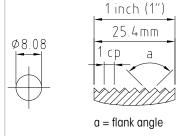
This standard specifies the number of teeth over a distance of 1 inch  $(1\sim25.4 \text{ mm})$ . To calculate the pitch, divide 1 inch by the number of teeth. The profile angle is defined as  $70^{\circ}$  or  $90^{\circ}$ , depending on the number of teeth per inch.

## Conversion example:

Specification CP (TPI) = 20

Pitch (mm) =

1 inch ( $\sim$ 25.4 mm) : 20 (number of teeth) = 1.27 mm



### ■ DP = Diametral Pitch

As opposed to CP (TPI) this standard specifies the number of teeth on the circumference of a circle with a diameter of 1 inch (1"~25.4 mm). To calculate the pitch, divide the circumference of a 1 inch circle by the number of teeth.

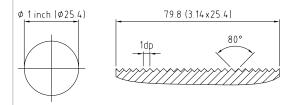
The profile angle is defined as 80°.

## **Conversion example:**

Specification DP = 64

Pitch (mm) =

1 inch ( $\sim$ 25.4) x  $\pi$  (3.14...) : 64 (number of teeth) = 1.25 mm



# Material displacement non-cutting forming

## Our empirical values for enlargement of the workpiece diameter

Knurling profile acc. to DIN 82: RAA (knurling profile on workpiece) Knurling wheels according to DIN 403: AA (knurling profile on knurling wheel)



Pitch	Pitch [mm]		0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	2.0
Material	Workpiece Ø [mm]		Enlargement of workpiece diameter in mm									
Free-cutting	5	0.08	0.14	0.18	0.22	0.27	0.29	0.35	0.50	_	_	_
steel	15	0.08	0.14	0.18	0.23	0.30	0.40	0.44	0.50	0.60	0.65	0.70
	25	0.08	0.15	0.23	0.24	0.28	0.35	0.44	0.53	0.62	0.70	0.98
Stainless	5	0.10	0.15	0.20	0.25	0.28	0.30	0.42	0.41	_	_	_
steel	15	0.10	0.15	0.19	0.25	0.30	0.34	0.45	0.51	0.60	_	_
	25	0.10	0.14	0.20	0.26	0.31	0.33	0.43	0.50	0.62	_	_
Brass	5	0.08	0.12	0.18	0.20	0.21	0.22	0.25	0.28	_	_	_
	15	0.10	0.14	0.20	0.26	0.28	0.29	0.35	0.41	0.44	0.48	0.55
	25	0.10	0.15	0.20	0.25	0.28	0.30	0.36	0.43	0.46	0.50	0.53
Aluminium	5	0.09	0.15	0.19	0.23	0.28	0.30	0.41	0.40	-	_	_
	15	0.10	0.15	0.19	0.26	0.29	0.33	0.45	0.51	0.57	0.65	_
	25	0.09	0.15	0.19	0.26	0.29	0.32	0.45	0.52	0.59	0.65	0.75

Knurling profile acc. to DIN 82: Knurling wheels according to DIN 403: BR30°/BL30° (knurling profile on knurling wheel)

RBL30°/ RBR30° (knurling profile on workpiece)

RBL30°

RBR30°

Pitch	n [mm]	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	2.0
Material	Workpiece Ø [mm]		Enlargement of workpiece diameter in mm									
Free-cutting	5	0.11	0.15	0.20	0.24	0.28	0.34	0.45	0.55	_	_	_
steel	15	0.11	0.15	0.22	0.26	0.30	0.35	0.45	0.52	0.67	0.73	0.85
	25	0.11	0.14	0.23	0.25	0.28	0.36	0.45	0.56	0.70	0.72	0.90
Stainless	5	0.09	0.14	0.19	0.25	0.31	0.34	0.45	0.52	_	_	_
steel	15	0.12	0.20	0.23	0.31	0.35	0.40	0.51	0.62	0.66	0.73	0.97
0.00.	25	0.12	0.18	0.24	0.27	0.37	0.39	0.49	0.59	0.80	0.84	0.96
Brass	5	0.10	0.14	0.20	0.23	0.24	0.28	0.33	0.37	_	_	_
	15	0.10	0.15	0.21	0.23	0.24	0.31	0.41	0.47	0.53	0.55	0.63
	25	0.11	0.15	0.22	0.22	0.25	0.30	0.40	0.45	0.55	0.61	0.68
Aluminium	5	0.12	0.14	0.21	0.24	0.29	0.34	0.41	0.51	_	_	_
,	15	0.12	0.18	0.23	0.26	0.36	0.40	0.50	0.56	0.56	0.61	0.75
	25	0.12	0.18	0.25	0.28	0.37	0.39	0.50	0.58	0.77	0.82	0.96

