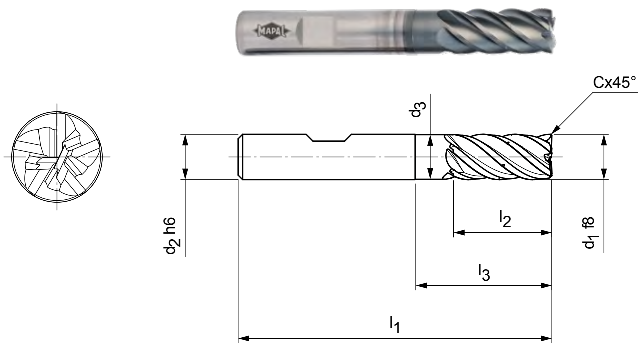
Your technology partner for cost-effective machining

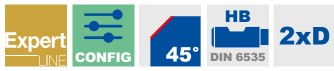
OptiMill®-Tro-Uni (2nd generation)

OptiMill®-Tro-Uni (2nd generation)

Shoulder milling cutter, 2xD design with chip breaker
SCM942

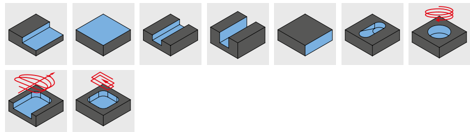


Design:
Diameter of milling cutter: 4.00 - 25.00 mm
Cutting material: HP830
Number of cutting edges: 5
Helix angle: ~ 41°



Configurable features:

Application:



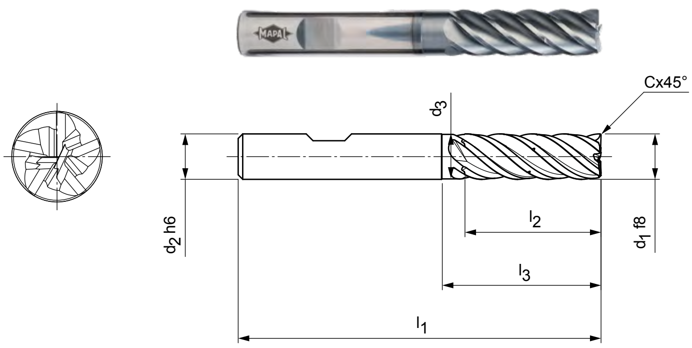
P	1	2	3	4	5	M	1	2	3	K	1	2	3	4	5	N	1	2	3	4	5	S	1	2	3	4	H	1	2	3	C	1	2	3	4	5
	■	■	■	■	■		⬓	⬓	⬓		■	■	■	■	■													⬓								

Dimensions							z	Chip breaker	Specification	Order no.
d_1 f8	d_2 h6	d_3	l_1	l_2	l_3	Cx45°				
4,00	6	3,9	57	11	13	0,08	5	–	SCM942-0400Z05R-F0008HB2-HP830	31663069
5,00	6	4,8	57	13	15,5	0,10	5	–	SCM942-0500Z05R-F0010HB2-HP830	31663140
6,00	6	5,8	57	13	19	0,12	5	–	SCM942-0600Z05R-F0012HB2-HP830	31663141
8,00	8	7,8	63	19	25	0,16	5	–	SCM942-0800Z05R-F0016HB2-HP830	31663142
10,00	10	9,8	72	22	30	0,20	5	–	SCM942-1000Z05R-F0020HB2-HP830	31663143
12,00	12	11,8	83	26	36	0,24	5	1	SCM942-1200Z05R-F0024HB2-HP830	31663144
16,00	16	15,8	92	32	42	0,32	5	1	SCM942-1600Z05R-F0032HB2-HP830	31663146
20,00	20	19,8	104	41	52	0,40	5	1	SCM942-2000Z05R-F0040HB2-HP830	31663148
25,00	25	24,5	125	50	65	0,50	5	1	SCM942-2500Z05R-F0050HB2-HP830	31663149

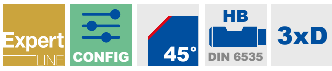
Dimensions in mm.
For cutting data recommendations, see end of chapter.
Special designs and other coatings available upon request.

OptiMill®-Tro-Uni (2nd generation)

Shoulder milling cutter, 3xD design with chip breaker
SCM942

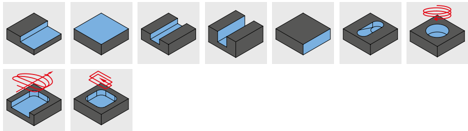


Design:
Diameter of milling cutter: 4.00 - 20.00 mm
Cutting material: HP830
Number of cutting edges: 5
Helix angle: ~ 41°



Configurable features:

Application:



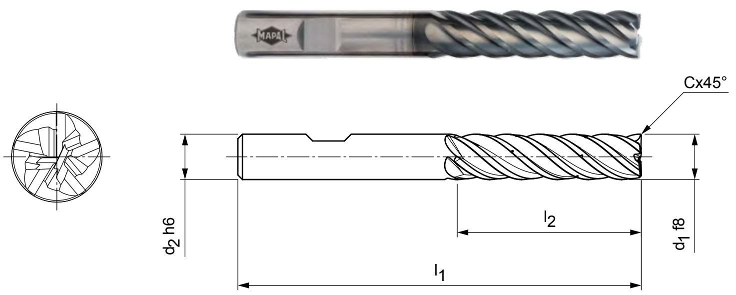
P	1	2	3	4	5	M	1	2	3	K	1	2	3	4	5	N	1	2	3	4	5	S	1	2	3	4	H	1	2	3	C	1	2	3	4	5
	■	■	■	■	■		⬓	⬓	⬓		■	■	■	■	■													⬓								

Dimensions							z	Chip breaker	Specification	Order no.
d_1 f8	d_2 h6	d_3	l_1	l_2	l_3	Cx45°				
4,00	6	3,9	62	16	23	0,08	5	1	SCM942-0400Z05R-F0008HB3-HP830	31663150
5,00	6	4,8	62	17	24	0,10	5	1	SCM942-0500Z05R-F0010HB3-HP830	31663151
6,00	6	5,8	62	18	25	0,12	5	1	SCM942-0600Z05R-F0012HB3-HP830	31663152
8,00	8	7,8	68	24	30	0,16	5	1	SCM942-0800Z05R-F0016HB3-HP830	31663153
10,00	10	9,8	80	30	35	0,20	5	1	SCM942-1000Z05R-F0020HB3-HP830	31663154
12,00	12	11,8	93	36	45	0,24	5	2	SCM942-1200Z05R-F0024HB3-HP830	31663155
16,00	16	15,8	108	48	55	0,32	5	2	SCM942-1600Z05R-F0032HB3-HP830	31663157
20,00	20	19,8	126	60	70	0,40	5	2	SCM942-2000Z05R-F0040HB3-HP830	31663159

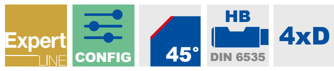
Dimensions in mm.
For cutting data recommendations, see end of chapter.
Special designs and other coatings available upon request.

OptiMill®-Tro-Uni (2nd generation)

Shoulder milling cutter, 4xD design with chip breaker
SCM942

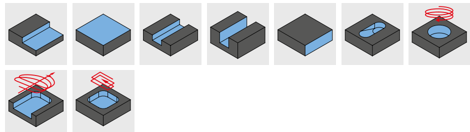


Design:
Diameter of milling cutter: 5.00 - 20.00 mm
Cutting material: HP830
Number of cutting edges: 5
Helix angle: ~ 41°



Configurable features:

Application:



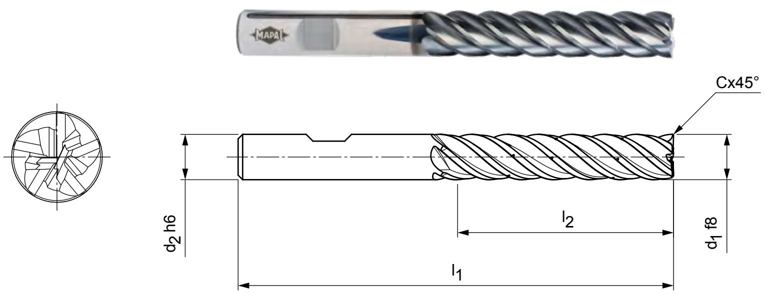
P	1	2	3	4	5	M	1	2	3	K	1	2	3	4	5	N	1	2	3	4	5	S	1	2	3	4	H	1	2	3	C	1	2	3	4	5
	■	■	■	■	■		⬓	⬓	⬓		■	■	■	■	■													⬓								

Dimensions					z	Chip breaker	Specification	Order no.
d_1 f8	d_2 h6	l_1	l_2	Cx45°				
5,00	6	66	20	0,10	5	2	SCM942-0500Z05R-F0010HB4-HP830	31663161
6,00	6	66	24	0,12	5	2	SCM942-0600Z05R-F0012HB4-HP830	31663162
8,00	8	74	32	0,16	5	2	SCM942-0800Z05R-F0016HB4-HP830	31663163
10,00	10	89	40	0,20	5	2	SCM942-1000Z05R-F0020HB4-HP830	31663164
12,00	12	100	48	0,24	5	2	SCM942-1200Z05R-F0024HB4-HP830	31663165
16,00	16	123	64	0,32	5	2	SCM942-1600Z05R-F0032HB4-HP830	31663167
20,00	20	140	80	0,40	5	2	SCM942-2000Z05R-F0040HB4-HP830	31663169

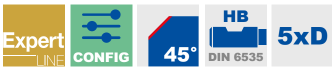
Dimensions in mm.
For cutting data recommendations, see end of chapter.
Special designs and other coatings available upon request.

