



High volume milling - Trochoidal milling

Forbes has designed a program of HVM (High Volume Machining) or roughing on a wide spectrum of applications and materials: Steel up to 50HRc, alloy steel, tools steel, stainless steel, carbon steel, cast iron as well as materials that contain Chrome (Cr) or Nickel (Ni).



- Trochoidal milling
 - ▶ Stainless
 - ▶ Titanium
 - ▶ Steels

- Efficient production
- Longer tool life
- Lower cycle time

Trochoidal Milling is an efficient way to cut a slot other than using a standard slot milling method. In trochoidal milling, an end mill is used to machine the slot width using a circular movement. This is called the trochoid method

Advantages

- Highest dynamic speed rates
- Highest material removal rate
- Least cutting forces
- Prolonged tool life due to reduced shock
- High savings in cycle time when compared to the conventional milling strategy

Program

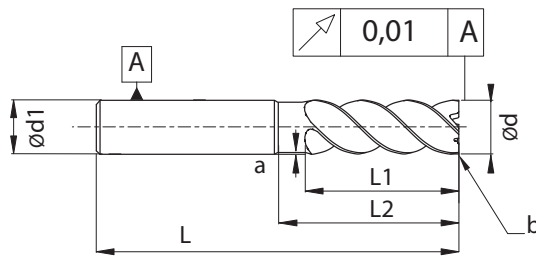
- Center cutting high performance trochoidal mills for stainless and titanium
- Center cutting high performance trochoidal mills for steel

Optimum Flutes

Centre cutting high performance trochoidal mill for stainless steel, titanium



END MILLS



P1-P6

K1-K2

M1-M3

S1-S4

H1

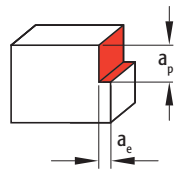
Unit : mm

Ød (mm)	b (mm)	Ød1 (mm)	L (mm)	L1 (mm)	L2 (mm)	a (mm)	z	γ (°)	EDP No
3	0.1	6	57	10	15	0.1	4	-	FBK0505959
4	0.1	6	57	13	15	0.1	4	-	FBK0505960
5	0.1	6	57	16	20	0.1	4	-	FBK0505961
6	0.1	6	57	19	25	0.1	5	-	FBK0505962
8	0.15	8	63	25	30	0.1	5	-	FBK0505963
10	0.2	10	72	32	35	0.1	5	-	FBK0505964
12	0.2	12	83	38	45	0.1	6	-	FBK0505965
16	0.3	16	108	42	55	0.1	6	-	FBK0505966
20	0.4	20	126	50	70	0.1	7	-	FBK0505967

Cutting conditions

Centre cutting high performance trochoidal mill for stainless steel, titanium

Material group	TSR	Hardness	Cutting speed	Coolant
	(N/mm ²)	HRc	Vc m/min	
P3	< 750	< 35 HRc	220 - 280	emulsion
P4	< 1000	< 35-48 HRc	145 - 225	emulsion
P4	< 1400	< 35 HRc	100 - 180	emulsion
H1		42-50 HRc	100 - 150	emulsion
M1	< 600		115 - 165	emulsion
M2	600-800	< 25 HRc	85 - 125	emulsion
M3	< 800	< 30 HRc	85 - 125	emulsion
K1	125-500	< 32 HRc	100 - 160	emulsion
S1	500-1200	25-48 HRc	55 - 75	emulsion
S2	1000-1500	25-48 HRc	60 - 90	emulsion
S3	600-1700	<48 HRc	45 - 65	emulsion
S4	900-1600	33-48 HRc	80 - 120	emulsion



Shoulder milling

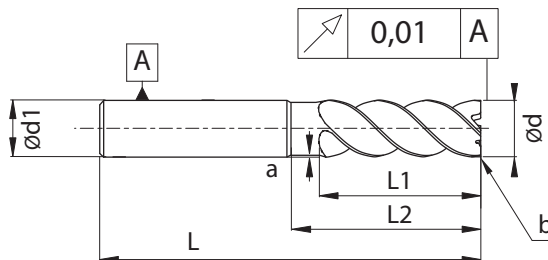
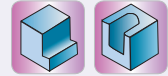
Ød (mm)	ap max. (mm)	ae max. (mm)	fz (mm/tooth)
3.0	< 9.00	< 0.450	0.015 - 0.035
4.0	< 12.00	< 0.600	0.025 - 0.050
5.0	< 15.00	< 0.750	0.030 - 0.060
6.0	< 18.00	< 0.900	0.040 - 0.070
8.0	< 24.00	< 1.200	0.050 - 0.085
10.0	< 30.00	< 1.500	0.060 - 0.100
12.0	< 36.00	< 1.800	0.085 - 0.120
16.0	< 40.00	< 2.400	0.100 - 0.145
20.0	< 50.00	< 3.000	0.125 - 0.175