Knurling profile acc. to DIN 82: Knurling wheels according to DIN 403: BR30°/ BL30° (knurling profile on knurling wheel)

RGE30° (knurling profile on workpiece)



Pitch	Pitch [mm]		0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	2.0
Material	Workpiece Ø [mm]		Enlargement of workpiece diameter in mm									
Free-cutting	5	0.12	0.16	0.20	0.25	0.33	0.41	0.55	0.65	_	_	_
steel	15	0.13	0.22	0.30	0.32	0.35	0.41	0.52	0.62	0.67	0.81	0.95
	25	0.12	0.18	0.28	0.32	0.35	0.38	0.55	0.67	0.77	0.87	0.98
Stainless	5	0.11	0.20	0.25	0.30	0.36	0.39	0.55	0.55	_	_	_
steel	15	0.10	0.14	0.21	0.24	0.29	0.34	0.43	0.53	0.66	0.72	0.88
	25	0.11	0.13	0.20	0.25	0.28	0.32	0.44	0.52	0.67	0.70	0.83
Brass	5	0.12	0.13	0.16	0.20	0.24	0.28	0.32	0.38	_	_	_
	15	0.12	0.16	0.18	0.24	0.28	0.30	0.39	0.40	0.48	0.52	0.63
	25	0.12	0.17	0.22	0.23	0.27	0.30	0.38	0.41	0.48	0.50	0.63
Aluminium	5	0.10	0.15	0.21	0.25	0.33	0.36	0.50	0.57	_	_	_
	15	0.11	0.14	0.20	0.25	0.28	0.33	0.43	0.54	0.67	0.71	0.89
	25	0.11	0.15	0.22	0.25	0.29	0.34	0.44	0.53	0.68	0.69	0.88



Important notice:

This information represents empirical values. Deviations are possible.

# Reference values for cutting speed and feed rate



# Form knurling - non-cutting process

	Markaigas (	Vaurling wheel &	Vc [m/min]		f [mm/U]					
Material	Workpiece Ø [mm]	Knurling wheel Ø [mm]			Rad	dial		Ax		
								Pitch	[mm]	
			from	to	from	to	> 0.3 < 0.5	> 0.5 < 1.0	> 1.0 < 1.5	> 1.5 < 2.0
Free-cutting	< 10	10/15	20	50	0.04	0.08	0,14	0.09	0.06	0.05
steel	10 - 40	15/20	25	55	0.05	0.10	0.20	0.13	0.10	0.07
0.00.	40 - 100	20/25	30	60	0.05	0.10	0.25	0.18	0.12	0.08
	100 - 250	20/25	30	60	0.05	0.10	0.30	0.20	0.13	0.09
	> 250	25	30	60	0.05	0.10	0.32	0.21	0.14	0.10
Stainless	< 10	10/15	15	40	0.04	0.08	0.12	0.08	0.05	0.04
steel	10 - 40	15/20	20	50	0.05	0.10	0.17	0.11	0.09	0.06
	40 - 100	20/25	25	50	0.05	0.10	0.21	0.15	0.10	0.07
	100 - 250	20/25	25	50	0.05	0.10	0.26	0.17	0.11	0.08
	> 250	25	25	50	0.05	0.10	0.27	0.18	0.12	0.09
Brass	< 10	10/15	30	75	0.04	0.08	0.15	0.09	0.06	0.05
	10 - 40	15/20	40	85	0.05	0.10	0.21	0.14	0.11	0.07
	40 - 100	20/25	45	90	0.05	0.10	0.26	0.19	0.13	0.08
	100 - 250	20/25	45	90	0.05	0.10	0.32	0.21	0.14	0.09
	> 250	25	45	90	0.05	0.10	0.34	0.22	0.15	0.11
Aluminium	< 10	10/15	25	60	0.04	0.08	0.18	0.11	0.08	0.06
	10 - 40	15/20	30	65	0.05	0.10	0.25	0.16	0.13	0.09
	40 - 100	20/25	35	70	0.05	0.10	0.31	0.23	0.15	0.10
	100 - 250	20/25	35	70	0.05	0.10	0.38	0.25	0.16	0.11
	> 250	25	35	70	0.05	0.10	0.40	0.26	0.18	0.13

