

GÜHRING



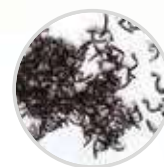
Ratio®

Roughing end mills The complete programme

GÜHRING – YOUR WORLDWIDE PARTNER

NEW RATIO®-HIGH-PERFORMANCE ROUGHING END MILLS

with optimised geometries



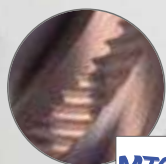
the innovative round knuckle HRf geometry ensures particularly small chips

with neck clearance and 2 length options

high cutting efficiency, round knuckle HRf geometry for minimum power consumption and lower cutting force

larger flutes guarantee an optimal chip evacuation with increased feeds

large face chip chambers and double protected cutting edge corners for minimum vibration plunging, ramping and orbital milling



MTC

new roughing end mill with ROUND KNUCKLE-TYPE GEOMETRY

- // perfect stability thanks to extra-flat round knuckle-type HRf roughing geometry
- // lower cutting forces ideal for less powerful machines & clamping conditions
- // stable machining conditions allow high metal removal rates with cutting depths up to 2xD

You can find the new roughing end mills with round knuckle-type geometry on page 10 and 11.



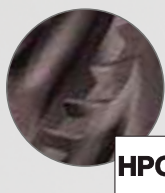
short chips thanks
to innovative
roughing geometry



more stable asymmetrical
knuckles produce smooth
rough-finish surfaces

larger flutes for
optimal chip evacuation

roughing geometry reduces the
cutting pressure in comparison
to smooth cutting milling cutters



HPC

new roughing end mill with FLAT KNUCKLE-TYPE TEETH

- // increased metal removal rate by utilising the entire cutting edge length
- // up to 60 % longer tool life with high process reliability
- // ideal for less powerful machines and unstable clamping

You can find the new roughing end mills with flat knuckle-type teeth from page 12.



For high-performance roughing of aluminium with Carbo-coating

RF 100 A WF | page 23-26



For machining of steel, high tensile and cast iron materials

RF 100 U HF | page 12-14



Universal application for soft tough steels, stainless, low-alloyed cast iron and non-ferrous materials

RF 100 VA NF | page 16-17

RATIO



RATIO END MILLS

- // extremely smooth operation and max. metal removal rates thanks to unequal helix angles and unequal cutting edge
- // long tool life and process reliable machining thanks to tough carbide substrates and wear-resistant coatings
- // material-specific flute profiles and face cutting for optimal smooth running and perfect chip evacuation



For universal roughing operations

GS 100 U | page 19-20



For high-performance roughing of
aluminium and non-ferrous metals

GS 100 A | page 27



For all tough materials

RS 100 U | page 18



Machining of high tensile materials

RS 100 F | page 15



UNIVERSAL

ISO code

P	Steel, high-alloyed steel
M	Stainless steel
K	Grey cast iron, spheroidal graphite iron and malleable cast iron
N	Aluminium and other non-ferrous metals
S	Special, super and titanium-alloys
H	Hardened steel and chilled cast iron

On the product pages you will find recommendations on the suitability for the application groups and information on the max. tensile strength and hardness for every tool:

- optimal suitability
- limited suitability

Coatings

○ bright **Ch** Carbo **F** FIRE/nano FIRE **a** TiAlN nanoA **Y** Signum

Pictograms

Tool material	VHM Solid carbide finest grain (carbide-UF) HSS-E-PM High speed steel
Shank form	 B  HA  HB to DIN 6535
Standard	 DIN 844K  DIN 6527L to DIN  WN to Gühring standard
Type	HF HR HRf NF NRf WF WR Application area similar to DIN 1836
Applications	 Slotting  Roughing  Ramping  Helix  Drilling
Length	 short (DIN)  medium length  extra length  3xD
Number of cutting edges	 3  3-6  4  4-5  4-6 Number of major cutting edges
Helix angle	 20°  30°  45°  30°/32°  36°/38°  30°/29°/31° Size of helix angle/number of different helix angles
Rake angle	 3°  4°  7°  8°  9°  11°  12° Rake angle of circumference cutting edges
Cutting edge form	 45° Corner chamfer
Feed	 for lateral feed and ramping  for lateral feed, ramping and drilling

RF 100 HRf

 Ratio[®] 

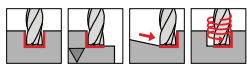
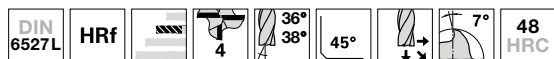




P	M	K	N	S	H	Tool illustration	Z	Hardness	Length	Helix angle °	Tool material	Surface	d1/mm	Article no.	Page
Standard Ratio end mills RF 100 U															
•	•	•	•	•	•		NEW	4	48 HRC		36°/38°	VHM	Y	6.000 - 20.000	6970 10
•	•	•	•	•	•		NEW	4	48 HRC		36°/38°	VHM	Y	6.000 - 20.000	6971 10
•	•	•	•	•	•		NEW	4	48 HRC		36°/38°	VHM	Y	6.000 - 20.000	6972 11
•	•	•	•	•	•		NEW	4	48 HRC		36°/38°	VHM	Y	6.000 - 20.000	6973 11
•	•	•	•	•	•			4			30°/32°	VHM	F	6.000 - 25.000	6881 12
•	•	•	•	•	•			4			30°/32°	VHM	F	6.000 - 25.000	6882 12
•	•	•	•	•	•			4	3xD		30°/32°	VHM	F	6.000 - 20.000	6883 13
•	•	•	•	•	•			4	3xD		30°/32°	VHM	F	6.000 - 20.000	6884 13
•	•	•	•	•	•			4			30°/32°	VHM	F	6.000 - 20.000	6885 14
•	•	•	•	•	•			4			30°/32°	VHM	F	6.000 - 20.000	6886 14
High-performance roughing end mills RS 100 F															
•	•	•	•	•	•			5-6	48 HRC		45°	VHM	F	6.000 - 25.000	6889 15
•	•	•	•	•	•			5-6	48 HRC		45°	VHM	F	6.000 - 25.000	6890 15
Ratio end mills RF 100 VA															
•	•	•	•	•	•			4			36°/38°	VHM	a	5.000 - 25.000	6877 16
•	•	•	•	•	•			4			36°/38°	VHM	a	5.000 - 25.000	6878 16
•	•	•	•	•	•			4			36°/38°	VHM	a	6.000 - 20.000	6879 17
•	•	•	•	•	•			4			36°/38°	VHM	a	6.000 - 20.000	6880 17
High-performance roughing end mills RS 100 U															
•	•	•	•	•	•			4-5			30°	VHM	F	6.000 - 25.000	6887 18
•	•	•	•	•	•			4-5			30°	VHM	F	6.000 - 25.000	6888 18
Roughing end mills GS 100 U (fine teeth)															
•	•	•	•	•	•			4-5			30°	VHM	F	6.000 - 25.000	3723 19
•	•	•	•	•	•			4			30°	VHM	F	6.000 - 20.000	3365 20

P	M	K	N	S	H	Tool illustration	Z	Hard-ness	Length	Helix angle °	Tool material	Sur-face	d1/mm	Article no.	Page
Hard roughing end mills GS 100 H (fine teeth)															
•	•	•	•	•	•		4	55 HRC		20°	VHM	Y	6.000 - 25.000	6704	21
•	•	•	•	•	•		4	55 HRC		20°	VHM	Y	6.000 - 25.000	6705	21
•	•	•	•	•	•		4	55 HRC		20°	VHM	Y	6.000 - 20.000	3682	22
Ratio end mills Alu RF 100 A															
•	•	•	•	•	•		NEW 3			30° 29° 31°	VHM	Cb	6.000 - 20.000	6974	23
•	•	•	•	•	•		NEW 3			30° 29° 31°	VHM	Cb	6.000 - 20.000	6975	23
•	•	•	•	•	•		NEW 3			30° 29° 31°	VHM	Cb	6.000 - 20.000	6976	24
•	•	•	•	•	•		NEW 3			30° 29° 31°	VHM	Cb	6.000 - 20.000	6977	24
•	•	•	•	•	•		3			30° 29° 31°	VHM	○	6.000 - 25.000	6868	25
•	•	•	•	•	•		3			30° 29° 31°	VHM	○	6.000 - 25.000	6869	25
•	•	•	•	•	•		3			30° 29° 31°	VHM	○	6.000 - 20.000	6870	26
•	•	•	•	•	•		3			30° 29° 31°	VHM	○	6.000 - 20.000	6871	26
Roughing end mills GS 100 A (coarse teeth)															
•	•	•	•	•	•		3			30°	VHM	○	6.000 - 25.000	3364	27
•	•	•	•	•	•		3			30°	VHM	○	6.000 - 25.000	3127	27
Roughing end mills GS 40 (fine teeth)															
•	•	•	•	•	•		3			30°	HSS-E-PM	○	6.000 - 20.000	3322	28
•	•	•	•	•	•		3			30°	HSS-E-PM	F	6.000 - 20.000	3668	28
•	•	•	•	•	•		4-6			30°	HSS-E-PM	○	6.000 - 32.000	3340	29
•	•	•	•	•	•		4-6			30°	HSS-E-PM	F	6.000 - 32.000	3660	29
Roughing end mills GS 80 (fine teeth)															
•	•	•	•	•	•		3-6			45°	HSS-E-PM	F	4.000 - 25.000	6756	31

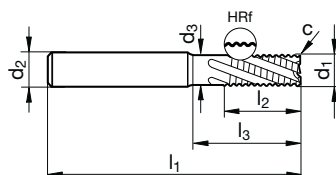
Standard Ratio end mills RF 100 U



P	•	GÜHRING NAVIGATOR Cutting data page 32-33
M	•	
K	•	
N	•	
S	○	
H	○	

• neck clearance
• centre cutting

Tool material	Solid carbide	
Surface		
Type	HRf	HRf
Shank form	HA	HB

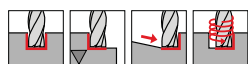
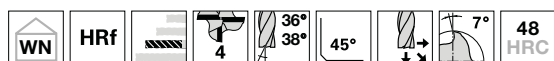


Article no.									6970	6971
Discount group									106	106
d1 h10	d2 h6	d3	l1	l2	l3	c	Z	Code no.	Availability	
mm	mm	mm	mm	mm	mm	mm x 45°				
6.00	6.00	5.70	57	13.0	20.0	0.12	4	6.00	•	•
8.00	8.00	7.70	63	19.0	26.0	0.16	4	8.00	•	•
10.00	10.00	9.50	72	22.0	30.0	0.20	4	10.00	•	•
12.00	12.00	11.50	83	26.0	36.0	0.24	4	12.00	•	•
16.00	16.00	15.50	92	32.0	42.0	0.32	4	16.00	•	•
20.00	20.00	19.50	104	38.0	52.0	0.40	4	20.00	•	•

