

1. DIAMETAL

2. BIMU

3. IFANGER

4. ARNO

5. SPHINX

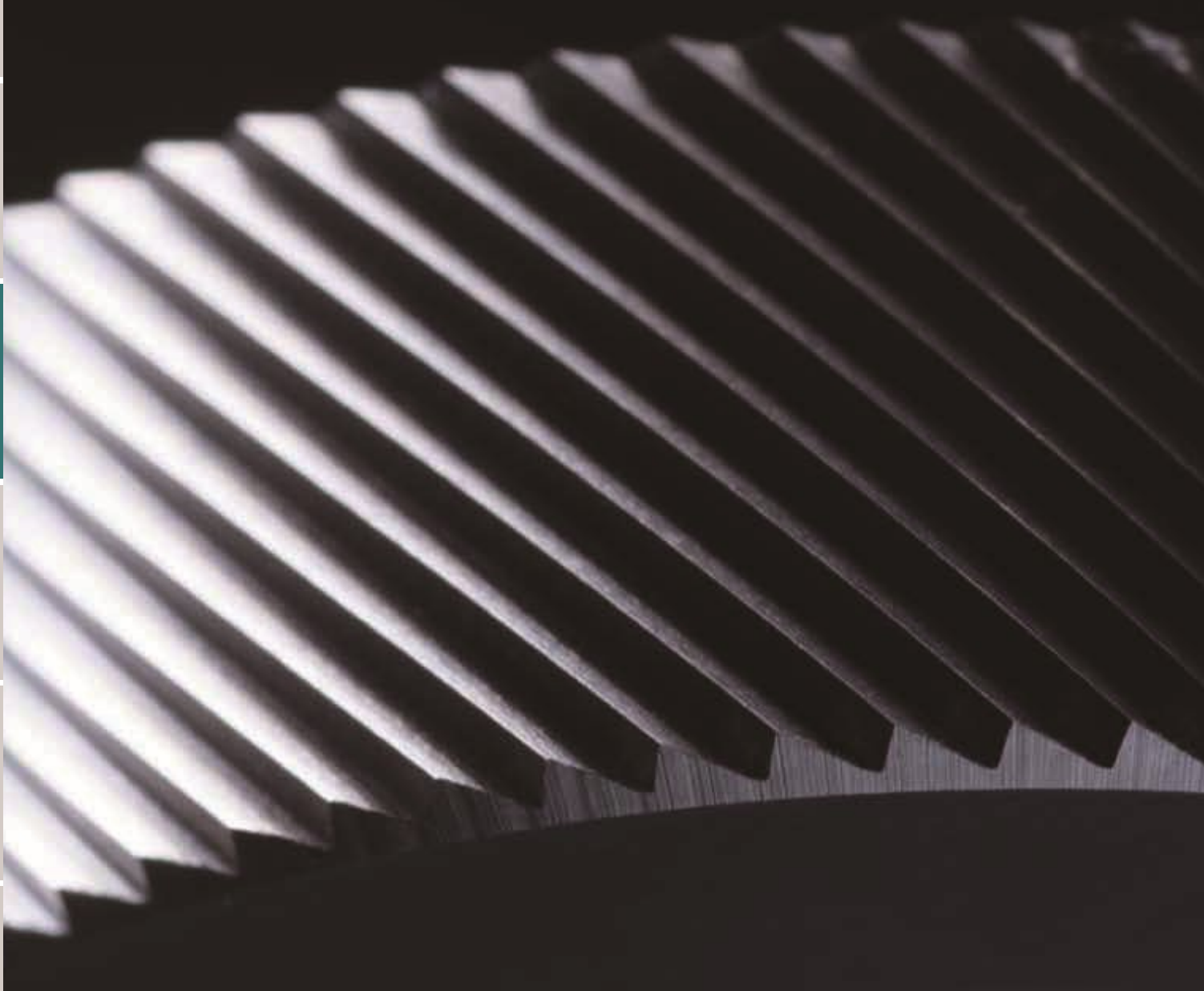
6. ZEUS

7. PRAMET

8. BECKER

9. WHIZCUT

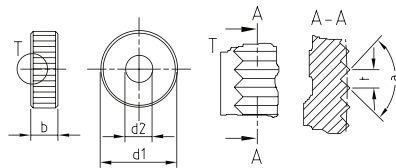
zeus Knurling wheels



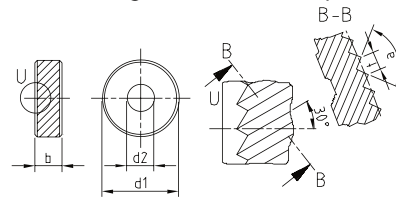
THE KNURLING WHEEL-DIN 403

The DIN 403 is the standard for the knurling profile on the knurling wheel. The DIN 403 specifies the knurl profiles AA, BL, BR, GE, GV, KE and KV. Knurling wheels with profiles other than the ones described in the DIN 82, are classified as customized knurling wheels and are manufactured by Hommel + Keller according to customer drawings.

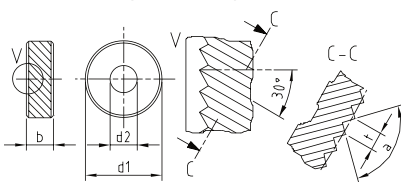
AA Knurling wheel with straight pattern



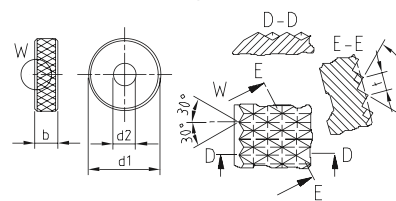
BL Knurling wheel, left-hand spiral



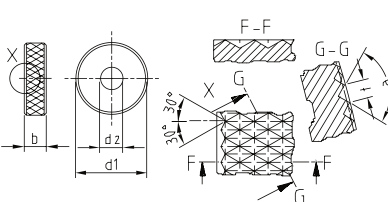
BR Knurling wheel, right-hand spiral



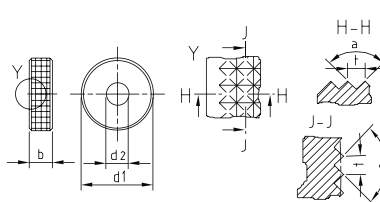
GE Cross-knurling wheel, points up, 30°, male



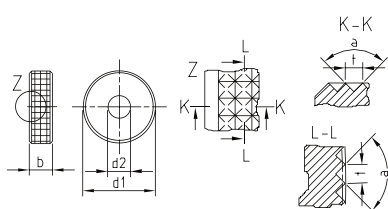
GV Cross-knurling wheel, points down, 30°, female



KE Square knurling wheel, crossed, points up, 90°, male



KV Square knurling wheel, crossed, points down, 90°, female

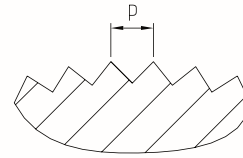


The appropriate knurling wheel's profile depends on the required profile on the work piece according to DIN 82 and the knurling tool applied. The product details from page 15 onwards, suggests the appropriate knurling wheel according to the application.



THE KNURLING WHEEL'S PITCH

The knurling wheel's pitch 'p' refers to the distance between the tips of two teeth. Standard pitch sizes according to DIN 403 include: $p=0,5/0,6/0,8/1,0/1,2/1,6$. The Hommel + Keller product programme covers also non-standard pitch sizes. They are listed below in mm and TPI. Additional pitch sizes are available on demand.