# **Cut knurling – cutting process**

	Warkningo Ø	Vaurling whool &	Vc [m/min]		f [mm/U]						
Material	Workpiece Ø [mm]	Knurling wheel Ø [mm]			Radial			Ax Pitch			
			from	to	from	to	> 0.3 < 0.5	> 0.5 < 1.0		> 1.5 < 2.0	
Free-cutting	< 10	10/15	40	70	0.04	0.08	0.20	0.13	0.08	0.07	
steel	10 - 40	15/25	50	90	0.05	0.10	0.28	0.18	0.14	0.10	
	40 - 100	25/32/42	65	110	0.05	0.10	0.35	0.25	0.17	0.11	
	100 - 250	25/32/42	65	110	0.05	0.10	0.42	0.28	0.18	0.13	
	> 250	32/42	80	100	0.05	0.10	0.45	0.29	0.20	0.14	
Stainless	< 10	10/15	22	40	0.04	0.08	0.14	0.09	0.06	0.05	
steel	10 - 40	15/25	30	50	0.05	0.10	0.20	0.13	0.10	0.07	
	40 - 100	25/32/42	35	60	0.05	0.10	0.25	0.18	0.12	0.08	
	100 - 250	25/32/42	35	60	0.05	0.10	0.29	0.20	0.13	0.09	
	> 250	32/42	45	55	0.05	0.10	0.31	0.21	0.14	0.10	
Brass	< 10	10/15	55	100	0.04	0.08	0.22	0.14	0.09	0.08	
	10 - 40	15/25	70	125	0.05	0.10	0.31	0.20	0.15	0.11	
	40 - 100	25/32/42	90	155	0.05	0.10	0.39	0.28	0.18	0.12	
	100 - 250	25/32/42	90	155	0.05	0.10	0.46	0.31	0.20	0.14	
	> 250	32/42	115	140	0.05	0.10	0.49	0.32	0.22	0.15	
Aluminium	< 10	10/15	70	120	0.04	0.08	0.12	0.08	0.05	0.04	
	10 - 40	15/25	80	150	0.05	0.10	0.17	0.11	0.08	0.06	
	40 - 100	25/32/42	110	160	0.05	0.10	0.21	0.15	0.10	0.07	
	100 - 250	25/32/42	110	160	0.05	0.10	0.25	0.17	0.11	0.08	
	> 250	32/42	130	150	0.05	0.10	0.27	0.18	0.12	0.08	



Important notice:

This information represents reference values.
The optimal values are to be found in the application.
Ensure effective cooling/lubrication to prevent chips from being rolled

into the profile and to prolong the life of the knurling wheels.

# Optimization of knurling

The pitch corresponds to the workpiece circumference

In many cases the user does not notice the relationship between the pitch and the workpiece circumference, since the pitch already corresponds to the workpiece circumference.

The knurling wheel can compensate the distortion of the pitch to produce good knurling (see Figure 1).

The pitch does not optimally correspond to the workpiece circumference

The more unfavourable the pitch corresponds to the workpiece circumference, the more the knurling wheel has to compensate. This results in knurling of poor quality and reduces the tool life.

# Effects on the knurling quality:

#### Form knurling:

The less favourable forming process (unnecessary strain on the material) results in a rough surface and reduced tool life. The sub-optimal penetration process causes material abrasion, which is formed into the knurling profile (indistinct profile flanks). This results in distortions of the knurling profile, which are evident in flattening of the profile and rounding of the tooth crest and tooth gullet (see Figure 2).

#### Cut knurling:

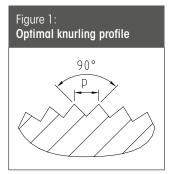
The sub-optimal penetration process of the knurling wheel results in indistinct profile flanks (shadowing). This results in distortions of the knurling profile, which are evident in flattening of the knurling profile and rounding of the tooth crest and tooth gullet (see Figure 2).

The pitch does not correspond to the work-piece circumference

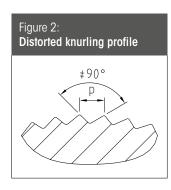
This is an extreme case. The knurling wheel cannot compensate the unfavourable relationship between the pitch and the workpiece circumference, or the profile is heavily distorted.

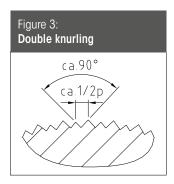
In the worst case this can result in "double knurling". The knurling wheel then no longer engages in the knurling profile after one workpiece rotation, but instead engages between the profile.

This is evident in the finer pitch of the knurling (see Figure 3).



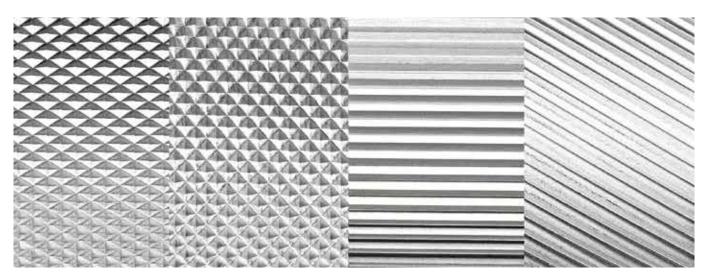
p = pitch





# Optimization of knurling





The knurling quality and the tool life can be improved substantially by optimising the knurling by changing the rough-turn diameter and/or the pitch.

