

# GÜHRING



/// Ratio<sup>®</sup> ///

## **Roughing end mills** The complete programme

GÜHRING – YOUR WORLDWIDE PARTNER



# RATIO®

## NEW RATIO®-HIGH-PERFORMANCE ROUGHING END MILLS

with optimised geometries



with neck clearance  
and 2 length options

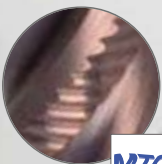
high cutting efficiency,  
round knuckle HRf  
geometry for minimum  
power consumption and  
lower cutting force

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



the innovative  
round knuckle HRf  
geometry ensures  
particularly small  
chips



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.

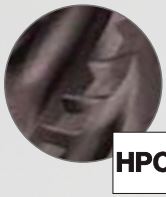


short chips thanks to innovative roughing geometry

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



### 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

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


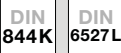


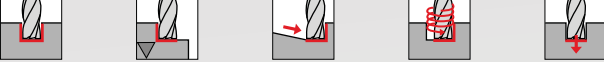





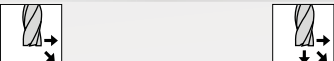
On the product pages you will find recommendations on the suitability for the application groups and information on the max. tensile strength and hardness for every tool:

- optimal suitability
- limited suitability

# Coatings

- bright
- Ⓢ Carbo
- Ⓡ FIRE/nano FIRE
- ⓐ TiAlN nanoA
- Ⓢ Signum

# Pictograms

Tool material	<b>VHM</b> Solid carbide finest grain (carbide-UF)	<b>HSS-E-PM</b> High speed steel
Shank form	 to DIN 6535	
Standard	 to DIN	
	 to Gühring standard	
Type	 Application area similar to DIN 1836	
Applications	 Slotting    Roughing    Ramping    Helix    Drilling	
Length	 short (DIN)    medium length    extra length    3xD	
Number of cutting edges	 Number of major cutting edges	
Helix angle	 Size of helix angle/ number of different helix angles	
Rake angle	 Rake angle of circumference cutting edges	
Cutting edge form	 Corner chamfer	
Feed	 for lateral feed and ramping    for lateral feed, ramping and drilling	

# RF 100 HRf

Ratio®



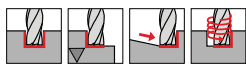
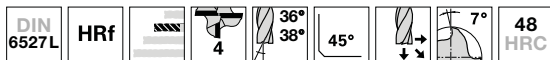
P	M	K	N	S	H	Tool illustration	Z	Hardness	Length	Helix angle °	Tool material	Surface	d1/mm	Article no.	Page	
Standard Ratio end mills RF 100 U																
•	•	•	○	○			NEW	4	48 HRC			VHM	Y	6.000 - 20.000	6970	10
•	•	•	○	○			NEW	4	48 HRC			VHM	Y	6.000 - 20.000	6971	10
•	•	•	○	○			NEW	4	48 HRC			VHM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





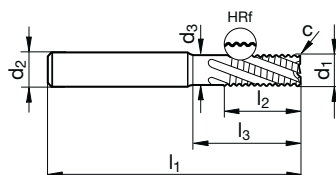
P	M	K	N	S	H	Tool illustration	Z	Hardness	Length	Helix angle °	Tool material	Surface	d1/mm	Article no.	Page
Hard roughing end mills GS 100 H (fine teeth)															
•	•	•					4	55 HRC		20°	VHM	Y	6.000 - 25.000	6704	21
•	•	•					4	55 HRC		20°	VHM	Y	6.000 - 25.000	6705	21
•	•	•					4	55 HRC		20°	VHM	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



- GÜHRING NAVIGATOR**
- P** •
  - 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

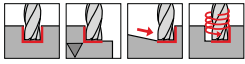
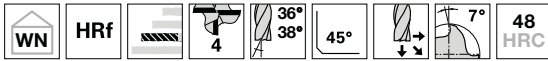


									Article no.	6970	6971
									Discount group	106	106
d1 h10	d2 h6	d3	l1	l2	l3	c	Z	Code no.	Availability		
mm	mm	mm	mm	mm	mm	mm x 45°					
6.00	6.00	5.70	57	13.0	20.0	0.12	4	6.00	●	●	
8.00	8.00	7.70	63	19.0	26.0	0.16	4	8.00	●	●	
10.00	10.00	9.50	72	22.0	30.0	0.20	4	10.00	●	●	
12.00	12.00	11.50	83	26.0	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 <sub>c</sub>	f <sub>z</sub> (mm/z) / Ø							v <sub>c</sub>	f <sub>z</sub> (mm/z) / Ø						
			3	6	8	10	12	16	20		3	6	8	10	12	16	20
		a <sub>p</sub> = 1,0xD				a <sub>e</sub> = 1,0xD			a <sub>p</sub> = 1,5xD				a <sub>e</sub> max = 0,75xD				
<b>P</b>	≤ 850 N/mm <sup>2</sup>	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 <sup>2</sup>	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
<b>M</b>	≤ 750 N/mm <sup>2</sup>	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 <sup>2</sup>	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
<b>S</b>	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
<b>K</b>	≤ 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