ISO	Hardness	v _c	f _z (mm/z) / Ø								v _c	f _z (mm/z) / Ø							
			3	6	8	10	12	16	20	3		6	8	10	12	16	20		
			a _p = 1,0xD					a _e = 1,0xD				a _p = 1,5xD					a _e max = 0,75xD		
P	≤ 850 N/mm ²	135	0,009	0,018	0,024	0,032	0,038	0,051	0,064	160	0,010	0,021	0,028	0,037	0,044	0,059	0,074		
	≥ 850 N/mm ²	100	0,008	0,017	0,022	0,030	0,036	0,048	0,060	120	0,010	0,019	0,026	0,035	0,041	0,055	0,069		
M	≤ 750 N/mm ²	90	0,008	0,017	0,022	0,030	0,036	0,048	0,060	110	0,010	0,019	0,026	0,035	0,041	0,055	0,069		
	≥ 750 N/mm ²	55	0,007	0,013	0,018	0,025	0,030	0,040	0,050	70	0,008	0,016	0,021	0,030	0,036	0,048	0,060		
S	Ni-based	25	0,006	0,012	0,016	0,022	0,026	0,035	0,044	40	0,007	0,014	0,019	0,026	0,032	0,042	0,053		
	Ti-based	50	0,007	0,013	0,018	0,025	0,030	0,040	0,050	70	0,008	0,016	0,021	0,030	0,036	0,048	0,060		
K	≤ 240 HB	120	0,009	0,018	0,024	0,032	0,038	0,051	0,064	140	0,010	0,021	0,028	0,037	0,044	0,059	0,074		
	≥ 240 HB	105	0,008	0,017	0,022	0,030	0,036	0,048	0,060	130	0,010	0,019	0,026	0,035	0,041	0,055	0,069		



Standard Ratio end mills RF 100 U



P • GUHRING NAVIGATOR

M • Cutting data page 32-33

K •

N

S ○

H ○

- neck clearance
- centre cutting

Tool material

Solid carbide

Surface

Y

Y

Type

HRf

HRf

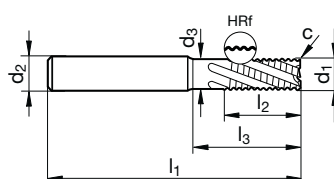
Shank form

HA

HB

NEW

NEW



Article no.

6972

6973

Discount group

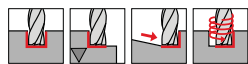
106

106

d1 h10	d2 h6	d3	l1	l2	l3	c	Z	Code no.	Availability
mm	mm	mm	mm	mm	mm	mm x 45°			
6.00	6.00	5.70	65	13.0	28.0	0.12	4	6.00	• •
8.00	8.00	7.70	75	19.0	38.0	0.16	4	8.00	• •
10.00	10.00	9.50	80	22.0	38.0	0.20	4	10.00	• •
12.00	12.00	11.50	93	26.0	46.0	0.24	4	12.00	• •
16.00	16.00	15.50	108	32.0	58.0	0.32	4	16.00	• •
20.00	20.00	19.50	126	38.0	74.0	0.40	4	20.00	• •

ISO	Hardness	v _c	f _z (mm/z)/Ø							v _c	f _z (mm/z)/Ø						
			3	6	8	10	12	16	20		3	6	8	10	12	16	20
			a _p = 1,0xD					a _e = 1,0xD			a _p = 2,0xD					a _e max = 0,33xD	
P	≤ 850 N/mm ²	55	0,003	0,006	0,008	0,011	0,013	0,018	0,022	80	0,004	0,008	0,011	0,015	0,017	0,023	0,029
	≥ 850 N/mm ²	40	0,003	0,006	0,008	0,011	0,013	0,017	0,021	60	0,004	0,008	0,010	0,014	0,016	0,022	0,027
K	≤ 240 HB	50	0,003	0,006	0,008	0,011	0,013	0,018	0,022	70	0,004	0,008	0,011	0,015	0,017	0,023	0,029
	≥ 240 HB	40	0,003	0,006	0,008	0,011	0,013	0,017	0,021	65	0,004	0,008	0,010	0,014	0,016	0,022	0,027

Standard Ratio end mills RF 100 U



P	•	GÜHRING NAVIGATOR Cutting data page 32-33
M		
K	•	
N		
S		
H		

- neck clearance
- centre cutting

Tool material

Solid carbide

Surface

F

F

Type

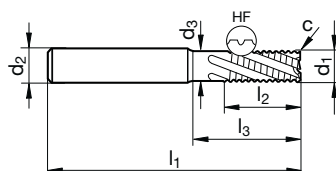
HF

HF

Shank form

HA

HB



Article no.

6881

6882

Discount group

106

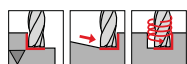
106

d1 h10	d2 h6	d3	l1	l2	l3	c	Z	Code no.	Availability
mm	mm	mm	mm	mm	mm	mm x 45°			
6.00	6.00	5.70	57	13.0	20.0	0.12	4	6.00	•
8.00	8.00	7.70	63	19.0	26.0	0.16	4	8.00	•
10.00	10.00	9.50	72	22.0	30.0	0.20	4	10.00	•
12.00	12.00	11.50	83	26.0	36.0	0.24	4	12.00	•
16.00	16.00	15.50	92	32.0	42.0	0.32	4	16.00	•
20.00	20.00	19.50	104	38.0	52.0	0.40	4	20.00	•
25.00	25.00	24.00	121	45.0	63.0	0.50	4	25.00	•

ISO	Hardness	v _c	f _z (mm/z)/Ø							v _c	f _z (mm/z)/Ø						
			3	6	8	10	12	16	20		3	6	8	10	12	16	20
			a _p = 1,0xD				a _e = 1,0xD				a _p = 1,5xD				a _e max = 0,75xD		
P	≤ 850 N/mm ²	135	0,009	0,018	0,024	0,032	0,038	0,051	0,064	160	0,010	0,021	0,028	0,037	0,044	0,059	0,074
	≥ 850 N/mm ²	100	0,008	0,017	0,022	0,030	0,036	0,048	0,060	120	0,010	0,019	0,026	0,035	0,041	0,055	0,069
K	≤ 240 HB	120	0,009	0,018	0,024	0,032	0,038	0,051	0,064	140	0,010	0,021	0,028	0,037	0,044	0,059	0,074
	≥ 240 HB	105	0,008	0,017	0,022	0,030	0,036	0,048	0,060	130	0,010	0,019	0,026	0,035	0,041	0,055	0,069



Standard Ratio end mills RF 100 U



P	•	GÜHRING NAVIGATOR
M		
K	•	
N		
S		
H		

Cutting data page 32-33

• neck clearance
• centre cutting

Tool material

Solid carbide

Surface

F

F

Type

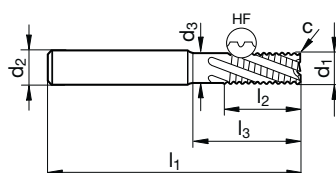
HF

HF

Shank form

HA

HB



Article no.

6883

6884

Discount group

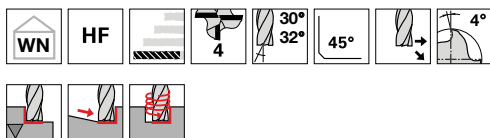
106

106

d1 h10	d2 h6	d3	l1	l2	l3	c	Z	Code no.	Availability
mm	mm	mm	mm	mm	mm	mm x 45°			
6.00	6.00	5.70	65	18.0	28.0	0.12	4	6.00	•
8.00	8.00	7.70	75	24.0	38.0	0.16	4	8.00	•
10.00	10.00	9.50	80	30.0	38.0	0.20	4	10.00	•
12.00	12.00	11.50	93	36.0	46.0	0.24	4	12.00	•
16.00	16.00	15.50	108	48.0	58.0	0.32	4	16.00	•
20.00	20.00	19.50	126	60.0	74.0	0.40	4	20.00	•

ISO	Hardness	v _c	f _z (mm/z) / Ø							v _c	f _z (mm/z) / Ø						
			3	6	8	10	12	16	20		3	6	8	10	12	16	20
			a _p = 1,0xD					a _e = 1,0xD			a _p = 3,0xD					a _e max = 0,33xD	
P	≤ 850 N/mm ²	80	0,005	0,011	0,014	0,019	0,023	0,031	0,038	140	0,008	0,016	0,022	0,029	0,035	0,047	0,058
	≥ 850 N/mm ²	60	0,005	0,010	0,013	0,018	0,022	0,029	0,036	105	0,008	0,015	0,020	0,027	0,033	0,044	0,055
K	≤ 240 HB	70	0,005	0,011	0,014	0,019	0,023	0,031	0,038	125	0,008	0,016	0,022	0,029	0,035	0,047	0,058
	≥ 240 HB	65	0,005	0,010	0,013	0,018	0,022	0,029	0,036	110	0,008	0,015	0,020	0,027	0,033	0,044	0,055

Standard Ratio end mills RF 100 U



P	•
M	
K	•
N	
S	
H	

GÜHRING NAVIGATOR

Cutting data page 32-33

- neck clearance
- centre cutting

Tool material

Solid carbide

Surface

F

F

Type

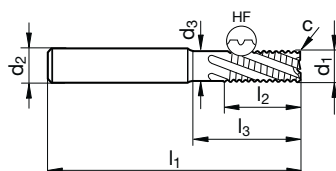
HF

HF

Shank form

HA

HB



Article no.

