TuffCut® GP

General Purpose End Mill Recommended Cutting Data - Profile Milling

Length	2 Flute Series		3 Flute Series		4 Flute Series			
Stub	164	166	169		163		165	
Standard	121	150	116	145	111	140	117	114
Long Length	123*				122*			132*

*Chip thinning may not be possible with 122, 123 and 132 series if radial width of cut exceeds 20%.

For ball nose end mills - If axial depth (ap) is less than the ball diameter, the speed is figured using the effective cutting diameter.

Inch

For diameters 1/4" and below, see Micro Charts starting on page 369.

Workpiece Material Group	ISO	Hardness	Coolant • Preferred o Possible x Not Possible			Profile Milling (ae)					End Mill Diameters					
						5%	10%	20%	30%	50%	5/16	3/8	1/2	5/8	3/4	1
						ae > .3D use < 1D ap ae < .2D use < 2D ap										
						2.3	1.8	1.2	1.1	1	← Multiply fz by this Factor based on ae. When finishing, use the standard fz per chart below. Only add chip thinning when roughing or semi-finishing.					
			Max.	Air	MMS	vc - SFM Increase speeds by 30% for ALtima® coated tools					fz - in/tooth					
Free Machining & Low Carbon Steels 1006, 1008, 1015, 1018, 1020, 1022, 1025, 1117, 1140, 1141, 11L08, 11L14, 1213, 12L13, 12L14, 1215, 1330	P	up to 28 Rc	•	•	•	1050	700	385	375	350	.0027	.0032	.0045	.0054	.0063	.0090
Medium Carbon & High Carbon Steels, Alloy Steels & Easy to Machine Tool Steels 1030, 1035, 1040, 1045, 1050, 1052, 1055, 1060, 1085, 1095, 1541, 1551, 9255, 2515, 3135, 3415, 4130, 4137, 4140, 4150, 4320, 4340, 4520, 5015, 5115, 5120, 5132, 5140, 5155, 6150, 8620, 9262, 9840, 52100, O1, O2, O6, S2, W1 to W310	P	28 to 38 Rc	•	•	•	630	420	320	250	210	.0027	.0032	.0045	.0054	.0063	.0090
Tool Steels & Die Steels O7, M1, M2, M3, M4, M7, T1, T2, T4, T5, T8, T15, A2, A3, A6, A7, H10, H11, H12, H13, H19, H21, L3, L6, L7, P2, P20, S1, S5, S7, 52100, A 128, D2, D3, D4, D5, D7	P	28 to 44 Rc	•	•	•	525	350	300	275	250	.0027	.0032	.0045	.0054	.0063	.0090
Hardened Steels	H	45-55 Rc	•	o	o	250	240	230	210	200	.0018	.0021	.0030	.0036	.0042	.0060
Hardened Steels	H	55-65 Rc	•	o	o	200	180	160	150	100	.0013	.0014	.0021	.0024	.0029	.0041
Stainless Steel - Easy to Machine 430F, 301, 303, 410, 416 Annealed, 420F, 430, 430F	M	up to 28 Rc	•	x	o	650	600	550	500	450	.0027	.0032	.0045	.0054	.0063	.0090
Stainless Steel - Moderately Difficult 301, 302, 303 High Tensile, 304, 304L, 305, 420, 15-5PH, 17-4PH, 17-7PH	M	up to 28 Rc	•	x	o	525	400	350	300	250	.0027	.0032	.0045	.0054	.0063	.0090
Stainless Steel - Difficult to Machine 302B, 304B, 309, 310, 316, 316B, 316L, 316Ti, 317, 317L, 321, PH13-8Mo, Nitronics	M	over 28 Rc	•	x	o	525	400	350	300	250	.0027	.0032	.0045	.0054	.0063	.0090

General Purpose End Mill Recommended Cutting Data - Profile Milling

Length	2 Flute Series		3 Flute Series		4 Flute Series			
Stub	164	166	169		163		165	
Standard	121	150	116	145	111	140	117	114
Long Length	123*				122*			132*

*Chip thinning may not be possible with 122, 123 and 132 series if radial width of cut exceeds 20%.

For ball nose end mills - If axial depth (ap) is less than the ball diameter, the speed is figured using the effective cutting diameter.

Inch Continued

For diameters 1/4" and below, see Micro Charts starting on page 369.