OptiMill®-Tro-Uni (2nd generation)

Shoulder milling cutter, 5xD design with chip breaker
SCM942

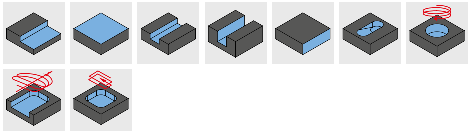


Design:
Diameter of milling cutter: 8.00 - 20.00 mm
Cutting material: HP830
Number of cutting edges: 5
Helix angle: ~ 41°



Configurable features:

Application:



P	1	2	3	4	5	M	1	2	3	K	1	2	3	4	5	N	1	2	3	4	5	S	1	2	3	4	H	1	2	3	C	1	2	3	4	5
	■	■	■	■	■		⬓	⬓	⬓		■	■	■	■	■													⬓								

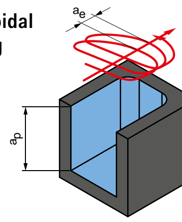
Dimensions					z	Chip breaker	Specification	Order no.
d_1 f8	d_2 h6	l_1	l_2	Cx45°				
8,00	8	81	40	0,16	5	3	SCM942-0800Z05R-F0016HB5-HP830	31663171
10,00	10	96	50	0,20	5	3	SCM942-1000Z05R-F0020HB5-HP830	31663172
12,00	12	112	60	0,24	5	3	SCM942-1200Z05R-F0024HB5-HP830	31663173
16,00	16	136	80	0,32	5	3	SCM942-1600Z05R-F0032HB5-HP830	31663175
20,00	20	160	100	0,40	5	3	SCM942-2000Z05R-F0040HB5-HP830	31663177

Dimensions in mm.
For cutting data recommendations, see end of chapter.
Special designs and other coatings available upon request.

Cutting data recommendation for trochoidal milling cutters

Feed and cutting speed

Trochoidal milling



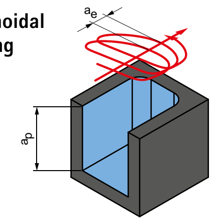
LOW dynamics
a_p = depending on max. machining depth of the tool
a_e = depending on the workpiece material

OptiMill-Tro-Uni (2nd generation) | SCM942 (2xD, 3xD)

MMG*		Workpiece material	Strength/ hardness [N/mm²] [HRC]	Cooling			Feed per tooth [f_z] [mm/tooth] for diameter of milling cutter [mm]										
				MQL/Air	Dry	Wet	v_c [m/min]	a_e in %	4.00	5.00	6.00	8.00	10.00	12.00	14.00	16.00	20.00
P	P1-1	Unalloyed steel ≤ 0.15% C, annealed	420	✓	✓	✓	**405**	**20**	0.060	0.073	0.085	0.109	0.131	0.152	0.172	0.190	0.222
P	P1-2	Unalloyed steel ≤ 0.45% C, annealed	650	✓	✓	✓	**360**	**20**	0.072	0.088	0.103	0.132	0.159	0.184	0.207	0.229	0.268
P	P1-3	Unalloyed steel ≤ 0.45% C, quenched and tempered	850	✓	✓	✓	**342**	**20**	0.058	0.070	0.082	0.105	0.127	0.147	0.166	0.183	0.214
P	P1-4	Unalloyed steel ≤ 0.75% C, annealed	900	✓	✓	✓	**306**	**20**	0.057	0.069	0.081	0.103	0.125	0.144	0.163	0.180	0.211
P	P1-5	Unalloyed steel ≤ 0.75% C, quenched and tempered	1,000	✓	✓	✓	**288**	**20**	0.055	0.066	0.078	0.100	0.120	0.139	0.157	0.173	0.203
P	P2-1	Low-alloyed steel, annealed	600	✓	✓	✓	**324**	**20**	0.059	0.072	0.084	0.107	0.129	0.150	0.169	0.187	0.218
P	P2-2	Low-alloyed steel, quenched and tempered	930	✓	✓	✓	**288**	**20**	0.055	0.066	0.078	0.100	0.120	0.139	0.157	0.173	0.203
P	P2-3	Low-alloyed steel, quenched and tempered	1,000	✓	✓	✓	**261**	**20**	0.052	0.063	0.073	0.094	0.113	0.131	0.148	0.163	0.191
P	P2-4	Low-alloyed steel, quenched and tempered	1,200	✓	✓	✓	**225**	**20**	0.048	0.059	0.069	0.088	0.106	0.123	0.139	0.153	0.179
P	P3-1	High-alloyed steel and high-alloyed tool steel, annealed	680	✓	✓	✓	**216**	**20**	0.054	0.065	0.076	0.098	0.118	0.136	0.154	0.170	0.199
P	P3-2	High-alloyed steel and high-alloyed tool steel, quenched and tempered	1,100	✓	✓	✓	**198**	**20**	0.051	0.061	0.072	0.092	0.111	0.128	0.145	0.160	0.187
P	P3-3	High-alloyed steel and high-alloyed tool steel, quenched and tempered	1,250	✓	✓	✓	**171**	**20**	0.047	0.058	0.067	0.086	0.104	0.120	0.136	0.150	0.175
P	P4-1	Bainitic steel, ultra-high-carbon steel, bainitic-quenched and tempered	1,650			✓	**180**	**17**	0.034	0.041	0.048	0.061	0.074	0.086	0.096	0.107	0.125
P	P5-1	Stainless steel, ferritic / martensitic, quenched and tempered	680			✓	**225**	**18**	0.046	0.056	0.066	0.084	0.101	0.118	0.133	0.147	0.172
P	P5-2	Stainless steel, martensitic, quenched and tempered	800			✓	**198**	**18**	0.044	0.054	0.063	0.080	0.097	0.112	0.127	0.140	0.164
P	P5-3	Stainless steel, martensitic, precipitation-hardened	1,200			✓	**144**	**18**	0.039	0.047	0.055	0.071	0.085	0.099	0.112	0.123	0.144
M	M1-1	Stainless steel, austenitic, quenched	680			✓	88	18	0.041	0.050	0.059	0.075	0.091	0.105	0.118	0.131	0.153
M	M1-2	Stainless steel, austenitic (super austenitic), precipitation-hardened	1,010			✓	74	15	0.039	0.047	0.055	0.071	0.085	0.098	0.111	0.123	0.144
M	M2-1	Stainless steel, austenitic / ferritic (duplex), solution-annealed	780			✓	81	15	0.039	0.047	0.055	0.071	0.085	0.098	0.111	0.123	0.144
M	M2-2	Stainless steel, austenitic / ferritic (super-duplex), solution-annealed	780			✓	74	13	0.036	0.044	0.051	0.066	0.079	0.092	0.104	0.115	0.134
M	M3-1	Stainless steel, heat-resistant austenitic steel, cast	720			✓	74	15	0.035	0.042	0.050	0.063	0.076	0.089	0.100	0.110	0.129
K	K1-1	Grey cast iron, GJL, pearlitic / ferritic	200	✓	✓	✓	**418**	**20**	0.120	0.146	0.171	0.219	0.263	0.305	0.344	0.380	0.445
K	K1-2	Grey cast iron, GJL, pearlitic	250	✓	✓	✓	**380**	**20**	0.107	0.130	0.153	0.195	0.235	0.272	0.307	0.339	0.397
K	K1-3	Grey cast iron, GJL, pearlitic	350	✓	✓	✓	**342**	**20**	0.107	0.130	0.153	0.195	0.235	0.272	0.307	0.339	0.397
K	K2-1	Spheroidal graphite cast iron, GJS, ferritic	400	✓	✓	✓	**380**	**20**	0.102	0.124	0.145	0.186	0.224	0.259	0.292	0.323	0.378
K	K2-2	Spheroidal graphite cast iron, GJS, ferritic / pearlitic	500	✓	✓	✓	**342**	**20**	0.084	0.102	0.119	0.153	0.184	0.213	0.240	0.266	0.311
K	K2-3	Spheroidal graphite cast iron, GJS, pearlitic	700	✓	✓	✓	**304**	**18**	0.084	0.102	0.119	0.153	0.184	0.213	0.240	0.266	0.311
K	K2-4	Austempered ductile iron, ADI, austenitic / ferritic	1,400	✓	✓	✓	**171**	**15**	0.048	0.058	0.068	0.087	0.105	0.121	0.137	0.151	0.177
K	K3-1	Compacted graphite cast iron, GJV, ferritic	400	✓	✓	✓	**276**	**20**	0.084	0.102	0.119	0.153	0.184	0.213	0.240	0.266	0.311
K	K3-2	Compacted graphite cast iron, GJV, pearlitic	> 400	✓	✓	✓	**257**	**20**	0.072	0.088	0.103	0.132	0.159	0.184	0.207	0.229	0.268
K	K4-1	Malleable cast iron, GJMW / GJMB, ferritic	400	✓	✓	✓	**418**	**20**	0.120	0.146	0.171	0.219	0.263	0.305	0.344	0.380	0.445
K	K4-2	Malleable cast iron, GJMW / GJMB, pearlitic	600	✓	✓	✓	**342**	**20**	0.107	0.130	0.153	0.195	0.235	0.272	0.307	0.339	0.397
K	K5-1	Austenitic cast iron, GJLA / GJSA, lamellar graphite	210	✓	✓	✓	**342**	**20**	0.084	0.102	0.119	0.153	0.184	0.213	0.240	0.266	0.311
K	K5-2	Austenitic cast iron, GJLA / GJSA, spheroidal graphite	420	✓	✓	✓	**304**	**20**	0.072	0.088	0.103	0.132	0.159	0.184	0.207	0.229	0.268

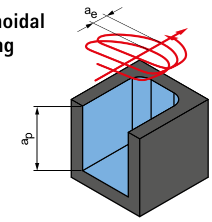
* MAPAL machining groups
The specified cutting data are guide values.

