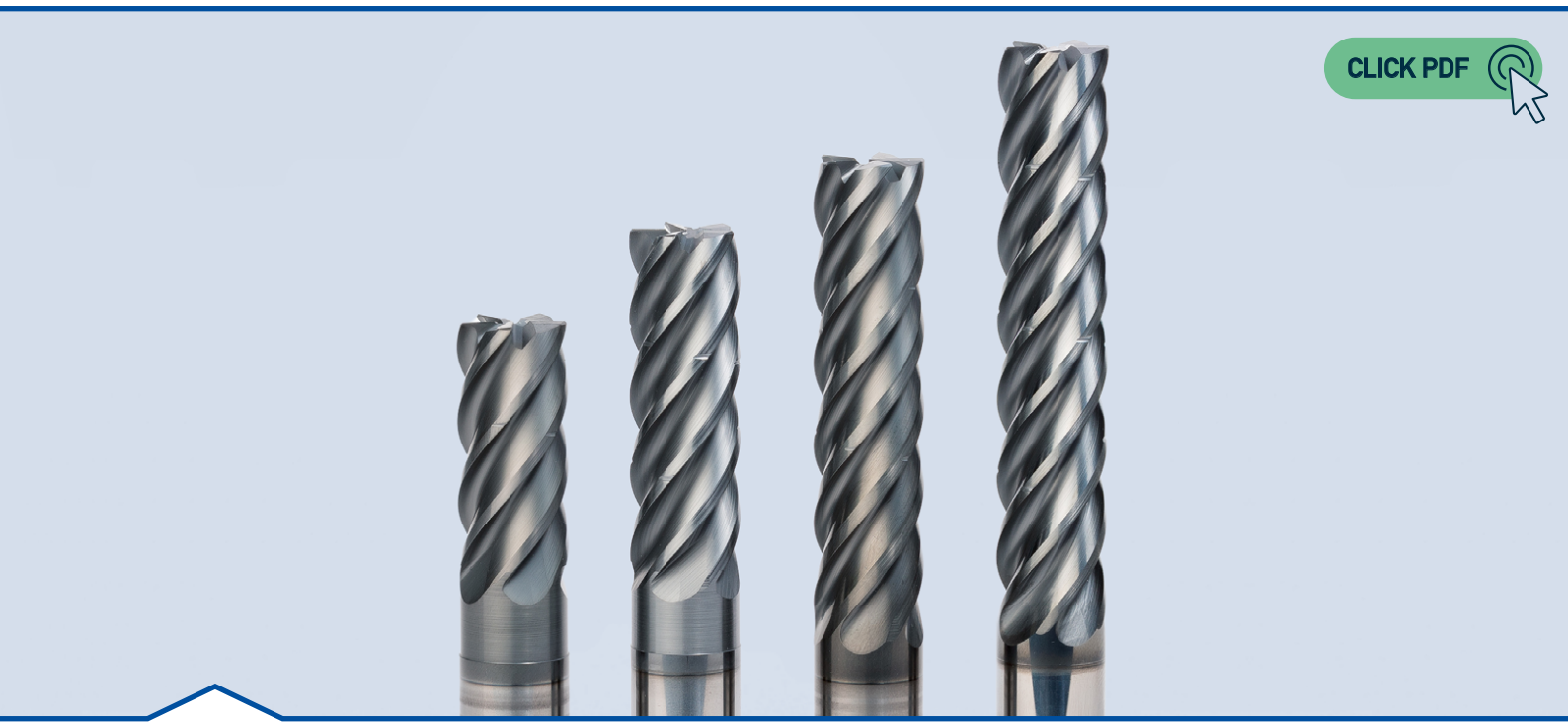
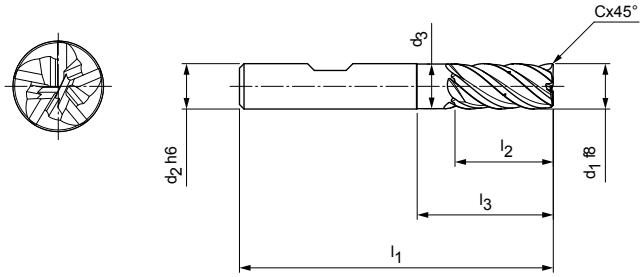