Advantages

- High MRR (Material Removal Rate)
- Constant cutting force
 - ▶ Better for machine
 - ▶ Better for end mill
 - ▶ Increased lifetime
- Optimized cutting conditions to application area

Optimum Flutes

Centre cutting high performance trochoidal mill for steel



- P1-P6
- K1-K2
- M1-M3
- S1-S4
- H1

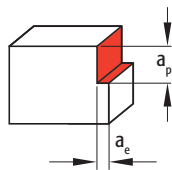
Unit : mm

Ød (mm)	b (mm)	Ød1 (mm)	L (mm)	L1 (mm)	L2 (mm)	a (mm)	z	γ (°)	EDP No
3	0.1	6	57	10	15	0.1	4	-	FBK0505968
4	0.1	6	57	13	15	0.1	4	-	FBK0505969
5	0.1	6	57	16	20	0.1	4	-	FBK0505970
6	0.1	6	57	19	25	0.1	5	-	FBK0505971
8	0.15	8	63	25	30	0.1	5	-	FBK0505972
10	0.2	10	72	32	35	0.1	5	-	FBK0505973
12	0.2	12	90	38	45	0.1	6	-	FBK0508648
16	0.3	16	108	42	55	0.1	6	-	FBK0505975
20	0.4	20	126	50	70	0.1	7	-	FBK0505976

Cutting conditions

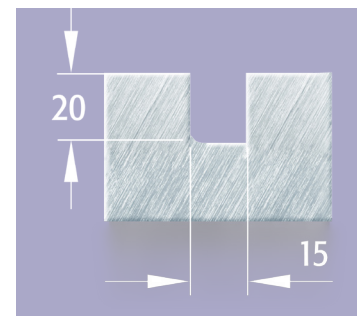
Centre cutting high performance trochoidal mill for steel

Material group	TSR	Hardness	Cutting speed	Coolant
	(N/mm ²)	HRc	Vc m/min	
P3	< 750	< 35 HRc	240 - 300	emulsion
P4	< 1000	< 35-48 HRc	160 - 240	emulsion
P4	< 1400	< 35 HRc	130 - 200	emulsion
H1		42-50 HRc	100 - 150	emulsion
M1	< 600		100 - 150	emulsion
M2	600-800	< 25 HRc	90 - 120	emulsion
M3	< 800	< 30 HRc	90 - 120	emulsion
K1	125-500	<32 HRc	125 - 225	emulsion
S1	500-1200	25-48 HRc	45 - 65	emulsion
S2	1000-1500	25-48 HRc	50 - 80	emulsion
S3	600-1700	<48 HRc	35 - 55	emulsion
S4	900-1600	33-48 HRc	70 - 105	emulsion



Shoulder milling

Ød (mm)	ap max. (mm)	ae max. (mm)	fz (mm/tooth)
3	< 9.00	< 0.600	0.015 - 0.035
4	< 12.00	< 0.800	0.025 - 0.050
5	< 15.00	< 1.000	0.030 - 0.060
6	< 18.00	< 1.200	0.040 - 0.070
8	< 24.00	< 1.600	0.050 - 0.085
10	< 30.00	< 2.000	0.060 - 0.100
12	< 36.00	< 2.400	0.085 - 0.120
16	< 40.00	< 3.200	0.100 - 0.145
20	< 50.00	< 4.000	0.125 - 0.175



FBK0505973

Workpiece material: St.37

	Competitor	Totem
Ø	10mm	10mm
Z	4 Flutes	5 Flutes
vc	180 mtr/min	250 mtr/min
n	5730 rpm	7957 rpm
Fz	0.04 mm/t	0.12 mm/t
vf	912 mm/min	4774 mm/min
ap	10 mm	20 mm
ae	10 mm / 5 mm	1 mm (programmed)
Coolant	emulsion	emulsion