Trochoidal milling



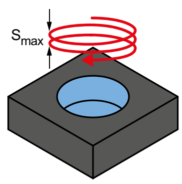
MEDIUM dynamics
a_p = depending on max. machining depth of the tool
a_e = depending on the workpiece material

Trochoidal milling



HIGH dynamics
a_p = depending on max. machining depth of the tool
a_e = depending on the workpiece material

Helix milling



Feed per tooth [f_z] [mm/tooth] for diameter of milling cutter [mm]											Feed per tooth [f_z] [mm/tooth] for diameter of milling cutter [mm]											Helix milling G=1.8	
v_c [m/min]	a_e in %	4.00	5.00	6.00	8.00	10.00	12.00	14.00	16.00	20.00	v_c [m/min]	a_e in %	4.00	5.00	6.00	8.00	10.00	12.00	14.00	16.00	20.00	Smax	EW [°]
446	**15**	0.067	0.081	0.095	0.121	0.146	0.169	0.191	0.211	0.247	**490**	**10**	0.077	0.094	0.110	0.140	0.169	0.196	0.221	0.244	0.285	0.5xD	10
396	**15**	0.084	0.101	0.119	0.152	0.183	0.212	0.239	0.264	0.309	**436**	**10**	0.102	0.124	0.146	0.186	0.224	0.260	0.293	0.324	0.379	0.5xD	10
376	**15**	0.064	0.078	0.091	0.117	0.141	0.163	0.184	0.203	0.238	**414**	**10**	0.074	0.090	0.106	0.135	0.163	0.189	0.213	0.235	0.275	0.5xD	10
337	**15**	0.063	0.077	0.090	0.115	0.138	0.160	0.181	0.200	0.234	**370**	**10**	0.073	0.089	0.104	0.133	0.160	0.185	0.209	0.231	0.270	0.5xD	10
317	**15**	0.061	0.074	0.086	0.110	0.133	0.154	0.174	0.192	0.225	**348**	**10**	0.070	0.085	0.100	0.128	0.154	0.178	0.201	0.223	0.260	0.5xD	10
356	**15**	0.065	0.079	0.093	0.119	0.143	0.166	0.187	0.207	0.242	**392**	**10**	0.076	0.092	0.108	0.138	0.166	0.192	0.217	0.240	0.280	0.5xD	10
317	**15**	0.061	0.074	0.086	0.110	0.133	0.154	0.174	0.192	0.225	**348**	**10**	0.070	0.085	0.100	0.128	0.154	0.178	0.201	0.223	0.260	0.5xD	10
287	**15**	0.057	0.069	0.081	0.104	0.125	0.145	0.164	0.181	0.212	**316**	**10**	0.066	0.080	0.094	0.121	0.145	0.168	0.190	0.210	0.245	0.5xD	10
248	**15**	0.054	0.065	0.076	0.098	0.118	0.136	0.154	0.170	0.199	**272**	**10**	0.062	0.076	0.088	0.113	0.136	0.158	0.178	0.197	0.230	0.5xD	10
238	**15**	0.060	0.072	0.085	0.108	0.131	0.151	0.171	0.189	0.221	**261**	**10**	0.069	0.084	0.098	0.125	0.151	0.175	0.197	0.218	0.255	0.5xD	10
218	**15**	0.056	0.068	0.080	0.102	0.123	0.142	0.161	0.177	0.208	**240**	**10**	0.065	0.079	0.092	0.118	0.142	0.165	0.186	0.205	0.240	0.5xD	10
188	**15**	0.053	0.064	0.075	0.096	0.115	0.133	0.150	0.166	0.195	**207**	**10**	0.061	0.074	0.087	0.111	0.133	0.154	0.174	0.193	0.225	0.5xD	10
198	**12**	0.037	0.045	0.053	0.068	0.082	0.095	0.107	0.118	0.138	**218**	**7**	0.043	0.053	0.062	0.079	0.095	0.110	0.124	0.137	0.160	0.3xD	7
248	**13**	0.051	0.062	0.073	0.093	0.113	0.130	0.147	0.163	0.190	**272**	**8**	0.059	0.072	0.085	0.108	0.130	0.151	0.170	0.188	0.220	0.3xD	7
218	**13**	0.049	0.060	0.070	0.089	0.107	0.125	0.140	0.155	0.182	**240**	**8**	0.057	0.069	0.081	0.103	0.124	0.144	0.163	0.180	0.210	0.3xD	7
158	**13**	0.043	0.052	0.061	0.079	0.095	0.110	0.124	0.137	0.160	**174**	**8**	0.050	0.061	0.071	0.091	0.110	0.127	0.143	0.158	0.185	0.3xD	7
97	13	0.048	0.058	0.068	0.087	0.105	0.121	0.137	0.151	0.177	106	8	0.058	0.071	0.083	0.106	0.128	0.148	0.167	0.185	0.217	0.05xD	1
82	10	0.045	0.054	0.064	0.081	0.098	0.114	0.128	0.142	0.166	90	5	0.055	0.067	0.078	0.100	0.120	0.139	0.157	0.174	0.203	0.05xD	1
89	10	0.045	0.054	0.064	0.081	0.098	0.114	0.128	0.142	0.166	98	5	0.055	0.067	0.078	0.100	0.120	0.139	0.157	0.174	0.203	0.05xD	1
82	7	0.042	0.051	0.059	0.076	0.092	0.106	0.120	0.132	0.155	90	5	0.051	0.062	0.073	0.093	0.112	0.130	0.147	0.162	0.190	0.05xD	1
82	10	0.040	0.049	0.057	0.073	0.088	0.102	0.115	0.128	0.149	90	5	0.049	0.060	0.070	0.090	0.108	0.125	0.141	0.156	0.183	0.05xD	1
460	**15**	0.139	0.169	0.197	0.252	0.304	0.352	0.397	0.439	0.514	**506**	**10**	0.170	0.206	0.242	0.309	0.372	0.431	0.487	0.538	0.629	0.5xD	10
418	**15**	0.124	0.150	0.176	0.225	0.271	0.314	0.355	0.392	0.459	**460**	**10**	0.152	0.184	0.216	0.276	0.332	0.385	0.434	0.480	0.562	0.5xD	10
376	**15**	0.124	0.150	0.176	0.225	0.271	0.314	0.355	0.392	0.459	**414**	**10**	0.152	0.184	0.216	0.276	0.332	0.385	0.434	0.480	0.562	0.5xD	10
418	**15**	0.118	0.143	0.168	0.214	0.258	0.299	0.338	0.373	0.437	**460**	**10**	0.144	0.175	0.205	0.263	0.316	0.367	0.413	0.457	0.535	0.5xD	10
376	**15**	0.097	0.118	0.138	0.176	0.213	0.246	0.278	0.307	0.359	**414**	**10**	0.119	0.144	0.169	0.216	0.260	0.302	0.340	0.376	0.440	0.5xD	10
334	**13**	0.097	0.118	0.138	0.176	0.213	0.246	0.278	0.307	0.359	**368**	**8**	0.119	0.144	0.169	0.216	0.260	0.302	0.340	0.376	0.440	0.3xD	7
188	**10**	0.055	0.067	0.079	0.100	0.121	0.140	0.158	0.175	0.204	**207**	**5**	0.068	0.082	0.096	0.123	0.148	0.172	0.194	0.214	0.250	0.25xD	5
303	**15**	0.097	0.118	0.138	0.176	0.213	0.246	0.278	0.307	0.359	**333**	**10**	0.119	0.144	0.169	0.216	0.260	0.302	0.340	0.376	0.440	0.5xD	10
282	**15**	0.084	0.101	0.119	0.152	0.183	0.212	0.239	0.264	0.309	**310**	**10**	0.102	0.124	0.146	0.186	0.224	0.260	0.293	0.324	0.379	0.5xD	10
460	**15**	0.139	0.169	0.197	0.252	0.304	0.352	0.397	0.439	0.514	**506**	**10**	0.170	0.206	0.242	0.309	0.372	0.431	0.487	0.538	0.629	0.5xD	10
376	**15**	0.124	0.150	0.176	0.225	0.271	0.314	0.355	0.392	0.459	**414**	**10**	0.152	0.184	0.216	0.276	0.332	0.385	0.434	0.480	0.562	0.5xD	10
376	**15**	0.097	0.118	0.138	0.176	0.213	0.246	0.278	0.307	0.359	**414**	**10**	0.119	0.144	0.169	0.216	0.260	0.302	0.340	0.376	0.440	0.5xD	10
334	**15**	0.084	0.101	0.119	0.152	0.183	0.212	0.239	0.264	0.309	**368**	**10**	0.102	0.124	0.146	0.186	0.224	0.260	0.293	0.324	0.379	0.5xD	10

Explanation of terms:

S_{max} = Maximum slope of the helix
G = Ratio of circular pocket Ø when plunging to the tool Ø
E.g.: Tool Ø 12 mm at G=1.5 results in a pocket Ø of 18 mm
EW_{max} = Slope angle of the helix (results from G and S_{max})

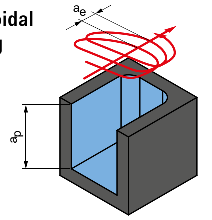
Next page:
Contact angle and maximum chip thickness

The optimum data for the respective machining task should be determined during the test or machining.
Bold text: Best suited | Normal text: Suitable in some situations

Cutting data recommendation for trochoidal milling cutters

Contact angle and maximum chip thickness

Trochoidal milling



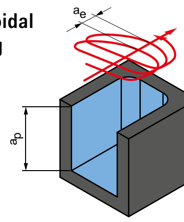
LOW dynamics
a_p = depending on max. machining depth of the tool
a_e = depending on the workpiece material

OptiMill-Tro-Uni (2nd generation) | SCM942 (2xD, 3xD)

