GÜHRING

RF 100 Speed

GÜHRING – YOUR WORLDWIDE PARTNER

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

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

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

version with corner radius and radius correction for long tool life

increased clearance in the centre for efficient ramping and helical milling

NEW

RF 100 5 SPEED

RF 100 7 SPEED

THE NEW GTC POWER

Highest metal removal rates with outstanding process reliability

GTC
GÜHRING TROCHOIDAL CUTTING

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

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

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

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

48°

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

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

GTC
GÜHRING TROCHOIDAL CUTTING

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 % P K H

RF 100 Speed P, page 6

with 3° rake angle suitable for materials such as high-strength steels up to 1600 N/mm² or 48 HRC as well as all types of cast iron

a_e <15 % M S P

RF 100 Speed M, page 8

with 9° rake angle the specialist for soft steels up to 850 N/mm², 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 % M S P K

RF 100 5 Speed, page 10

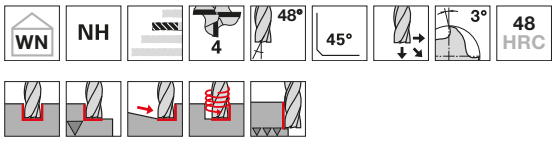
Applicable in all tough materials up to 1200 N/mm².
Ramping up to 10°, slotting with cutting depths up to 1 x D, helical milling.

a_e <8 % M S P K

RF 100 7 Speed, page 13

Applicable in all tough materials up to 1200 N/mm².
Helical milling up to 0.05 x D a_p infeeds per cycle.

Ratio end mills RF 100 Speed P

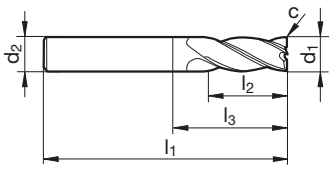


Tool material	Solid carbide	
Surface	A	A
Type	NH	NH
Shank form	HA	HB

P	•
M	
K	•
N	
S	
H	○

GÜHRINGNAVIGATOR
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



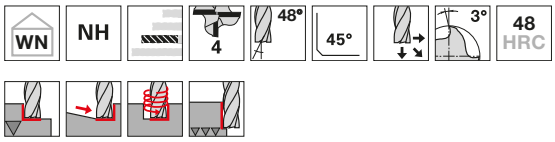
Article no.	6958	6959

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_c	f_z (mm/z)/Ø 3	6	8	10	12	16	20
			a_p = l2		HPC	HSC		a_e max = 0,10xD	
P	≤850 N/mm²	340	0,036	0,072	0,096	0,138	0,17	0,22	0,28
	≥850 N/mm²	250	0,031	0,062	0,083	0,115	0,14	0,18	0,23
K	≤240 HB	300	0,038	0,076	0,101	0,150	0,18	0,24	0,30
	≥240 HB	260	0,035	0,069	0,092	0,127	0,15	0,20	0,25

v_c	f_z (mm/z)/Ø 3	6	8	10	12	16	20
	a_p = l2					a_e max = 0,02xD	
360	0,017	0,034	0,046	0,066	0,08	0,11	0,13
270	0,015	0,030	0,040	0,055	0,07	0,09	0,11
320	0,018	0,036	0,048	0,072	0,09	0,11	0,14
280	0,017	0,033	0,044	0,061	0,07	0,10	0,12

Ratio end mills RF 100 Speed P

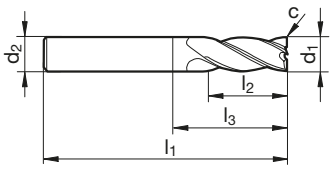


Tool material	Solid carbide	
Surface	A	A
Type	NH	NH
Shank form	HA	HB

P	•
M	
K	•
N	
S	
H	○

GÜHRINGNAVIGATOR
Cutting data page 19

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



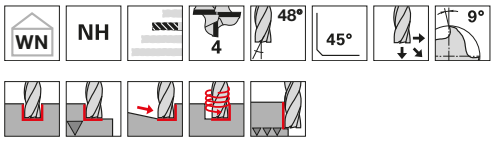
Article no.	6960	6961

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_c	f_z (mm/z)/Ø 3	6	8	10	12	16	20
			$a_p = l2$		HPC	HSC		a_e max = 0,10xD	
P	≤850 N/mm²	340	0,036	0,072	0,096	0,138	0,17	0,22	0,28
	≥850 N/mm²	250	0,031	0,062	0,083	0,115	0,14	0,18	0,23
K	≤240 HB	300	0,038	0,076	0,101	0,150	0,18	0,24	0,30
	≥240 HB	260	0,035	0,069	0,092	0,127	0,15	0,20	0,25

v_c	f_z (mm/z)/Ø 3	6	8	10	12	16	20
	$a_p = l2$					a_e max = 0,02xD	
360	0,017	0,034	0,046	0,066	0,08	0,11	0,13
270	0,015	0,030	0,040	0,055	0,07	0,09	0,11
320	0,018	0,036	0,048	0,072	0,09	0,11	0,14
280	0,017	0,033	0,044	0,061	0,07	0,10	0,12