Workpiece Material Group	ISO	Hardness	Coolant • Preferred o Possible x Not Possible			Profile Milling (ae)					End Mill Diameter					
						5%	10%	20%	30%	50%	5/16	3/8	1/2	5/8	3/4	1
											ae > .3D use < 1D ap ae < .2D use < 2D ap					
						2.3	1.8	1.2	1.1	1	← Multiply fz by this Factor based on ae. When finishing, use the standard fz per chart below. Only add chip thinning when roughing or semi-finishing.					
			Max.	Air	MMS	vc - SFM Increase speeds by 30% for ALtima® coated tools					fz - in/tooth					
High Temp Alloys Nimonics, Inconel, Monel, Hastelloy	S	up to 42 Rc	•	x	x	265	200	175	150	100	.0014	.0016	.0023	.0027	.0032	.0045
Titanium Alloys 6Al-4V, 5Al-2.5 Sn, 6Al-2 Sn-4Zr-6Mo, 3Al-8V-6Cr4Mo-4Zr, 10V-2Fe-3Al, 13V-11Cr-3Al	S	up to 42 Rc	•	x	x	230	200	175	150	125	.0014	.0016	.0023	.0027	.0032	.0045
Cast-Iron - Gray CG, ASTM A48, CLASS 20, 25, 30, 35, SAE J431C, GRADES G1800, G3000, G3500, GG 10, 15, 20, 25, 30, 35, 40	K	up to 240 HB	•	o	o	425	400	375	350	300	.0027	.0032	.0045	.0054	.0063	.0090
Cast Iron - Ductile & Malleable CGI 60-40-18, 65-45-12, D4018, D4512, D5506, 32510, 35108, M3210, M4504, M5503, 250, 300, 350, 400, 450	K	over 240 HB	•	o	o	320	300	250	225	200	.0027	.0032	.0045	.0054	.0063	.0090
Non-Ferrous, Plastics, Graphite	N		•			1000	960	920	880	840	.0027	.0032	.0045	.0054	.0063	.0090

TuffCut® GP

General Purpose End Mill Recommended Cutting Data - Slotting

Length	2 Flute Series		3 Flute Series		4 Flute Series			
Stub	164	166	169		163		165	
Standard	121	150	116	145	111	140	117	114

For ball nose end mills - If axial depth (ap) is less than the ball diameter, the speed is figured using the effective cutting diameter.

Inch

For diameters 1/4" and below, see Micro Charts starting on page 369.

Workpiece Material Group	ISO	Hardness	Coolant • Preferred o Possible x Not Possible			Slotting			End Mill Diameter					
									5/16	3/8	1/2	5/8	3/4	1
						25%	50%	100%						
			Max.	Air	MMS	vc - SFM Increase speeds by 30% for ALtima® coated tools			fz - in/tooth					
Free Machining & Low Carbon Steels 1006, 1008, 1015, 1018, 1020, 1022, 1025, 1117, 1140, 1141, 11L08, 11L14, 1213, 12L13, 12L14, 1215, 1330	P	up to 28 Rc	•	•	•	385	370	350	.0016	.0019	.0025	.0031	.0038	.0050
Medium Carbon & High Carbon Steels, Alloy Steels & Easy to Machine Tool Steels 1030, 1035, 1040, 1045, 1050, 1052, 1055, 1060, 1085, 1095, 1541, 1551, 9255, 2515, 3135, 3415, 4130, 4137, 4140, 4150, 4320, 4340, 4520, 5015, 5115, 5120, 5132, 5140, 5155, 6150, 8620, 9262, 9840, 52100, O1, O2, O6, S2, W1 to W310	P	28 to 38 Rc	•	•	•	245	230	210	.0016	.0019	.0025	.0031	.0038	.0050
Tool Steels & Die Steels O7, M1, M2, M3, M4, M7, T1, T2, T4, T5, T8, T15, A2, A3, A6, A7, H10, H11, H12, H13, H19, H21, L3, L6, L7, P2, P20, S1, S5, S7, 52100, A 128, D2, D3, D4, D5, D7	P	28 to 44 Rc	•	•	•	210	195	175	.0016	.0019	.0025	.0031	.0038	.0050
Hardened Steels	H	35-45 Rc	•	o	o	245	230	210	.0016	.0019	.0025	.0031	.0038	.0050
Hardened Steels		45-55 Rc	•	o	o	175	160	140	.0008	.0010	.0013	.0016	.0020	.0025
Hardened Steels		55-65 Rc	•	o	o	150	125	100	.0004	.0005	.0008	.0008	.0010	.0012
Stainless Steel - Easy to Machine 430F, 301, 303, 410, 416 Annealed, 420F, 430, 430F	M	up to 28 Rc	•	x	o	385	370	350	.0016	.0019	.0025	.0031	.0038	.0050
Stainless Steel - Moderately Difficult 301, 302, 303 High Tensile, 304, 304L, 305, 420, 15-5PH, 17-4PH, 17-7PH	M	up to 28 Rc	•	x	o	245	210	175	.0016	.0019	.0025	.0031	.0038	.0050
Stainless Steel - Difficult to Machine 302B, 304B, 309, 310, 316, 316B, 316L, 316Ti, 317, 317L, 321, PH13-8Mo, Nitronics	M	over 28 Rc	•	x	o	210	195	175	.0016	.0019	.0025	.0031	.0038	.0050