MMG*		Workpiece material	Strength/ hardness [N/mm²] [HRC]	Cooling MQL/Air	Dry	Wet	Contact angle EW [°]	hmax [mm] for diameter of milling cutter [mm] 4.00	5.00	6.00	8.00	10.00	12.00	14.00	16.00	20.00
P	P1-1	Unalloyed steel ≤ 0.15% C, annealed	420	✓	✓	✓	**53.1**	0.048	0.058	0.068	0.087	0.105	0.122	0.137	0.152	0.178
P	P1-2	Unalloyed steel ≤ 0.45% C, annealed	650	✓	✓	✓	**53.1**	0.058	0.070	0.082	0.105	0.127	0.147	0.166	0.183	0.214
P	P1-3	Unalloyed steel ≤ 0.45% C, quenched and tempered	850	✓	✓	✓	**53.1**	0.046	0.056	0.066	0.084	0.101	0.118	0.133	0.147	0.172
P	P1-4	Unalloyed steel ≤ 0.75% C, annealed	900	✓	✓	✓	**53.1**	0.045	0.055	0.065	0.083	0.100	0.115	0.130	0.144	0.168
P	P1-5	Unalloyed steel ≤ 0.75% C, quenched and tempered	1,000	✓	✓	✓	**53.1**	0.044	0.053	0.062	0.080	0.096	0.111	0.125	0.139	0.162
P	P2-1	Low-alloyed steel, annealed	600	✓	✓	✓	**53.1**	0.047	0.057	0.067	0.086	0.103	0.120	0.135	0.149	0.175
P	P2-2	Low-alloyed steel, quenched and tempered	930	✓	✓	✓	**53.1**	0.044	0.053	0.062	0.080	0.096	0.111	0.125	0.139	0.162
P	P2-3	Low-alloyed steel, quenched and tempered	1,000	✓	✓	✓	**53.1**	0.041	0.050	0.059	0.075	0.090	0.105	0.118	0.131	0.153
P	P2-4	Low-alloyed steel, quenched and tempered	1,200	✓	✓	✓	**53.1**	0.039	0.047	0.055	0.070	0.085	0.098	0.111	0.123	0.143
P	P3-1	High-alloyed steel and high-alloyed tool steel, annealed	680	✓	✓	✓	**53.1**	0.043	0.052	0.061	0.078	0.094	0.109	0.123	0.136	0.159
P	P3-2	High-alloyed steel and high-alloyed tool steel, quenched and tempered	1,100	✓	✓	✓	**53.1**	0.040	0.049	0.058	0.074	0.089	0.103	0.116	0.128	0.150
P	P3-3	High-alloyed steel and high-alloyed tool steel, quenched and tempered	1,250	✓	✓	✓	**53.1**	0.038	0.046	0.054	0.069	0.083	0.096	0.109	0.120	0.140
P	P4-1	Bainitic steel, ultra-high-carbon steel, bainitic-quenched and tempered	1,650			✓	**48.7**	0.025	0.031	0.036	0.046	0.055	0.064	0.072	0.080	0.094
P	P5-1	Stainless steel, ferritic / martensitic, quenched and tempered	680			✓	**50.2**	0.036	0.043	0.051	0.065	0.078	0.090	0.102	0.113	0.132
P	P5-2	Stainless steel, martensitic, quenched and tempered	800			✓	**50.2**	0.034	0.041	0.048	0.062	0.074	0.086	0.097	0.108	0.126
P	P5-3	Stainless steel, martensitic, precipitation-hardened	1,200			✓	**50.2**	0.030	0.036	0.043	0.054	0.066	0.076	0.086	0.095	0.111
M	M1-1	Stainless steel, austenitic, quenched	680			✓	50.2	0.032	0.039	0.045	0.058	0.070	0.081	0.091	0.101	0.118
M	M1-2	Stainless steel, austenitic (super austenitic), precipitation-hardened	1,010			✓	45.6	0.028	0.034	0.039	0.050	0.061	0.070	0.079	0.088	0.103
M	M2-1	Stainless steel, austenitic / ferritic (duplex), solution-annealed	780			✓	45.6	0.028	0.034	0.039	0.050	0.061	0.070	0.079	0.088	0.103
M	M2-2	Stainless steel, austenitic / ferritic (super-duplex), solution-annealed	780			✓	42.3	0.024	0.030	0.035	0.044	0.053	0.062	0.070	0.077	0.090
M	M3-1	Stainless steel, heat-resistant austenitic steel, cast	720			✓	45.6	0.025	0.030	0.035	0.045	0.055	0.063	0.071	0.079	0.092
K	K1-1	Grey cast iron, GJL, pearlitic / ferritic	200	✓	✓	✓	**53.1**	0.096	0.117	0.137	0.175	0.211	0.244	0.275	0.304	0.356
K	K1-2	Grey cast iron, GJL, pearlitic	250	✓	✓	✓	**53.1**	0.086	0.104	0.122	0.156	0.188	0.218	0.246	0.272	0.318
K	K1-3	Grey cast iron, GJL, pearlitic	350	✓	✓	✓	**53.1**	0.086	0.104	0.122	0.156	0.188	0.218	0.246	0.272	0.318
K	K2-1	Spheroidal graphite cast iron, GJS, ferritic	400	✓	✓	✓	**53.1**	0.082	0.099	0.116	0.149	0.179	0.207	0.234	0.258	0.302
K	K2-2	Spheroidal graphite cast iron, GJS, ferritic / pearlitic	500	✓	✓	✓	**53.1**	0.067	0.082	0.096	0.122	0.147	0.171	0.192	0.213	0.249
K	K2-3	Spheroidal graphite cast iron, GJS, pearlitic	700	✓	✓	✓	**50.2**	0.065	0.078	0.092	0.117	0.141	0.164	0.185	0.204	0.239
K	K2-4	Austempered ductile iron, ADI, austenitic / ferritic	1,400	✓	✓	✓	**45.6**	0.034	0.041	0.049	0.062	0.075	0.087	0.098	0.108	0.126
K	K3-1	Compacted graphite cast iron, GJV, ferritic	400	✓	✓	✓	**53.1**	0.067	0.082	0.096	0.122	0.147	0.171	0.192	0.213	0.249
K	K3-2	Compacted graphite cast iron, GJV, pearlitic	> 400	✓	✓	✓	**53.1**	0.058	0.070	0.082	0.105	0.127	0.147	0.166	0.183	0.214
K	K4-1	Malleable cast iron, GJMW / GJMB, ferritic	400	✓	✓	✓	**53.1**	0.096	0.117	0.137	0.175	0.211	0.244	0.275	0.304	0.356
K	K4-2	Malleable cast iron, GJMW / GJMB, pearlitic	600	✓	✓	✓	**53.1**	0.086	0.104	0.122	0.156	0.188	0.218	0.246	0.272	0.318
K	K5-1	Austenitic cast iron, GJLA / GJSA, lamellar graphite	210	✓	✓	✓	**53.1**	0.067	0.082	0.096	0.122	0.147	0.171	0.192	0.213	0.249
K	K5-2	Austenitic cast iron, GJLA / GJSA, spheroidal graphite	420	✓	✓	✓	**53.1**	0.058	0.070	0.082	0.105	0.127	0.147	0.166	0.183	0.214

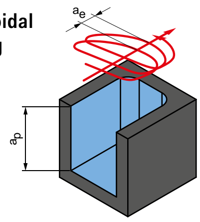
* MAPAL machining groups
The specified cutting data are guide values.

Trochoidal milling



MEDIUM dynamics
a_p = depending on max. machining depth of the tool
a_e = depending on the workpiece material

Trochoidal milling



HIGH dynamics
a_p = depending on max. machining depth of the tool
a_e = depending on the workpiece material