6885

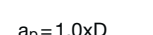
6886

Discount group

106

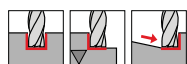
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d1 h10	d2 h6	d3	l1	l2	l3	c	Z	Code no.	Availability
mm	mm	mm	mm	mm	mm	mm x 45°			
6.00	6.00	5.70	75	13.0	34.0	0.12	4	6.00	•
8.00	8.00	7.70	100	19.0	49.0	0.16	4	8.00	•
10.00	10.00	9.50	100	22.0	48.0	0.20	4	10.00	•
12.00	12.00	11.50	150	26.0	58.0	0.24	4	12.00	•
16.00	16.00	15.50	150	32.0	78.0	0.32	4	16.00	•
20.00	20.00	19.50	150	38.0	78.0	0.40	4	20.00	•

ISO	Hardness	v _c	f _z (mm/z)/Ø								v _c	f _z (mm/z)/Ø							
			3	6	8	10	12	16	20	3		6	8	10	12	16	20		
			a _p = 1,0xD					a _e = 1,0xD				a _p = 1,0xD					a _e max = 0,75xD		
P	≤ 850 N/mm ²	80	0,005	0,011	0,014	0,019	0,023	0,031	0,038	110	0,007	0,014	0,019	0,026	0,031	0,041	0,052		
	≥ 850 N/mm ²	60	0,005	0,010	0,013	0,018	0,022	0,029	0,036	85	0,007	0,014	0,018	0,024	0,029	0,039	0,048		
M	≤ 750 N/mm ²	55	0,005	0,010	0,013	0,018	0,022	0,029	0,036	75	0,007	0,014	0,018	0,024	0,029	0,039	0,048		
	≥ 750 N/mm ²	35	0,004	0,008	0,011	0,015	0,018	0,024	0,030	50	0,006	0,011	0,015	0,021	0,025	0,034	0,042		
S	Ni-based	15	0,004	0,007	0,010	0,013	0,016	0,021	0,026	30	0,005	0,010	0,013	0,018	0,022	0,030	0,037		
	Ti-based	30	0,004	0,008	0,011	0,015	0,018	0,024	0,030	50	0,006	0,011	0,015	0,021	0,025	0,034	0,042		
K	≤ 240 HB	70	0,005	0,011	0,014	0,019	0,023	0,031	0,038	100	0,007	0,014	0,019	0,026	0,031	0,041	0,052		
	≥ 240 HB	65	0,005	0,010	0,013	0,018	0,022	0,029	0,036	90	0,007	0,014	0,018	0,024	0,029	0,039	0,048		



High-performance roughing end mills RS 100 F



P • GUHRING NAVIGATOR

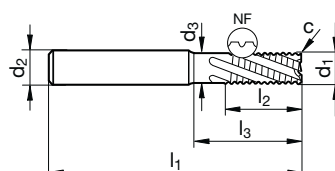
Cutting data page 32-33

P	•
M	
K	•
N	
S	
H	○

- neck clearance
- centre cutting

Tool material **Solid carbide**

Surface	F	F
Type	NF	NF
Shank form	HA	HB



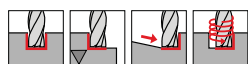
Article no. **6889** **6890**

Discount group **106** **106**

d1 h10	d2 h6	d3	l1	l2	l3	c	Z	Code no.	Availability
mm	mm	mm	mm	mm	mm	mm x 45°			
6.00	6.00	5.70	57	13.0	20.0	0.30	5	6.00	•
8.00	8.00	7.70	63	19.0	26.0	0.30	5	8.00	•
10.00	10.00	9.50	72	22.0	30.0	0.30	5	10.00	•
12.00	12.00	11.50	83	26.0	36.0	0.50	5	12.00	•
14.00	14.00	13.50	83	26.0	36.0	0.50	5	14.00	•
16.00	16.00	15.50	92	32.0	42.0	0.50	6	16.00	•
18.00	18.00	17.50	92	32.0	42.0	0.50	6	18.00	•
20.00	20.00	19.50	104	38.0	52.0	0.50	6	20.00	•
25.00	25.00	24.00	121	45.0	63.0	0.60	6	25.00	•

ISO	Hardness	v _c	f _z (mm/z)/Ø							v _c	f _z (mm/z)/Ø						
			3	6	8	10	12	16	20		3	6	8	10	12	16	20
			a _p = 1,0xD				a _e = 1,0xD				a _p = 1,5xD				a _e max = 0,75xD		
P	≤ 850 N/mm ²	135	0,009	0,018	0,024	0,032	0,038	0,051	0,064	160	0,010	0,021	0,028	0,037	0,044	0,059	0,074
	≥ 850 N/mm ²	100	0,008	0,017	0,022	0,030	0,036	0,048	0,060	120	0,010	0,019	0,026	0,035	0,041	0,055	0,069
K	≤ 240 HB	120	0,009	0,018	0,024	0,032	0,038	0,051	0,064	140	0,010	0,021	0,028	0,037	0,044	0,059	0,074
	≥ 240 HB	105	0,008	0,017	0,022	0,030	0,036	0,048	0,060	130	0,010	0,019	0,026	0,035	0,041	0,055	0,069

Ratio end mills RF 100 VA



P	•	GÜHRING NAVIGATOR Cutting data page 32-33
M	•	
K	•	
N	○	
S	○	
H		

• neck clearance
• centre cutting

Tool material

Solid carbide

Surface

a

a

Type

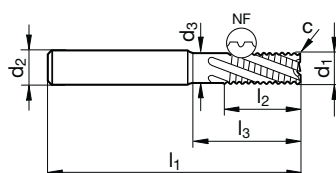
NF

NF

Shank form

HA

HB



Article no.

6877

6878

Discount group

106

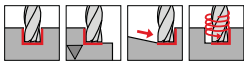
106

d1 h10	d2 h6	d3	l1	l2	l3	c	Z	Code no.	Availability
mm	mm	mm	mm	mm	mm	mm x 45°			
5.00	6.00	4.80	57	13.0	18.0	0.10	4	5.00	•
6.00	6.00	5.70	57	13.0	20.0	0.12	4	6.00	•
7.00	8.00	6.70	63	16.0	24.9	0.14	4	7.00	•
8.00	8.00	7.70	63	19.0	26.0	0.16	4	8.00	•
9.00	10.00	8.70	72	19.0	29.9	0.18	4	9.00	•
10.00	10.00	9.50	72	22.0	30.0	0.20	4	10.00	•
12.00	12.00	11.50	83	26.0	36.0	0.24	4	12.00	•
14.00	14.00	13.50	83	26.0	36.0	0.28	4	14.00	•
16.00	16.00	15.50	92	32.0	42.0	0.32	4	16.00	•
18.00	18.00	17.50	92	32.0	42.0	0.36	4	18.00	•
20.00	20.00	19.50	104	38.0	52.0	0.40	4	20.00	•
25.00	25.00	24.00	121	45.0	63.0	0.50	4	25.00	•

ISO	Hardness	v _c	f _z (mm/z)/Ø							v _c	f _z (mm/z)/Ø						
			3	6	8	10	12	16	20		3	6	8	10	12	16	20
			a _p = 1,0xD				a _e = 1,0xD				a _p = 1,5xD				a _e max = 0,75xD		
P	≤ 850 N/mm ²	135	0,009	0,018	0,024	0,032	0,038	0,051	0,064	160	0,010	0,021	0,028	0,037	0,044	0,059	0,074
	≥ 850 N/mm ²	100	0,008	0,017	0,022	0,030	0,036	0,048	0,060	120	0,010	0,019	0,026	0,035	0,041	0,055	0,069
M	≤ 750 N/mm ²	90	0,008	0,017	0,022	0,030	0,036	0,048	0,060	110	0,010	0,019	0,026	0,035	0,041	0,055	0,069
	≥ 750 N/mm ²	55	0,007	0,013	0,018	0,025	0,030	0,040	0,050	70	0,008	0,016	0,021	0,030	0,036	0,048	0,060
S	Ni-based	25	0,006	0,012	0,016	0,022	0,026	0,035	0,044	40	0,007	0,014	0,019	0,026	0,032	0,042	0,053
	Ti-based	50	0,007	0,013	0,018	0,025	0,030	0,040	0,050	70	0,008	0,016	0,021	0,030	0,036	0,048	0,060
K	≤ 240 HB	120	0,009	0,018	0,024	0,032	0,038	0,051	0,064	140	0,010	0,021	0,028	0,037	0,044	0,059	0,074
	> 240 HB	105	0,008	0,017	0,022	0,030	0,036	0,048	0,060	130	0,010	0,019	0,026	0,035	0,041	0,055	0,069



Ratio end mills RF 100 VA



P	•	GÜHRING NAVIGATOR
M	•	
K	•	
N	○	
S	○	
H		
		Cutting data page 32-33
		• neck clearance
		• centre cutting

Tool material

Solid carbide

Surface

a

a

Type

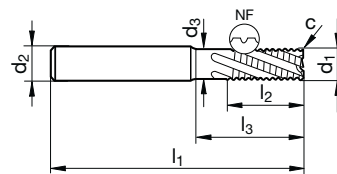
NF

NF

Shank form

HA

HB



Article no.

6879

6880

Discount group

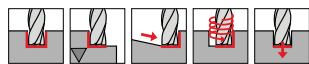
106

106

d1 h10	d2 h6	d3	l1	l2	l3	c	Z	Code no.	Availability
mm	mm	mm	mm	mm	mm	mm x 45°			
6.00	6.00	5.70	65	10.0	28.0	0.12	4	6.00	•
8.00	8.00	7.70	75	12.0	38.0	0.16	4	8.00	•
10.00	10.00	9.50	80	14.0	38.0	0.20	4	10.00	•
12.00	12.00	11.50	93	16.0	46.0	0.24	4	12.00	•
16.00	16.00	15.50	108	22.0	58.0	0.32	4	16.00	•
20.00	20.00	19.50	126	26.0	74.0	0.40	4	20.00	•

ISO	Hardness	v _c	f _z (mm/z) / Ø								v _c	f _z (mm/z) / Ø							
			3	6	8	10	12	16	20	3		6	8	10	12	16	20		
			a _p = 1,0xD					a _e = 1,0xD				a _p = 1,0xD					a _e max = 0,75xD		
P	≤ 850 N/mm ²	80	0,005	0,011	0,014	0,019	0,023	0,031	0,038	110	0,007	0,014	0,019	0,026	0,031	0,041	0,052		
	≥ 850 N/mm ²	60	0,005	0,010	0,013	0,018	0,022	0,029	0,036	85	0,007	0,014	0,018	0,024	0,029	0,039	0,048		
M	≤ 750 N/mm ²	55	0,005	0,010	0,013	0,018	0,022	0,029	0,036	75	0,007	0,014	0,018	0,024	0,029	0,039	0,048		
	≥ 750 N/mm ²	35	0,004	0,008	0,011	0,015	0,018	0,024	0,030	50	0,006	0,011	0,015	0,021	0,025	0,034	0,042		
S	Ni-based	15	0,004	0,007	0,010	0,013	0,016	0,021	0,026	30	0,005	0,010	0,013	0,018	0,022	0,030	0,037		
	Ti-based	30	0,004	0,008	0,011	0,015	0,018	0,024	0,030	50	0,006	0,011	0,015	0,021	0,025	0,034	0,042		
K	≤ 240 HB	70	0,005	0,011	0,014	0,019	0,023	0,031	0,038	100	0,007	0,014	0,019	0,026	0,031	0,041	0,052		
	≥ 240 HB	65	0,005	0,010	0,013	0,018	0,022	0,029	0,036	90	0,007	0,014	0,018	0,024	0,029	0,039	0,048		

High-performance roughing end mills RS 100 U



P	•	GÜHRING NAVIGATOR Cutting data page 32-33
M	•	
K	•	
N	○	
S	•	
H		

• neck clearance
• centre cutting

Tool material

Solid carbide

Surface

F

F

Type

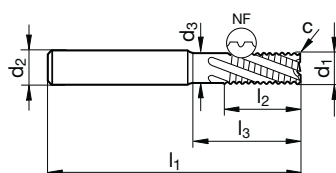
NF

NF

Shank form

HA

HB



Article no.