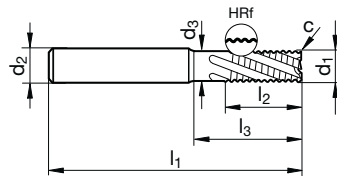
Standard Ratio end mills RF 100 U



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

- neck clearance
- centre cutting

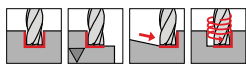
Tool material	Solid carbide	
Surface	Y	Y
Type	HRf	HRf
Shank form	HA	HB
	NEW	NEW



										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	•	•		

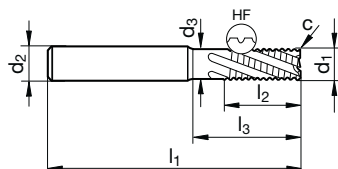
ISO	Hardness	v <sub>c</sub>	f <sub>z</sub> (mm/z) / Ø							v <sub>c</sub>	f <sub>z</sub> (mm/z) / Ø						
			3	6	8	10	12	16	20		3	6	8	10	12	16	20
		a <sub>p</sub> = 1,0xD		a <sub>e</sub> = 1,0xD				a <sub>p</sub> = 2,0xD		a <sub>e</sub> max = 0,33xD							
<b>P</b>	≤ 850 N/mm <sup>2</sup>	<b>55</b>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

Standard Ratio end mills RF 100 U



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

Tool material	Solid carbide	
Surface	F	F
Type	HF	HF
Shank form	HA	HB

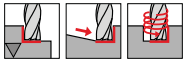


									Article no.	6881	6882
									Discount group	106	106
d1 h10	d2 h6	d3	l1	l2	l3	c	Z	Code no.	Availability		
mm	mm	mm	mm	mm	mm	mm x 45°					
6.00	6.00	5.70	57	13.0	20.0	0.12	4	6.00	•	•	
8.00	8.00	7.70	63	19.0	26.0	0.16	4	8.00	•	•	
10.00	10.00	9.50	72	22.0	30.0	0.20	4	10.00	•	•	
12.00	12.00	11.50	83	26.0	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 <sub>c</sub>	f <sub>z</sub> (mm/z)/Ø							v <sub>c</sub>	f <sub>z</sub> (mm/z)/Ø						
			3	6	8	10	12	16	20		3	6	8	10	12	16	20
P	≤ 850 N/mm <sup>2</sup>	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 <sup>2</sup>	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
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

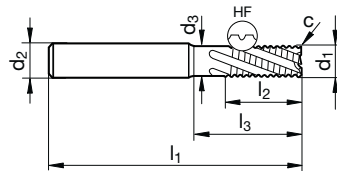


Standard Ratio end mills RF 100 U



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

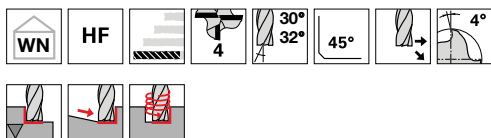
Tool material	Solid carbide	
Surface	F	F
Type	HF	HF
Shank form	HA	HB



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

Standard Ratio end mills RF 100 U



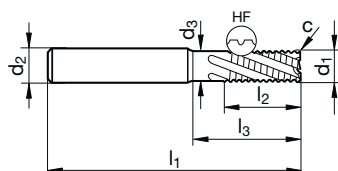
P	•
M	
K	•
N	
S	
H	

**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

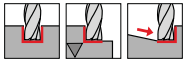
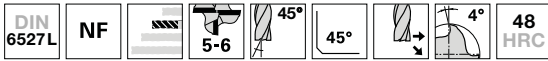


									Article no.	6885	6886
									Discount group	106	106
d1 h10	d2 h6	d3	l1	l2	l3	c	Z	Code no.	Availability		
mm	mm	mm	mm	mm	mm	mm x 45°					
6.00	6.00	5.70	75	13.0	34.0	0.12	4	6.00	•	•	
8.00	8.00	7.70	100	19.0	49.0	0.16	4	8.00	•	•	
10.00	10.00	9.50	100	22.0	48.0	0.20	4	10.00	•	•	
12.00	12.00	11.50	150	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 <sub>c</sub>	f <sub>z</sub> (mm/z) / Ø							v <sub>c</sub>	f <sub>z</sub> (mm/z) / Ø						
			3	6	8	10	12	16	20		3	6	8	10	12	16	20
		a <sub>p</sub> = 1,0xD					a <sub>e</sub> = 1,0xD				a <sub>p</sub> = 1,0xD					a <sub>e</sub> max = 0,75xD	
P	≤ 850 N/mm <sup>2</sup>	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 <sup>2</sup>	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 <sup>2</sup>	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 <sup>2</sup>	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

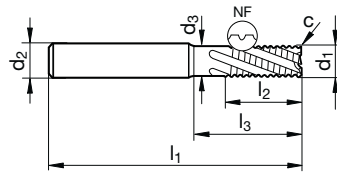


High-performance roughing end mills RS 100 F



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

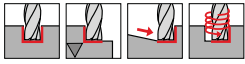
Tool material	Solid carbide	
Surface	F	F
Type	NF	NF
Shank form	HA	HB



