

# GÜHRING



NEW

**5**<sup>RF 100</sup>  
**SPEED**

NEW

**7**<sup>RF 100</sup>  
**SPEED**

## RF 100 Speed

GÜHRING – YOUR WORLDWIDE PARTNER

RF 100  
**7 SPEED**

**32° helix angle with unequal flute spacing** for reduced contact points and low-vibration machining



**increased clearance in the centre** for efficient plunging by helical milling with 0.05 x D infeed



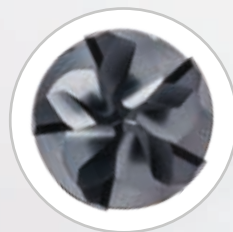
RF 100  
**5 SPEED**

**38° helix angle with unequal flute spacing** for quiet cut and low-vibration machining



**large, wide flutes and chip breakers** for secure chip evacuation

**stable cutting edge corner with corner chamfer and face correction = Double Protection** for long tool life



**version with corner radius and radius correction** for long tool life

**increased clearance in the centre** for efficient ramping and helical milling

# NEW

**5** RF 100 **SPEED** **7** RF 100 **SPEED**

## **THE NEW GTC POWER**

**Highest metal removal rates with  
outstanding process reliability**



Particularly when machining very tough materials, it is only possible to increase the cutting speed to a limited extent under consideration of process reliability. Thanks to the increased tooth number of the **5 Speed** and **7 Speed** even with difficult-to-machine materials high metal removal rates with stable process reliability can be achieved.

- // high-performance roughing even at high cutting depths
- // maximum feed rates for large metal removal rates
- // highly dynamic GTC milling in tough stainless steels, special alloys and a wide variety of steel and cast iron grades

# RF 100 SPEED

// Ratio //



**48° helix angle** with unequal cutting edge spacing for soft, quiet cut

**optimised chip space** with deepened flute on front cutting edge area for improved chip evacuation

**stable cutting edge corner** thanks to corner protection chamfer and face correction

**large front chip spaces and small chisel edge** for easy plunging and secure chip evacuation



**Chip breaker** for short chips: The load on the machine is clearly reduced and the volume performance increased thanks to the light cut.

## YOUR ADVANTAGES AT A GLANCE

- // high-performance roughing even at high cutting depths
- // great running smoothness and high metal removal rate
- // universal GTC milling in different steel and cast iron grades and special alloys



## RF 100 SPEED P & RF 100 SPEED M (4-FLUTED)

GTC machining with an  $a_e$  of up to 15 %

Thanks to its high helix angle and large flutes, the RF 100 Speed P and the RF 100 Speed M ensure low machine load and power consumption. The lower number of teeth provides maximum chip space for good chip evacuation.

$a_e$   
<15%  *RF 100 Speed P, page 6*

with 3° rake angle suitable for materials such as high-strength steels up to 1600N/mm<sup>2</sup> or 48 HRC as well as all types of cast iron



$a_e$   
<15%  *RF 100 Speed M, page 8*

with 9° rake angle the specialist for soft steels up to 850N/mm<sup>2</sup>, high-alloy and stainless steels and special alloys



## RF 100 5 SPEED & RF 100 7 SPEED

Highly dynamic GTC machining at an  $a_e$  of up to 10 %

At limited machine speeds or cutting speeds limited by the material, the RF 100 5 and 7 Speed ensure high feed rates and long tool life thanks to the increased number of teeth. They are particularly suitable for difficult-to-machine materials under stable conditions.

$a_e$   
<10%  *RF 100 5 Speed, page 10*

Applicable in all tough materials up to 1200N/mm<sup>2</sup>.  
Ramping up to 10°, slotting with cutting depths up to 1 x D, helical milling.

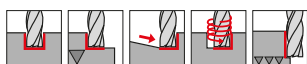


$a_e$   
<8%  *RF 100 7 Speed, page 13*

Applicable in all tough materials up to 1200N/mm<sup>2</sup>.  
Helical milling up to 0.05 x D  $a_p$  infeeds per cycle.



Ratio end mills RF 100 Speed P



P	•
M	
K	•
N	
S	
H	○

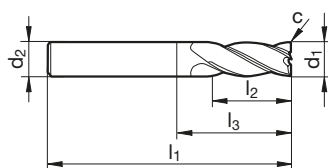
**GÜHRING NAVIGATOR**

Cutting data page 19

- with chip breaker
- slotting operations of up to max. 0.8xD depth
- re-inforced core from Ø 6 mm
- centre cutting

Tool material **Solid carbide**

Surface	<b>A</b>	<b>A</b>
Type	NH	NH
Shank form	HA	HB



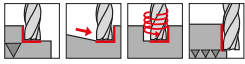
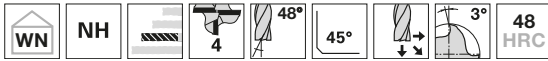
Article no. **6958** **6959**

d1 h10	d2 h6	l1	l2	l3	c	Z	Code no.
mm	mm	mm	mm	mm	mm x 45°		
6.00	6.00	57	15.0	21.0	0.12	4	6.000
8.00	8.00	63	20.0	27.0	0.16	4	8.000
10.00	10.00	72	24.0	32.0	0.20	4	10.000
12.00	12.00	83	28.0	38.0	0.24	4	12.000
16.00	16.00	92	36.0	44.0	0.32	4	16.000
20.00	20.00	104	45.0	54.0	0.40	4	20.000
25.00	25.00	121	55.0	65.0	0.50	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
P	≤ 850 N/mm <sup>2</sup>	<b>340</b>	0,036	0,072	0,096	0,138	0,17	0,22	0,28	<b>360</b>	0,017	0,034	0,046	0,066	0,08	0,11	0,13
	≥ 850 N/mm <sup>2</sup>	<b>250</b>	0,031	0,062	0,083	0,115	0,14	0,18	0,23		<b>270</b>	0,015	0,030	0,040	0,055	0,07	0,09
K	≤ 240 HB	<b>300</b>	0,038	0,076	0,101	0,150	0,18	0,24	0,30	<b>320</b>	0,018	0,036	0,048	0,072	0,09	0,11	0,14
	≥ 240 HB	<b>260</b>	0,035	0,069	0,092	0,127	0,15	0,20	0,25		<b>280</b>	0,017	0,033	0,044	0,061	0,07	0,10