6887

6888

Discount group

106

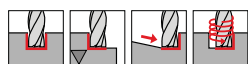
106

d1 h10	d2 h6	d3	l1	l2	l3	c	Z	Code no.	Availability
mm	mm	mm	mm	mm	mm	mm x 45°			
6.00	6.00	5.70	57	13.0	20.0	0.12	4	6.00	•
8.00	8.00	7.70	63	19.0	26.0	0.16	4	8.00	•
10.00	10.00	9.50	72	22.0	30.0	0.20	4	10.00	•
12.00	12.00	11.50	83	26.0	36.0	0.24	4	12.00	•
14.00	14.00	13.50	83	26.0	36.0	0.28	4	14.00	•
16.00	16.00	15.50	92	32.0	42.0	0.32	4	16.00	•
18.00	18.00	17.50	92	32.0	42.0	0.36	4	18.00	•
20.00	20.00	19.50	104	38.0	52.0	0.40	4	20.00	•
25.00	25.00	24.00	121	45.0	63.0	0.60	5	25.00	•

ISO	Hardness	v _c	f _z (mm/z)/Ø								v _c	f _z (mm/z)/Ø							
			3	6	8	10	12	16	20	3		6	8	10	12	16	20		
			a _p = 1,0xD					a _e = 1,0xD				a _p = 1,5xD					a _e max = 0,75xD		
P	≤ 850 N/mm ²	135	0,009	0,018	0,024	0,032	0,038	0,051	0,064		160	0,010	0,021	0,028	0,037	0,044	0,059	0,074	
	≥ 850 N/mm ²	100	0,008	0,017	0,022	0,030	0,036	0,048	0,060		120	0,010	0,019	0,026	0,035	0,041	0,055	0,069	
M	≤ 750 N/mm ²	90	0,008	0,017	0,022	0,030	0,036	0,048	0,060		110	0,010	0,019	0,026	0,035	0,041	0,055	0,069	
	≥ 750 N/mm ²	55	0,007	0,013	0,018	0,025	0,030	0,040	0,050		70	0,008	0,016	0,021	0,030	0,036	0,048	0,060	
S	Ni-based	25	0,006	0,012	0,016	0,022	0,026	0,035	0,044		40	0,007	0,014	0,019	0,026	0,032	0,042	0,053	
	Ti-based	50	0,007	0,013	0,018	0,025	0,030	0,040	0,050		70	0,008	0,016	0,021	0,030	0,036	0,048	0,060	
K	≤ 240 HB	120	0,009	0,018	0,024	0,032	0,038	0,051	0,064		140	0,010	0,021	0,028	0,037	0,044	0,059	0,074	
	≥ 240 HB	105	0,008	0,017	0,022	0,030	0,036	0,048	0,060		130	0,010	0,019	0,026	0,035	0,041	0,055	0,069	



Roughing end mills GS 100 U (fine teeth)



P	•	GÜHRING NAVIGATOR
M	•	
K	•	
N	○	
S	○	
H		

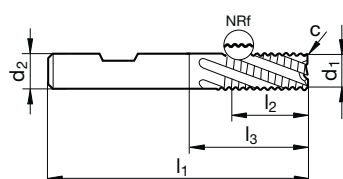
Cutting data page 32-33

• centre cutting

Tool material **Solid carbide**

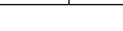
Surface **F**

Type **NRf**

Shank form **HB**

Article no. **3723**

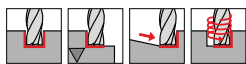
Discount group **117**

d1 h10	d2 h6	l1	l2	l3	c	Z	Code no.	Availability
mm	mm	mm	mm	mm	mm x 45°			
6.00	6.00	57	13.0	21.0	0.30	4	6.000	•
8.00	8.00	63	19.0	27.0	0.30	4	8.000	•
10.00	10.00	72	22.0	32.0	0.30	4	10.000	•
12.00	12.00	83	26.0	38.0	0.50	4	12.000	•
14.00	14.00	83	26.0	38.0	0.50	4	14.000	•
14.00	16.00	92	32.0	42.0	0.50	4	14.001	•
16.00	16.00	92	32.0	44.0	0.50	4	16.000	•
18.00	18.00	92	32.0	44.0	0.50	4	18.000	•
18.00	20.00	104	38.0	50.0	0.50	4	18.001	•
20.00	20.00	104	38.0	54.0	0.50	4	20.000	•
25.00	25.00	121	45.0	65.0	0.60	5	25.000	•

ISO	Hardness	v _c	f _z (mm/z)/Ø							v _c	f _z (mm/z)/Ø						
			3	6	8	10	12	16	20		3	6	8	10	12	16	20
			a _p = 1,0xD				a _e = 1,0xD				a _p = 1,5xD				a _e max = 0,75xD		
P	≤ 850 N/mm ²	120	0,008	0,017	0,022	0,030	0,036	0,048	0,060	140	0,010	0,019	0,026	0,035	0,041	0,055	0,069
	≥ 850 N/mm ²	90	0,008	0,015	0,020	0,028	0,034	0,045	0,056	110	0,009	0,017	0,023	0,032	0,039	0,052	0,064
M	≤ 750 N/mm ²	80	0,008	0,015	0,020	0,028	0,034	0,045	0,056	100	0,009	0,017	0,023	0,032	0,039	0,052	0,064
	≥ 750 N/mm ²	50	0,006	0,012	0,016	0,022	0,026	0,035	0,044	70	0,007	0,014	0,019	0,026	0,032	0,042	0,053
S	Ni-based	20	0,005	0,011	0,014	0,020	0,024	0,032	0,040	30	0,006	0,013	0,017	0,024	0,029	0,038	0,048
	Ti-based	45	0,006	0,012	0,016	0,022	0,026	0,035	0,044	60	0,007	0,014	0,019	0,026	0,032	0,042	0,053
K	≤ 240 HB	100	0,008	0,017	0,022	0,030	0,036	0,048	0,060	120	0,010	0,019	0,026	0,035	0,041	0,055	0,069
	> 240 HB	90	0,008	0,015	0,020	0,028	0,034	0,045	0,056	110	0,009	0,017	0,023	0,032	0,039	0,052	0,064

Please reduce cutting values for bright finished tools: v_c -50% and f_z -25%

Roughing end mills GS 100 U (fine teeth)



P	•	GÜHRING NAVIGATOR Cutting data page 32-33
M	•	
K	•	
N	○	
S	○	
H		

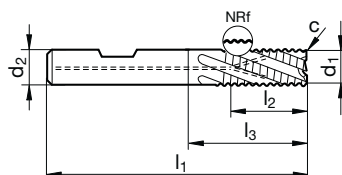
• with internal coolant supply
• centre cutting

Tool material **Solid carbide**

Surface **F**

Type **NRf**

Shank form **HB**



Article no. **3365**

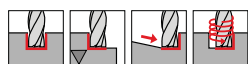
Discount group **106**

d1 h10	d2 h6	l1	l2	l3	c	Z	Code no.	Availability
mm	mm	mm	mm	mm	mm x 45°			
6.00	6.00	57	13.0	21.0	0.30	4	6.000	•
8.00	8.00	63	19.0	27.0	0.30	4	8.000	•
10.00	10.00	72	22.0	32.0	0.30	4	10.000	•
12.00	12.00	83	26.0	38.0	0.50	4	12.000	•
16.00	16.00	92	32.0	44.0	0.50	4	16.000	•
20.00	20.00	104	38.0	54.0	0.50	4	20.000	•

ISO	Hardness	v _c	f _z (mm/z) / Ø								v _c	f _z (mm/z) / Ø							
			3	6	8	10	12	16	20	3		6	8	10	12	16	20		
			a _p = 1,0xD					a _e = 1,0xD				a _p = 1,5xD					a _e max = 0,75xD		
P	≤ 850 N/mm²	120	0,008	0,017	0,022	0,030	0,036	0,048	0,060	140	0,010	0,019	0,026	0,035	0,041	0,055	0,069		
	≥ 850 N/mm²	90	0,008	0,015	0,020	0,028	0,034	0,045	0,056	110	0,009	0,017	0,023	0,032	0,039	0,052	0,064		
M	≤ 750 N/mm²	80	0,008	0,015	0,020	0,028	0,034	0,045	0,056	100	0,009	0,017	0,023	0,032	0,039	0,052	0,064		
	≥ 750 N/mm²	50	0,006	0,012	0,016	0,022	0,026	0,035	0,044	70	0,007	0,014	0,019	0,026	0,032	0,042	0,053		
S	Ni-based	20	0,005	0,011	0,014	0,020	0,024	0,032	0,040	30	0,006	0,013	0,017	0,024	0,029	0,038	0,048		
	Ti-based	45	0,006	0,012	0,016	0,022	0,026	0,035	0,044	60	0,007	0,014	0,019	0,026	0,032	0,042	0,053		
K	≤ 240 HB	100	0,008	0,017	0,022	0,030	0,036	0,048	0,060	120	0,010	0,019	0,026	0,035	0,041	0,055	0,069		
	≥ 240 HB	90	0,008	0,015	0,020	0,028	0,034	0,045	0,056	110	0,009	0,017	0,023	0,032	0,039	0,052	0,064		



Hard roughing end mills GS 100 H (fine teeth)



P • M K • N S H • GÜHRING NAVIGATOR

Cutting data page 32-33

- with internal coolant supply
- centre cutting

Tool material

Solid carbide

Surface

Y

Y

Type

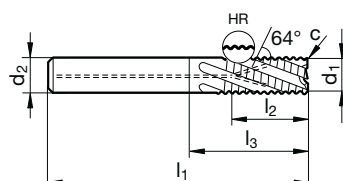
HR

HR

Shank form

HA

HB



Article no.