									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	●	●	

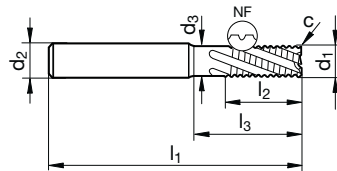
ISO	Hardness	v <sub>c</sub>	f <sub>z</sub> (mm/z)/Ø							v <sub>c</sub>	f <sub>z</sub> (mm/z)/Ø						
			3	6	8	10	12	16	20		3	6	8	10	12	16	20
<b>P</b>	≤ 850 N/mm <sup>2</sup>	<b>135</b>	0,009	0,018	0,024	0,032	0,038	0,051	0,064	<b>160</b>	0,010	0,021	0,028	0,037	0,044	0,059	0,074
	≥ 850 N/mm <sup>2</sup>	<b>100</b>	0,008	0,017	0,022	0,030	0,036	0,048	0,060		<b>120</b>	0,010	0,019	0,026	0,035	0,041	0,055
<b>K</b>	≤ 240 HB	<b>120</b>	0,009	0,018	0,024	0,032	0,038	0,051	0,064	<b>140</b>	0,010	0,021	0,028	0,037	0,044	0,059	0,074
	≥ 240 HB	<b>105</b>	0,008	0,017	0,022	0,030	0,036	0,048	0,060		<b>130</b>	0,010	0,019	0,026	0,035	0,041	0,055

Ratio end mills RF 100 VA



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

Tool material	Solid carbide	
Surface	<b>a</b>	<b>a</b>
Type	NF	NF
Shank form	HA	HB



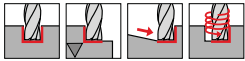
									Article no.	6877	6878
									Discount group	106	106
d1 h10	d2 h6	d3	l1	l2	l3	c	Z	Code no.	Availability		
mm	mm	mm	mm	mm	mm	mm x 45°					
5.00	6.00	4.80	57	13.0	18.0	0.10	4	5.00	●	●	
6.00	6.00	5.70	57	13.0	20.0	0.12	4	6.00	●	●	
7.00	8.00	6.70	63	16.0	24.9	0.14	4	7.00	●	●	
8.00	8.00	7.70	63	19.0	26.0	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 <sub>c</sub>	f <sub>z</sub> (mm/z)/Ø							v <sub>c</sub>	f <sub>z</sub> (mm/z)/Ø							
			3	6	8	10	12	16	20		3	6	8	10	12	16	20	
<b>P</b>	≤ 850 N/mm <sup>2</sup>	<b>135</b>	0,009	0,018	0,024	0,032	0,038	0,051	0,064		<b>160</b>	0,010	0,021	0,028	0,037	0,044	0,059	0,074
	≥ 850 N/mm <sup>2</sup>	<b>100</b>	0,008	0,017	0,022	0,030	0,036	0,048	0,060			<b>120</b>	0,010	0,019	0,026	0,035	0,041	0,055
<b>M</b>	≤ 750 N/mm <sup>2</sup>	<b>90</b>	0,008	0,017	0,022	0,030	0,036	0,048	0,060		<b>110</b>	0,010	0,019	0,026	0,035	0,041	0,055	0,069
	≥ 750 N/mm <sup>2</sup>	<b>55</b>	0,007	0,013	0,018	0,025	0,030	0,040	0,050			<b>70</b>	0,008	0,016	0,021	0,030	0,036	0,048
<b>S</b>	Ni-based	<b>25</b>	0,006	0,012	0,016	0,022	0,026	0,035	0,044		<b>40</b>	0,007	0,014	0,019	0,026	0,032	0,042	0,053
	Ti-based	<b>50</b>	0,007	0,013	0,018	0,025	0,030	0,040	0,050			<b>70</b>	0,008	0,016	0,021	0,030	0,036	0,048
<b>K</b>	≤ 240 HB	<b>120</b>	0,009	0,018	0,024	0,032	0,038	0,051	0,064		<b>140</b>	0,010	0,021	0,028	0,037	0,044	0,059	0,074
	≥ 240 HB	<b>105</b>	0,008	0,017	0,022	0,030	0,036	0,048	0,060			<b>130</b>	0,010	0,019	0,026	0,035	0,041	0,055





Ratio end mills RF 100 VA

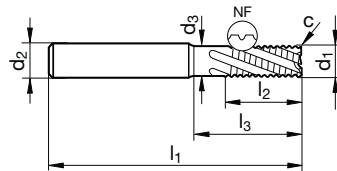


<b>P</b>	•	<b>GÜHRING</b> NAVIGATOR
<b>M</b>	•	
<b>K</b>	•	
<b>N</b>	○	
<b>S</b>	○	
<b>H</b>		

Cutting data page 32-33

- neck clearance
- centre cutting

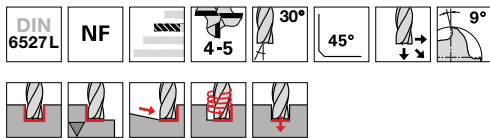
Tool material	Solid carbide	
Surface	<b>a</b>	<b>a</b>
Type	NF	NF
Shank form	HA	HB