hmax [mm] for diameter of milling cutter [mm]									hmax [mm] for diameter of milling cutter [mm]								
4.00	5.00	6.00	8.00	10.00	12.00	14.00	16.00	20.00	4.00	5.00	6.00	8.00	10.00	12.00	14.00	16.00	20.00
0.053	0.065	0.076	0.097	0.117	0.135	0.152	0.169	0.197	0.062	0.075	0.088	0.112	0.135	0.157	0.177	0.195	0.228
0.067	0.081	0.095	0.122	0.146	0.170	0.191	0.212	0.248	0.082	0.099	0.116	0.149	0.179	0.208	0.234	0.259	0.303
0.051	0.062	0.073	0.093	0.113	0.130	0.147	0.163	0.190	0.059	0.072	0.085	0.108	0.130	0.151	0.170	0.188	0.220
0.050	0.061	0.072	0.092	0.111	0.128	0.144	0.160	0.187	0.058	0.071	0.083	0.106	0.128	0.148	0.167	0.185	0.216
0.049	0.059	0.069	0.088	0.106	0.123	0.139	0.154	0.180	0.056	0.068	0.080	0.102	0.123	0.143	0.161	0.178	0.208
0.052	0.064	0.074	0.095	0.115	0.133	0.150	0.166	0.194	0.061	0.074	0.086	0.110	0.133	0.154	0.173	0.192	0.224
0.049	0.059	0.069	0.088	0.106	0.123	0.139	0.154	0.180	0.056	0.068	0.080	0.102	0.123	0.143	0.161	0.178	0.208
0.046	0.056	0.065	0.083	0.100	0.116	0.131	0.145	0.170	0.053	0.064	0.075	0.096	0.116	0.135	0.152	0.168	0.196
0.043	0.052	0.061	0.078	0.094	0.109	0.123	0.136	0.159	0.050	0.060	0.071	0.091	0.109	0.126	0.142	0.157	0.184
0.048	0.058	0.068	0.087	0.104	0.121	0.136	0.151	0.176	0.055	0.067	0.078	0.100	0.121	0.140	0.158	0.175	0.204
0.045	0.054	0.064	0.082	0.098	0.114	0.128	0.142	0.166	0.052	0.063	0.074	0.094	0.114	0.132	0.149	0.164	0.192
0.042	0.051	0.060	0.076	0.092	0.107	0.120	0.133	0.156	0.049	0.059	0.069	0.089	0.107	0.124	0.139	0.154	0.180
0.028	0.034	0.040	0.051	0.062	0.071	0.080	0.089	0.104	0.032	0.039	0.046	0.059	0.071	0.083	0.093	0.103	0.120
0.039	0.048	0.056	0.072	0.087	0.100	0.113	0.125	0.146	0.046	0.056	0.065	0.083	0.100	0.116	0.131	0.145	0.169
0.038	0.046	0.054	0.069	0.083	0.096	0.108	0.119	0.140	0.044	0.053	0.062	0.079	0.096	0.111	0.125	0.138	0.162
0.033	0.040	0.047	0.060	0.073	0.084	0.095	0.105	0.123	0.038	0.047	0.055	0.070	0.084	0.098	0.110	0.122	0.142
0.037	0.045	0.052	0.067	0.080	0.093	0.105	0.116	0.136	0.045	0.055	0.064	0.082	0.098	0.114	0.129	0.142	0.166
0.032	0.039	0.045	0.058	0.070	0.081	0.092	0.101	0.118	0.039	0.048	0.056	0.071	0.086	0.099	0.112	0.124	0.145
0.032	0.039	0.045	0.058	0.070	0.081	0.092	0.101	0.118	0.039	0.048	0.056	0.071	0.086	0.099	0.112	0.124	0.145
0.028	0.034	0.040	0.051	0.062	0.071	0.080	0.089	0.104	0.034	0.042	0.049	0.063	0.075	0.087	0.099	0.109	0.127
0.029	0.035	0.041	0.052	0.063	0.073	0.082	0.091	0.107	0.035	0.043	0.050	0.064	0.077	0.089	0.101	0.112	0.130
0.111	0.135	0.158	0.202	0.243	0.282	0.318	0.351	0.411	0.136	0.165	0.193	0.247	0.298	0.345	0.389	0.430	0.504
0.099	0.120	0.141	0.180	0.217	0.252	0.284	0.314	0.367	0.121	0.147	0.173	0.221	0.266	0.308	0.347	0.384	0.449
0.099	0.120	0.141	0.180	0.217	0.252	0.284	0.314	0.367	0.121	0.147	0.173	0.221	0.266	0.308	0.347	0.384	0.449
0.094	0.115	0.134	0.172	0.207	0.239	0.270	0.298	0.349	0.115	0.140	0.164	0.210	0.253	0.293	0.331	0.366	0.428
0.078	0.094	0.110	0.141	0.170	0.197	0.222	0.246	0.287	0.095	0.115	0.135	0.173	0.208	0.241	0.272	0.301	0.352
0.075	0.091	0.106	0.136	0.163	0.189	0.213	0.236	0.276	0.091	0.111	0.130	0.166	0.200	0.232	0.261	0.289	0.338
0.039	0.048	0.056	0.072	0.086	0.100	0.113	0.125	0.146	0.048	0.059	0.069	0.088	0.106	0.123	0.138	0.153	0.179
0.078	0.094	0.110	0.141	0.170	0.197	0.222	0.246	0.287	0.095	0.115	0.135	0.173	0.208	0.241	0.272	0.301	0.352
0.067	0.081	0.095	0.122	0.146	0.170	0.191	0.212	0.248	0.082	0.099	0.116	0.149	0.179	0.208	0.234	0.259	0.303
0.111	0.135	0.158	0.202	0.243	0.282	0.318	0.351	0.411	0.136	0.165	0.193	0.247	0.298	0.345	0.389	0.430	0.504
0.099	0.120	0.141	0.180	0.217	0.252	0.284	0.314	0.367	0.121	0.147	0.173	0.221	0.266	0.308	0.347	0.384	0.449
0.078	0.094	0.110	0.141	0.170	0.197	0.222	0.246	0.287	0.095	0.115	0.135	0.173	0.208	0.241	0.272	0.301	0.352
0.067	0.081	0.095	0.122	0.146	0.170	0.191	0.212	0.248	0.082	0.099	0.116	0.149	0.179	0.208	0.234	0.259	0.303

Explanation of terms:

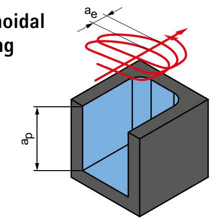
S_{max} = Maximum slope of the helix
G = Ratio of circular pocket Ø when plunging to the tool Ø
E.g.: Tool Ø 12 mm at G=1.5 results in a pocket Ø of 18 mm
EW_{max} = Slope angle of the helix (results from G and S_{max})

The optimum data for the respective machining task should be determined during the test or machining.
Bold text: Best suited | Normal text: Suitable in some situations

Cutting data recommendation for trochoidal milling cutters

Feed and cutting speed

Trochoidal milling



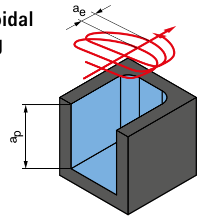
LOW dynamics
a_p = depending on max. machining depth of the tool
a_e = depending on the workpiece material

OptiMill-Tro-Uni (2nd generation) | SCM942 (4xD, 5xD)

MMG*		Workpiece material	Strength/ hardness [N/mm²] [HRC]	Cooling			Feed per tooth [f_z] [mm/tooth] for diameter of milling cutter [mm]								
				MQL/Air	Dry	Wet	v_c [m/min]	a_e in %	5.00	6.00	8.00	10.00	12.00	16.00	20.00
P	P1-1	Unalloyed steel ≤ 0.15% C, annealed	420	✓	✓	✓	**225**	**10**	0.053	0.062	0.079	0.095	0.111	0.138	0.161
P	P1-2	Unalloyed steel ≤ 0.45% C, annealed	650	✓	✓	✓	**200**	**10**	0.052	0.061	0.078	0.094	0.109	0.135	0.159
P	P1-3	Unalloyed steel ≤ 0.45% C, quenched and tempered	850	✓	✓	✓	**190**	**10**	0.051	0.060	0.076	0.092	0.107	0.133	0.156
P	P1-4	Unalloyed steel ≤ 0.75% C, annealed	900	✓	✓	✓	**170**	**10**	0.050	0.059	0.075	0.090	0.105	0.131	0.153
P	P1-5	Unalloyed steel ≤ 0.75% C, quenched and tempered	1,000	✓	✓	✓	**160**	**10**	0.048	0.057	0.072	0.087	0.101	0.126	0.147
P	P2-1	Low-alloyed steel, annealed	600	✓	✓	✓	**180**	**10**	0.052	0.061	0.078	0.094	0.109	0.135	0.159
P	P2-2	Low-alloyed steel, quenched and tempered	930	✓	✓	✓	**160**	**10**	0.048	0.057	0.072	0.087	0.101	0.126	0.147
P	P2-3	Low-alloyed steel, quenched and tempered	1,000	✓	✓	✓	**145**	**10**	0.045	0.053	0.068	0.082	0.095	0.119	0.139
P	P2-4	Low-alloyed steel, quenched and tempered	1,200	✓	✓	✓	**125**	**10**	0.043	0.050	0.064	0.077	0.089	0.111	0.130
P	P3-1	High-alloyed steel and high-alloyed tool steel, annealed	680	✓	✓	✓	**120**	**10**	0.047	0.055	0.071	0.085	0.099	0.123	0.144
P	P3-2	High-alloyed steel and high-alloyed tool steel, quenched and tempered	1,100	✓	✓	✓	**110**	**10**	0.045	0.052	0.067	0.080	0.093	0.116	0.136
P	P3-3	High-alloyed steel and high-alloyed tool steel, quenched and tempered	1,250	✓	✓	✓	**95**	**10**	0.042	0.049	0.063	0.075	0.087	0.109	0.127
P	P4-1	Bainitic steel, ultra-high-carbon steel, bainitic-quenched and tempered	1,650			✓	**100**	**7**	0.030	0.035	0.044	0.054	0.062	0.077	0.091
P	P5-1	Stainless steel, ferritic / martensitic, quenched and tempered	680			✓	**125**	**8**	0.041	0.048	0.061	0.074	0.085	0.106	0.125
P	P5-2	Stainless steel, martensitic, quenched and tempered	800			✓	**110**	**8**	0.039	0.046	0.058	0.070	0.082	0.102	0.119
P	P5-3	Stainless steel, martensitic, precipitation-hardened	1,200			✓	**80**	**8**	0.034	0.040	0.051	0.062	0.072	0.090	0.105
M	M1-1	Stainless steel, austenitic, quenched	680			✓	88	8	0.030	0.035	0.044	0.054	0.062	0.077	0.091
M	M1-2	Stainless steel, austenitic (super austenitic), precipitation-hardened	1,010			✓	75	5	0.028	0.033	0.042	0.050	0.058	0.073	0.085
M	M2-1	Stainless steel, austenitic / ferritic (duplex), solution-annealed	780			✓	81	5	0.028	0.033	0.042	0.050	0.058	0.073	0.085
M	M2-2	Stainless steel, austenitic / ferritic (super-duplex), solution-annealed	780			✓	75	7	0.026	0.030	0.039	0.047	0.054	0.068	0.079
M	M3-1	Stainless steel, heat-resistant austenitic steel, cast	720			✓	75	5	0.025	0.029	0.038	0.045	0.052	0.065	0.076
K	K1-1	Grey cast iron, GJL, pearlitic / ferritic	200	✓	✓	✓	**220**	**10**	0.086	0.101	0.129	0.156	0.180	0.225	0.263
K	K1-2	Grey cast iron, GJL, pearlitic	250	✓	✓	✓	**200**	**10**	0.077	0.090	0.115	0.139	0.161	0.201	0.235
K	K1-3	Grey cast iron, GJL, pearlitic	350	✓	✓	✓	**180**	**10**	0.077	0.090	0.115	0.139	0.161	0.201	0.235
K	K2-1	Spheroidal graphite cast iron, GJS, ferritic	400	✓	✓	✓	**200**	**10**	0.073	0.086	0.110	0.132	0.153	0.191	0.224
K	K2-2	Spheroidal graphite cast iron, GJS, ferritic / pearlitic	500	✓	✓	✓	**180**	**10**	0.060	0.071	0.090	0.109	0.126	0.157	0.184
K	K2-3	Spheroidal graphite cast iron, GJS, pearlitic	700	✓	✓	✓	**160**	**8**	0.060	0.071	0.090	0.109	0.126	0.157	0.184
K	K2-4	Austempered ductile iron, ADI, austenitic / ferritic	1,400	✓	✓	✓	**90**	**5**	0.034	0.040	0.051	0.062	0.072	0.090	0.105
K	K3-1	Compacted graphite cast iron, GJV, ferritic	400	✓	✓	✓	**145**	**10**	0.060	0.071	0.090	0.109	0.126	0.157	0.184
K	K3-2	Compacted graphite cast iron, GJV, pearlitic	> 400	✓	✓	✓	**135**	**10**	0.052	0.061	0.078	0.094	0.109	0.135	0.159
K	K4-1	Malleable cast iron, GJMW / GJMB, ferritic	400	✓	✓	✓	**220**	**10**	0.086	0.101	0.129	0.156	0.180	0.225	0.263
K	K4-2	Malleable cast iron, GJMW / GJMB, pearlitic	600	✓	✓	✓	**180**	**10**	0.077	0.090	0.115	0.139	0.161	0.201	0.235
K	K5-1	Austenitic cast iron, GJLA / GJSA, lamellar graphite	210	✓	✓	✓	**180**	**10**	0.060	0.071	0.090	0.109	0.126	0.157	0.184
K	K5-2	Austenitic cast iron, GJLA / GJSA, spheroidal graphite	420	✓	✓	✓	**160**	**10**	0.052	0.061	0.078	0.094	0.109	0.135	0.159