6704

6705

Discount group

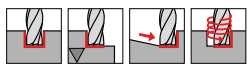
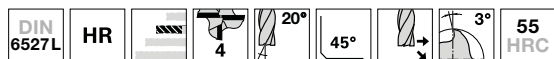
106

106

d1 h10	d2 h6	l1	l2	l3	c	Z	Code no.	Availability
mm	mm	mm	mm	mm	mm x 45°			
6.00	6.00	57	13.0	21.0	0.30	4	6.000	•
8.00	8.00	63	19.0	27.0	0.30	4	8.000	•
10.00	10.00	72	22.0	32.0	0.30	4	10.000	•
12.00	12.00	83	26.0	38.0	0.50	4	12.000	•
16.00	16.00	92	32.0	44.0	0.50	4	16.000	•
20.00	20.00	104	38.0	54.0	0.50	4	20.000	•
25.00	25.00	121	45.0	65.0	0.60	4	25.000	•

ISO	Hardness	v _c	f _z (mm/z)/Ø							v _c	f _z (mm/z)/Ø						
			3	6	8	10	12	16	20		3	6	8	10	12	16	20
P	≥ 850 N/mm ²	90	0,008	0,015	0,020	0,028	0,034	0,045	0,056	110	0,009	0,017	0,023	0,032	0,039	0,052	0,064
K	≥ 240 HB	90	0,008	0,015	0,020	0,028	0,034	0,045	0,056	110	0,009	0,017	0,023	0,032	0,039	0,052	0,064
H	≤ 55 HRC	50	0,005	0,011	0,014	0,020	0,024	0,032	0,040	70	0,007	0,014	0,019	0,026	0,031	0,042	0,052

Hard roughing end mills GS 100 H (fine teeth)



P	•	GÜHRING NAVIGATOR Cutting data page 32-33
M		
K	•	
N		
S		
H	•	

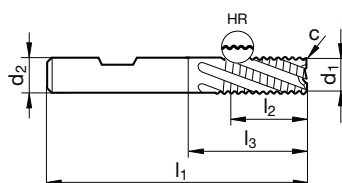
• centre cutting

Tool material **Solid carbide**

Surface **Y**

Type **HR**

Shank form **HB**



Article no. **3682**

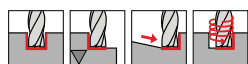
Discount group **117**

d1 h10	d2 h6	l1	l2	l3	c	Z	Code no.	Availability
mm	mm	mm	mm	mm	mm x 45°			
6.00	6.00	57	13.0	21.0	0.30	4	6.000	•
8.00	8.00	63	19.0	27.0	0.30	4	8.000	•
10.00	10.00	72	22.0	32.0	0.30	4	10.000	•
12.00	12.00	83	26.0	38.0	0.50	4	12.000	•
16.00	16.00	92	32.0	44.0	0.50	4	16.000	•
20.00	20.00	104	38.0	54.0	0.50	4	20.000	•

ISO	Hardness	v _c	f _z (mm/z)/Ø								v _c	f _z (mm/z)/Ø							
			3	6	8	10	12	16	20	3		6	8	10	12	16	20		
			a _p = 1,0xD					a _e = 1,0xD				a _p = 1,5xD					a _e max = 0,33xD		
P	≥ 850 N/mm ²	90	0,008	0,015	0,020	0,028	0,034	0,045	0,056	110	0,009	0,017	0,023	0,032	0,039	0,052	0,064		
K	≥ 240 HB	90	0,008	0,015	0,020	0,028	0,034	0,045	0,056	110	0,009	0,017	0,023	0,032	0,039	0,052	0,064		
H	≤ 55 HRC	50	0,005	0,011	0,014	0,020	0,024	0,032	0,040	70	0,007	0,014	0,019	0,026	0,031	0,042	0,052		



Ratio end mills Alu RF 100 A



P GÜHRING NAVIGATOR

Cutting data page 32-33

P	
M	
K	
N	•
S	
H	

- with internal cooling: Radial and axial exits
- neck clearance
- centre cutting

Tool material

Solid carbide

Surface

Ⓢ

Ⓢ

Type

WF

WF

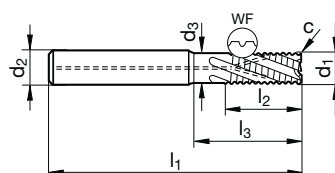
Shank form

HA

HB

NEW

NEW



Article no.

6974

6975

Discount group

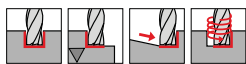
106

106

d1 js9	d2 h6	d3	l1	l2	l3	c	Z	Code no.	Availability
mm	mm	mm	mm	mm	mm	mm x 45°			
6.00	6.00	5.70	57	13.0	20.0	0.06	3	6.00	•
8.00	8.00	7.70	63	19.0	26.0	0.08	3	8.00	•
10.00	10.00	9.50	72	22.0	30.0	0.10	3	10.00	•
12.00	12.00	11.50	83	26.0	36.0	0.12	3	12.00	•
16.00	16.00	15.50	92	32.0	42.0	0.16	3	16.00	•
20.00	20.00	19.50	104	38.0	52.0	0.20	3	20.00	•

ISO	Hardness	v _c	f _z (mm/z) / Ø							v _c	f _z (mm/z) / Ø						
			3	6	8	10	12	16	20		3	6	8	10	12	16	20
			a _p = 1,0xD					a _e = 1,0xD			a _p = 1,5xD					a _e max = 0,75xD	
N	≤ 5 % Si	375	0,011	0,021	0,028	0,037	0,044	0,059	0,074	440	0,012	0,024	0,032	0,043	0,051	0,068	0,085
	≥ 5 % Si	180	0,010	0,019	0,026	0,035	0,042	0,056	0,070	210	0,011	0,022	0,029	0,040	0,048	0,064	0,081
NE	≤ 850 N/mm ²	200	0,010	0,019	0,026	0,035	0,042	0,056	0,070	230	0,011	0,022	0,029	0,040	0,048	0,064	0,081

Ratio end mills Alu RF 100 A



P GÜHRING NAVIGATOR

Cutting data page 32-33

P	
M	
K	
N	•
S	
H	

- with internal cooling: Radial and axial exits
- neck clearance
- centre cutting

Tool material

Solid carbide

Surface

Ⓢ

Ⓢ

Type

WF

W

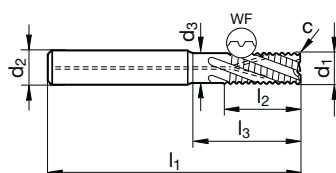
Shank form

HA

HB

NEW

NEW



Article no.

6976

6977

Discount group

106

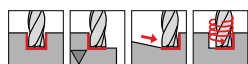
106

d1 js9	d2 h6	d3	l1	l2	l3	c	Z	Code no.	Availability
mm	mm	mm	mm	mm	mm	mm x 45°			
6.00	6.00	5.70	65	13.0	28.0	0.06	3	6.00	•
8.00	8.00	7.70	75	19.0	38.0	0.08	3	8.00	•
10.00	10.00	9.50	80	22.0	38.0	0.10	3	10.00	•
12.00	12.00	11.50	93	26.0	46.0	0.12	3	12.00	•
16.00	16.00	15.50	108	32.0	58.0	0.16	3	16.00	•
20.00	20.00	19.50	126	38.0	74.0	0.20	3	20.00	•

ISO	Hardness	v _c	f _z (mm/z)/Ø								v _c	f _z (mm/z)/Ø							
			3	6	8	10	12	16	20	3		6	8	10	12	16	20		
			a _p = 1,0xD					a _e = 1,0xD				a _p = 1,5xD					a _e max = 0,75xD		
N	≤ 5 % Si	375	0,011	0,021	0,028	0,037	0,044	0,059	0,074	440	0,012	0,024	0,032	0,043	0,051	0,068	0,085		
	≥ 5 % Si	180	0,010	0,019	0,026	0,035	0,042	0,056	0,070	210	0,011	0,022	0,029	0,040	0,048	0,064	0,081		
NE	≤ 850 N/mm ²	200	0,010	0,019	0,026	0,035	0,042	0,056	0,070	230	0,011	0,022	0,029	0,040	0,048	0,064	0,081		

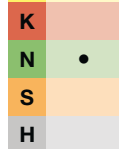


Ratio end mills Alu RF 100 A



P GÜHRING NAVIGATOR

M Cutting data page 32-33



- neck clearance
- centre cutting

Tool material

Solid carbide

Surface



Type

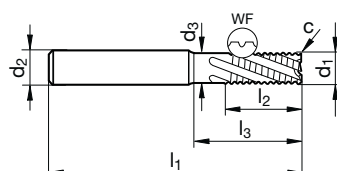
WF

WF

Shank form

HA

HB



Article no.

6868

6869

Discount group

106

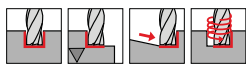
106

d1 js9	d2 h6	d3	l1	l2	l3	c	Z	Code no.	Availability
mm	mm	mm	mm	mm	mm	mm x 45°			
6.00	6.00	5.70	57	13.0	20.0	0.06	3	6.00	● ●
8.00	8.00	7.70	63	19.0	26.0	0.08	3	8.00	● ●
10.00	10.00	9.50	72	22.0	30.0	0.10	3	10.00	● ●
12.00	12.00	11.50	83	26.0	36.0	0.12	3	12.00	● ●
16.00	16.00	15.50	92	32.0	42.0	0.16	3	16.00	● ●
20.00	20.00	19.50	104	38.0	52.0	0.20	3	20.00	● ●
25.00	25.00	24.00	121	45.0	63.0	0.25	3	25.00	● ●

ISO	Hardness	v _c	f _z (mm/z)/Ø								v _c	f _z (mm/z)/Ø							
			3	6	8	10	12	16	20	3		6	8	10	12	16	20		
			a _p = 1,0xD				a _e = 1,0xD					a _p = 1,5xD				a _e max = 0,75xD			
N	≤ 5 % Si	375	0,011	0,021	0,028	0,037	0,044	0,059	0,074	440	0,012	0,024	0,032	0,043	0,051	0,068	0,085		
	≥ 5 % Si	180	0,010	0,019	0,026	0,035	0,042	0,056	0,070	210	0,011	0,022	0,029	0,040	0,048	0,064	0,081		
NE	≤ 850 N/mm ²	200	0,010	0,019	0,026	0,035	0,042	0,056	0,070	230	0,011	0,022	0,029	0,040	0,048	0,064	0,081		

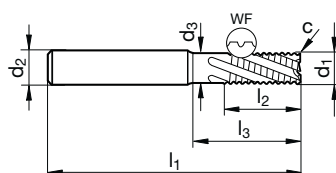
Our Carbo-coating is available as an option to improve chip flow and tool life

Ratio end mills Alu RF 100 A



P	GUHRING NAVIGATOR
M	Cutting data page 32-33
K	
N	•
S	
H	• neck clearance • centre cutting

Tool material	Solid carbide	
Surface	○	○
Type	WF	WF
Shank form	HA	HB



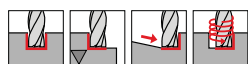
Article no.									6870	6871
Discount group									106	106
d1 js9	d2 h6	d3	l1	l2	l3	c	Z	Code no.	Availability	
mm	mm	mm	mm	mm	mm	mm x 45°				
6.00	6.00	5.70	65	13.0	28.0	0.06	3	6.00	●	●
8.00	8.00	7.70	75	19.0	38.0	0.08	3	8.00	●	●
10.00	10.00	9.50	80	22.0	38.0	0.10	3	10.00	●	●
12.00	12.00	11.50	93	26.0	46.0	0.12	3	12.00	●	●
16.00	16.00	15.50	108	32.0	58.0	0.16	3	16.00	●	●
20.00	20.00	19.50	126	38.0	74.0	0.20	3	20.00	●	●

ISO	Hardness	v _c	f _z (mm/z)/Ø							v _c	f _z (mm/z)/Ø						
			3	6	8	10	12	16	20		3	6	8	10	12	16	20
			a _p = 1,0xD				a _e = 1,0xD				a _p = 1,5xD				a _e max = 0,75xD		
N	≤ 5 % Si	375	0,011	0,021	0,028	0,037	0,044	0,059	0,074	440	0,012	0,024	0,032	0,043	0,051	0,068	0,085
	≥ 5 % Si	180	0,010	0,019	0,026	0,035	0,042	0,056	0,070	210	0,011	0,022	0,029	0,040	0,048	0,064	0,081
NE	≤ 850 N/mm²	200	0,010	0,019	0,026	0,035	0,042	0,056	0,070	230	0,011	0,022	0,029	0,040	0,048	0,064	0,081

Our Carbo-coating is available as an option to improve chip flow and tool life



Roughing end mills GS 100 A (coarse teeth)



P	GÜHRING NAVIGATOR
M	Cutting data page 32-33
K	
N	•
S	
H	• with internal coolant supply • centre cutting

Tool material

Solid carbide

Surface

○

○

Type

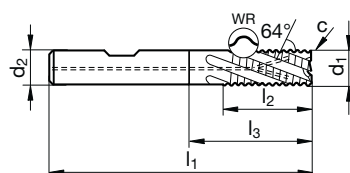
WR

WR

Shank form

HB

HB



Article no.