										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		•	•	

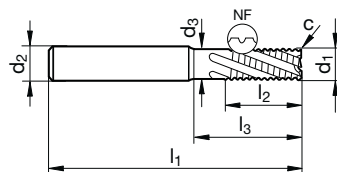
ISO	Hardness	v <sub>c</sub>	f <sub>z</sub> (mm/z) / Ø							v <sub>c</sub>	f <sub>z</sub> (mm/z) / Ø						
			3	6	8	10	12	16	20		3	6	8	10	12	16	20
			a <sub>p</sub> = 1,0xD				a <sub>e</sub> = 1,0xD				a <sub>p</sub> = 1,0xD				a <sub>e</sub> max = 0,75xD		
<b>P</b>	≤ 850 N/mm <sup>2</sup>	<b>80</b>	0,005	0,011	0,014	0,019	0,023	0,031	0,038	<b>110</b>	0,007	0,014	0,019	0,026	0,031	0,041	0,052
	≥ 850 N/mm <sup>2</sup>	<b>60</b>	0,005	0,010	0,013	0,018	0,022	0,029	0,036	<b>85</b>	0,007	0,014	0,018	0,024	0,029	0,039	0,048
<b>M</b>	≤ 750 N/mm <sup>2</sup>	<b>55</b>	0,005	0,010	0,013	0,018	0,022	0,029	0,036	<b>75</b>	0,007	0,014	0,018	0,024	0,029	0,039	0,048
	≥ 750 N/mm <sup>2</sup>	<b>35</b>	0,004	0,008	0,011	0,015	0,018	0,024	0,030	<b>50</b>	0,006	0,011	0,015	0,021	0,025	0,034	0,042
<b>S</b>	Ni-based	<b>15</b>	0,004	0,007	0,010	0,013	0,016	0,021	0,026	<b>30</b>	0,005	0,010	0,013	0,018	0,022	0,030	0,037
	Ti-based	<b>30</b>	0,004	0,008	0,011	0,015	0,018	0,024	0,030	<b>50</b>	0,006	0,011	0,015	0,021	0,025	0,034	0,042
<b>K</b>	≤ 240 HB	<b>70</b>	0,005	0,011	0,014	0,019	0,023	0,031	0,038	<b>100</b>	0,007	0,014	0,019	0,026	0,031	0,041	0,052
	≥ 240 HB	<b>65</b>	0,005	0,010	0,013	0,018	0,022	0,029	0,036	<b>90</b>	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**  
**M** • Cutting data page 32-33  
**K** •  
**N** ○  
**S** •  
**H** • neck clearance  
 • centre cutting

Tool material	Solid carbide	
Surface	F	F
Type	NF	NF
Shank form	HA	HB

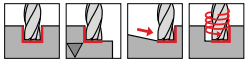


									Article no.	6887	6888
									Discount group	106	106
d1 h10	d2 h6	d3	l1	l2	l3	c	Z	Code no.	Availability		
mm	mm	mm	mm	mm	mm	mm x 45°					
6.00	6.00	5.70	57	13.0	20.0	0.12	4	6.00	●	●	
8.00	8.00	7.70	63	19.0	26.0	0.16	4	8.00	●	●	
10.00	10.00	9.50	72	22.0	30.0	0.20	4	10.00	●	●	
12.00	12.00	11.50	83	26.0	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 <sub>c</sub>	f <sub>z</sub> (mm/z)/Ø							v <sub>c</sub>	f <sub>z</sub> (mm/z)/Ø						
			3	6	8	10	12	16	20		3	6	8	10	12	16	20
<b>P</b>	≤ 850 N/mm <sup>2</sup>	<b>135</b>	0,009	0,018	0,024	0,032	0,038	0,051	0,064	<b>160</b>	0,010	0,021	0,028	0,037	0,044	0,059	0,074
	≥ 850 N/mm <sup>2</sup>	<b>100</b>	0,008	0,017	0,022	0,030	0,036	0,048	0,060		<b>120</b>	0,010	0,019	0,026	0,035	0,041	0,055
<b>M</b>	≤ 750 N/mm <sup>2</sup>	<b>90</b>	0,008	0,017	0,022	0,030	0,036	0,048	0,060	<b>110</b>	0,010	0,019	0,026	0,035	0,041	0,055	0,069
	≥ 750 N/mm <sup>2</sup>	<b>55</b>	0,007	0,013	0,018	0,025	0,030	0,040	0,050		<b>70</b>	0,008	0,016	0,021	0,030	0,036	0,048
<b>S</b>	Ni-based	<b>25</b>	0,006	0,012	0,016	0,022	0,026	0,035	0,044	<b>40</b>	0,007	0,014	0,019	0,026	0,032	0,042	0,053
	Ti-based	<b>50</b>	0,007	0,013	0,018	0,025	0,030	0,040	0,050		<b>70</b>	0,008	0,016	0,021	0,030	0,036	0,048
<b>K</b>	≤ 240 HB	<b>120</b>	0,009	0,018	0,024	0,032	0,038	0,051	0,064	<b>140</b>	0,010	0,021	0,028	0,037	0,044	0,059	0,074
	≥ 240 HB	<b>105</b>	0,008	0,017	0,022	0,030	0,036	0,048	0,060		<b>130</b>	0,010	0,019	0,026	0,035	0,041	0,055