Cut time	37 s	24 s
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Advantages

- High MRR (Material Removal Rate)
- Lower process time



Trochoidal Milling



Features

- Robust Core Design
- Multiflutes for High Productivity
- Available with alternate coating

Functions

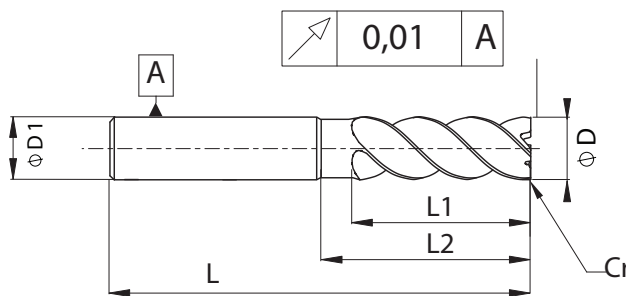
- Operates at high cutting speeds
- Geometry programmed to suit adequate material removal at various engagement angles

Benefits

- Highest dynamic speed rates
- Highest material removal rate
- Least cutting forces
- Prolonged tool life due to reduced shock
- High savings in cycle time when compared to the conventional milling strategy

5 Flute

Centre cutting end mill for finishing steel and super alloys for Trochoidal milling



- P5-P6
- K1-K3
- S2-S4
- M1-M3

Unit : mm

ØD (mm)	L1 (mm)	L2 (mm)	L (mm)	Ø D1 (mm)	Ø Cr (mm)	EDP No
6	13	18	64	6	0.5	FBK0508649
6	13	18	64	6	1.0	FBK0508650
6	13	18	64	6	1.5	FBK0508651
6	14	18	64	6	-	FBK0508652
8	19	24	76	8	0.5	FBK0508653
8	19	24	76	8	1.0	FBK0508654
8	18	24	76	8	-	FBK0508655
10	22	30	76	10	0.5	FBK0508656
10	22	30	76	10	1.0	FBK0508657
10	22	30	76	10	2.0	FBK0508658
10	22	30	76	10	-	FBK0508659
12	26	36	84	12	0.5	FBK0508660
12	26	36	84	12	1.0	FBK0508661
12	26	36	84	12	2.0	FBK0508662
12	26	36	84	12	-	FBK0508663
16	32	48	100	16	0.5	FBK0508664
16	32	48	100	16	1.0	FBK0508665
16	32	48	100	16	2.0	FBK0508666
16	32	48	100	16	3.0	FBK0508667
16	32	48	100	16	-	FBK0508668

Features

- 5 Flutes
- Variable Helix
- Variable Pitch
- Effective for machining Steel/ Stainless (Wet) / Super Alloys (Wet)
- Also available with more flutes/ Neck and through coolant as a special option

Functions

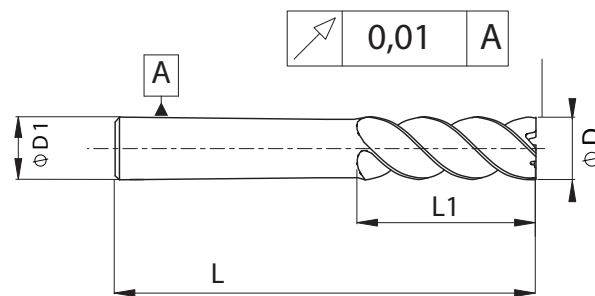
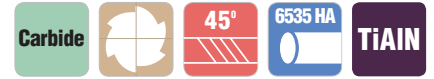
- Effective for Trochoidal Milling and I-machining
- High MRR
- Optimal Flutes as per Diameter of Tool

Benefits

- Stable Cutting edge at elevated cutting conditions
- Superior Tool Life

6 Flute

Centre cutting high performance
6 flute end mill for Trochoidal milling



- P0-P6
- K1-K3
- S1-S4
- M1-M3
- H1

Unit : mm

ØD (mm)	L1 (mm)	L (mm)	ØD1 (mm)	EDP No
6	13	57	6	FBK0508789
8	19	63	8	FBK0508790
10	22	72	10	FBK0508791
12	26	83	12	FBK0508792
16	32	92	16	FBK0508793
20	38	104	20	FBK0508794

Features

- 6 Flutes
- 45° Helix
- Good geometry for finishing
- Effective for machining Steel/ Stainless (Wet) / SuperAlloys (Wet)
- Also available with more flutes/ Neck and through coolant as a special option