STANDARD PITCH SIZES:

mm 0,3	0,4	0,5	0,6	0,7	0,8	0,9	mm 0,3	0,4	0,5	0,6	0,7	0,8	0,9		
TPI 84,7	63,5	50,8	42,3	36,3	31,8	28,2	TPI 84,7	63,5	50,8	42,3	36,3	31,8	28,2		
mm 1,0	1,2	1,5	1,6	1,8	2,0		mm 1,0	1,2	1,5	1,6	1,8	2,0			
TPI 25,4	21,2	16,9	15,9	14,1	12,7		TPI 25,4	21,2	16,9	15,9	14,1	12,7			

KNURLINGS ACCORDING TO AMERICAN NATIONAL STANDARD CP (TPI) AND DP

Apart from the DIN 82 / DIN 403 the American National Standard specifies the pitch and profile angle of the knurling application. The CP (TPI) and DP are distinguished as follows:

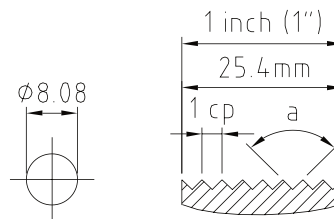
CP (TPI) = Circular pitch (Teeth per inch)

This standard specifies the number of teeth on a length of 1 inch (1"~25,4 mm). The CP (TPI) is calculated by dividing 1 inch through the number of teeth. The profile angle is determined according to the number of teeth with either 70° or 90°.

Arithmetic example:

Value CP (TPI) = 20

Pitch (mm) = 1 inch (~25,4 mm) : 20 (Number of teeth) = 1,27 mm



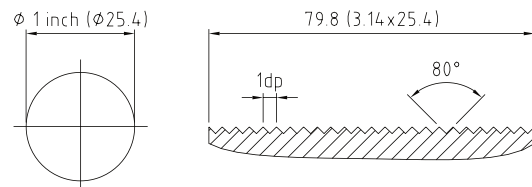
DP = Diametral pitch

Contrary to the CP (TPI), this standard specifies the number of teeth along the circumference of a circle with a diameter of 1 inch (1"~25,4 mm). The pitch is calculated by dividing the circumference (= 1 inch) by the number of teeth. The profile angle is generally determined with 80°.

Arithmetic example:

Value DP = 64

Pitch (mm) = 1 inch (~25,4) x π (3,14...) : 64 (Number of teeth) = 1.25 mm



A list of mm and CP (TPI) conversions can be found on page 63. Furthermore, the Technical Appendix contains a separate chapter on how to optimize the relation between number of teeth and work piece circumference by adjusting the pitch size.

Form knurling – non-cutting process



Knurling wheels, milled, with 45° chamfer – PM

Standard variants	Profile		Dimension [mm]			Pitches [mm]
			Ø	Width	Bore	
No. 11	AA		10	4	4	○
No. 11	AA		15	4	4	○
No. 11	AA		15	6	4	○
No. 11	AA		15	6	6A8	□
No. 11	AA		15	6	6A11	□
No. 11	AA		20	6	6	○
No. 11	AA		20	8	6	●
No. 11	AA		20	8	6A13	□
No. 11	AA		20	10	6	□
No. 11	AA		25	6	6	□
No. 11	AA		25	8	6	□
No. 11	AA		25	10	6	□
No. 11	BL	30°	10	4	4	○
No. 11			15	4	4	□
No. 11			20	6	6	□
No. 11	BL	45°	20	8	6	■
No. 11			10	4	4	□
No. 11			15	4	4	□
No. 11	BR	30°	20	8	6	□
No. 11			10	4	4	○
No. 11			15	4	4	□
No. 11			20	6	6	□
No. 11	BR	45°	20	8	6	■
No. 11			10	4	4	□
No. 11			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° 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°

GE45°

KE

Knurling wheels, milled, with 45° chamfer – PM

Standard variants	Profile		Dimension [mm]			Pitches [mm]
			∅	Width	Bore	
No. 11	GE	30°	15	4	4	◆
No. 11			15	6	4	◆
No. 11			20	6	6	◆
No. 11			20	8	6	□
No. 11	GE	45°	20	8	6	□
No. 11	KE		☑	☑	☑	☑