Your technology partner for cost-effective machining

OptiMill®-Tro-Uni (2nd generation)

OptiMill®-Tro-Uni (2nd generation)

Shoulder milling cutter, 2xD design with chip breaker
SCM942



Design:

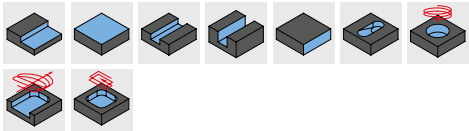
Diameter of milling cutter:	4.00 - 25.00 mm
Cutting material:	HP830
Number of cutting edges:	5
Helix angle:	~ 41°

Expert LINE | CONFIG | 45° | HB DIN 6535 | 2xD

Configurable features:

45° | CR | 90° | HA DIN 6535

Application:



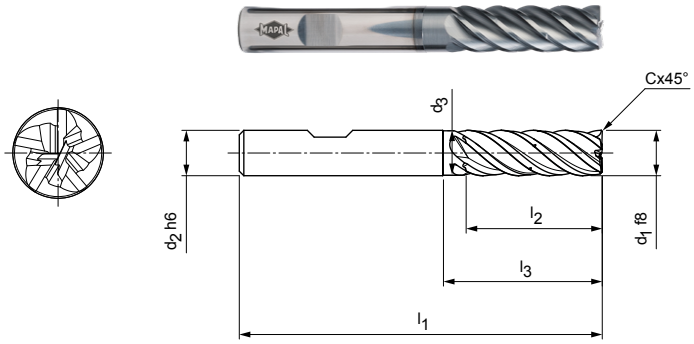
P	1	2	3	4	5	M	1	2	3	K	1	2	3	4	5	N	1	2	3	4	5	S	1	2	3	4	H	1	2	3	C	1	2	3	4	5
	■	■	■	■	■		◒	◒	◒		■	■	■	■	■													◒								

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:

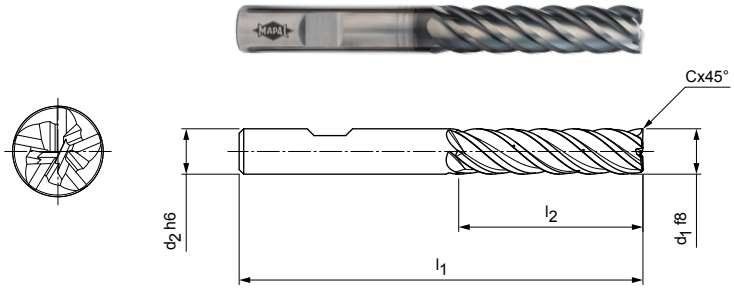
P	1	2	3	4	5	M	1	2	3	K	1	2	3	4	5	N	1	2	3	4	5	S	1	2	3	4	H	1	2	3	C	1	2	3	4	5
■	■	■	■	■	■		◒	◒	◒		■	■	■	■	■													◒								

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:

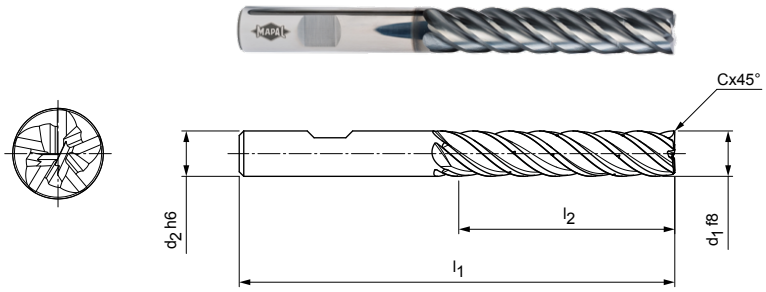
P	1	2	3	4	5	M	1	2	3	K	1	2	3	4	5	N	1	2	3	4	5	S	1	2	3	4	H	1	2	3	C	1	2	3	4	5
■	■	■	■	■	■		⬓	⬓	⬓	■	■	■	■	■														⬓								