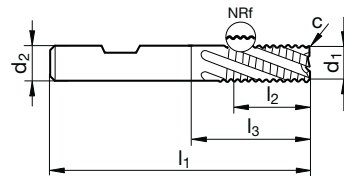


**Roughing end mills GS 100 U (fine teeth)**



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

Tool material	<b>Solid carbide</b>
Surface	<b>F</b>
Type	NRf
Shank form	HB



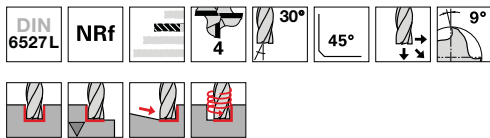
Article no.	<b>3723</b>
Discount group	<b>117</b>

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

Please reduce cutting values for bright finished tools: v<sub>c</sub> -50% and f<sub>z</sub> -25%

**Roughing end mills GS 100 U (fine teeth)**



Tool material	<b>Solid carbide</b>
Surface	<b>F</b>
Type	NRf
Shank form	HB

**P** • **GÜHRING NAVIGATOR**

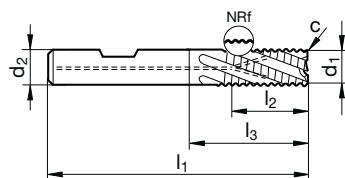
**M** • Cutting data page 32-33

**K** •

**N** ○

**S** ○

**H** • with internal coolant supply  
• centre cutting



Article no. **3365**

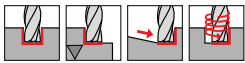
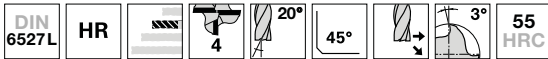
Discount group **106**

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



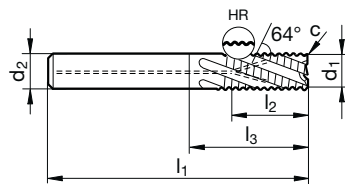
**Hard roughing end mills GS 100 H (fine teeth)**



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

- with internal coolant supply
- centre cutting

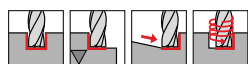
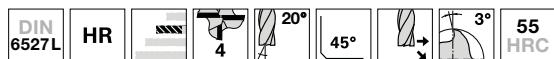
Tool material	Solid carbide	
Surface	Y	Y
Type	HR	HR
Shank form	HA	HB



								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	•	•	

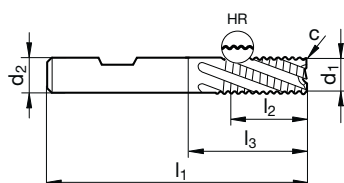
ISO	Hardness	v <sub>c</sub>	f <sub>z</sub> (mm/z)/Ø							v <sub>c</sub>	f <sub>z</sub> (mm/z)/Ø						
			3	6	8	10	12	16	20		3	6	8	10	12	16	20
<b>P</b>	≥ 850 N/mm <sup>2</sup>	<b>90</b>	0,008	0,015	0,020	0,028	0,034	0,045	0,056	<b>110</b>	0,009	0,017	0,023	0,032	0,039	0,052	0,064
<b>K</b>	≥ 240 HB	<b>90</b>	0,008	0,015	0,020	0,028	0,034	0,045	0,056	<b>110</b>	0,009	0,017	0,023	0,032	0,039	0,052	0,064
<b>H</b>	≤ 55 HRC	<b>50</b>	0,005	0,011	0,014	0,020	0,024	0,032	0,040	<b>70</b>	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**  
**M** Cutting data page 32-33  
**K** •  
**N**  
**S**  
**H** • • centre cutting

Tool material	<b>Solid carbide</b>
Surface	Ⓚ
Type	HR
Shank form	HB



Article no. **3682**

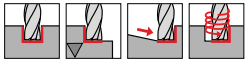
Discount group **117**

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



Ratio end mills Alu RF 100 A



P	
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N	•
S	
H	

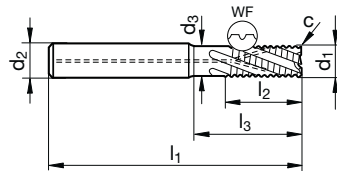
**GÜHRING** NAVIGATOR

Cutting data page 32-33

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

Tool material **Solid carbide**

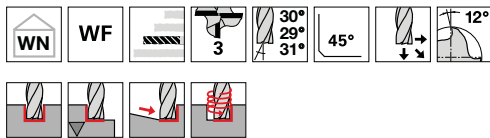
Surface	Ⓞ <sub>cb</sub>	Ⓞ <sub>cb</sub>
Type	WF	WF
Shank form	HA	HB
	<b>NEW</b>	<b>NEW</b>



										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 <sub>c</sub>	f <sub>z</sub> (mm/z) / Ø							v <sub>c</sub>	f <sub>z</sub> (mm/z) / Ø						
			3	6	8	10	12	16	20		3	6	8	10	12	16	20
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
NE	≤ 850 N/mm <sup>2</sup>	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



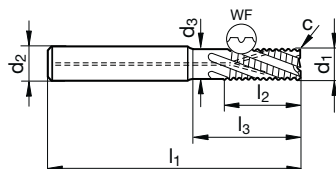
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**GÜHRING** NAVIGATOR