Functions

- Effective for Trochoidal Milling and I-machining
- High MRR
- Optimal Flutes as per Diameter of Tool

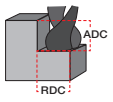
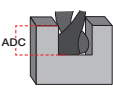
Benefits

- Stable Cutting edge at elevated cutting conditions
- Superior Tool Life

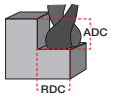
Application data on page no 2.132



Cutting parameters for 5VR

	Material	Side Milling		Slot Milling	Cutting Speed Vc (m/min)		Recommended feed per tooth (fz = mm/tooth) for side milling & For slotting, reduce fz by 20%.								
					min	max	Diameter in mm								
		ap	ae	ap			mm	6.0	8.0	10.0	12.0	16.0	20.0	25.0	
Steel	P	5	1.5xD	0.5xD	1xD	60	100	Fz	0.029	0.040	0.048	0.056	0.070	0.081	0.091
		6	1.5xD	0.5xD	0.75xD	50	75	Fz	0.025	0.034	0.040	0.047	0.057	0.065	0.071
Special Alloys	S	2	1.5xD	0.3xD	0.3xD	25	40	Fz	0.019	0.026	0.032	0.037	0.046	0.054	0.061
		3	1.5xD	0.5xD	1xD	60	80	Fz	0.029	0.040	0.048	0.056	0.070	0.081	0.091
		4	1.5xD	0.5xD	1xD	50	60	Fz	0.026	0.037	0.045	0.052	0.064	0.074	0.084

Cutting parameters for 6VR

	Material	Side Milling		Cutting Speed Vc (m/min)		Recommended feed per tooth (fz = mm/tooth) for side milling										
				min	max	mm	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0	
Steel	P	0	Ap1 max	0.05	150	200	fz	0.028	0.044	0.060	0.072	0.083	0.092	0.101	0.108	0.114
		1	Ap1 max	0.05	150	200	fz	0.028	0.044	0.060	0.072	0.083	0.092	0.101	0.108	0.114
		2	Ap1 max	0.05	140	190	fz	0.028	0.044	0.060	0.072	0.083	0.092	0.101	0.108	0.114
		3	Ap1 max	0.05	120	160	fz	0.023	0.036	0.050	0.061	0.070	0.079	0.087	0.095	0.101
		4	Ap1 max	0.05	90	150	fz	0.021	0.033	0.045	0.054	0.062	0.070	0.077	0.083	0.088
		5	Ap1 max	0.05	60	100	fz	0.019	0.029	0.040	0.048	0.056	0.063	0.070	0.076	0.081
Stainless Steel	M	1	Ap1 max	0.05	90	115	fz	0.023	0.036	0.050	0.061	0.070	0.079	0.087	0.095	0.101
		2	Ap1 max	0.05	60	80	fz	0.019	0.029	0.040	0.048	0.056	0.063	0.070	0.076	0.081
		3	Ap1 max	0.05	60	70	fz	0.016	0.025	0.034	0.040	0.047	0.052	0.057	0.061	0.065
Cast Iron	K	1	Ap1 max	0.05	120	150	fz	0.028	0.044	0.060	0.072	0.083	0.092	0.101	0.108	0.114
		2	Ap1 max	0.05	110	140	fz	0.023	0.036	0.050	0.061	0.070	0.079	0.087	0.095	0.101
		3	Ap1 max	0.05	110	130	fz	0.019	0.029	0.040	0.048	0.056	0.063	0.070	0.076	0.081
Special Alloys	S	1	Ap1 max	0.04	50	90	fz	0.023	0.036	0.050	0.061	0.070	0.079	0.087	0.095	0.101
		2	Ap1 max	0.04	25	40	fz	0.013	0.019	0.026	0.032	0.037	0.042	0.046	0.050	0.054
		3	Ap1 max	0.05	60	80	fz	0.019	0.029	0.040	0.048	0.056	0.063	0.070	0.076	0.081
		4	Ap1 max	0.05	50	60	fz	0.016	0.026	0.037	0.045	0.052	0.058	0.064	0.069	0.074
Hardened Steel	H	1	Ap1 max	0.04	80	140	fz	0.021	0.033	0.045	0.054	0.062	0.070	0.077	0.083	0.088