Ratio end mills RF 100 Speed M

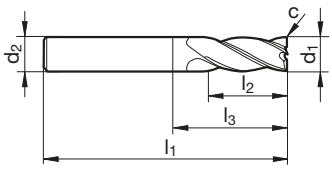


Tool material	Solid carbide	
Surface	A	A
Type	NH	NH
Shank form	HA	HB

P	•
M	•
K	
N	
S	•
H	

GÜHRINGNAVIGATOR
Cutting data page 19

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



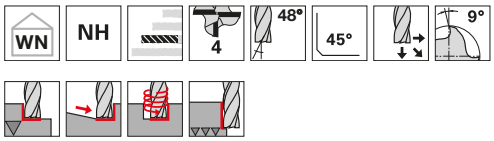
Article no.	6765	6760

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_c	f_z (mm/z)/Ø						
			3	6	8	10	12	16	20
			a_p = l2		HPC	HSC		a_e max = 0,10xD	
P	≤850 N/mm²	**340**	0,036	0,072	0,096	0,138	0,17	0,22	0,28
	≥850 N/mm²	**250**	0,031	0,062	0,083	0,115	0,14	0,18	0,23
M	≤750 N/mm²	**220**	0,031	0,062	0,083	0,115	0,14	0,18	0,23
	≥750 N/mm²	**110**	0,024	0,048	0,064	0,092	0,11	0,15	0,18
S	Ni-based	**60**	0,019	0,039	0,052	0,074	0,09	0,12	0,15
	Ti-based	**110**	0,028	0,055	0,074	0,104	0,12	0,17	0,21

v_c	f_z (mm/z)/Ø						
	3	6	8	10	12	16	20
	a_p = l2				a_e max = 0,02xD		
360	0,017	0,034	0,046	0,066	0,08	0,11	0,13
270	0,015	0,030	0,040	0,055	0,07	0,09	0,11
240	0,015	0,030	0,040	0,055	0,07	0,09	0,11
120	0,011	0,021	0,028	0,040	0,05	0,06	0,08
60	0,008	0,017	0,022	0,032	0,04	0,05	0,06
120	0,013	0,026	0,035	0,050	0,06	0,08	0,10

Ratio end mills RF 100 Speed M

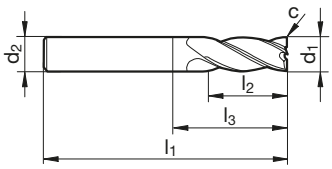


Tool material	Solid carbide	
Surface	A	A
Type	NH	NH
Shank form	HA	HB

P	•
M	•
K	
N	
S	•
H	

GÜHRINGNAVIGATOR
Cutting data page 19

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



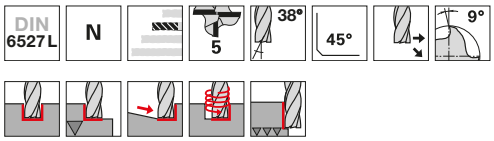
Article no.	6766	6761

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_c	f_z (mm/z)/Ø 3	6	8	10	12	16	20
			a_p = l2		HPC	HSC		a_e max = 0,10xD	
P	≤850 N/mm²	340	0,036	0,072	0,096	0,138	0,17	0,22	0,28
	≥850 N/mm²	250	0,031	0,062	0,083	0,115	0,14	0,18	0,23
M	≤750 N/mm²	220	0,031	0,062	0,083	0,115	0,14	0,18	0,23
	≥750 N/mm²	110	0,024	0,048	0,064	0,092	0,11	0,15	0,18
S	Ni-based	60	0,019	0,039	0,052	0,074	0,09	0,12	0,15
	Ti-based	110	0,028	0,055	0,074	0,104	0,12	0,17	0,21

v_c	f_z (mm/z)/Ø 3	6	8	10	12	16	20
	a_p = l2					a_e max = 0,02xD	
360	0,017	0,034	0,046	0,066	0,08	0,11	0,13
270	0,015	0,030	0,040	0,055	0,07	0,09	0,11
240	0,015	0,030	0,040	0,055	0,07	0,09	0,11
120	0,011	0,021	0,028	0,040	0,05	0,06	0,08
60	0,008	0,017	0,022	0,032	0,04	0,05	0,06
120	0,013	0,026	0,035	0,050	0,06	0,08	0,10