3364

3127

Discount group

106

117

d1 h10	d2 h6	l1	l2	l3	c	Z	Code no.	Availability
mm	mm	mm	mm	mm	mm x 45°			
6.00	6.00	57	10.0	21.0	0.30	3	6.000	● ●
8.00	8.00	63	16.0	27.0	0.30	3	8.000	● ●
10.00	10.00	72	19.0	32.0	0.30	3	10.000	● ●
12.00	12.00	83	22.0	38.0	0.50	3	12.000	● ●
14.00	14.00	83	22.0	38.0	0.50	3	14.000	● ●
16.00	16.00	92	26.0	44.0	0.50	3	16.000	● ●
18.00	18.00	92	26.0	44.0	0.50	3	18.000	● ●
20.00	20.00	104	32.0	54.0	0.50	3	20.000	● ●
25.00	25.00	121	45.0	65.0	0.60	3	25.000	● ●

ISO	Hardness	v _c	f _z (mm/z) / Ø								vc	f _z (mm/z) / Ø							
			3	6	8	10	12	16	20	3		6	8	10	12	16	20		
			a _p = 1,0xD					a _e = 1,0xD				a _p = 1,5xD					a _e max = 0,75xD		
N	≤ 7% Si	350	0,010	0,019	0,026	0,035	0,042	0,056	0,070	410	0,011	0,022	0,029	0,040	0,048	0,064	0,081		
	≥ 7% Si	180	0,009	0,018	0,024	0,032	0,038	0,051	0,064	210	0,010	0,021	0,028	0,037	0,044	0,059	0,074		
NE	≤ 850 N/mm ²	180	0,009	0,018	0,024	0,032	0,038	0,051	0,064	210	0,010	0,021	0,028	0,037	0,044	0,059	0,074		

Our Carbo-coating is available as an option to improve chip flow and tool life

Roughing end mills GS 40 (fine teeth)



Tool material

HSS-E-PM

Surface



Type

NRf

NRf

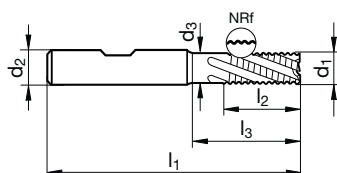
Shank form

B

B

P	•
M	•
K	•
N	•
S	○
H	

- neck clearance
- centre cutting



Article no.

3322

3668

Discount group

112

112

d1 js12	d2	d3	l1	l2	l3	Z	Code no.	Availability
mm	mm	mm	mm	mm	mm			
6.00	6.00	5.70	57	13.0	20.0	3	6.000	•
8.00	10.00	7.70	69	19.0	21.5	3	8.000	•
10.00	10.00	9.50	72	22.0	30.0	3	10.000	•
12.00	12.00	11.50	83	26.0	36.0	3	12.000	•
14.00	12.00	12.00	83	26.0	38.0	3	14.000	•
16.00	16.00	15.50	92	32.0	42.0	3	16.000	•
18.00	16.00	16.00	92	32.0	44.0	3	18.000	•
20.00	20.00	19.00	104	38.0	52.0	3	20.000	•

ISO	Hardness	v _c	f _z (mm/z)/Ø							v _c	f _z (mm/z)/Ø						
			3	6	8	10	12	16	20		3	6	8	10	12	16	20
			a _p = 1,0xD				a _e = 1,0xD				a _p = 1,0xD				a _e max = 0,75xD		
P	≤ 850 N/mm ²	60	0,013	0,025	0,034	0,045	0,05	0,07	0,09	70	0,014	0,029	0,039	0,052	0,06	0,08	0,10
	≥ 850 N/mm ²	50	0,011	0,023	0,030	0,040	0,05	0,06	0,08	60	0,013	0,026	0,035	0,046	0,06	0,07	0,09
M	≤ 750 N/mm ²	50	0,010	0,020	0,026	0,035	0,04	0,06	0,07	60	0,011	0,023	0,030	0,040	0,05	0,06	0,08
	≥ 750 N/mm ²	30	0,008	0,015	0,020	0,027	0,03	0,04	0,05	40	0,009	0,018	0,024	0,032	0,04	0,05	0,06
K	≤ 240 HB	50	0,013	0,025	0,034	0,045	0,05	0,07	0,09	60	0,014	0,029	0,039	0,052	0,06	0,08	0,10
N	≥ 7 % Si	80	0,016	0,032	0,042	0,055	0,07	0,09	0,11	100	0,018	0,037	0,049	0,063	0,08	0,10	0,13

Please reduce cutting values for bright finished tools: v_c -50% and f_z -25%



Roughing end mills GS 40 (fine teeth)



Tool material

HSS-E-PM

Surface



Type

NRf

NRf

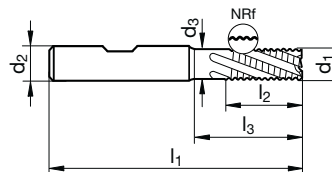
Shank form

B

B

P	•
M	•
K	•
N	•
S	○
H	

- neck clearance
- centre cutting



Article no.

3340

3660

Discount group

112

112

d1 js12	d2	d3	l1	l2	l3	Z	Code no.	Availability
mm	mm	mm	mm	mm	mm			
6.00	6.00	5.70	57	13.0	20.0	4	6.000	•
7.00	10.00	6.70	66	16.0	17.9	4	7.000	•
8.00	10.00	7.70	69	19.0	21.5	4	8.000	•
9.00	10.00	8.70	69	19.0	24.3	4	9.000	•
10.00	10.00	9.50	72	22.0	30.0	4	10.000	•
11.00	12.00	10.50	79	22.0	30.7	4	11.000	•
12.00	12.00	11.50	83	26.0	36.0	4	12.000	•
13.00	12.00	12.00	83	26.0	38.0	4	13.000	•
14.00	12.00	12.00	83	26.0	38.0	4	14.000	•
15.00	12.00	12.00	83	26.0	38.0	4	15.000	•
16.00	16.00	15.50	92	32.0	42.0	4	16.000	•
18.00	16.00	16.00	92	32.0	44.0	4	18.000	•
20.00	20.00	19.00	104	38.0	52.0	4	20.000	•
25.00	25.00	24.00	121	45.0	63.0	5	25.000	•
28.00	25.00	25.00	121	45.0	65.0	5	28.000	•
30.00	25.00	25.00	121	45.0	65.0	5	30.000	•
32.00	32.00	31.00	133	53.0	71.0	6	32.000	•

ISO	Hardness	v _c	f _z (mm/z)/Ø								v _c	f _z (mm/z)/Ø							
			3	6	8	10	12	16	20			3	6	8	10	12	16	20	
			a _p = 1,0xD				a _e = 1,0xD					a _p = 1,0xD				a _e max = 0,75xD			
P	≤ 850 N/mm ²	60	0,013	0,025	0,034	0,045	0,05	0,07	0,09		70	0,014	0,029	0,039	0,052	0,06	0,08	0,10	
	≥ 850 N/mm ²	50	0,011	0,023	0,030	0,040	0,05	0,06	0,08		60	0,013	0,026	0,035	0,046	0,06	0,07	0,09	
M	≤ 750 N/mm ²	50	0,010	0,020	0,026	0,035	0,04	0,06	0,07		60	0,011	0,023	0,030	0,040	0,05	0,06	0,08	
	≥ 750 N/mm ²	30	0,008	0,015	0,020	0,027	0,03	0,04	0,05		40	0,009	0,018	0,024	0,032	0,04	0,05	0,06	
K	≤ 240 HB	50	0,013	0,025	0,034	0,045	0,05	0,07	0,09		60	0,014	0,029	0,039	0,052	0,06	0,08	0,10	
N	≥ 7 % Si	80	0,016	0,032	0,042	0,055	0,07	0,09	0,11		100	0,018	0,037	0,049	0,063	0,08	0,10	0,13	

Please reduce cutting values for bright finished tools: v_c -50% and f_z -25%

GS 80 – High-performance PM roughing end mills for difficult applications in steel and high strength steels



Optimal chip evacuation
thanks to curved, deep flute geometry

Minimum cutting pressure and power consumption
thanks to 45° helix angle and fine NRf roughing geometry.
Application also on less rigid machines and with unstable clamping.

High heat resistance and toughness
thanks to HSS-E-PM tool material with FIRE-coating.
Especially for tough and difficult-to-machine materials.