Cutting data page 32-33

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

Tool material	Solid carbide	
Surface	ⓐ	ⓑ
Type	WF	W
Shank form	HA	HB



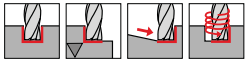
										Article no.	6976	6977
										Discount group	106	106
d1 js9	d2 h6	d3	l1	l2	l3	c	Z	Code no.		Availability		
mm	mm	mm	mm	mm	mm	mm x 45°						
6.00	6.00	5.70	65	13.0	28.0	0.06	3	6.00		•		•
8.00	8.00	7.70	75	19.0	38.0	0.08	3	8.00		•		•
10.00	10.00	9.50	80	22.0	38.0	0.10	3	10.00		•		•
12.00	12.00	11.50	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 <sub>c</sub>	f <sub>z</sub> (mm/z) / Ø							v <sub>c</sub>	f <sub>z</sub> (mm/z) / Ø						
			3	6	8	10	12	16	20		3	6	8	10	12	16	20
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
NE	≤850 N/mm <sup>2</sup>	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



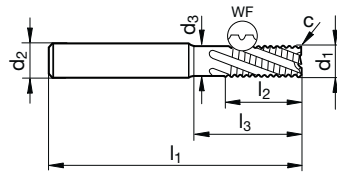


Ratio end mills Alu RF 100 A



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

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

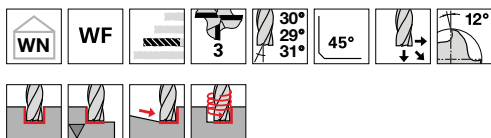


										Article no.	6868	6869
										Discount group	106	106
d1 js9	d2 h6	d3	l1	l2	l3	c	Z	Code no.	Availability			
mm	mm	mm	mm	mm	mm	mm x 45°						
6.00	6.00	5.70	57	13.0	20.0	0.06	3	6.00	●	●		
8.00	8.00	7.70	63	19.0	26.0	0.08	3	8.00	●	●		
10.00	10.00	9.50	72	22.0	30.0	0.10	3	10.00	●	●		
12.00	12.00	11.50	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 <sub>c</sub>	f <sub>z</sub> (mm/z)/Ø							v <sub>c</sub>	f <sub>z</sub> (mm/z)/Ø						
			3	6	8	10	12	16	20		3	6	8	10	12	16	20
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
NE	≤ 850 N/mm <sup>2</sup>	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



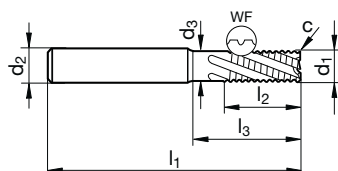
P	
M	
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H	

**GÜHRING** NAVIGATOR

Cutting data page 32-33

- neck clearance
- centre cutting

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



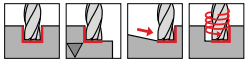
										Article no.	6870	6871
										Discount group	106	106
d1 js9	d2 h6	d3	l1	l2	l3	c	Z	Code no.	Availability			
mm	mm	mm	mm	mm	mm	mm x 45°						
6.00	6.00	5.70	65	13.0	28.0	0.06	3	6.00	•	•		
8.00	8.00	7.70	75	19.0	38.0	0.08	3	8.00	•	•		
10.00	10.00	9.50	80	22.0	38.0	0.10	3	10.00	•	•		
12.00	12.00	11.50	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 <sub>c</sub>	f <sub>z</sub> (mm/z) / Ø							v <sub>c</sub>	f <sub>z</sub> (mm/z) / Ø						
			3	6	8	10	12	16	20		3	6	8	10	12	16	20
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
NE	≤850 N/mm <sup>2</sup>	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

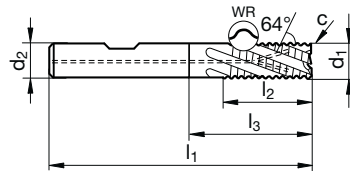


**Roughing end mills GS 100 A (coarse teeth)**



**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	vc	fz (mm/z) / Ø							vc	fz (mm/z) / Ø						
			3	6	8	10	12	16	20		3	6	8	10	12	16	20
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
NE	≤ 850 N/mm²	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

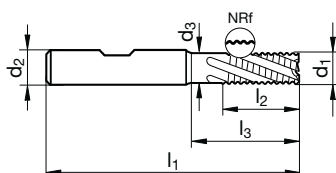
**Roughing end mills GS 40 (fine teeth)**



Tool material **HSS-E-PM**

Surface	○	● <b>F</b>
Type	NRf	NRf
Shank form	B	B

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

Please reduce cutting values for bright finished tools: v<sub>c</sub> -50% and f<sub>z</sub> -25%



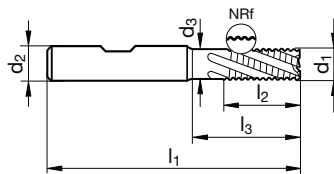
**Roughing end mills GS 40 (fine teeth)**



Tool material **HSS-E-PM**

Surface	○	● <b>F</b>
Type	NRf	NRf
Shank form	B	B

<b>P</b>	●	<ul style="list-style-type: none"> <li>• neck clearance</li> <li>• centre cutting</li> </ul>
<b>M</b>	●	
<b>K</b>	●	
<b>N</b>	●	
<b>S</b>	○	
<b>H</b>	○	