Ratio end mills RF 100 5 Speed

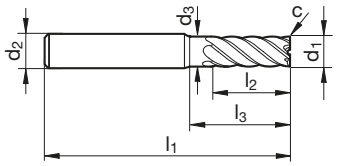


Tool material	Solid carbide	
Surface	A	A
Type	N	N
Shank form	HA	HB

P	•
M	•
K	•
N	○
S	•
H	

GÜHRINGNAVIGATOR
Cutting data page 19

- with chip breaker
- neck clearance
- without centre cutting

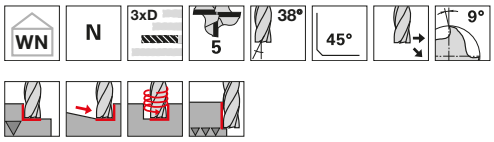


Article no.	6856	6857

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_c	f_z (mm/z)/Ø							v_c	f_z (mm/z)/Ø						
			3	6	8	10	12	16	20		3	6	8	10	12	16	20
			$a_p = l2$		HPC	HSC		a_e max = 0,10xD			$a_p = l2$				a_e max = 0,02xD		
P	≤850 N/mm²	**340**	0,036	0,072	0,096	0,138	0,17	0,22	0,28	**360**	0,017	0,034	0,046	0,066	0,08	0,11	0,13
	≥850 N/mm²	**250**	0,031	0,062	0,083	0,115	0,14	0,18	0,23	**270**	0,015	0,030	0,040	0,055	0,07	0,09	0,11
M	≤750 N/mm²	**220**	0,031	0,062	0,083	0,115	0,14	0,18	0,23	**240**	0,015	0,030	0,040	0,055	0,07	0,09	0,11
	≥750 N/mm²	**110**	0,024	0,048	0,064	0,092	0,11	0,15	0,18	**120**	0,011	0,021	0,028	0,040	0,05	0,06	0,08
S	Ni-based	**60**	0,019	0,039	0,052	0,074	0,09	0,12	0,15	**60**	0,008	0,017	0,022	0,032	0,04	0,05	0,06
	Ti-based	**110**	0,028	0,055	0,074	0,104	0,12	0,17	0,21	**120**	0,013	0,026	0,035	0,050	0,06	0,08	0,10

Ratio end mills RF 100 5 Speed

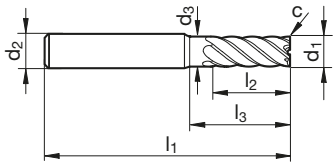


Tool material	Solid carbide	
Surface	A	A
Type	N	N
Shank form	HA	HB

P	•
M	•
K	•
N	○
S	•
H	

GÜHRINGNAVIGATOR
Cutting data page 19

- with chip breaker
- neck clearance
- without centre cutting

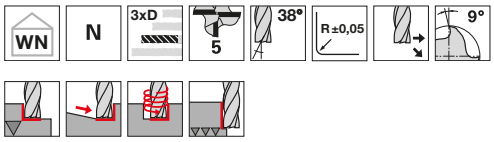


Article no.	6858	6859

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_c	f_z (mm/z)/Ø							v_c	f_z (mm/z)/Ø						
			3	6	8	10	12	16	20		3	6	8	10	12	16	20
			a_p = l2		HPC	HSC		a_e max = 0,10xD			a_p = l2				a_e max = 0,02xD		
P	≤ 850 N/mm²	**340**	0,036	0,072	0,096	0,138	0,17	0,22	0,28	**360**	0,017	0,034	0,046	0,066	0,08	0,11	0,13
	≥ 850 N/mm²	**250**	0,031	0,062	0,083	0,115	0,14	0,18	0,23	**270**	0,015	0,030	0,040	0,055	0,07	0,09	0,11
M	≤ 750 N/mm²	**220**	0,031	0,062	0,083	0,115	0,14	0,18	0,23	**240**	0,015	0,030	0,040	0,055	0,07	0,09	0,11
	≥ 750 N/mm²	**110**	0,024	0,048	0,064	0,092	0,11	0,15	0,18	**120**	0,011	0,021	0,028	0,040	0,05	0,06	0,08
S	Ni-based	**60**	0,019	0,039	0,052	0,074	0,09	0,12	0,15	**60**	0,008	0,017	0,022	0,032	0,04	0,05	0,06
	Ti-based	**110**	0,028	0,055	0,074	0,104	0,12	0,17	0,21	**120**	0,013	0,026	0,035	0,050	0,06	0,08	0,10