General Purpose End Mill Recommended Cutting Data - Slotting

Length	2 Flute Series		3 Flute Series		4 Flute Series			
Stub	164	166	169		163		165	
Standard	121	150	116	145	111	140	117	114

For ball nose end mills - If axial depth (ap) is less than the ball diameter, the speed is figured using the effective cutting diameter.

Inch Continued

For diameters 1/4" and below, see Micro Charts starting on page 369.

Workpiece Material Group	ISO	Hardness	Coolant • Preferred o Possible x Not Possible			Slotting			End Mill Diameter					
						25%	50%	100%	5/16	3/8	1/2	5/8	3/4	1
			Max.	Air	MMS	vc - SFM Increase speeds by 30% for ALtima® coated tools			fz - in/tooth					
High Temp Alloys Nimonics, Inconel, Monel, Hastelloy	S	up to 42 Rc	•	x	x	125	105	90	.0008	.0010	.0013	.0016	.0017	.0026
Titanium Alloys 6Al-4V, 5Al-2.5 Sn, 6Al-2 Sn-4Zr-6Mo, 3Al-8V-6Cr4Mo-4Zr, 10V-2Fe-3Al, 13V-11Cr-3Al	S	up to 42 Rc	•	x	x	100	90	80	.0008	.0010	.0013	.0016	.0017	.0026
Cast-Iron - Gray CG, ASTM A48, CLASS 20, 25, 30, 35, SAE J431C, GRADES G1800, G3000, G3500, GG 10, 15, 20, 25, 30, 35, 40	K	up to 240 HB	•	o	o	450	400	350	.0016	.0019	.0025	.0031	.0038	.0050
Cast Iron - Ductile & Malleable CGI 60-40-18, 65-45-12, D4018, D4512, D5506, 32510, 35108, M3210, M4504, M5503, 250, 300, 350, 400, 450	K	over 240 HB	•	o	o	300	250	225	.0016	.0019	.0025	.0031	.0038	.0050
Non-Ferrous, Plastic, Graphite	N		•			750	600	450	.0016	.0019	.0025	.0031	.0038	.0050

Micro End Mill Recommended Cutting Data - Profile Milling

Length	2 Flute Series		3 Flute Series		4 Flute Series			
Standard	121	150	116	145	111	140	117	114
Long Length	123				122			132

Inch - Standard / Long Length

Ball Nose End Mills - If axial depth (ap) is less than the ball diameter, the speed is figured using the effective cutting diameter.

For diameters > 1/4", see Charts Starting on page 360.