Ratio end mills RF 100 Speed P



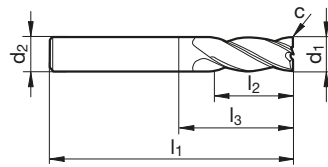
**P** • **GÜHRING NAVIGATOR**

Cutting data page 19

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

- with chip breaker
- re-inforced core from Ø 6 mm
- centre cutting

Tool material	Solid carbide	
Surface	<b>A</b>	<b>A</b>
Type	NH	NH
Shank form	HA	HB

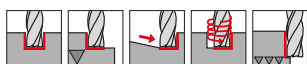


Article no. **6960** **6961**

d1 h10	d2 h6	l1	l2	l3	c	Z	Code no.
mm	mm	mm	mm	mm	mm x 45°		
6.00	6.00	65	24.0	29.0	0.12	4	6.000
8.00	8.00	75	32.0	39.0	0.16	4	8.000
10.00	10.00	90	40.0	50.0	0.20	4	10.000
12.00	12.00	100	46.0	55.0	0.24	4	12.000
16.00	16.00	108	55.0	60.0	0.32	4	16.000
20.00	20.00	126	65.0	76.0	0.40	4	20.000
25.00	25.00	150	85.0	94.0	0.50	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>340</b>	0,036	0,072	0,096	0,138	0,17	0,22	0,28	<b>360</b>	0,017	0,034	0,046	0,066	0,08	0,11	0,13
	≥ 850 N/mm <sup>2</sup>	<b>250</b>	0,031	0,062	0,083	0,115	0,14	0,18	0,23	<b>270</b>	0,015	0,030	0,040	0,055	0,07	0,09	0,11
<b>K</b>	≤ 240 HB	<b>300</b>	0,038	0,076	0,101	0,150	0,18	0,24	0,30	<b>320</b>	0,018	0,036	0,048	0,072	0,09	0,11	0,14
	≥ 240 HB	<b>260</b>	0,035	0,069	0,092	0,127	0,15	0,20	0,25	<b>280</b>	0,017	0,033	0,044	0,061	0,07	0,10	0,12

Ratio end mills RF 100 Speed M



**P** • **GÜHRING NAVIGATOR**

**M** • Cutting data page 19

**K**

**N**

**S** • slotting operations of up to max. 0.8xD depth

**H** • re-inforced core from Ø 6 mm

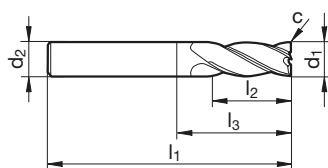
• centre cutting

Tool material **Solid carbide**

Surface **A** **A**

Type **NH** **NH**

Shank form **HA** **HB**



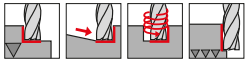
Article no. **6765** **6760**

d1 h10	d2 h6	l1	l2	l3	c	Z	Code no.
mm	mm	mm	mm	mm	mm x 45°		
3.00	6.00	57	8.0	10.9	0.06	4	3.000
4.00	6.00	57	11.0	13.9	0.08	4	4.000
5.00	6.00	57	13.0	15.9	0.10	4	5.000
6.00	6.00	57	15.0	21.0	0.12	4	6.000
8.00	8.00	63	20.0	27.0	0.16	4	8.000
10.00	10.00	72	24.0	32.0	0.20	4	10.000
12.00	12.00	83	28.0	38.0	0.24	4	12.000
16.00	16.00	92	36.0	44.0	0.32	4	16.000
20.00	20.00	104	45.0	54.0	0.40	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>340</b>	0,036	0,072	0,096	0,138	0,17	0,22	0,28	<b>360</b>	0,017	0,034	0,046	0,066	0,08	0,11	0,13
	≥ 850 N/mm <sup>2</sup>	<b>250</b>	0,031	0,062	0,083	0,115	0,14	0,18	0,23		<b>270</b>	0,015	0,030	0,040	0,055	0,07	0,09
<b>M</b>	≤ 750 N/mm <sup>2</sup>	<b>220</b>	0,031	0,062	0,083	0,115	0,14	0,18	0,23	<b>240</b>	0,015	0,030	0,040	0,055	0,07	0,09	0,11
	≥ 750 N/mm <sup>2</sup>	<b>110</b>	0,024	0,048	0,064	0,092	0,11	0,15	0,18		<b>120</b>	0,011	0,021	0,028	0,040	0,05	0,06
<b>S</b>	Ni-based	<b>60</b>	0,019	0,039	0,052	0,074	0,09	0,12	0,15	<b>60</b>	0,008	0,017	0,022	0,032	0,04	0,05	0,06
	Ti-based	<b>110</b>	0,028	0,055	0,074	0,104	0,12	0,17	0,21		<b>120</b>	0,013	0,026	0,035	0,050	0,06	0,08

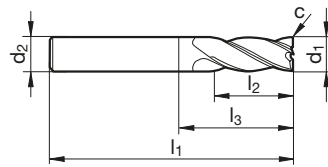


Ratio end mills RF 100 Speed M



- P** • **GÜHRING NAVIGATOR**  
**M** • Cutting data page 19  
**K**  
**N**  
**S** •  
**H**
- with chip breaker
  - re-inforced core from Ø 6 mm
  - centre cutting