Innovative roughing geometry
ensures small chips





Roughing end mills GS 80 (fine teeth)


Tool material **HSS-E-PM**

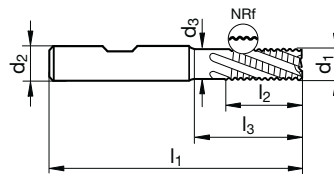
Surface **F**

Type **NRf**

Shank form **B**

P	•
M	•
K	•
N	•
S	○
H	

• neck clearance
• centre cutting


Article no. **6756**

Discount group **112**

d1 js12	d2	d3	l1	l2	l3	Z	Code no.	Availability
mm	mm	mm	mm	mm	mm			
4.00	6.00	3.70	55	11.0	15.0	3	4.000	•
5.00	6.00	4.70	57	13.0	18.0	4	5.000	•
6.00	6.00	5.70	57	13.0	20.0	4	6.000	•
7.00	10.00	6.70	66	16.0	22.1	4	7.000	•
8.00	10.00	7.70	69	19.0	26.0	4	8.000	•
9.00	10.00	8.70	69	19.0	26.9	4	9.000	•
10.00	10.00	9.50	72	22.0	30.0	4	10.000	•
12.00	12.00	11.50	83	26.0	36.0	4	12.000	•
14.00	12.00	13.50	83	26.0	38.0	5	14.000	•
16.00	16.00	15.50	92	32.0	42.0	5	16.000	•
18.00	16.00	17.50	92	32.0	44.0	6	18.000	•
20.00	20.00	19.00	104	38.0	52.0	6	20.000	•
25.00	25.00	24.00	121	45.0	63.0	6	25.000	•

ISO	Hardness	v _c	f _z (mm/z)/Ø							v _c	f _z (mm/z)/Ø						
			3	6	8	10	12	16	20		3	6	8	10	12	16	20
			a _p = 1,0xD			a _e = 1,0xD					a _p = 1,0xD			a _e max = 0,75xD			
P	≤ 850 N/mm ²	60	0,013	0,025	0,034	0,045	0,05	0,07	0,09	70	0,014	0,029	0,039	0,052	0,06	0,08	0,10
	≥ 850 N/mm ²	50	0,011	0,023	0,030	0,040	0,05	0,06	0,08	60	0,013	0,026	0,035	0,046	0,06	0,07	0,09
M	≤ 750 N/mm ²	50	0,010	0,020	0,026	0,035	0,04	0,06	0,07	60	0,011	0,023	0,030	0,040	0,05	0,06	0,08
	≥ 750 N/mm ²	30	0,008	0,015	0,020	0,027	0,03	0,04	0,05	40	0,009	0,018	0,024	0,032	0,04	0,05	0,06
K	≤ 240 HB	50	0,013	0,025	0,034	0,045	0,05	0,07	0,09	60	0,014	0,029	0,039	0,052	0,06	0,08	0,10
N	≥ 7 % Si	80	0,016	0,032	0,042	0,055	0,07	0,09	0,11	100	0,018	0,037	0,049	0,063	0,08	0,10	0,13



Milling conditions:

	unstable machining conditions low drive power
	long tools

Correction factors:

	a_p roughing > 1.5xD	v_c -25%	f_z -25%
	medium length tools	v_c -40%	f_z -40%
	extra length tools	v_c -60%	f_z -55%
	uncoated tools	v_c -50%	f_z -25%



Material	Hard-ness	Type	Application	a _e max	v _c	f _z (mm/z) with nom. Ø									
						3	4	6	8	10	12	16	20	25	
Struct./free-cutting steels, unall. heat-treat./case hard. steels 1.0035 S185. 1.0486 P275N. 1.0345 P235GH. 1.0050. 1.0070. 1.8937 1.0718 11SMnPb30. 1.0736 11SMn37 1.0402 C22. 1.1178 C30E 1.0503 C45. 1.1191 C30E 1.0301 C10. 1.1121 C10E 1.1750 C75W. 1.2076 102Cr6. 1.2307 29CrMoV9	≤ 850 N/mm ²	VA/U	Slotting	1xD	135	0.009	0.012	0.018	0.024	0.032	0.038	0.05	0.06	0.08	
		VA/U	Roughing	0.75xD	160	0.010	0.014	0.021	0.028	0.037	0.044	0.06	0.07	0.09	
Free-cutting steels, unall. case hard. steels, nitr. steels 1.0727 46 S20. 1.0728 60 S20. 1.0757 46SPb20 1.0601 C60. 1.1221 C60E 1.7043 38Cr4 1.5752 15NiCr13. 1.7131 16MnCr5. 1.7264 20CrMo5 1.8504 34CrAl6 1.8519 31CrMoV9. 1.8550 34CrAlNi7	850- 1.200 N/mm ²	VA/U	Slotting	1xD	120	0.009	0.012	0.018	0.024	0.032	0.038	0.05	0.06	0.08	
		VA/U	Roughing	0.75xD	140	0.010	0.014	0.021	0.028	0.037	0.044	0.06	0.07	0.09	
Alloyed heat-treatable, tool and high speed steels 1.5131 50MnSi4. 1.7003 38Cr2. 1.7030 28Cr4 1.5710 36NiCr6. 1.7035 41Cr4. 1.7225 42CrMo4 1.2080 X210Cr12. 1.2083 X42Cr13. 1.2419 105WCr6. 1.2379 X155CrVMo12-1 1.3243 S 6-5-2-5. 1.3343 S 6-5-2. 1.3344 S 6-5-3 Spring steel = 1.5026 55Si7. 1.7176 55Cr3. 1.8159 51CrV4	850- 1.400 N/mm ²	U/F	Slotting	1xD	100	0.008	0.011	0.017	0.022	0.030	0.036	0.05	0.06	0.08	
		U/F	Roughing	0.75xD	120	0.010	0.013	0.019	0.026	0.035	0.041	0.06	0.07	0.09	
Hardened steel Tool steel, heat-treatable steel, spring steel, high-speed steel, case hardened steel, etc. Z.B.: 1.2344 X40CrMoV5-1; 1.2767 X45NiCrMo4; 1.2379 X155CrVMo12-1; 1.2080 X210Cr12; 1.3343 S 6-5-2	≤ 54 HRC	U/F	Slotting	1xD	55	0.006	0.008	0.012	0.016	0.022	0.026	0.04	0.04	0.06	
		U/F	Roughing	0.33xD	80	0.008	0.010	0.016	0.021	0.029	0.034	0.05	0.06	0.07	
	55 - 63 HRC														
Stainless steel 1.4104 X14CrMoS17. 1.4105 X6CrMoS17. 1.4305 X10CrNiS18-9 USA = 303. 410. 420F. 430. 430F	≤ 750 N/mm ²	VA/U	Slotting	1xD	90	0.008	0.011	0.017	0.022	0.030	0.036	0.05	0.06	0.08	
		VA/U	Roughing	0.75xD	110	0.010	0.013	0.019	0.026	0.035	0.041	0.06	0.07	0.09	
Stainless steel 1.4301X5CrNi18-10. 1.4303 X5CrNi18-12 1.4310 XCrNi18-8 USA = 304. 304L. 420	750-850 N/mm ²	VA/U	Slotting	1xD	65	0.008	0.010	0.015	0.020	0.028	0.034	0.04	0.06	0.07	
		VA/U	Roughing	0.75xD	80	0.009	0.012	0.017	0.023	0.032	0.039	0.05	0.06	0.08	
Stainless steel 1.4438 X2CrNiMo18-15-4. 1.4404 X2CrNiMo17-12-2. 1.4571 X6CrNiTi18-10 USA = 310. 316. 316B. 316L. 317	≥ 850 N/mm ²	VA/U	Slotting	1xD	55	0.007	0.009	0.013	0.018	0.025	0.030	0.04	0.05	0.06	
		VA/U	Roughing	0.60xD	70	0.008	0.011	0.016	0.021	0.030	0.036	0.05	0.06	0.08	
Special alloys (nickel based “Ni”) Nimonic. Inconel. Monel. Hastelloy	≤ 1.300 N/mm ²	VA/U	Slotting	1xD	25	0.006	0.008	0.012	0.016	0.022	0.026	0.04	0.04	0.06	
		VA/U	Roughing	0.60xD	40	0.007	0.010	0.014	0.019	0.026	0.032	0.04	0.05	0.07	
Titanium alloys (“Ti”) 3.7024 Ti99.5. 3.7114 TiAl5Sn2.5. 3.7124 TiCu2 3.7154 TiAl6Zr5. 3.7164 TiAl6V4. 3.7184 TiAl4Mo4Sn2.5	≤ 1.300 N/mm ²	VA/U	Slotting	1xD	50	0.007	0.009	0.013	0.018	0.025	0.030	0.04	0.05	0.06	
		VA/U	Roughing	0.60xD	70	0.008	0.011	0.016	0.021	0.030	0.036	0.05	0.06	0.08	
Cast/grey cast iron, spher.graphite/mall. cast iron 0.6010 EN-GL100 (GG10). 0.6020 EN-GJL-200 (GG20). 0.7050 EN-GJS-500-7 (GGG50). 0.8535 EN-GJMW-350-4 (GTW35)	≤ 240 HB	U/F	Slotting	1xD	120	0.009	0.012	0.018	0.024	0.032	0.038	0.05	0.06	0.08	
		U/F	Roughing	0.75xD	140	0.010	0.014	0.021	0.028	0.037	0.044	0.06	0.07	0.09	
Cast/grey cast iron, spher.graphite/mall. cast iron 0.6025 EN-GL250 (GG25). 0.6035 EN-GJL-350 (GG35). 0.7070 EN-GJS-700-2 (GGG70). 0.8170 EN-GJMB-700-2 (GTS70)	≥ 240 HB	U/F	Slotting	1xD	105	0.008	0.011	0.017	0.022	0.030	0.036	0.05	0.06	0.08	
		U/F	Roughing	0.75xD	130	0.010	0.013	0.019	0.026	0.035	0.041	0.06	0.07	0.09	
Aluminium, Al-wrought alloys, Al-alloys 3.0255 Al99.5. 3.2315 AlMgSi1. 3.3515 AlMg1 3.0615 AlMgSiPb. 3.1325 AlCuMg1. 3.3245 AlMg3Si. 3.4365 AlZnMgCu1.5	≤ 7% Si	A/WF	Slotting	1xD	375	0.011	0.014	0.021	0.028	0.037	0.044	0.06	0.07	0.09	
		A/WF	Roughing	0.75xD	500	0.012	0.016	0.024	0.032	0.043	0.051	0.07	0.09	0.11	
Aluminium-cast alloys 3.2131 G-AlSi5Cu1. 3.2153 G-AlSi7Cu3. 3.2573 G-AlSi9 3.2581 G-AlSi12. 3.2583 G-AlSi12Cu. - G-AlSi12CuNiMg	≥ 7% Si	A/WF	Slotting	1xD	180	0.010	0.013	0.019	0.026	0.035	0.042	0.06	0.07	0.09	
		A/WF	Roughing	0.75xD	300	0.011	0.015	0.022	0.029	0.040	0.048	0.06	0.08	0.10	
Magnesium-alloys MgMn2. G-MgAl8Zn1. G-MgAl6Zn3	-	VA/A	Slotting	1xD	140	0.010	0.013	0.019	0.026	0.035	0.042	0.06	0.07	0.09	
		VA/A	Roughing	0.75xD	170	0.011	0.015	0.022	0.029	0.040	0.048	0.06	0.08	0.10	
Non-ferr. met. (copper, short-/long-chipp. brass/bronze) 2.0070 SE-Cu. 2.1020 CuSn6. 2.1096 G-CuSn5ZnPb 2.0380 CuZn39Pb2. 2.0401 CuZn39Pb3. 2.0410 ... 2.0250 CuZn20. 2.0280 CuZn33. 2.0332 CuZn37Pb0.5 2.1090 CuSn7ZnPB. 2.1170 CuPb5Sn5. 2.1176 ... 2.0916 CuAl5. 2.0960 CuAl9Mn. 2.1050 CuSn10	≤ 850 N/mm ²	VA/A	Slotting	1xD	200	0.010	0.013	0.019	0.026	0.035	0.042	0.06	0.07	0.09	
		VA/A	Roughing	0.75xD	230	0.011	0.015	0.022	0.029	0.040	0.048	0.06	0.08	0.10	