Workpiece Material Group	ISO	Hardness	Coolant • Preferred o Possible x Not Possible			Profile Milling	End Mill Diameter (Inch)								
							.0150	.0310	.0470	.0620	.0780	.0930	.1250	.1870	.2500
							13% Dia. ae			25% Dia. ae					
							<2 Dia. ap			<2 Dia. ap					
			Max.	Air	MMS	vc - SFM Increase speed by 30% for ALtima® coated tools.	fz - in/tooth								
Free Machining & Low Carbon Steels 1006, 1008, 1015, 1018, 1020, 1022, 1025, 1117, 1140, 1141, 11L08, 11L14, 1213, 12L13, 12L14, 1215, 1330	P	up to 28 Rc	•	•	•	400	0.00007	0.00015	0.00023	0.00027	0.00034	0.00040	0.00054	0.00081	0.00100
Medium Carbon & High Carbon Steels, Alloy Steels & Easy to Machine Tool Steels 1030, 1035, 1040, 1045, 1050, 1052, 1055, 1060, 1085, 1095, 1541, 1551, 9255, 2515, 3135, 3415, 4130, 4137, 4140, 4150, 4320, 4340, 4520, 5015, 5115, 5120, 5132, 5140, 5155, 6150, 8620, 9262, 9840, 52100, O1, O2, O6, S2, W1 to W310	P	28 to 38 Rc	•	•	•	300	0.00007	0.00015	0.00023	0.00027	0.00034	0.00040	0.00054	0.00081	0.00100
Tool Steels & Die Steels O7, M1, M2, M3, M4, M7, T1, T2, T4, T5, T8, T15, A2, A3, A6, A7, H10, H11, H12, H13, H19, H21, L3, L6, L7, P2, P20, S1, S5, S7, 52100, A 128, D2, D3, D4, D5, D7	P	28 to 44 Rc	•	•	•	200	0.00007	0.00015	0.00023	0.00027	0.00034	0.00040	0.00054	0.00081	0.00100
Hardened Steels	H	45-55 Rc	•	o	o	100	0.00010	0.00030	0.00050	0.00140	0.00180	0.00210	0.00300	0.00360	0.00420
Stainless Steel - Easy to Machine 430F, 301, 303, 410, 416 Annealed, 420F, 430, 430F	M	up to 28 Rc	•	x	o	400	0.00007	0.00015	0.00023	0.00027	0.00034	0.00040	0.00054	0.00081	0.00100
Stainless Steel - Moderately Difficult 301, 302, 303 High Tensile, 304, 304L, 305, 420, 15-5PH, 17-4PH, 17-7PH	M	up to 28 Rc	•	x	o	200	0.00007	0.00015	0.00023	0.00027	0.00034	0.00040	0.00054	0.00081	0.00100
Stainless Steel - Difficult to Machine 302B, 304B, 309, 310, 316, 316B, 316L, 316Ti, 317, 317L, 321, PH13-8Mo, Nitronics	M	over 28 Rc	•	x	o	150	0.00007	0.00015	0.00023	0.00027	0.00034	0.00040	0.00054	0.00081	0.00100
Cast Iron	K	160-200 HB	•	o	o	400	0.00007	0.00015	0.00023	0.00027	0.00034	0.00040	0.00054	0.00081	0.00100
Malleable / Ductile Cast Iron	K	200-250 HB	•	o	o	250	0.00007	0.00015	0.00023	0.00027	0.00034	0.00040	0.00054	0.00081	0.00100
High Temp Alloys Nimonics, Inconel, Monel, Hastelloy	S	up to 42 Rc	•	x	x	70	0.00004	0.00008	0.00015	0.00023	0.00027	0.00034	0.00040	0.00054	0.00080
Titanium Alloys 6Al-4V, 5Al-2.5 Sn, 6Al-2 Sn-4Zr-6Mo, 3Al-8V-6Cr4Mo-4Zr, 10V-2Fe-3Al, 13V-11Cr-3Al	S	up to 42 Rc	•	x	x	150	0.00004	0.00008	0.00015	0.00023	0.00027	0.00034	0.00040	0.00054	0.00080
Aluminum < 10 % Si	N		•			750	0.00007	0.00015	0.00023	0.00027	0.00034	0.00040	0.00054	0.00081	0.00100
Aluminum > 10 % Si	N														

TuffCut® GP

Micro End Mill Recommended Cutting Data - Profile Milling

Length	2 Flute Series		3 Flute Series	4 Flute Series	
Stub	164	166	169	163	165

Inch - Stub Length

Ball Nose End Mills - If axial depth (ap) is less than the ball diameter, the speed is figured using the effective cutting diameter.

For diameters > 1/4", see Charts Starting on page 360.