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

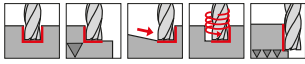


Article no. **6766** **6761**

d1 h10	d2 h6	l1	l2	l3	c	Z	Code no.
mm	mm	mm	mm	mm	mm x 45°		
3.00	6.00	57	12.0	14.9	0.06	4	3.000
4.00	6.00	65	16.0	18.9	0.08	4	4.000
5.00	6.00	65	20.0	22.9	0.10	4	5.000
6.00	6.00	65	24.0	29.0	0.12	4	6.000
8.00	8.00	75	32.0	39.0	0.16	4	8.000
10.00	10.00	90	40.0	50.0	0.20	4	10.000
12.00	12.00	100	46.0	55.0	0.24	4	12.000
16.00	16.00	108	55.0	60.0	0.32	4	16.000
20.00	20.00	126	65.0	76.0	0.40	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>340</b>	0,036	0,072	0,096	0,138	0,17	0,22	0,28	<b>360</b>	0,017	0,034	0,046	0,066	0,08	0,11	0,13
	≥ 850 N/mm <sup>2</sup>	<b>250</b>	0,031	0,062	0,083	0,115	0,14	0,18	0,23	<b>270</b>	0,015	0,030	0,040	0,055	0,07	0,09	0,11
<b>M</b>	≤ 750 N/mm <sup>2</sup>	<b>220</b>	0,031	0,062	0,083	0,115	0,14	0,18	0,23	<b>240</b>	0,015	0,030	0,040	0,055	0,07	0,09	0,11
	≥ 750 N/mm <sup>2</sup>	<b>110</b>	0,024	0,048	0,064	0,092	0,11	0,15	0,18	<b>120</b>	0,011	0,021	0,028	0,040	0,05	0,06	0,08
<b>S</b>	Ni-based	<b>60</b>	0,019	0,039	0,052	0,074	0,09	0,12	0,15	<b>60</b>	0,008	0,017	0,022	0,032	0,04	0,05	0,06
	Ti-based	<b>110</b>	0,028	0,055	0,074	0,104	0,12	0,17	0,21	<b>120</b>	0,013	0,026	0,035	0,050	0,06	0,08	0,10

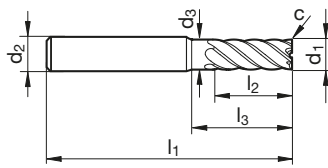
Ratio end mills RF 100 5 Speed



**P** • **GÜHRING NAVIGATOR**  
**M** • Cutting data page 19  
**K** •  
**N** ○  
**S** •  
**H** •

- with chip breaker
- neck clearance
- without centre cutting

Tool material	Solid carbide	
Surface	A	A
Type	N	N
Shank form	HA	HB



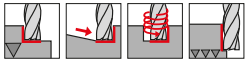
Article no. **6856** **6857**

d1 h10	d2 h6	d3	l1	l2	l3	c	Z	Code no.
mm	mm	mm	mm	mm	mm	mm x 45°		
6.00	6.00	5.70	57	13.0	20.0	0.12	5	6.000
8.00	8.00	7.70	63	19.0	26.0	0.16	5	8.000
10.00	10.00	9.50	72	22.0	30.0	0.20	5	10.000
12.00	12.00	11.50	83	26.0	36.0	0.24	5	12.000
16.00	16.00	15.50	92	32.0	42.0	0.32	5	16.000
20.00	20.00	19.50	104	38.0	52.0	0.40	5	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>340</b>	0,036	0,072	0,096	0,138	0,17	0,22	0,28	<b>360</b>	0,017	0,034	0,046	0,066	0,08	0,11	0,13
	≥ 850 N/mm <sup>2</sup>	<b>250</b>	0,031	0,062	0,083	0,115	0,14	0,18	0,23		<b>270</b>	0,015	0,030	0,040	0,055	0,07	0,09
<b>M</b>	≤ 750 N/mm <sup>2</sup>	<b>220</b>	0,031	0,062	0,083	0,115	0,14	0,18	0,23	<b>240</b>	0,015	0,030	0,040	0,055	0,07	0,09	0,11
	≥ 750 N/mm <sup>2</sup>	<b>110</b>	0,024	0,048	0,064	0,092	0,11	0,15	0,18		<b>120</b>	0,011	0,021	0,028	0,040	0,05	0,06
<b>S</b>	Ni-based	<b>60</b>	0,019	0,039	0,052	0,074	0,09	0,12	0,15	<b>60</b>	0,008	0,017	0,022	0,032	0,04	0,05	0,06
	Ti-based	<b>110</b>	0,028	0,055	0,074	0,104	0,12	0,17	0,21		<b>120</b>	0,013	0,026	0,035	0,050	0,06	0,08

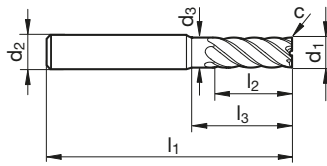


Ratio end mills RF 100 5 Speed



- P** • **GÜHRING NAVIGATOR**  
**M** • Cutting data page 19  
**K** •  
**N** ○  
**S** •  
**H** •
- with chip breaker
  - neck clearance
  - without centre cutting

Tool material	Solid carbide	
Surface	A	A
Type	N	N
Shank form	HA	HB

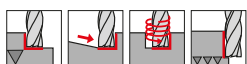


Article no. **6858** **6859**

d1 h10	d2 h6	d3	l1	l2	l3	c	Z	Code no.
mm	mm	mm	mm	mm	mm	mm x 45°		
6.00	6.00	5.70	65	20.0	28.0	0.12	5	6.000
8.00	8.00	7.70	75	26.0	38.0	0.16	5	8.000
10.00	10.00	9.50	80	32.0	38.0	0.20	5	10.000
12.00	12.00	11.50	93	40.0	46.0	0.24	5	12.000
16.00	16.00	15.50	108	50.0	58.0	0.32	5	16.000
20.00	20.00	19.50	126	62.0	74.0	0.40	5	20.000