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
■	■	■	■	■	■		◒	◒	◒	■	■	■	■	■														◒								

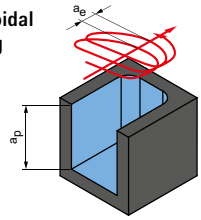
Dimensions					z	Chip breaker	Specification	Order no.
d_1 f8	d_2 h6	l_1	l_2	Cx45°				
8,00	8	81	40	0,16	5	3	SCM942-0800Z05R-F0016HB5-HP830	31663171
10,00	10	96	50	0,20	5	3	SCM942-1000Z05R-F0020HB5-HP830	31663172
12,00	12	112	60	0,24	5	3	SCM942-1200Z05R-F0024HB5-HP830	31663173
16,00	16	136	80	0,32	5	3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

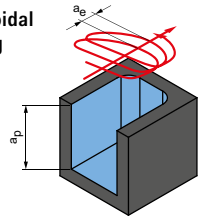
OptiMill-Tro-Uni (2nd generation) | SCM942 (2xD, 3xD)

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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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

Note:
When machining with a cooling lubricant (KSS), the cutting speed must be reduced by approximately 30% compared to dry machining. This prevents thermal shock to the cutting edge.

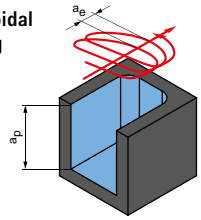
* MAPAL machining groups
The specified cutting data are guide values.

Trochoidal milling



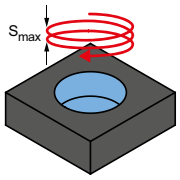
MEDIUM dynamics
a_p = depending on max. machining depth of the tool
a_e = depending on the workpiece material

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})

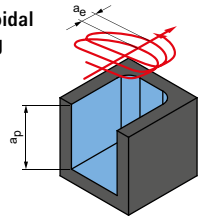
Next page:
Contact angle and maximum chip thickness

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

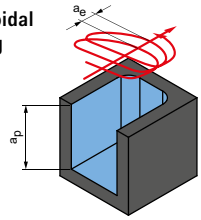
OptiMill-Tro-Uni (2nd generation) | SCM942 (2xD, 3xD)

MMG*		Workpiece material	Strength/ hardness [N/mm²] [HRC]	Cooling			Contact angle EW [°]	hmax [mm] for diameter of milling cutter [mm]								
				MQL/Air	Dry	Wet		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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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

Note:
When machining with a cooling lubricant (KSS), the cutting speed must be reduced by approximately 30% compared to dry machining. This prevents thermal shock to the cutting edge.

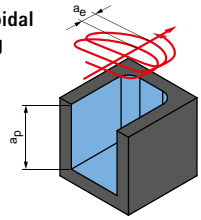
* MAPAL machining groups
The specified cutting data are guide values.

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

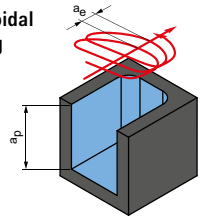
Explanation of terms:
S_{max} = Maximum slope of the helix
G = Ratio of circular pocket Ø when plunging to the tool Ø
E.g.: Tool Ø 12 mm at G=1.5 results in a pocket Ø of 18 mm
EW_{max} = Slope angle of the helix (results from G and S_{max})

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

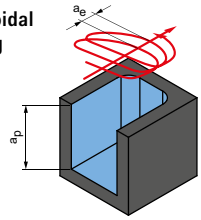
OptiMill-Tro-Uni (2nd generation) | SCM942 (4xD, 5xD)