Workpiece Material Group	ISO	Hardness	Coolant • Preferred o Possible x Not Possible			Profile Milling	End Mill Diameter (Inch)								
							.0150	.0310	.0470	.0620	.0780	.0930	.1250	.1870	.2500
							13% Dia. ae			25% Dia. ae					
							<1 Dia. ap			<1 Dia. ap					
			Max.	Air	MMS	vc - SFM Increase speed by 30% for ALtima® coated tools.	fz - in/tooth								
Free Machining & Low Carbon Steels 1006, 1008, 1015, 1018, 1020, 1022, 1025, 1117, 1140, 1141, 11L08, 11L14, 1213, 12L13, 12L14, 1215, 1330	P	up to 28 Rc	•	•	•	400	0.00007	0.00015	0.00023	0.00027	0.00034	0.00040	0.00054	0.00081	0.00100
Medium Carbon & High Carbon Steels, Alloy Steels & Easy to Machine Tool Steels 1030, 1035, 1040, 1045, 1050, 1052, 1055, 1060, 1085, 1095, 1541, 1551, 9255, 2515, 3135, 3415, 4130, 4137, 4140, 4150, 4320, 4340, 4520, 5015, 5115, 5120, 5132, 5140, 5155, 6150, 8620, 9262, 9840, 52100, O1, O2, O6, S2, W1 to W310	P	28 to 38 Rc	•	•	•	300	0.00007	0.00015	0.00023	0.00027	0.00034	0.00040	0.00054	0.00081	0.00100
Tool Steels & Die Steels O7, M1, M2, M3, M4, M7, T1, T2, T4, T5, T8, T15, A2, A3, A6, A7, H10, H11, H12, H13, H19, H21, L3, L6, L7, P2, P20, S1, S5, S7, 52100, A 128, D2, D3, D4, D5, D7	P	28 to 44 Rc	•	•	•	200	0.00007	0.00015	0.00023	0.00027	0.00034	0.00040	0.00054	0.00081	0.00100
Hardened Steels	H	45-55 Rc	•	o	o	100	0.00010	0.00030	0.00050	0.00140	0.00180	0.00210	0.00300	0.00360	0.00420
Stainless Steel - Easy to Machine 430F, 301, 303, 410, 416 Annealed, 420F, 430, 430F	M	up to 28 Rc	•	x	o	400	0.00007	0.00015	0.00023	0.00027	0.00034	0.00040	0.00054	0.00081	0.00100
Stainless Steel - Moderately Difficult 301, 302, 303 High Tensile, 304, 304L, 305, 420, 15-5PH, 17-4PH, 17-7PH	M	up to 28 Rc	•	x	o	200	0.00007	0.00015	0.00023	0.00027	0.00034	0.00040	0.00054	0.00081	0.00100
Stainless Steel - Difficult to Machine 302B, 304B, 309, 310, 316, 316B, 316L, 316Ti, 317, 317L, 321, PH13-8Mo, Nitronics	M	over 28 Rc	•	x	o	150	0.00007	0.00015	0.00023	0.00027	0.00034	0.00040	0.00054	0.00081	0.00100
Cast Iron	K	160-200 HB	•	o	o	400	0.00007	0.00015	0.00023	0.00027	0.00034	0.00040	0.00054	0.00081	0.00100
Malleable / Ductile Cast Iron	K	200-250 HB	•	o	o	250	0.00007	0.00015	0.00023	0.00027	0.00034	0.00040	0.00054	0.00081	0.00100
High Temp Alloys Nimonics, Inconel, Monel, Hastelloy	S	up to 42 Rc	•	x	x	70	0.00004	0.00008	0.00015	0.00023	0.00027	0.00034	0.00040	0.00054	0.00080
Titanium Alloys 6Al-4V, 5Al-2.5 Sn, 6Al-2 Sn-4Zr-6Mo, 3Al-8V-6Cr4Mo-4Zr, 10V-2Fe-3Al, 13V-11Cr-3Al	S	up to 42 Rc	•	x	x	150	0.00004	0.00008	0.00015	0.00023	0.00027	0.00034	0.00040	0.00054	0.00080
Aluminum < 10 % Si	N		•			750	0.00007	0.00015	0.00023	0.00027	0.00034	0.00040	0.00054	0.00081	0.00100
Aluminum > 10 % Si	N														

TuffCut® GP

Micro End Mill Recommended Cutting Data - Slotting

Length	2 Flute Series		3 Flute Series	
Standard	121	150	116	145
Long Length	123			

Inch - Standard / Long Length 2-3 Flute

Ball Nose End Mills - If axial depth (ap) is less than the ball diameter, the speed is figured using the effective cutting diameter.

For diameters > 1/4", see Charts Starting on page 360.