Milling conditions:



unstable machining conditions
low drive power



long tools

Correction factors:



a_p roughing > 1.5xD

v_c -25% f_z -25%



uncoated tools

v_c -50% f_z -25%



Material	Hard- ness	Type	Application	a _e max	v _c	f _z (mm/z) with nom. Ø								
						3	4	6	8	10	12	16	20	25
Struct./free-cutting steels, unall. heat-treat./case hard. steels 1.0035 S185. 1.0486 P275N. 1.0345 P235GH. 1.0050. 1.0070. 1.8937 1.0718 11SMnPb30. 1.0736 11SMn37 1.0402 C22. 1.1178 C30E 1.0503 C45. 1.1191 C30E 1.0301 C10. 1.1121 C10E 1.1750 C75W. 1.2076 102Cr6. 1.2307 29CrMoV9	≤ 850 N/mm ²	U	Slotting	1xD	120	0.008	0.011	0.017	0.022	0.030	0.036	0.05	0.06	0.08
		U	Roughing	0.75xD	140	0.010	0.013	0.019	0.026	0.035	0.041	0.06	0.07	0.09
Free-cutting steels, unall. case hard. steels, nitr. steels 1.0727 46 S20. 1.0728 60 S20. 1.0757 46SPb20 1.0601 C60. 1.1221 C60E 1.7043 38Cr4 1.5752 15NiCr13. 1.7131 16MnCr5. 1.7264 20CrMo5 1.8504 34CrAl6 1.8519 31CrMoV9. 1.8550 34CrAlNi7	850- 1.200 N/mm ²	U	Slotting	1xD	100	0.008	0.011	0.017	0.022	0.030	0.036	0.05	0.06	0.08
		U	Roughing	0.75xD	120	0.010	0.013	0.019	0.026	0.035	0.041	0.06	0.07	0.09
Alloyed heat-treatable, tool and high speed steels 1.5131 50MnSi4. 1.7003 38Cr2. 1.7030 28Cr4 1.5710 36NiCr6. 1.7035 41Cr4. 1.7225 42CrMo4 1.2080 X210Cr12. 1.2083 X42Cr13. 1.2419 105WCr6. 1.2379 X155CrVMo12-1 1.3243 S 6-5-2-5. 1.3343 S 6-5-2. 1.3344 S 6-5-3 Spring steel = 1.5026 55Si7. 1.7176 55Cr3. 1.8159 51CrV4	850- 1.400 N/mm ²	H	Slotting	1xD	90	0.008	0.010	0.015	0.020	0.028	0.034	0.04	0.06	0.07
		H	Roughing	0.75xD	110	0.009	0.012	0.017	0.023	0.032	0.039	0.05	0.06	0.08
Hardened steel Tool steel, heat-treatable steel, spring steel, high-speed steel, case hardened steel, etc. Z.B.: 1.2344 X40CrMoV5-1; 1.2767 X45NiCrMo4; 1.2379 X155CrVMo12-1; 1.2080 X210Cr12; 1.3343 S 6-5-2	≤ 54 HRC	H	Slotting	1xD	50	0.005	0.007	0.011	0.014	0.020	0.024	0.03	0.04	0.05
		H	Roughing	0.33xD	70	0.007	0.009	0.014	0.019	0.026	0.031	0.04	0.05	0.07
	55 - 63 HRC													
Stainless steel 1.4104 X14CrMoS17. 1.4105 X6CrMoS17. 1.4305 X10CrNiS18-9 USA = 303. 410. 420F. 430. 430F	≤ 750 N/mm ²	U	Slotting	1xD	80	0.008	0.010	0.015	0.020	0.028	0.034	0.04	0.06	0.07
		U	Roughing	0.75xD	100	0.009	0.012	0.017	0.023	0.032	0.039	0.05	0.06	0.08
Stainless steel 1.4301X5CrNi18-10. 1.4303 X5CrNi18-12 1.4310 XCrNi18-8 USA = 304. 304L. 420	750-850 N/mm ²	U	Slotting	1xD	55	0.007	0.009	0.013	0.018	0.025	0.030	0.04	0.05	0.06
		U	Roughing	0.75xD	70	0.008	0.010	0.015	0.020	0.029	0.035	0.05	0.06	0.07
Stainless steel 1.4438 X2CrNiMo18-15-4. 1.4404 X2CrNiMo17-12-2. 1.4571 X6CrNiTi18-10 USA = 310. 316. 316B. 316L. 317	≥ 850 N/mm ²	U	Slotting	1xD	50	0.006	0.008	0.012	0.016	0.022	0.026	0.04	0.04	0.06
		U	Roughing	0.60xD	70	0.007	0.010	0.014	0.019	0.026	0.032	0.04	0.05	0.07
Special alloys (nickel based “Ni”) Nimonic, Inconel, Monel, Hastelloy	≤ 1.300 N/mm ²	U	Slotting	1xD	20	0.005	0.007	0.011	0.014	0.020	0.024	0.03	0.04	0.05
		U	Roughing	0.60xD	30	0.006	0.009	0.013	0.017	0.024	0.029	0.04	0.05	0.06
Titanium alloys (“Ti”) 3.7024 Ti99.5. 3.7114 TiAl5Sn2.5. 3.7124 TiCu2 3.7154 TiAl6Zr5. 3.7164 TiAl6V4. 3.7184 TiAl4Mo4Sn2.5	≤ 1.300 N/mm ²	U	Slotting	1xD	45	0.006	0.008	0.012	0.016	0.022	0.026	0.04	0.04	0.06
		U	Roughing	0.60xD	60	0.007	0.010	0.014	0.019	0.026	0.032	0.04	0.05	0.07
Cast/grey cast iron, spher.graphite/mall. cast iron 0.6010 EN-GL100 (GG10). 0.6020 EN-GJL-200 (GG20). 0.7050 EN-GJS-500-7 (GGG50). 0.8535 EN- GJMW-350-4 (GTW35)	≤ 240 HB	U	Slotting	1xD	100	0.008	0.011	0.017	0.022	0.030	0.036	0.05	0.06	0.08
		U	Roughing	0.75xD	120	0.010	0.013	0.019	0.026	0.035	0.041	0.06	0.07	0.09
Cast/grey cast iron, spher.graphite/mall. cast iron 0.6025 EN-GL250 (GG25). 0.6035 EN-GJL-350 (GG35). 0.7070 EN-GJS-700-2 (GGG70). 0.8170 EN-GJMB-700-2 (GTS70)	≥ 240 HB	H	Slotting	1xD	90	0.008	0.010	0.015	0.020	0.028	0.034	0.04	0.06	0.07
		H	Roughing	0.75xD	110	0.009	0.012	0.017	0.023	0.032	0.039	0.05	0.06	0.08
Aluminium, Al-wrought alloys, Al-alloys 3.0255 Al99.5. 3.2315 AlMgSi1. 3.3515 AlMg1 3.0615 AlMgSiPb. 3.1325 AlCuMg1. 3.3245 AlMg3Si. 3.4365 AlZnMgCu1.5	≤ 7% Si	A	Slotting	1xD	350	0.010	0.013	0.019	0.026	0.035	0.042	0.06	0.07	0.09
		A	Roughing	0.75xD	410	0.011	0.015	0.022	0.029	0.040	0.048	0.06	0.08	0.10
Aluminium-cast alloys 3.2131 G-AlSi5Cu1. 3.2153 G-AlSi7Cu3. 3.2573 G-AlSi9 3.2581 G-AlSi12. 3.2583 G-AlSi12Cu. - G-AlSi12CuNiMg	≥ 7% Si	A	Slotting	1xD	180	0.009	0.012	0.018	0.024	0.032	0.038	0.05	0.06	0.08
		A	Roughing	0.75xD	210	0.010	0.014	0.021	0.028	0.037	0.044	0.06	0.07	0.09
Magnesium-alloys MgMn2. G-MgAl8Zn1. G-MgAl6Zn3	-	A	Slotting	1xD	120	0.009	0.012	0.018	0.024	0.032	0.038	0.05	0.06	0.08
		A	Roughing	0.75xD	140	0.010	0.014	0.021	0.028	0.037	0.044	0.06	0.07	0.09
Non-ferr. met. (copper, short-/long-chipp. brass/bronze) 2.0070 SE-Cu. 2.1020 CuSn6. 2.1096 G-CuSn5ZnPb 2.0380 CuZn39Pb2. 2.0401 CuZn39Pb3. 2.0410 ... 2.0250 CuZn20. 2.0280 CuZn33. 2.0332 CuZn37Pb0.5 2.1090 CuSn7ZnPb. 2.1170 CuPb5Sn5. 2.1176 ... 2.0916 CuAl5. 2.0960 CuAl9Mn. 2.1050 CuSn10	≤ 850 N/mm ²	A	Slotting	1xD	180	0.009	0.012	0.018	0.024	0.032	0.038	0.05	0.06	0.08
		A	Roughing	0.75xD	210	0.010	0.014	0.021	0.028	0.037	0.044	0.06	0.07	0.09

Foundations for economically efficient milling

Peripheral requirements

Applicable in every material group

- 
- easy to machine materials = increase in productivity
- difficult to machine materials = increase in process reliability

High-dynamic machining centres

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

Heavy machines

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

Unstable to stable workpiece clamping

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

Application parameters

Low cutting width a_e to $0.33 \times D$

- low angle of engagement $< 70^\circ$
- short t. of contact between cutting edge and component

Very high tooth feed f_z

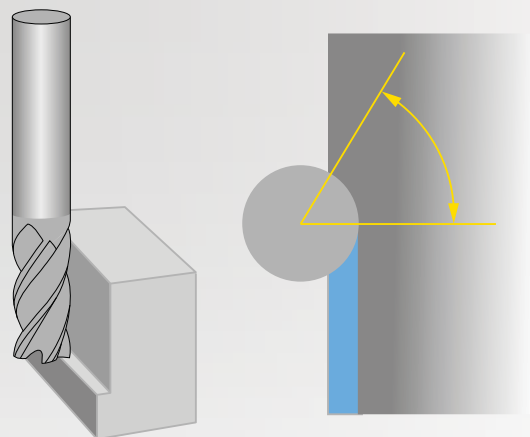
- reduced chip thickness allows considerably higher f_z

Very high cutting speed v_c

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

High cutting depth a_p

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



Tool angle of engagement & tool contact time

Metal removal rate

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

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



General recommendation for tool cooling

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

Exceptions for material ranges



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

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

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

Other notes

Finishing

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

Very long tools

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

Alignment of coolant

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



Solid carbide milling cutters with internal cooling

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

Peripheral cooling / Gührojet

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



|GÜHROJET|



GÜHRING

P.O. Box 100247 • 72423 Albstadt
Herderstrasse 50-54 • 72458 Albstadt

T +49 74 31 17-0
F +49 74 31 17-21279

info@guehring.de
www.guehring.de

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