# The following procedure ensures systematic optimisation:

 Correction of the rough-turn diameter until optimal knurling is achieved.

#### Note:

Changing the rough-turn diameter by only a few hundredths of a millimetre has a substantial effect on the circumference {factor  $\pi$  (x 3.14...)} and can change the knurling quality significantly.

If a correction is not possible (tolerances cannot be maintained; workpiece diameter should not be turned), then:

#### Check whether the pitch can be changed.

If it is not possible to change the pitch, it is necessary to manufacture a special knurling wheel with optimised pitch (defined number of teeth/outer diameter of knurling wheel).

Consultation is provided by the Hommel+Keller application engineer on the basis of a workpiece drawing and information about the machine.

The calculation of the optimal pitch is conducted on the basis of approximate formulas. Due to influencing factors (such as differences in materials) further optimisation may be necessary.

## **Summary:**

#### **Customer requirements:**

- Clear, distinct knurling profile
- Fully formed teeth
- No double knurling/no incomplete knurling

#### **Solutions:**

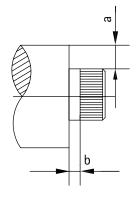
- 1) Optimisation measures by user:
- Correction of the rough-turn diameter
- Change of the pitch

### 2) Optimisation measures by Hommel+Keller:

- Optimisation by manufacturing a special knurling wheel:
- Calculation of the number of teeth allows development of a knurling wheel that is specially designed for the application based on the optimal relationship between the diameter and the number of teeth.

# Influencing factors

# Clearance dimensions/plunge cut for cut knurling



#### ■ Clearance dimension for cut knurling – workpiece collar

Due to the design-related inclination (30°) of the knurling head and the overhang of the cover plate, knurling up to a collar is not possible with a cut knurling tool.

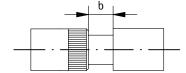
Dimension a corresponds to the increase in the step (mm). Dimension b corresponds to the minimum clearance for the respective knurling wheel ( $\varnothing$  specified in mm).

Dimension a is calculated with shoulder-height and 1/2 pitsch with a flank angle of  $90^{\circ}$ .

Dimension "a" [mm]	b 10 x 3 x 6 mm	b 15 x 4 x 8 mm	b 25 x 6 x 8 mm	b 42 x 13 x 16 mm
1	1.3	1.5	2	3
3	2.7	4.2	3.2	5
5	3	4.9	4.5	7
7	3	5.2	5.5	9
10	3	5.2	6.7	12
12	3	5.2	7	12

Dimension a = shoulder-height + 1/2 pitsch (flank angle  $90^{\circ}$ )

.



#### ■ Minimum width of the plunge cut – cut knurling

If knurling is to be applied in the middle of the workpiece, a "knurling undercut" is needed (the knurling wheel requires a chamfer for centring).

Depth of the plunge cut: at least 1/2 pitch + 0.3 mm.

Dimension Knurling wheels [mm]	10 x 3 x 6 mm	15 x 4 x 8 mm	25 x 6 x 8 mm	42 x 13 x 16 mm
Minimum width of plunge (b)	3 mm	4 mm	6.5 mm	14 mm

# Influencing factors



# Factors affecting quality and process reliability during knurling

Numerous factors must be taken into account and optimised in order to manufacture a high-quality and functional knurling profile.

The factors listed below are crucial for process reliability, quality, precision and surface quality and should be taken into account in order to optimise the application.

		Knurl width Knurling wheel with chamfer		
			Base material for the knurling wheel	
	Quality and specification of the knurling	Material properties	Hardness of the knurling wheel	
			Reworking	PVD coating TENIFER®
	wheel		Run-out accuracy	
			Concentricity	
Tool properties		Precision	Profile properties	Sharpness of tooth crest Radius in tooth gullet
			Trome properties	Flank angle
				Plunge knurling
				Feed knurling
		Type of knurling process	Form knurling	Plunge/feed knurling
			Cut knurling	
	Type of tool holder used	Quality and condition of the axle pin/bearing bush		
		Stability/freedom from vibration		
		Precision		
	Precision			
Machine properties	Stability/freedom from vibration			
	Hardness			
	Strength			
	Cutting values	Feed rate		
	Plunge depth			
Properties of	Cooling/lubrication	Cutting speed		
the material to be machined	Clearance angle			
be machined		Rough-turn diameter		
		Pitch/number of teeth		
	Quality of teeth	Material distortion		

# Otto Dieterle Spezialwerkzeuge GmbH

Predigerstr. 56

78628 Rottweil, Germany

Tel.: +49 (0) 741 / 9 42 05 - 0 Fax: +49 (0) 741 / 9 42 05 - 50 Email: info@dieterle-tools.com

www.dieterle-tools.com