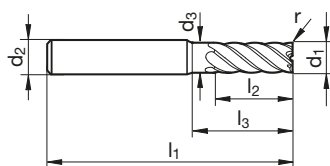
ISO	Hardness	v <sub>c</sub>	f <sub>z</sub> (mm/z) / Ø							v <sub>c</sub>	f <sub>z</sub> (mm/z) / Ø						
			3	6	8	10	12	16	20		3	6	8	10	12	16	20
<b>P</b>	≤ 850 N/mm <sup>2</sup>	<b>340</b>	0,036	0,072	0,096	0,138	0,17	0,22	0,28	<b>360</b>	0,017	0,034	0,046	0,066	0,08	0,11	0,13
	≥ 850 N/mm <sup>2</sup>	<b>250</b>	0,031	0,062	0,083	0,115	0,14	0,18	0,23	<b>270</b>	0,015	0,030	0,040	0,055	0,07	0,09	0,11
<b>M</b>	≤ 750 N/mm <sup>2</sup>	<b>220</b>	0,031	0,062	0,083	0,115	0,14	0,18	0,23	<b>240</b>	0,015	0,030	0,040	0,055	0,07	0,09	0,11
	≥ 750 N/mm <sup>2</sup>	<b>110</b>	0,024	0,048	0,064	0,092	0,11	0,15	0,18	<b>120</b>	0,011	0,021	0,028	0,040	0,05	0,06	0,08
<b>S</b>	Ni-based	<b>60</b>	0,019	0,039	0,052	0,074	0,09	0,12	0,15	<b>60</b>	0,008	0,017	0,022	0,032	0,04	0,05	0,06
	Ti-based	<b>110</b>	0,028	0,055	0,074	0,104	0,12	0,17	0,21	<b>120</b>	0,013	0,026	0,035	0,050	0,06	0,08	0,10

Ratio end mills RF 100 5 Speed



- P** • **GÜHRING NAVIGATOR**  
**M** • Cutting data page 19  
**K** •  
**N** ○  
**S** •  
**H** •
- with chip breaker
  - neck clearance
  - without centre cutting

Tool material	Solid carbide	
Surface	A	A
Type	N	N
Shank form	HA	HB



Article no. **6860** **6861**

d1 h10	d2 h6	d3	l1	l2	l3	r	Z	Code no.
mm	mm	mm	mm	mm	mm	mm		
6.00	6.00	5.70	65	20.0	28.0	0.2	5	6.002
6.00	6.00	5.70	65	20.0	28.0	0.5	5	6.005
6.00	6.00	5.70	65	20.0	28.0	1.0	5	6.010
8.00	8.00	7.70	75	26.0	38.0	0.3	5	8.003
8.00	8.00	7.70	75	26.0	38.0	0.5	5	8.005
8.00	8.00	7.70	75	26.0	38.0	1.0	5	8.010
8.00	8.00	7.70	75	26.0	38.0	1.5	5	8.015
10.00	10.00	9.50	80	32.0	38.0	0.5	5	10.005
10.00	10.00	9.50	80	32.0	38.0	1.0	5	10.010
10.00	10.00	9.50	80	32.0	38.0	1.5	5	10.015
10.00	10.00	9.50	80	32.0	38.0	2.0	5	10.020
12.00	12.00	11.50	93	40.0	46.0	0.5	5	12.005
12.00	12.00	11.50	93	40.0	46.0	1.0	5	12.010
12.00	12.00	11.50	93	40.0	46.0	1.5	5	12.015
12.00	12.00	11.50	93	40.0	46.0	2.0	5	12.020
16.00	16.00	15.50	108	50.0	58.0	0.5	5	16.005
16.00	16.00	15.50	108	50.0	58.0	1.0	5	16.010
16.00	16.00	15.50	108	50.0	58.0	1.5	5	16.015
16.00	16.00	15.50	108	50.0	58.0	2.0	5	16.020
16.00	16.00	15.50	108	50.0	58.0	3.0	5	16.030
20.00	20.00	19.50	126	62.0	74.0	1.0	5	20.010
20.00	20.00	19.50	126	62.0	74.0	1.5	5	20.015
20.00	20.00	19.50	126	62.0	74.0	2.0	5	20.020
20.00	20.00	19.50	126	62.0	74.0	3.0	5	20.030

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/mm <sup>2</sup>	<b>340</b>	0,036	0,072	0,096	0,138	0,17	0,22	0,28	<b>360</b>	0,017	0,034	0,046	0,066	0,08	0,11	0,13
	≥ 850 N/mm <sup>2</sup>	<b>250</b>	0,031	0,062	0,083	0,115	0,14	0,18	0,23	<b>270</b>	0,015	0,030	0,040	0,055	0,07	0,09	0,11
<b>M</b>	≤ 750 N/mm <sup>2</sup>	<b>220</b>	0,031	0,062	0,083	0,115	0,14	0,18	0,23	<b>240</b>	0,015	0,030	0,040	0,055	0,07	0,09	0,11
	≥ 750 N/mm <sup>2</sup>	<b>110</b>	0,024	0,048	0,064	0,092	0,11	0,15	0,18	<b>120</b>	0,011	0,021	0,028	0,040	0,05	0,06	0,08
<b>S</b>	Ni-based	<b>60</b>	0,019	0,039	0,052	0,074	0,09	0,12	0,15	<b>60</b>	0,008	0,017	0,022	0,032	0,04	0,05	0,06
	Ti-based	<b>110</b>	0,028	0,055	0,074	0,104	0,12	0,17	0,21	<b>120</b>	0,013	0,026	0,035	0,050	0,06	0,08	0,10