Ratio end mills RF 100 5 Speed

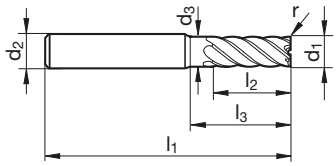


Tool material	Solid carbide	
Surface	A	A
Type	N	N
Shank form	HA	HB

P	•
M	•
K	•
N	○
S	•
H	

GÜHRINGNAVIGATOR
Cutting data page 19

- with chip breaker
- neck clearance
- without centre cutting

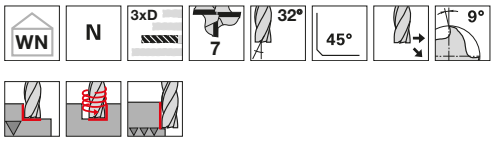


Article no.	6860	6861

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	v_c	f_z (mm/z)/Ø 3	6	8	10	12	16	20	v_c	f_z (mm/z)/Ø 3	6	8	10	12	16	20
			a_p = l2		HPC	HSC		a_e max = 0,10xD			a_p = l2					a_e max = 0,02xD	
P	≤850 N/mm²	**340**	0,036	0,072	0,096	0,138	0,17	0,22	0,28	**360**	0,017	0,034	0,046	0,066	0,08	0,11	0,13
	≥850 N/mm²	**250**	0,031	0,062	0,083	0,115	0,14	0,18	0,23	**270**	0,015	0,030	0,040	0,055	0,07	0,09	0,11
M	≤750 N/mm²	**220**	0,031	0,062	0,083	0,115	0,14	0,18	0,23	**240**	0,015	0,030	0,040	0,055	0,07	0,09	0,11
	≥750 N/mm²	**110**	0,024	0,048	0,064	0,092	0,11	0,15	0,18	**120**	0,011	0,021	0,028	0,040	0,05	0,06	0,08
S	Ni-based	**60**	0,019	0,039	0,052	0,074	0,09	0,12	0,15	**60**	0,008	0,017	0,022	0,032	0,04	0,05	0,06
	Ti-based	**110**	0,028	0,055	0,074	0,104	0,12	0,17	0,21	**120**	0,013	0,026	0,035	0,050	0,06	0,08	0,10

Ratio end mills RF 100 7 Speed

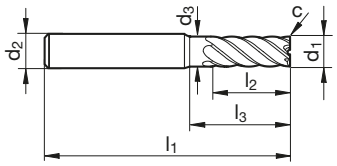


Tool material	Solid carbide	
Surface	A	A
Type	N	N
Shank form	HA	HB

P	•
M	•
K	•
N	○
S	•
H	

GÜHRINGNAVIGATOR
Cutting data page 19

- with chip breaker
- neck clearance
- without centre cutting



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_c	f_z (mm/z)/Ø							v_c	f_z (mm/z)/Ø						
			3	6	8	10	12	16	20		3	6	8	10	12	16	20
			a_p = l2		HPC	HSC		a_e max = 0,10xD			a_p = l2				a_e max = 0,02xD		
P	≤ 850 N/mm²	**340**	0,036	0,072	0,096	0,138	0,17	0,22	0,28	**360**	0,017	0,034	0,046	0,066	0,08	0,11	0,13
	≥ 850 N/mm²	**250**	0,031	0,062	0,083	0,115	0,14	0,18	0,23	**270**	0,015	0,030	0,040	0,055	0,07	0,09	0,11
M	≤ 750 N/mm²	**220**	0,031	0,062	0,083	0,115	0,14	0,18	0,23	**240**	0,015	0,030	0,040	0,055	0,07	0,09	0,11
	≥ 750 N/mm²	**110**	0,024	0,048	0,064	0,092	0,11	0,15	0,18	**120**	0,011	0,021	0,028	0,040	0,05	0,06	0,08
S	Ni-based	**60**	0,019	0,039	0,052	0,074	0,09	0,12	0,15	**60**	0,008	0,017	0,022	0,032	0,04	0,05	0,06
	Ti-based	**110**	0,028	0,055	0,074	0,104	0,12	0,17	0,21	**120**	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.