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
	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
	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
	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
	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
	P2-1	Low-alloyed steel, annealed	600	✓	✓	✓	**180**	**10**	0.052	0.061	0.078	0.094	0.109	0.135	0.159
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	K1-2	Grey cast iron, GJL, pearlitic	250	✓	✓	✓	**200**	**10**	0.077	0.090	0.115	0.139	0.161	0.201	0.235
	K1-3	Grey cast iron, GJL, pearlitic	350	✓	✓	✓	**180**	**10**	0.077	0.090	0.115	0.139	0.161	0.201	0.235
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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

Note:
When machining with a cooling lubricant (KSS), the cutting speed must be reduced by approximately 30% compared to dry machining. This prevents thermal shock to the cutting edge.

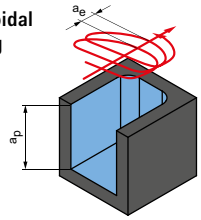
* MAPAL machining groups
The specified cutting data are guide values.

Trochoidal milling



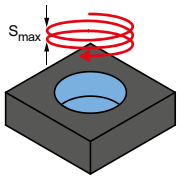
MEDIUM dynamics
a_p = depending on max. machining depth of the tool
a_e = depending on the workpiece material

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})

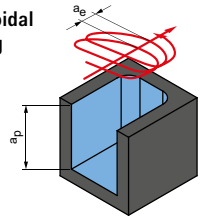
Next page:
Contact angle and maximum chip thickness

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

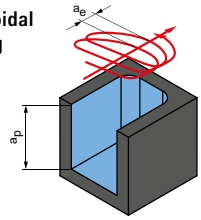
OptiMill-Tro-Uni (2nd generation) | SCM942 (4xD, 5xD)

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
	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
	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
	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
	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
	P2-1	Low-alloyed steel, annealed	600	✓	✓	✓	**31.8**	0.031	0.037	0.047	0.056	0.065	0.081	0.095
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	K1-2	Grey cast iron, GJL, pearlitic	250	✓	✓	✓	**31.8**	0.046	0.054	0.069	0.083	0.097	0.120	0.141
	K1-3	Grey cast iron, GJL, pearlitic	350	✓	✓	✓	**31.8**	0.046	0.054	0.069	0.083	0.097	0.120	0.141
	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
	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
	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
	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
	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
	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
	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
	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
	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
	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

Note:
When machining with a cooling lubricant (KSS), the cutting speed must be reduced by approximately 30% compared to dry machining. This prevents thermal shock to the cutting edge.

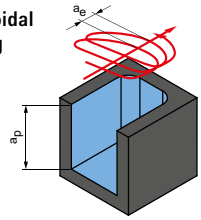
* MAPAL machining groups
The specified cutting data are guide values.

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

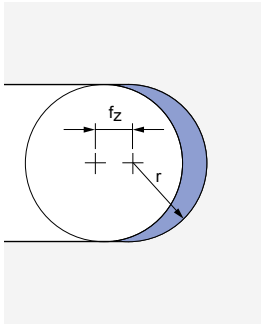
Trochoidal milling is a milling strategy with the aim of reducing process forces and simultaneously increasing material removal rates. By superimposing a circular movement of the tool on the feed movement, the contact conditions can be positively influenced. This results in cyclic material removal with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

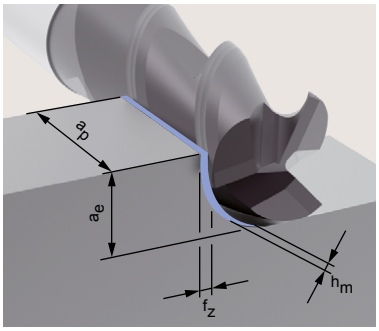
Example of full slot milling

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.