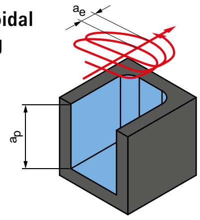
* MAPAL machining groups
The specified cutting data are guide values.

Trochoidal milling



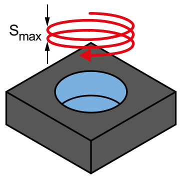
MEDIUM dynamics
a_p = depending on max. machining depth of the tool
a_e = depending on the workpiece material

Trochoidal milling



HIGH dynamics
a_p = depending on max. machining depth of the tool
a_e = depending on the workpiece material

Helix milling



Feed per tooth [f_z] [mm/tooth] for diameter of milling cutter [mm]									Feed per tooth [f_z] [mm/tooth] for diameter of milling cutter [mm]									Helix milling G=1.8	
v_c [m/min]	a_e in %	5.00	6.00	8.00	10.00	12.00	16.00	20.00	v_c [m/min]	a_e in %	5.00	6.00	8.00	10.00	12.00	16.00	20.00	Smax	EW [°]
248	**7.5**	0.061	0.072	0.092	0.110	0.128	0.159	0.186	**273**	**5**	0.075	0.088	0.112	0.135	0.156	0.195	0.228	0.25xD	5
220	**7.5**	0.060	0.070	0.090	0.108	0.125	0.156	0.183	**242**	**5**	0.074	0.086	0.110	0.133	0.154	0.192	0.224	0.25xD	5
209	**7.5**	0.059	0.069	0.088	0.106	0.123	0.154	0.180	**230**	**5**	0.072	0.085	0.108	0.130	0.151	0.188	0.220	0.25xD	5
187	**7.5**	0.058	0.068	0.087	0.104	0.121	0.151	0.177	**206**	**5**	0.071	0.083	0.106	0.128	0.148	0.185	0.216	0.25xD	5
176	**7.5**	0.056	0.065	0.083	0.101	0.117	0.145	0.170	**194**	**5**	0.068	0.080	0.102	0.123	0.143	0.178	0.208	0.25xD	5
198	**7.5**	0.060	0.070	0.090	0.108	0.125	0.156	0.183	**218**	**5**	0.074	0.086	0.110	0.133	0.154	0.192	0.224	0.25xD	5
176	**7.5**	0.056	0.065	0.083	0.101	0.117	0.145	0.170	**194**	**5**	0.068	0.080	0.102	0.123	0.143	0.178	0.208	0.25xD	5
160	**7.5**	0.053	0.062	0.079	0.095	0.110	0.137	0.160	**176**	**5**	0.064	0.075	0.096	0.116	0.134	0.168	0.196	0.25xD	5
138	**7.5**	0.049	0.058	0.074	0.089	0.103	0.128	0.150	**152**	**5**	0.060	0.071	0.090	0.109	0.126	0.157	0.184	0.25xD	5
132	**7.5**	0.055	0.064	0.082	0.099	0.114	0.142	0.167	**146**	**5**	0.067	0.078	0.100	0.121	0.140	0.174	0.204	0.25xD	5
121	**7.5**	0.051	0.060	0.077	0.093	0.108	0.134	0.157	**134**	**5**	0.063	0.074	0.094	0.114	0.132	0.164	0.192	0.25xD	5
105	**7.5**	0.048	0.056	0.072	0.087	0.101	0.126	0.147	**116**	**5**	0.059	0.069	0.088	0.107	0.123	0.154	0.180	0.25xD	5
110	**4.5**	0.034	0.040	0.051	0.062	0.072	0.089	0.105	**121**	**2.7**	0.042	0.049	0.063	0.076	0.088	0.109	0.128	0.15xD	3
138	**5**	0.047	0.055	0.071	0.085	0.099	0.123	0.144	**152**	**3**	0.058	0.068	0.087	0.104	0.121	0.151	0.176	0.15xD	3
121	**5**	0.045	0.053	0.067	0.081	0.094	0.117	0.137	**134**	**3**	0.055	0.065	0.083	0.099	0.115	0.144	0.168	0.15xD	3
88	**5**	0.040	0.046	0.059	0.072	0.083	0.103	0.121	**97**	**3**	0.049	0.057	0.073	0.088	0.102	0.127	0.148	0.15xD	3
97	5	0.034	0.040	0.051	0.062	0.072	0.089	0.105	107	3	0.042	0.049	0.063	0.076	0.088	0.109	0.128	0.05xD	1
83	3	0.032	0.038	0.048	0.058	0.067	0.084	0.098	92	1	0.039	0.046	0.059	0.071	0.082	0.103	0.120	0.05xD	1
90	3	0.032	0.038	0.048	0.058	0.067	0.084	0.098	99	1	0.039	0.046	0.059	0.071	0.082	0.103	0.120	0.05xD	1
83	4.5	0.030	0.035	0.045	0.054	0.063	0.078	0.092	92	2.7	0.037	0.043	0.055	0.066	0.077	0.096	0.112	0.05xD	1
83	3	0.029	0.034	0.043	0.052	0.060	0.075	0.088	92	1	0.035	0.042	0.053	0.064	0.074	0.092	0.108	0.05xD	1
242	**7.5**	0.100	0.117	0.149	0.180	0.208	0.260	0.304	**267**	**5**	0.122	0.143	0.183	0.220	0.255	0.318	0.372	0.25xD	5
220	**7.5**	0.089	0.104	0.133	0.161	0.186	0.232	0.271	**242**	**5**	0.109	0.128	0.163	0.197	0.228	0.284	0.332	0.25xD	5
198	**7.5**	0.089	0.104	0.133	0.161	0.186	0.232	0.271	**218**	**5**	0.109	0.128	0.163	0.197	0.228	0.284	0.332	0.25xD	5
220	**7.5**	0.085	0.099	0.127	0.153	0.177	0.221	0.258	**242**	**5**	0.104	0.121	0.155	0.187	0.217	0.270	0.316	0.25xD	5
198	**7.5**	0.070	0.082	0.104	0.126	0.146	0.182	0.212	**218**	**5**	0.085	0.100	0.128	0.154	0.178	0.222	0.260	0.25xD	5
176	**5**	0.070	0.082	0.104	0.126	0.146	0.182	0.212	**194**	**3**	0.085	0.100	0.128	0.154	0.178	0.222	0.260	0.15xD	3
99	**3**	0.040	0.046	0.059	0.072	0.083	0.103	0.121	**109**	**1**	0.049	0.057	0.073	0.088	0.102	0.127	0.148	0.05xD	1
160	**7.5**	0.070	0.082	0.104	0.126	0.146	0.182	0.212	**176**	**5**	0.085	0.100	0.128	0.154	0.178	0.222	0.260	0.25xD	5
149	**7.5**	0.060	0.070	0.090	0.108	0.125	0.156	0.183	**164**	**5**	0.074	0.086	0.110	0.133	0.154	0.192	0.224	0.25xD	5
242	**7.5**	0.100	0.117	0.149	0.180	0.208	0.260	0.304	**267**	**5**	0.122	0.143	0.183	0.220	0.255	0.318	0.372	0.25xD	5
198	**7.5**	0.089	0.104	0.133	0.161	0.186	0.232	0.271	**218**	**5**	0.109	0.128	0.163	0.197	0.228	0.284	0.332	0.25xD	5
198	**7.5**	0.070	0.082	0.104	0.126	0.146	0.182	0.212	**218**	**5**	0.085	0.100	0.128	0.154	0.178	0.222	0.260	0.25xD	5
176	**7.5**	0.060	0.070	0.090	0.108	0.125	0.156	0.183	**194**	**5**	0.074	0.086	0.110	0.133	0.154	0.192	0.224	0.25xD	5

Explanation of terms:
S_{max} = Maximum slope of the helix
G = Ratio of circular pocket Ø when plunging to the tool Ø
E.g.: Tool Ø 12 mm at G=1.5 results in a pocket Ø of 18 mm
EW_{max} = Slope angle of the helix (results from G and S_{max})

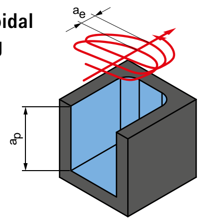
Next page:
Contact angle and maximum chip thickness

The optimum data for the respective machining task should be determined during the test or machining.
Bold text: Best suited | Normal text: Suitable in some situations

Cutting data recommendation for trochoidal milling cutters

Contact angle and maximum chip thickness

Trochoidal milling



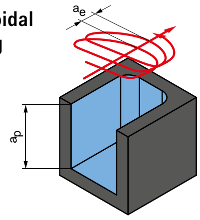
LOW dynamics
a_p = depending on max. machining depth of the tool
a_e = depending on the workpiece material