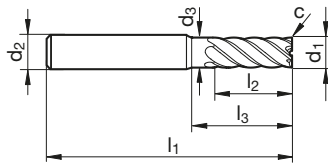


Ratio end mills RF 100 7 Speed



- P** • **GÜHRING NAVIGATOR**  
**M** • Cutting data page 19  
**K** •  
**N** ○  
**S** •  
**H** •
- with chip breaker
  - neck clearance
  - without centre cutting

Tool material	Solid carbide	
Surface	A	A
Type	N	N
Shank form	HA	HB



Article no. **6864** **6865**

d1 h10	d2 h6	d3	l1	l2	l3	c	Z	Code no.
mm	mm	mm	mm	mm	mm	mm x 45°		
6.00	6.00	5.70	65	20.0	28.0	0.12	7	6.000
8.00	8.00	7.70	75	26.0	38.0	0.16	7	8.000
10.00	10.00	9.50	80	32.0	38.0	0.20	7	10.000
12.00	12.00	11.50	93	40.0	46.0	0.24	7	12.000
16.00	16.00	15.50	108	50.0	58.0	0.32	7	16.000
20.00	20.00	19.50	126	62.0	74.0	0.40	7	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>340</b>	0,036	0,072	0,096	0,138	0,17	0,22	0,28	<b>360</b>	0,017	0,034	0,046	0,066	0,08	0,11	0,13
	≥ 850 N/mm <sup>2</sup>	<b>250</b>	0,031	0,062	0,083	0,115	0,14	0,18	0,23	<b>270</b>	0,015	0,030	0,040	0,055	0,07	0,09	0,11
<b>M</b>	≤ 750 N/mm <sup>2</sup>	<b>220</b>	0,031	0,062	0,083	0,115	0,14	0,18	0,23	<b>240</b>	0,015	0,030	0,040	0,055	0,07	0,09	0,11
	≥ 750 N/mm <sup>2</sup>	<b>110</b>	0,024	0,048	0,064	0,092	0,11	0,15	0,18	<b>120</b>	0,011	0,021	0,028	0,040	0,05	0,06	0,08
<b>S</b>	Ni-based	<b>60</b>	0,019	0,039	0,052	0,074	0,09	0,12	0,15	<b>60</b>	0,008	0,017	0,022	0,032	0,04	0,05	0,06
	Ti-based	<b>110</b>	0,028	0,055	0,074	0,104	0,12	0,17	0,21	<b>120</b>	0,013	0,026	0,035	0,050	0,06	0,08	0,10

## Efficient milling with the correct strategies

### GTC milling strategies

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



### HIGH PERFORMANCE CUTTING

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



### HIGH SPEED CUTTING

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

### Principles and objectives

#### Maximum tool utilisation

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

#### Modification of cutting distribution

- low cutting widths  $a_e$
- high cutting depths  $a_p$

#### High process reliability

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

#### Maximum metal removal rate

- saving time/machine costs





## Foundations for economically efficient milling

### Peripheral requirements

#### Applicable in every material group

- 
- 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 time of contact between cutting edge and component

#### Very high tooth feed $f_z$

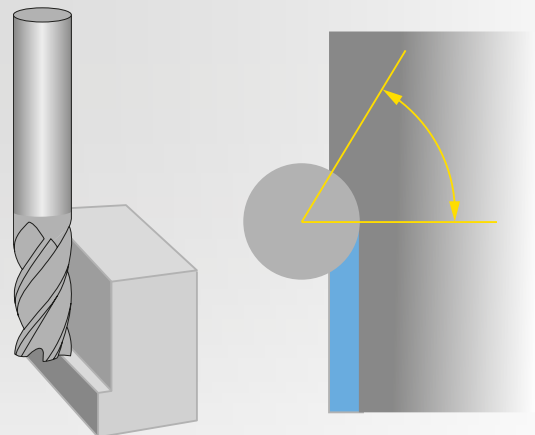
- reduced chip thickness allows considerably higher  $f_z$

#### Very high cutting speed $v_c$

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

#### High cutting depth $a_p$

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



Tool angle of engagement & tool contact time

### Metal removal rate

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

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

## Influence on process through tool engagement

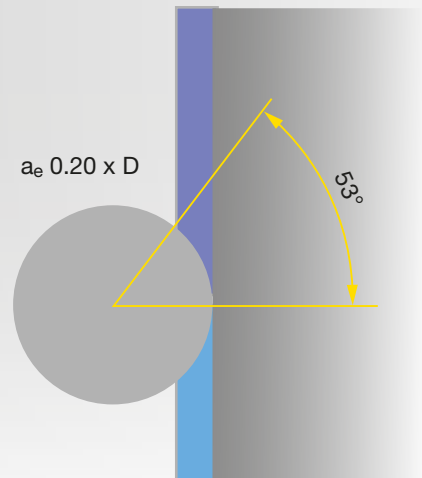
### Angle of engagement

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

#### Straight milling path

- constant angle of engagement
- constant tool stress

Example:  $a_e 0.20 \times D = 53^\circ$  engagement  
Engagement remains a constant  $53^\circ$



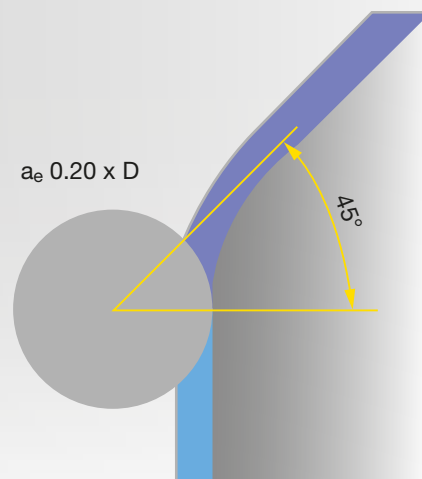
### Angle of engagement with convex contour radii