								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	Vc	fz (mm/z)/Ø								Vc	fz (mm/z)/Ø							
			3	6	8	10	12	16	20	3		6	8	10	12	16	20		
<b>P</b>	≤ 850 N/mm²	<b>60</b>	0,013	0,025	0,034	0,045	0,05	0,07	0,09		<b>70</b>	0,014	0,029	0,039	0,052	0,06	0,08	0,10	
	≥ 850 N/mm²	<b>50</b>	0,011	0,023	0,030	0,040	0,05	0,06	0,08			<b>60</b>	0,013	0,026	0,035	0,046	0,06	0,07	0,09
<b>M</b>	≤ 750 N/mm²	<b>50</b>	0,010	0,020	0,026	0,035	0,04	0,06	0,07		<b>60</b>	0,011	0,023	0,030	0,040	0,05	0,06	0,08	
	≥ 750 N/mm²	<b>30</b>	0,008	0,015	0,020	0,027	0,03	0,04	0,05			<b>40</b>	0,009	0,018	0,024	0,032	0,04	0,05	0,06
<b>K</b>	≤ 240 HB	<b>50</b>	0,013	0,025	0,034	0,045	0,05	0,07	0,09	<b>60</b>	0,014	0,029	0,039	0,052	0,06	0,08	0,10		
<b>N</b>	≥ 7 % Si	<b>80</b>	0,016	0,032	0,042	0,055	0,07	0,09	0,11	<b>100</b>	0,018	0,037	0,049	0,063	0,08	0,10	0,13		