OptiMill-Tro-Uni (2nd generation) | SCM942 (4xD, 5xD)

MMG*		Workpiece material	Strength/ hardness [N/mm²] [HRC]	Cooling			Contact angle EW [°]	hmax [mm] for diameter of milling cutter [mm]						
				MQL/Air	Dry	Wet		5.00	6.00	8.00	10.00	12.00	16.00	20.00
P	P1-1	Unalloyed steel ≤ 0.15% C, annealed	420	✓	✓	✓	**31.8**	0.032	0.037	0.048	0.057	0.066	0.083	0.097
P	P1-2	Unalloyed steel ≤ 0.45% C, annealed	650	✓	✓	✓	**31.8**	0.031	0.037	0.047	0.056	0.065	0.081	0.095
P	P1-3	Unalloyed steel ≤ 0.45% C, quenched and tempered	850	✓	✓	✓	**31.8**	0.031	0.036	0.046	0.055	0.064	0.080	0.093
P	P1-4	Unalloyed steel ≤ 0.75% C, annealed	900	✓	✓	✓	**31.8**	0.030	0.035	0.045	0.054	0.063	0.078	0.092
P	P1-5	Unalloyed steel ≤ 0.75% C, quenched and tempered	1,000	✓	✓	✓	**31.8**	0.029	0.034	0.043	0.052	0.061	0.075	0.088
P	P2-1	Low-alloyed steel, annealed	600	✓	✓	✓	**31.8**	0.031	0.037	0.047	0.056	0.065	0.081	0.095
P	P2-2	Low-alloyed steel, quenched and tempered	930	✓	✓	✓	**31.8**	0.029	0.034	0.043	0.052	0.061	0.075	0.088
P	P2-3	Low-alloyed steel, quenched and tempered	1,000	✓	✓	✓	**31.8**	0.027	0.032	0.041	0.049	0.057	0.071	0.083
P	P2-4	Low-alloyed steel, quenched and tempered	1,200	✓	✓	✓	**31.8**	0.026	0.030	0.038	0.046	0.054	0.067	0.078
P	P3-1	High-alloyed steel and high-alloyed tool steel, annealed	680	✓	✓	✓	**31.8**	0.028	0.033	0.043	0.051	0.059	0.074	0.087
P	P3-2	High-alloyed steel and high-alloyed tool steel, quenched and tempered	1,100	✓	✓	✓	**31.8**	0.027	0.031	0.040	0.048	0.056	0.070	0.082
P	P3-3	High-alloyed steel and high-alloyed tool steel, quenched and tempered	1,250	✓	✓	✓	**31.8**	0.025	0.029	0.038	0.045	0.052	0.065	0.076
P	P4-1	Bainitic steel, ultra-high-carbon steel, bainitic-quenched and tempered	1,650			✓	**24.5**	0.015	0.018	0.023	0.027	0.032	0.040	0.046
P	P5-1	Stainless steel, ferritic / martensitic, quenched and tempered	680			✓	**25.8**	0.022	0.026	0.033	0.040	0.046	0.058	0.068
P	P5-2	Stainless steel, martensitic, quenched and tempered	800			✓	**25.8**	0.021	0.025	0.032	0.038	0.044	0.055	0.065
P	P5-3	Stainless steel, martensitic, precipitation-hardened	1,200			✓	**25.8**	0.019	0.022	0.028	0.034	0.039	0.049	0.057
M	M1-1	Stainless steel, austenitic, quenched	680			✓	25.8	0.016	0.019	0.024	0.029	0.034	0.042	0.049
M	M1-2	Stainless steel, austenitic (super austenitic), precipitation-hardened	1,010			✓	19.9	0.012	0.014	0.018	0.022	0.025	0.032	0.037
M	M2-1	Stainless steel, austenitic / ferritic (duplex), solution-annealed	780			✓	19.9	0.012	0.014	0.018	0.022	0.025	0.032	0.037
M	M2-2	Stainless steel, austenitic / ferritic (super-duplex), solution-annealed	780			✓	24.5	0.013	0.016	0.020	0.024	0.028	0.035	0.040
M	M3-1	Stainless steel, heat-resistant austenitic steel, cast	720			✓	19.9	0.011	0.013	0.016	0.020	0.023	0.028	0.033
K	K1-1	Grey cast iron, GJL, pearlitic / ferritic	200	✓	✓	✓	**31.8**	0.052	0.061	0.078	0.093	0.108	0.135	0.158
K	K1-2	Grey cast iron, GJL, pearlitic	250	✓	✓	✓	**31.8**	0.046	0.054	0.069	0.083	0.097	0.120	0.141
K	K1-3	Grey cast iron, GJL, pearlitic	350	✓	✓	✓	**31.8**	0.046	0.054	0.069	0.083	0.097	0.120	0.141
K	K2-1	Spheroidal graphite cast iron, GJS, ferritic	400	✓	✓	✓	**31.8**	0.044	0.052	0.066	0.079	0.092	0.115	0.134
K	K2-2	Spheroidal graphite cast iron, GJS, ferritic / pearlitic	500	✓	✓	✓	**31.8**	0.036	0.042	0.054	0.065	0.076	0.094	0.110
K	K2-3	Spheroidal graphite cast iron, GJS, pearlitic	700	✓	✓	✓	**25.8**	0.033	0.038	0.049	0.059	0.068	0.085	0.100
K	K2-4	Austempered ductile iron, ADI, austenitic / ferritic	1,400	✓	✓	✓	**19.9**	0.015	0.018	0.022	0.027	0.031	0.039	0.046
K	K3-1	Compacted graphite cast iron, GJV, ferritic	400	✓	✓	✓	**31.8**	0.036	0.042	0.054	0.065	0.076	0.094	0.110
K	K3-2	Compacted graphite cast iron, GJV, pearlitic	> 400	✓	✓	✓	**31.8**	0.031	0.037	0.047	0.056	0.065	0.081	0.095
K	K4-1	Malleable cast iron, GJMW / GJMB, ferritic	400	✓	✓	✓	**31.8**	0.052	0.061	0.078	0.093	0.108	0.135	0.158
K	K4-2	Malleable cast iron, GJMW / GJMB, pearlitic	600	✓	✓	✓	**31.8**	0.046	0.054	0.069	0.083	0.097	0.120	0.141
K	K5-1	Austenitic cast iron, GJLA / GJSA, lamellar graphite	210	✓	✓	✓	**31.8**	0.036	0.042	0.054	0.065	0.076	0.094	0.110
K	K5-2	Austenitic cast iron, GJLA / GJSA, spheroidal graphite	420	✓	✓	✓	**31.8**	0.031	0.037	0.047	0.056	0.065	0.081	0.095

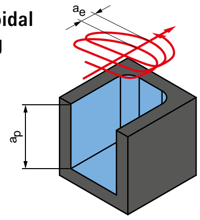
* MAPAL machining groups
The specified cutting data are guide values.

Trochoidal milling



MEDIUM dynamics
a_p = depending on max. machining depth of the tool
a_e = depending on the workpiece material

Trochoidal milling



HIGH dynamics
a_p = depending on max. machining depth of the tool
a_e = depending on the workpiece material

hmax [mm] for diameter of milling cutter [mm]							hmax [mm] for diameter of milling cutter [mm]						
5.00	6.00	8.00	10.00	12.00	16.00	20.00	5.00	6.00	8.00	10.00	12.00	16.00	20.00
0.032	0.038	0.048	0.058	0.067	0.084	0.098	0.032	0.038	0.048	0.058	0.067	0.084	0.098
0.032	0.037	0.047	0.057	0.066	0.082	0.096	0.032	0.037	0.047	0.057	0.066	0.082	0.096
0.031	0.036	0.047	0.056	0.065	0.081	0.095	0.031	0.036	0.047	0.056	0.065	0.081	0.095
0.030	0.036	0.046	0.055	0.064	0.079	0.093	0.030	0.036	0.046	0.055	0.064	0.079	0.093
0.029	0.034	0.044	0.053	0.061	0.077	0.090	0.029	0.034	0.044	0.053	0.061	0.077	0.090
0.032	0.037	0.047	0.057	0.066	0.082	0.096	0.032	0.037	0.047	0.057	0.066	0.082	0.096
0.029	0.034	0.044	0.053	0.061	0.077	0.090	0.029	0.034	0.044	0.053	0.061	0.077	0.090
0.028	0.032	0.041	0.050	0.058	0.072	0.084	0.028	0.032	0.041	0.050	0.058	0.072	0.084
0.026	0.030	0.039	0.047	0.054	0.068	0.079	0.026	0.030	0.039	0.047	0.054	0.068	0.079
0.029	0.034	0.043	0.052	0.060	0.075	0.088	0.029	0.034	0.043	0.052	0.060	0.075	0.088
0.027	0.032	0.041	0.049	0.057	0.071	0.083	0.027	0.032	0.041	0.049	0.057	0.071	0.083
0.025	0.030	0.038	0.046	0.053	0.066	0.077	0.025	0.030	0.038	0.046	0.053	0.066	0.077
0.014	0.017	0.021	0.026	0.030	0.037	0.043	0.014	0.017	0.021	0.026	0.030	0.037	0.043
0.021	0.024	0.031	0.037	0.043	0.054	0.063	0.021	0.024	0.031	0.037	0.043	0.054	0.063
0.020	0.023	0.029	0.035	0.041	0.051	0.060	0.020	0.023	0.029	0.035	0.041	0.051	0.060
0.017	0.020	0.026	0.031	0.036	0.045	0.053	0.017	0.020	0.026	0.031	0.036	0.045	0.053
0.015	0.018	0.022	0.027	0.031	0.039	0.046	0.015	0.018	0.022	0.027	0.031	0.039	0.046
0.011	0.013	0.016	0.020	0.023	0.029	0.033	0.011	0.013	0.016	0.020	0.023	0.029	0.033
0.011	0.013	0.016	0.020	0.023	0.029	0.033	0.011	0.013	0.016	0.020	0.023	0.029	0.033
0.012	0.015	0.019	0.022	0.026	0.032	0.038	0.012	0.015	0.019	0.022	0.026	0.032	0.038
0.010	0.012	0.015	0.018	0.021	0.026	0.030	0.010	0.012	0.015	0.018	0.021	0.026	0.030
0.053	0.062	0.079	0.095	0.110	0.137	0.160	0.053	0.062	0.079	0.095	0.110	0.137	0.160
0.047	0.055	0.070	0.085	0.098	0.122	0.143	0.047	0.055	0.070	0.085	0.098	0.122	0.143
0.047	0.055	0.070	0.085	0.098	0.122	0.143	0.047	0.055	0.070	0.085	0.098	0.122	0.143
0.045	0.052	0.067	0.080	0.093	0.116	0.136	0.045	0.052	0.067	0.080	0.093	0.116	0.136
0.037	0.043	0.055	0.066	0.077	0.096	0.112	0.037	0.043	0.055	0.066	0.077	0.096	0.112
0.030	0.036	0.045	0.055	0.063	0.079	0.093	0.030	0.036	0.045	0.055	0.063	0.079	0.093
0.014	0.016	0.020	0.024	0.028	0.035	0.041	0.014	0.016	0.020	0.024	0.028	0.035	0.041
0.037	0.043	0.055	0.066	0.077	0.096	0.112	0.037	0.043	0.055	0.066	0.077	0.096	0.112
0.032	0.037	0.047	0.057	0.066	0.082	0.096	0.032	0.037	0.047	0.057	0.066	0.082	0.096
0.053	0.062	0.079	0.095	0.110	0.137	0.160	0.053	0.062	0.079	0.095	0.110	0.137	0.160
0.047	0.055	0.070	0.085	0.098	0.122	0.143	0.047	0.055	0.070	0.085	0.098	0.122	0.143
0.037	0.043	0.055	0.066	0.077	0.096	0.112	0.037	0.043	0.055	0.066	0.077	0.096	0.112
0.032	0.037	0.047	0.057	0.066	0.082	0.096	0.032	0.037	0.047	0.057	0.066	0.082	0.096