GTC
GÜHRING TROCHOIDAL CUTTING

HPC HIGH PERFORMANCE CUTTING

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

HSC 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

- P K H M S N
- 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 x D

- low angle of engagement <70°
- short time of contact between cutting edge and component

Very high tooth feed f_z

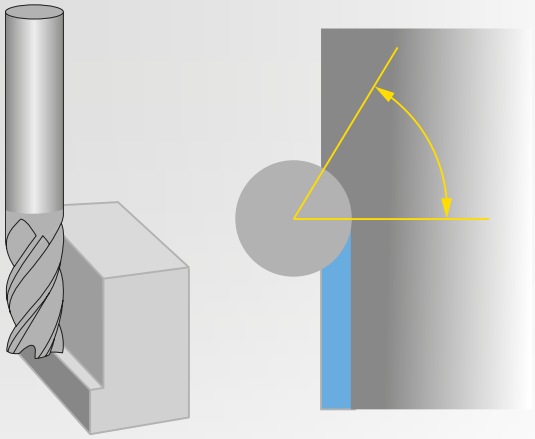
- reduced chip thickness allows considerably higher f_z

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.

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

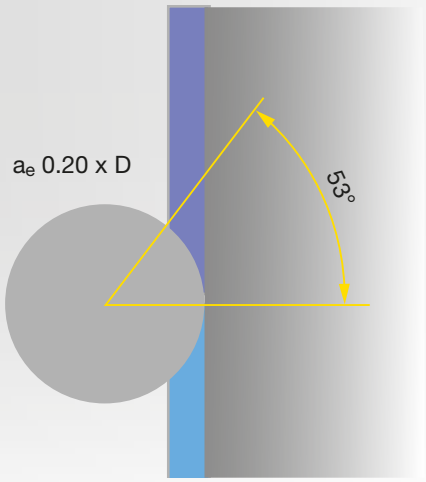
Influence on process through tool engagement

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 x D = 53° engagement
Engagement remains a constant 53°

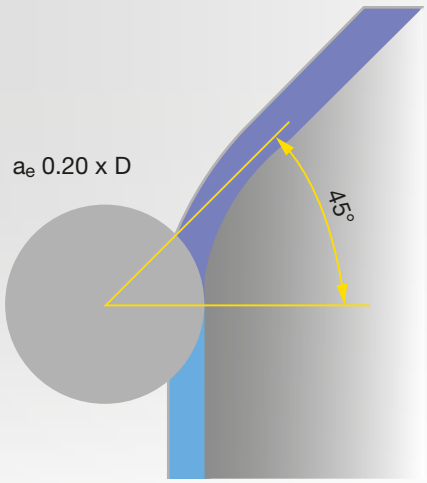


Angle of engagement with convex contour radii

Convex milling path
- decreasing angle of engagement
- reduced tool stress

Example: a_e 0.20 x D = 53° engagement
Engagement reduces to 45°

Measures: a_e may be increased
f_z can be increased

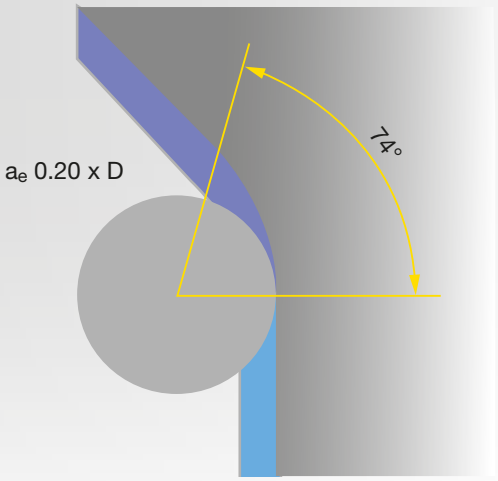


Angle of engagement with concave contour radii

Concave milling path
- increasing angle of engagement
- increased tool stress

Example: a_e 0.20 x D = 53° engagement
Engagement increases to 74°

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



Influence on process through tool engagement

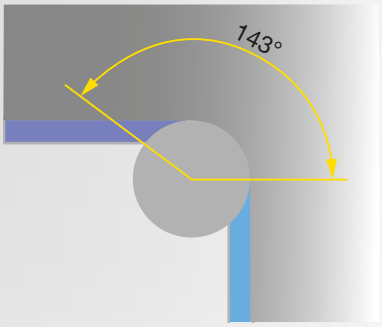
Angle of engagement with 90° corner radii