Please reduce cutting values for bright finished tools: vc -50% and fz -25%

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

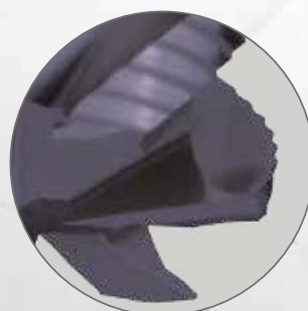


**Optimal chip evacuation**  
thanks to curved, deep flute geometry

**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)



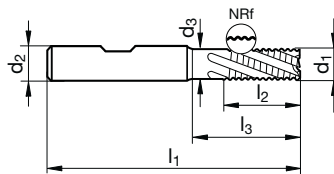
Tool material **HSS-E-PM**

Surface **F**

Type **NRf**

Shank form **B**

<b>P</b>	•	
<b>M</b>	•	
<b>K</b>	•	
<b>N</b>	•	
<b>S</b>	○	
<b>H</b>		• 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 <sub>c</sub>	f <sub>z</sub> (mm/z)/Ø							v <sub>c</sub>	f <sub>z</sub> (mm/z)/Ø							
			3	6	8	10	12	16	20		3	6	8	10	12	16	20	
<b>P</b>	≤ 850 N/mm <sup>2</sup>	<b>60</b>	0,013	0,025	0,034	0,045	0,05	0,07	0,09		<b>70</b>	0,014	0,029	0,039	0,052	0,06	0,08	0,10
	≥ 850 N/mm <sup>2</sup>	<b>50</b>	0,011	0,023	0,030	0,040	0,05	0,06	0,08			<b>60</b>	0,013	0,026	0,035	0,046	0,06	0,07
<b>M</b>	≤ 750 N/mm <sup>2</sup>	<b>50</b>	0,010	0,020	0,026	0,035	0,04	0,06	0,07		<b>60</b>	0,011	0,023	0,030	0,040	0,05	0,06	0,08
	≥ 750 N/mm <sup>2</sup>	<b>30</b>	0,008	0,015	0,020	0,027	0,03	0,04	0,05			<b>40</b>	0,009	0,018	0,024	0,032	0,04	0,05
<b>K</b>	≤ 240 HB	<b>50</b>	0,013	0,025	0,034	0,045	0,05	0,07	0,09		<b>60</b>	0,014	0,029	0,039	0,052	0,06	0,08	0,10
<b>N</b>	≥ 7 % Si	<b>80</b>	0,016	0,032	0,042	0,055	0,07	0,09	0,11		<b>100</b>	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	Hardness	Type	Application	$a_e$ max	$v_c$	$f_z$ (mm/z) with nom. Ø								
						3	4	6	8	10	12	16	20	25
<b>Struct./free-cutting steels. unall. heat-treat./case hard. steels</b> 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 <sup>2</sup>	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
<b>Free-cutting steels. unall. case hard. steels. nitr. steels</b> 1.0727 46 S20. 1.0728 60 S20. 1.0757 46SPb20 1.0601 C60. 1.1221 C60E 1.7043 38Cr4 1.5712 15NiCr13. 1.7131 16MnCr5. 1.7264 20CrMo5 1.8504 34CrAl6 1.8519 31CrMoV9. 1.8550 34CrAlNi7	850-1.200 N/mm <sup>2</sup>	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
<b>Alloyed heat-treatable. tool and high speed steels</b> 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 <sup>2</sup>	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
<b>Hardened steel</b> 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
<b>Stainless steel</b> 1.4104 X14CrMoS17. 1.4105 X6CrMoS17. 1.4305 X10CrNiS18-9 USA = 303. 410. 420F. 430. 430F	≤ 750 N/mm <sup>2</sup>	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
<b>Stainless steel</b> 1.4301 X5CrNi18-10. 1.4303 X5CrNi18-12 1.4310 XCrNi18-8 USA = 304. 304L. 420	750-850 N/mm <sup>2</sup>	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
<b>Stainless steel</b> 1.4438 X2CrNiMo18-15-4. 1.4404 X2CrNiMo17-12-2. 1.4571 X6CrNiTi18-10 USA = 310. 316. 316B. 316L. 317	≥ 850 N/mm <sup>2</sup>	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
<b>Special alloys (nickel based "Ni")</b> Nimonic. Inconel. Monel. Hastelloy	≤ 1.300 N/mm <sup>2</sup>	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
<b>Titanium alloys ("Ti")</b> 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 <sup>2</sup>	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
<b>Cast/grey cast iron. spher.graphite/mall. cast iron</b> 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
<b>Cast/grey cast iron. spher.graphite/mall. cast iron</b> 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
<b>Aluminium. Al-wrought alloys. Al-alloys</b> 3.2151 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
<b>Aluminium-cast alloys</b> 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
<b>Magnesium-alloys</b> 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
<b>Non-ferr. met. (copper. short-/long-chipp. brass/bronze)</b> 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 <sup>2</sup>	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	Hardness	Type	Application	$a_e$ max	$v_c$	$f_z$ (mm/z) with nom. Ø								
						3	4	6	8	10	12	16	20	25
<b>Struct./free-cutting steels. unall. heat-treat./case hard. steels</b> 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 <sup>2</sup>	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
<b>Free-cutting steels. unall. case hard. steels. nitr. steels</b> 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 <sup>2</sup>	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
<b>Alloyed heat-treatable. tool and high speed steels</b> 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 <sup>2</sup>	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
<b>Hardened steel</b> 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
<b>Stainless steel</b> 1.4104 X14CrMoS17. 1.4105 X6CrMoS17. 1.4305 X10CrNiS18-9 USA = 303. 410. 420F. 430. 430F	≤ 750 N/mm <sup>2</sup>	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
<b>Stainless steel</b> 1.4301X5CrNi18-10. 1.4303 X5CrNi18-12 1.4310 XCrNi18-8 USA = 304. 304L. 420	750-850 N/mm <sup>2</sup>	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
<b>Stainless steel</b> 1.4438 X2CrNiMo18-15-4. 1.4404 X2CrNiMo17-12-2. 1.4571 X6CrNiTi18-10 USA = 310. 316. 316B. 316L. 317	≥ 850 N/mm <sup>2</sup>	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
<b>Special alloys (nickel based "Ni")</b> Nimonic. Inconel. Monel. Hastelloy	≤ 1.300 N/mm <sup>2</sup>	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
<b>Titanium alloys ("Ti")</b> 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 <sup>2</sup>	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
<b>Cast/grey cast iron. spher.graphite/mall. cast iron</b> 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
<b>Cast/grey cast iron. spher.graphite/mall. cast iron</b> 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
<b>Aluminium. Al-wrought alloys. Al-alloys</b> 3.2151 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
<b>Aluminium-cast alloys</b> 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
<b>Magnesium-alloys</b> 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
<b>Non-ferr. met. (copper. short-/long-chipp. brass/bronze)</b> 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 <sup>2</sup>	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 $0.33xD$

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

#### Very high tooth feed $f_z$

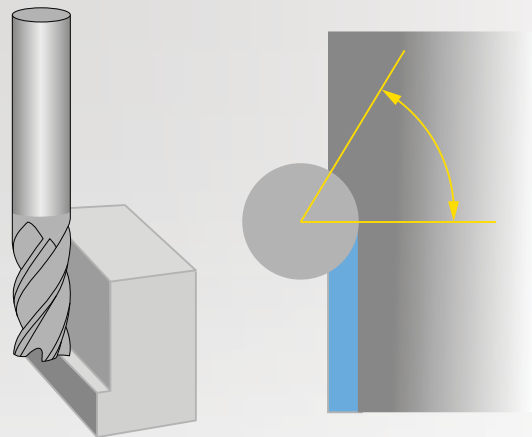
- reduced chip thickness allows considerably higher  $f_z$

#### 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

<b>Steel</b>			<ul style="list-style-type: none"> <li>• Avoid thermal shock</li> </ul>
<b>Cast iron</b>		Dry machining, compressed air, MQL:	<ul style="list-style-type: none"> <li>• Dissipate machining temperature via chip</li> <li>• Supporting chip evacuation</li> </ul>
<b>Hardened</b>			
<b>Stainless</b>			<ul style="list-style-type: none"> <li>• Cooling of tool cutting edge</li> <li>• Preventing built-up edge</li> <li>• Supporting chip evacuation</li> </ul>
<b>Special alloy</b>		Soluble oil, neat oil:	
<b>Non-ferrous metals</b>		Soluble oil, neat oil:	<ul style="list-style-type: none"> <li>• Preventing built-up edge</li> <li>• Supporting chip evacuation</li> </ul>

### 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



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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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