#### Convex milling path

- decreasing angle of engagement
- reduced tool stress

Example:  $a_e 0.20 \times D = 53^\circ$  engagement  
Engagement reduces to  $45^\circ$

Measures:  $a_e$  may be increased  
 $f_z$  can be increased



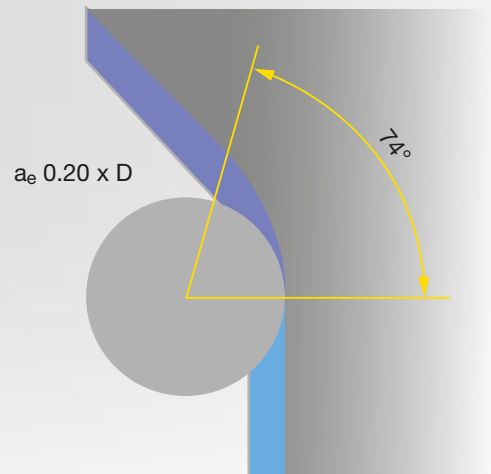
### Angle of engagement with concave contour radii

#### Concave milling path

- increasing angle of engagement
- increased tool stress

Example:  $a_e 0.20 \times D = 53^\circ$  engagement  
Engagement increases to  $74^\circ$

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





## Influence on process through tool engagement

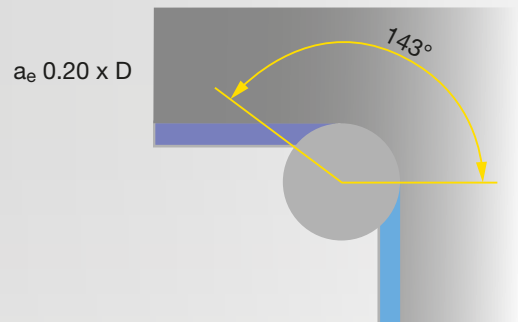
### Angle of engagement with 90° corner radii

#### Tool radius = Corner radius

- very unfavourable for tool dynamics
- change of stress direction
- abrupt increase in tool stress

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

Measures:  $v_c$  and  $f_z$  must be heavily reduced

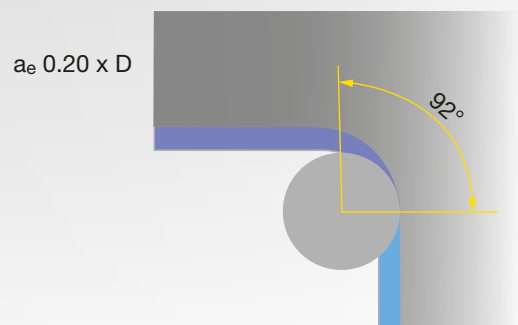


#### Tool radius < Corner radius

- machine can interpolate the path
- no "impact" on tool
- lower increase of tool stress

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

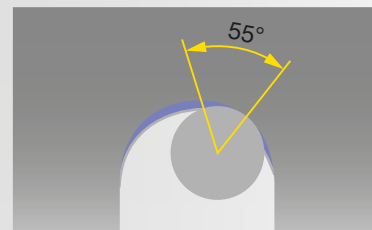
Measures:  $a_e$  must be reduced  
 $f_z$  must be heavily reduced in radius



### Ratio of flute width to tool diameter with trochoidal milling

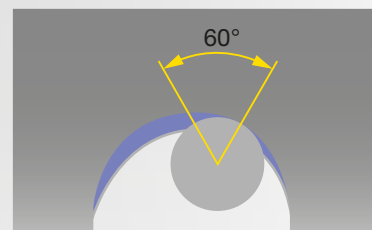
#### Flute width 1.7 – 2.0 x D

- cut in C arc
- $a_e$  max. 0.10 x D (theor. 37°)
- increase of angles of engagement by up to 50%



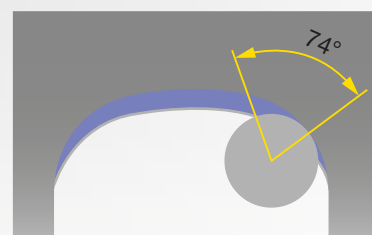
#### Flute width 2.1 – 3.0 x D

- cut in C arc
- $a_e$  max. 0.15 x D (theor. 46°)
- increase of angles of engagement by up to 50%



#### Flute width from 3.1 x D

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





Guide values for increasing the cutting values with cutting edge lengths up to 3 x D					
GTC HPC HSC Roughing and HSC finishing					
Material	Application	radial feed in % of Ø	v <sub>c</sub> factor *	f <sub>z</sub> factor *	Angle of engagement
	<b>Slotting</b>	<b>100 %</b>	<b>1</b>	<b>1</b>	<b>180°</b>
	HPC Roughing	33 %	1.5	1.3	70°
	HPC Roughing	25 %	1.6	1.5	60°
	HPC Roughing	20 %	1.7	1.6	53°
	HPC Roughing	15 %	1.8	1.9	46°
	HSC Roughing	10 %	1.9	2.3	37°
	HSC Roughing	8 %	2.0	2.5	31°
	HSC Roughing	5 %	2.1	2.5	26°
	HSC Finishing	3 %	2.0	1.2	20°
	HSC Finishing	2 %	2.0	1.1	18°
	HSC Finishing	1 %	2.0	1.0	11°
	HSC Fine finishing	0.5 %	2.2	0.9	8°

\* Base value for the calculation with v<sub>c</sub> and f<sub>z</sub> factors is the value specified in the Gühring Navigator for “slotting” in the respective material group.