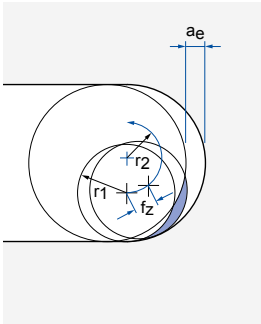


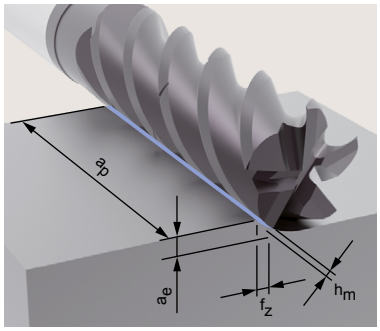
a_p: small (cutting depth ~1xD)
a_e: large (1xD)
f_z: small
v_c: low

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.





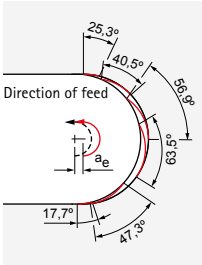
a_p: large (full utilisation of the cutting edge length possible)
a_e: small
f_z: large
v_c: high

Trochoidal milling – in detail

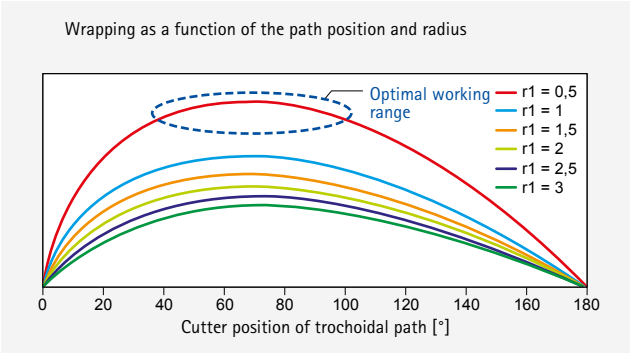
Trochoidal milling – circular path

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



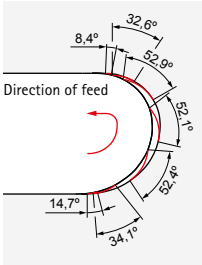
Wrapping as a function of the path position – circular path



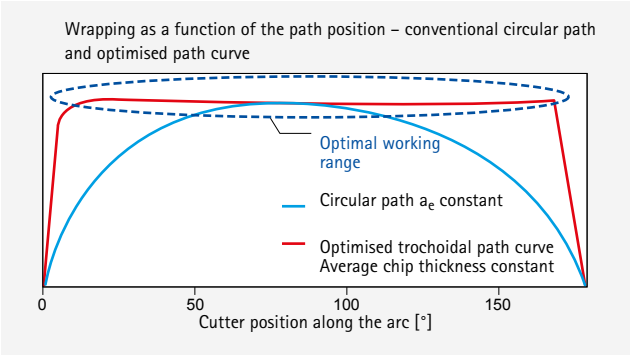
Trochoidal milling – optimised path curve

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

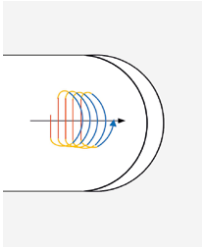


Wrapping as a function of the path position – optimised path curve



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.



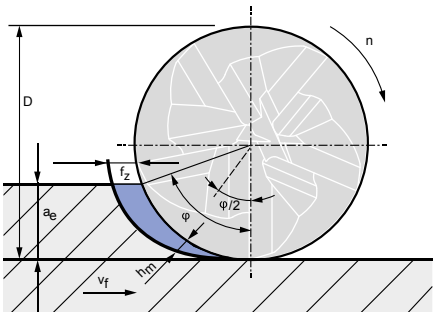
- Feed
- Ramp
- Rapid traverse

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	$\varphi = [°]$	$\cos\varphi = 1 - \frac{2 \cdot a_e}{D}$	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 φ/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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