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



GV30°

GV45°

KV

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

Knurling wheels, formed, with 45° chamfer – PM

Standard variants	Profile		Dimension [mm]			Pitches [mm]
			∅	Width	Bore	
No. 21	GV	30°	15	4	4	◆
No. 21			15	6	4	◆
No. 21			20	6	6	◆
No. 21			20	8	6	□
No. 21	GV	45°	20	8	6	◆
No. 21	KV		☑	☑	☑	☑

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 variants	Profile		Dimension [mm]			Pitches [mm]
			∅	Width	Bore	
No. 16	AA		8.9	2.5	4	○
No. 16			10	3	6	○
No. 16			14.5	3	5	■
No. 16			15	4	8	○
No. 16			21.5	5	8	■
No. 16			25	6	8	■
No. 16	BL	15°	10	3	6	◆
No. 16			15	4	8	□
No. 16			21.5	5	8	□
No. 16			25	6	8	■
No. 16	BL	30°	10	3	6	◆
No. 16			14.5	3	5	◆
No. 16			15	4	8	○
No. 16			21.5	5	8	□
No. 16	BR	15°	25	6	8	■
No. 16			10	3	6	◆
No. 16			15	4	8	□
No. 16			21.5	5	8	□
No. 16	BR	30°	25	6	8	■
No. 16			10	3	6	◆
No. 16			14.5	3	5	◆
No. 16			15	4	8	○
No. 16	BR	30°	21.5	5	8	□
No. 16			25	6	8	■

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

Special knurling wheels



HV



HHV

Bead knurl – No. 60

Note: Please indicate the bead diameter when ordering.



KAA



KGE



KBR



KBL

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.



C*



DL 20° *



DR 20° *

* Only radiuses > 3 mm are possible.



E



FL 20°



FR 20°

Concave and convex knurling wheels – No. 80

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



Nr. 90



Nr. 92



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).

Wheel geometries – see "Technology", page 44

Burnishing rolls



RRA



RRE

제우스 버니싱(burnishing) 롤은 누르는 타입 홀더에 병행 사용할 수 있다.
 고객 맞춤형으로 개발 및 생산 가능.
 이 시스템은 원형 제품 및 모서리, 원뿔형 가공 등 불룩하고 오목한
 외부 윤곽을 가공하는데 적합.

적용 :

제우스의 버니싱(burnishing) 롤은 주로
 롤러-버니싱과 R-버니싱을 사용한다.

결과 :

- 표면 조도 개선
- 표면 치수의 안정화
- 표면의 강도 개선

이점 :

- 작업물은 가공 후 마찰이 적고 부식에 대한 저항이 증가
- 그라인딩(grinding), 호닝(honing), 랩핑(lapping)과 같은 후처리 작업은
 간단한 롤러-버니싱 가공으로 대체 할 수 있음
- 391타입의 홀더로 사용 시 베어링과 클램핑 장치의 마모를 줄이고 제품의
 하중을 최소화 할 수 있다

Burnishing roll type RRA – cylindrical

Type	Dimension [mm]			Version		
	Ø	Width	Bore	N° 04 polished, Rz 4 µm	N° 05 ground, Rz 2–3 µm	N° 06 ground & polished, Rz 1 µm
RRA	10	4	4	✓	✓	✓
	15	4	4	✓	✓	✓
	20	8	6	✓	✓	✓
	25	8	6	✓	✓	✓

Burnishing roll type RRE – convex

Type	Dimension [mm]				Version		
	Ø	Width	Bore	R	N° 04 polished, Rz 4 µm	N° 05 ground, Rz 2–3 µm	N° 06 ground & polished, Rz 1 µm
RRE	10	4	4	2	✓	✓	✓
	15	4	4	2	✓	✓	✓
	20	8	6	6	✓	✓	✓
	25	8	6	6	✓	✓	✓

Marking Tools

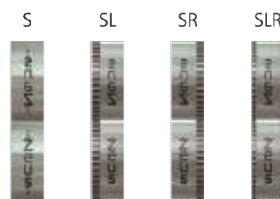
■ REVOLVING SYSTEM – zeus® MARKING ROLL No. 40 / No. 40-A / No. 40-K



No. 40: for identical text

- The design is based on the diameter of the workpiece

Possible types of marking No. 40, No. 40-A, No. 40-K:



No. 40-A: exchangeable characters



No. 40-K: for marking of tapered workpieces and flat faces.