**Base cutting values slotting – RF 100 tools – smooth cutting**

Material	Hardness	Application	v <sub>c</sub>	f <sub>z</sub> (mm/z) with nom. Ø									
				3	4	5	6	8	10	12	16	20	25
P1	≤ 850 N/mm <sup>2</sup>	Slotting	180	0.015	0.020	0.025	0.030	0.040	0.060	0.072	0.096	0.120	0.150
P2	850-1200 N/mm <sup>2</sup>	Slotting	160	0.014	0.019	0.024	0.029	0.038	0.055	0.066	0.088	0.110	0.138
P3	850-1400 N/mm <sup>2</sup>	Slotting	135	0.014	0.018	0.023	0.027	0.036	0.050	0.060	0.080	0.100	0.125
M1	< 750 N/mm <sup>2</sup>	Slotting	120	0.014	0.018	0.023	0.027	0.036	0.050	0.060	0.080	0.100	0.125
M2	750-850 N/mm <sup>2</sup>	Slotting	80	0.012	0.016	0.020	0.024	0.032	0.045	0.054	0.072	0.090	0.113
M3	> 850 N/mm <sup>2</sup>	Slotting	70	0.011	0.014	0.018	0.021	0.028	0.040	0.048	0.064	0.080	0.100
S-Ni	≤ 1300 N/mm <sup>2</sup>	Slotting	30	0.008	0.011	0.014	0.017	0.022	0.032	0.038	0.051	0.064	0.080
S-Ti	≤ 1300 N/mm <sup>2</sup>	Slotting	60	0.012	0.016	0.020	0.024	0.032	0.045	0.054	0.072	0.090	0.113
K1	≤ 240 HB	Slotting	160	0.017	0.022	0.028	0.033	0.044	0.065	0.078	0.104	0.130	0.163
K2	> 240 HB	Slotting	140	0.015	0.020	0.025	0.030	0.040	0.055	0.066	0.088	0.110	0.138
Wr. al. alloy	≤ 5 % Si	Slotting	500	0.020	0.026	0.033	0.039	0.052	0.075	0.090	0.120	0.150	0.188
Cast al. alloy	> 5 % Si	Slotting	230	0.017	0.022	0.028	0.033	0.044	0.060	0.072	0.096	0.120	0.150
Non-fer. metals	≤ 850 N/mm <sup>2</sup>	Slotting	250	0.017	0.022	0.028	0.033	0.044	0.060	0.072	0.096	0.120	0.150

**Metal removal rate**      $a_p$  (mm) X  $a_e$  (mm) X  $v_f$  (m/min) =  $Q$  (cm<sup>3</sup>/min)

Example	HPC roughing: 15% a <sub>e</sub> ; 2 x D a <sub>p</sub> ; C45
Tool	RF 100 U Ø12 mm – 4 flutes
Feed	radial feed a <sub>e</sub> 1.8 mm = 15% of D
Base value slotting	v <sub>c</sub> slotting = 180 m/min, f <sub>z</sub> slotting= 0.072 mm
Conversion	v <sub>c</sub> factor = 1.8 → v <sub>c</sub> : 180 m/min x 1.8 = v <sub>c</sub> 324 m/min f <sub>z</sub> factor = 1.9 → f <sub>z</sub> : 0.072 mm x 1.9 = f <sub>z</sub> 0.137
Increased values	v <sub>c</sub> : 324 m/min / f <sub>z</sub> : 0.137 mm n: 8594 U/min / v <sub>f</sub> : 4710 mm/min
Metal removal rate	Q = 203 cm <sup>3</sup> /min



**SLOTING**

Milling conditions	Material	Machinability	max. $a_p$	max. $a_e$	max. pressure angle	$v_c$	fz (mm/z) with nom. $\emptyset$								
							3	4	5	6	8	10	12	16	20
<b>HPC</b>	<b>P</b>	light / medial	0.80 x D	1.00 x D	180°	160	0.014	0.018	0.023	0.027	0.044	0.055	0.066	0.088	0.110
		difficult	0.80 x D	1.00 x D	180°	125	0.014	0.018	0.023	0.027	0.040	0.050	0.060	0.080	0.100
	<b>M</b>	light / medial	0.80 x D	1.00 x D	180°	85	0.011	0.014	0.018	0.021	0.028	0.035	0.042	0.056	0.070
		difficult	0.80 x D	1.00 x D	180°	55	0.011	0.014	0.018	0.021	0.028	0.035	0.042	0.056	0.070
	<b>S</b>	medial / difficult	0.80 x D	1.00 x D	180°	45	0.011	0.014	0.018	0.021	0.028	0.035	0.042	0.056	0.070
		very difficult	0.80 x D	1.00 x D	180°	30	0.009	0.012	0.015	0.018	0.024	0.030	0.036	0.048	0.060

**ROUGHING**

Milling conditions	Material	Machinability	max. $a_p$	max. $a_e$	max. pressure angle	$v_c$	fz (mm/z) with nom. $\emptyset$								
							3	4	5	6	8	10	12	16	20
<b>HPC</b>	<b>P</b>	light / medial	L2	0.20 x D	53°	270	0.022	0.029	0.036	0.043	0.070	0.088	0.106	0.141	0.176
		difficult	L2	0.20 x D	53°	210	0.022	0.029	0.036	0.043	0.064	0.080	0.096	0.128	0.160
	<b>M</b>	light / medial	L2	0.15 x D	46°	150	0.020	0.027	0.033	0.040	0.053	0.067	0.080	0.106	0.133
		difficult	L2	0.10 x D	37°	100	0.024	0.032	0.040	0.048	0.064	0.081	0.097	0.129	0.161
	<b>S</b>	medial / difficult	L2	0.08 x D	31°	90	0.026	0.035	0.044	0.053	0.070	0.088	0.105	0.140	0.175
		very difficult	L2	0.08 x D	31°	60	0.023	0.030	0.038	0.045	0.060	0.075	0.090	0.120	0.150