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

a_e 0.20 x D

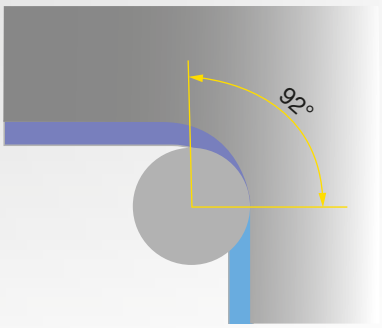


Tool radius < Corner radius
- machine can interpolate the path
- no “impact” on tool
- lower increase of tool stress

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

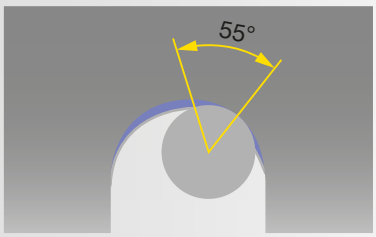
Measures: a_e must be reduced
f_z must be heavily reduced in radius

a_e 0.20 x D

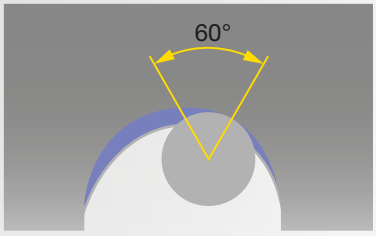


Ratio of flute width to tool diameter with trochoidal milling

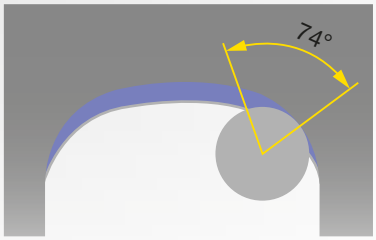
Flute width 1.7 – 2.0 x D
- cut in C arc
- a_e max. 0.10 x D (theor. 37°)
- increase of angles of engagement by up to 50%



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_c factor ***	**f_z factor ***	**Angle of engagement**
	Slotting	**100 %**	**1**	**1**	**180°**
N P K M S	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°
N P K M S	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_c and f_z 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_c	f_z (mm/z) with nom. Ø									
				3	4	5	6	8	10	12	16	20	25
P1	≤ 850 N/mm²	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/mm²	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/mm²	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/mm²	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/mm²	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/mm²	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/mm²	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/mm²	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/mm²	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 (cm³/min)

Example	HPC roughing: 15% a_e ; 2 x D a_p ; C45
Tool	RF 100 U Ø12 mm – 4 flutes
Feed	radial feed a_e 1.8 mm = 15% of D
Base value slotting	v_c slotting = 180 m/min, f_z slotting= 0.072 mm
Conversion	v_c factor = 1.8 → v_c: 180 m/min x 1.8 = v_c 324 m/min f_z factor = 1.9 → f_z: 0.072 mm x 1.9 = f_z 0.137
Increased values	v_c: 324 m/min / f_z: 0.137 mm n: 8594 U/min / v_f: 4710 mm/min
Metal removal rate	Q = 203 cm³/min

RF 100 SPEED | RF 100 5 SPEED

SLOTTING

Milling conditions	Material	Machinability	max. a_p	max. a_e	max. pressure angle	v_c	fz (mm/z) with nom. Ø								
							3	4	5	6	8	10	12	16	20
HPC	P	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
	M	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
	S	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. Ø								
							3	4	5	6	8	10	12	16	20
HPC	P	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
	M	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
	S	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. Ø								
							3	4	5	6	8	10	12	16	20
HSC	P	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
	M	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
	S	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. Ø								
							3	4	5	6	8	10	12	16	20
HSC	P	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
	M	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
	S	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

RF 100 SPEED | RF 100 5 SPEED | RF 100 7 SPEED | 3xD

ROUGHING

Milling conditions	Material	Machinability	max. a_p	max. a_e	max. pressure angle	v_c	fz (mm/z) with nom. Ø								
							3	4	5	6	8	10	12	16	20
HPC	P	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
	M	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
	S	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. Ø								
							3	4	5	6	8	10	12	16	20
HSC	P	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
	M	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
	S	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. Ø								
							3	4	5	6	8	10	12	16	20
HSC	P	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
	M	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
	S	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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148 870/19075-VII-05 | Printed in Germany | 2019