■ SPRING-RETURN SYSTEM – zeus® MARKING ROLL No. 41



- The design is independent of the workpiece diameter

Possible types of marking:



■ SPRING-RETURN SYSTEM – zeus® MARKING ROLL No. 42



- The design is independent of the workpiece diameter
- Exchangeable segments

Possible types of marking:



■ SPRING-RETURN SYSTEM – zeus® MARKING ROLL No. 43



- The design is independent of the workpiece diameter
- Exchangeable segments
- Marking up to a shoulder

Possible types of marking:



■ SPRING-RETURN SYSTEM – zeus® MARKING ROLL No. 44



- The design is independent of the workpiece diameter
- Marking up to a shoulder


Possible types of marking:



More information on page 47 (marking rolls) and in the catalogue zeus® Marking Technology.

Material displacement – non-cutting forming


경험을 통해 축적된 누르는 타입 사용시 소재 변화에 대한 자료

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

Pitch [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 steel	5	0.08	0.14	0.18	0.22	0.27	0.29	0.35	0.50	–	–	–
	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 steel	5	0.10	0.15	0.20	0.25	0.28	0.30	0.42	0.41	–	–	–
	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: RBL30°/RBR30° (knurling profile on workpiece)
 Knurling wheels according to DIN 403: BR30°/BL30° (knurling profile on knurling wheel)  RBL30°  RBR30°

Pitch [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 steel	5	0.11	0.15	0.20	0.24	0.28	0.34	0.45	0.55	–	–	–
	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 steel	5	0.09	0.14	0.19	0.25	0.31	0.34	0.45	0.52	–	–	–
	15	0.12	0.20	0.23	0.31	0.35	0.40	0.51	0.62	0.66	0.73	0.97
	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: RGE30° (knurling profile on workpiece)
 Knurling wheels according to DIN 403: BR30°+ BL30° (knurling profile on knurling wheel)  RGE30°

Pitch [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 steel	5	0.12	0.16	0.20	0.25	0.33	0.41	0.55	0.65	–	–	–
	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 steel	5	0.11	0.20	0.25	0.30	0.36	0.39	0.55	0.55	–	–	–
	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

Material	Workpiece Ø [mm]	Knurling wheel Ø [mm]	Vc [m/min]		f [mm/U]					
					Radial		Axial			
			from	to	from	to	Pitch [mm]			
							>0.3 < 0.5	>0.5 < 1.0	>1.0 < 1.5	>1.5 < 2.0
Free-cutting steel	< 10	10/15	20	50	0.04	0.08	0.14	0.09	0.06	0.05
	10 - 40	15/20	25	55	0.05	0.10	0.20	0.13	0.10	0.07
	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 steel	< 10	10/15	15	40	0.04	0.08	0.12	0.08	0.05	0.04
	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

Material	Workpiece Ø [mm]	Knurling wheel Ø [mm]	Vc [m/min]		f [mm/U]					
					Radial		Axial			
			from	to	from	to	Pitch [mm]			
							>0.3 < 0.5	>0.5 < 1.0	>1.0 < 1.5	>1.5 < 2.0
Free-cutting steel	< 10	10/15	40	70	0.04	0.08	0.20	0.13	0.08	0.07
	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 steel	< 10	10/15	22	40	0.04	0.08	0.14	0.09	0.06	0.05
	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.