**ROUGHING**

Milling conditions	Material	Machinability	max. $a_p$	max. $a_e$	max. pressure angle	$v_c$	fz (mm/z) with nom. $\emptyset$								
							3	4	5	6	8	10	12	16	20
<b>HSC</b>	<b>P</b>	light / medial	L2	0.15 x D	46°	290	0.026	0.034	0.043	0.051	0.084	0.105	0.125	0.167	0.209
		difficult	L2	0.15 x D	46°	230	0.026	0.034	0.043	0.051	0.076	0.095	0.114	0.152	0.190
	<b>M</b>	light / medial	L2	0.10 x D	37°	170	0.024	0.032	0.040	0.048	0.064	0.081	0.097	0.129	0.161
		difficult	L2	0.08 x D	31°	110	0.026	0.035	0.044	0.053	0.070	0.088	0.105	0.140	0.175
	<b>S</b>	medial / difficult	L2	0.05 x D	26°	100	0.026	0.035	0.044	0.053	0.070	0.088	0.105	0.140	0.175
		very difficult	L2	0.05 x D	26°	70	0.023	0.030	0.038	0.045	0.060	0.075	0.090	0.120	0.150

**FINISHING**

Milling conditions	Material	Machinability	max. $a_p$	max. $a_e$	max. pressure angle	$v_c$	fz (mm/z) with nom. $\emptyset$								
							3	4	5	6	8	10	12	16	20
<b>HSC</b>	<b>P</b>	light / medial	L2	0.02 x D	18°	320	0.019	0.025	0.032	0.038	0.062	0.077	0.092	0.123	0.154
		difficult	L2	0.02 x D	18°	250	0.019	0.025	0.032	0.038	0.056	0.070	0.084	0.112	0.140
	<b>M</b>	light / medial	L2	0.02 x D	18°	170	0.015	0.020	0.025	0.029	0.039	0.049	0.059	0.078	0.098
		difficult	L2	0.01 x D	11°	120	0.019	0.025	0.032	0.038	0.050	0.063	0.076	0.101	0.126
	<b>S</b>	medial / difficult	L2	0.01 x D	11°	100	0.019	0.025	0.032	0.038	0.050	0.063	0.076	0.101	0.126
		very difficult	L2	0.01 x D	11°	70	0.016	0.022	0.027	0.032	0.043	0.054	0.065	0.086	0.108



**ROUGHING**

Milling conditions	Material	Machinability	max. $a_p$	max. $a_e$	max. pressure angle	$v_c$	fz (mm/z) with nom. $\emptyset$								
							3	4	5	6	8	10	12	16	20
<b>HPC</b>	<b>P</b>	light / medial	L2	0.15 x D	46°	280	0.026	0.034	0.043	0.051	0.084	0.105	0.125	0.167	0.209
		difficult	L2	0.15 x D	46°	220	0.026	0.034	0.043	0.051	0.076	0.095	0.114	0.152	0.190
	<b>M</b>	light / medial	L2	0.10 x D	37°	160	0.024	0.032	0.040	0.048	0.064	0.081	0.097	0.129	0.161
		difficult	L2	0.10 x D	37°	100	0.024	0.032	0.040	0.048	0.064	0.081	0.097	0.129	0.161
	<b>S</b>	medial / difficult	L2	0.08 x D	31°	90	0.026	0.035	0.044	0.053	0.070	0.088	0.105	0.140	0.175
		very difficult	L2	0.08 x D	31°	60	0.023	0.030	0.038	0.045	0.060	0.075	0.090	0.120	0.150

**ROUGHING**

Milling conditions	Material	Machinability	max. $a_p$	max. $a_e$	max. pressure angle	$v_c$	fz (mm/z) with nom. $\emptyset$								
							3	4	5	6	8	10	12	16	20
<b>HSC</b>	<b>P</b>	light / medial	L2	0.10 x D	37°	310	0.031	0.041	0.052	0.062	0.101	0.127	0.152	0.202	0.253
		difficult	L2	0.10 x D	37°	240	0.031	0.041	0.052	0.062	0.092	0.115	0.138	0.184	0.230
	<b>M</b>	light / medial	L2	0.08 x D	31°	170	0.026	0.035	0.044	0.053	0.070	0.088	0.105	0.140	0.175
		difficult	L2	0.08 x D	31°	110	0.026	0.035	0.044	0.053	0.070	0.088	0.105	0.140	0.175
	<b>S</b>	medial / difficult	L2	0.05 x D	26°	100	0.026	0.035	0.044	0.053	0.070	0.088	0.105	0.140	0.175
		very difficult	L2	0.05 x D	26°	70	0.023	0.030	0.038	0.045	0.060	0.075	0.090	0.120	0.150

**FINISHING**

Milling conditions	Material	Machinability	max. $a_p$	max. $a_e$	max. pressure angle	$v_c$	fz (mm/z) with nom. $\emptyset$								
							3	4	5	6	8	10	12	16	20
<b>HSC</b>	<b>P</b>	light / medial	L2	0.01 x D	11°	340	0.024	0.032	0.041	0.049	0.079	0.099	0.119	0.158	0.198
		difficult	L2	0.01 x D	11°	270	0.024	0.032	0.041	0.049	0.072	0.090	0.108	0.144	0.180
	<b>M</b>	light / medial	L2	0.01 x D	11°	180	0.019	0.025	0.032	0.038	0.050	0.063	0.076	0.101	0.126
		difficult	L2	0.01 x D	11°	120	0.019	0.025	0.032	0.038	0.050	0.063	0.076	0.101	0.126
	<b>S</b>	medial / difficult	L2	0.01 x D	11°	100	0.019	0.025	0.032	0.038	0.050	0.063	0.076	0.101	0.126
		very difficult	L2	0.01 x D	11°	70	0.016	0.022	0.027	0.032	0.043	0.054	0.065	0.086	0.108



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