Explanation of terms:
S_{max} = Maximum slope of the helix
G = Ratio of circular pocket Ø when plunging to the tool Ø
E.g.: Tool Ø 12 mm at G=1.5 results in a pocket Ø of 18 mm
EW_{max} = Slope angle of the helix (results from G and S_{max})

The optimum data for the respective machining task should be determined during the test or machining.
Bold text: Best suited | Normal text: Suitable in some situations

Trochoidal milling – principles

Definition

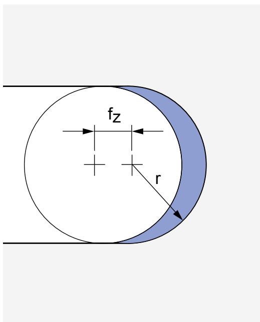
Trochoidal milling is a milling strategy with the aim of reducing process forces and simultaneously increasing material removal rates. By superimposing a circular movement of the tool on the feed movement, the contact conditions can be positively influenced. This results in cyclic material removal with variable contact conditions that can be adjusted to the tool application, as well as variable cutting widths along the circular path of the tool.

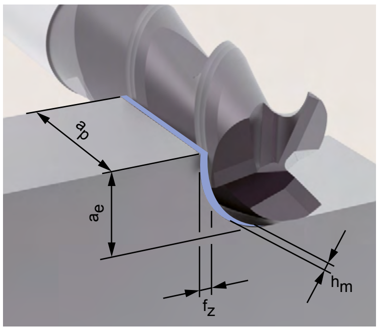
Example of full slot milling

Conventional milling

For roughing in a full cut, the contact conditions of the milling cutter are fixed at a wrapping angle of 180°.

In addition to the generation of long chips due to the long tooth contact, this leads to a comparatively high thermal load on the tool. The resulting large cutting cross section in turn produces high cutting forces, which limits process-stable infeed depths, feed rates and cutting speeds.



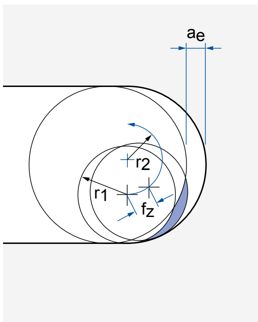


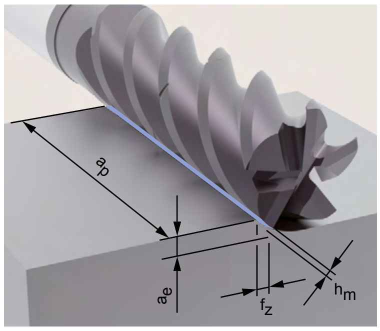
a_p: small (cutting depth ~1xD)
a_e: large (1xD)
f_z: small
v_c: low

Trochoidal milling

The specific kinematics of trochoidal milling makes it possible to positively influence the contact conditions as a circular movement of the tool is superimposed on the feed movement. The contact angle is correspondingly low.

The result of this technological approach is that a reduced cutting width and cutting length lead to significantly reduced process forces. This in turn makes it possible to achieve greater cutting depths.





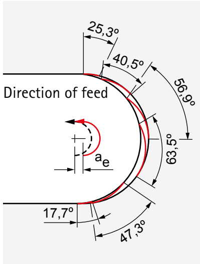
a_p: large (full utilisation of the cutting edge length possible)
a_e: small
f_z: large
v_c: high

Trochoidal milling – in detail

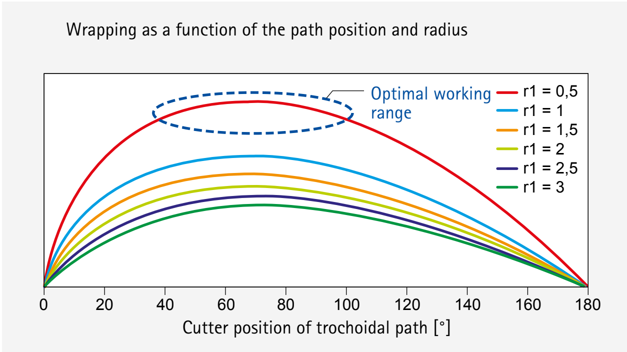
Trochoidal milling – circular path

For the case of a circular path with a constant radius, the wrapping angles on the contact tool cutting edge vary depending on the absolute radial material removal rate within one revolution.

- Contact conditions are constantly changing
- Optimal working range of the milling cutter
- Limited to a small area
- Low material removal rate
- Tends to vibrate more
- Increased tool wear



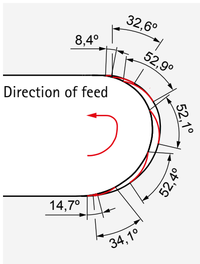
Wrapping as a function of the path position – circular path



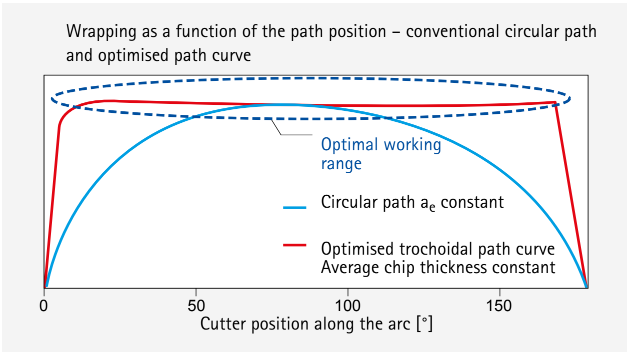
Trochoidal milling – optimised path curve

Through an adapted path movement of the tool, the contact ratios of the milling cutter can be kept constant at every point of the path over almost the entire machining operation. This means that the milling process can always be operated at its optimum. Within a path, the feed rate is adjusted so that the average chip thickness remains constant.

- Constant contact condition
- Constant strength level
- Less tool wear
- Maximum material removal rate

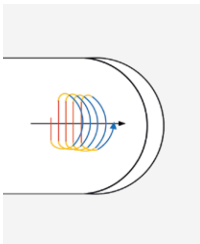


Wrapping as a function of the path position – optimised path curve



Feed movement – optimised air cut

For holistic process optimisation, the traversing motion in the air cut must be considered in addition to the tool path during engagement. The aim is to realise the fastest possible movement to the next entry point after the milling cutter has exited the material. Since the design of a circular path is not advantageous at this point, the most direct approach path possible is selected depending on the dynamics of the machine.



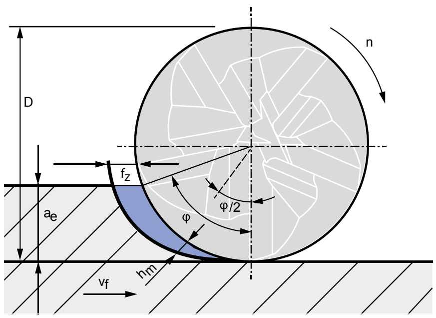
Feed
Ramp
Rapid traverse

NOTE

- In addition to a modern CAM system or a modern machine control system, trochoidal milling also requires a machining centre that is as dynamic as possible.

Maximum average chip thickness h_{max} and contact angle φ

Contact angle	φ = [°]	$\cos\varphi = 1 - \frac{2 \cdot a_e}{D}$	Depends on the contact ratio a_e/D and is limited depending on the workpiece material.
Maximum average chip thickness	h_{max} = [mm]	$h_{max} = f_z \cdot \sqrt{\frac{a_e}{D}}$	Is kept almost constant during trochoidal milling by dynamic feed rates. The average chip thickness is measured at $\varphi/2$.
Feed per tooth	fz = [mm]		Restricted variable, is adjusted during machining by CAM system.
Cutting width	a_e = [mm]		Constantly recalculated by the CAM software and limits the contact angle φ.
Tool diameter	D = [mm]		



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