Workpiece Material Group	ISO	Hardness	Coolant • Preferred o Possible x Not Possible			Slotting	End Mill Diameter (Inch)								
							.0150	.0310	.0470	.0620	.0780	.0930	.1250	.1870	.2500
							14%-Dia. ap			35%-Dia. ap					
			Max.	Air	MMS	vc - SFM Increase speed by 30% for ALtima® coated tools.	fz - in/tooth								
Free Machining & Low Carbon Steels 1006, 1008, 1015, 1018, 1020, 1022, 1025, 1117, 1140, 1141, 11L08, 11L14, 1213, 12L13, 12L14, 1215, 1330	P	up to 28 Rc	•	•	•	400	.0001	.0001	.0002	.0002	.0003	.0004	.0005	.0007	.0010
Medium Carbon & High Carbon Steels, Alloy Steels & Easy to Machine Tool Steels 1030, 1035, 1040, 1045, 1050, 1052, 1055, 1060, 1085, 1095, 1541, 1551, 9255, 2515, 3135, 3415, 4130, 4137, 4140, 4150, 4320, 4340, 4520, 5015, 5115, 5120, 5132, 5140, 5155, 6150, 8620, 9262, 9840, 52100, O1, O2, O6, S2, W1 to W310	P	28 to 38 Rc	•	•	•	300	.0001	.0001	.0002	.0002	.0003	.0003	.0004	.0007	.0009
Tool Steels & Die Steels O7, M1, M2, M3, M4, M7, T1, T2, T4, T5, T8, T15, A2, A3, A6, A7, H10, H11, H12, H13, H19, H21, L3, L6, L7, P2, P20, S1, S5, S7, 52100, A 128, D2, D3, D4, D5, D7	P	28 to 44 Rc	•	•	•	200	.0001	.0001	.0002	.0002	.0002	.0003	.0004	.0006	.0008
Hardened Steels	H	35-45 Rc	•	o	o	100	.0001	.0001	.0001	.0001	.0001	.0002	.0002	.0003	.0004
Stainless Steel - Easy to Machine 430F, 301, 303, 410, 416 Annealed, 420F, 430, 430F	M	up to 28 Rc	•	x	o	400	.0001	.0001	.0002	.0002	.0003	.0004	.0005	.0007	.0010
Stainless Steel - Moderately Difficult 301, 302, 303 High Tensile, 304, 304L, 305, 420, 15-5PH, 17-4PH, 17-7PH	M	up to 28 Rc	•	x	o	200	.0001	.0001	.0002	.0002	.0003	.0003	.0004	.0007	.0009
Stainless Steel - Difficult to Machine 302B, 304B, 309, 310, 316, 316B, 316L, 316Ti, 317, 317L, 321, PH13-8Mo, Nitronics	M	over 28 Rc	•	x	o	150	.0001	.0001	.0001	.0001	.0002	.0002	.0003	.0004	.0005
Cast Iron	K	160-200 HB	•	o	o	400	.0001	.0001	.0002	.0002	.0003	.0004	.0005	.0007	.0010
Malleable / Ductile Cast Iron	K	200-250 HB	•	o	o	250	.0001	.0001	.0002	.0002	.0003	.0003	.0004	.0007	.0009
High Temp Alloys Nimonics, Inconel, Monel, Hastelloy	S	up to 42 Rc	•	x	x	70	.0001	.0001	.0001	.0001	.0002	.0002	.0003	.0004	.0005
Titanium Alloys 6Al-4V, 5Al-2.5 Sn, 6Al-2 Sn-4Zr-6Mo, 3Al-8V-6Cr4Mo-4Zr, 10V-2Fe-3Al, 13V-11Cr-3Al	S	up to 42 Rc	•	x	x	150	.0001	.0001	.0001	.0001	.0002	.0002	.0003	.0004	.0005
Aluminum < 10 % Si	N		•			750	.0002	.0003	.0005	.0006	.0007	.0008	.0011	.0017	.0022
Aluminum > 10 % Si	N														

Micro End Mill Recommended Cutting Data - Slotting

Length	2 Flute Series		3 Flute Series
Stub	164	166	169

Inch - Stub Length 2-3 Flute

Ball Nose End Mills - If axial depth (ap) is less than the ball diameter, the speed is figured using the effective cutting diameter.

For diameters > 1/4", see Charts Starting on page 360.

Workpiece Material Group	ISO	Hardness	Coolant • Preferred o Possible x Not Possible			Slotting	End Mill Diameter (Inch)								
							.0150	.0310	.0470	.0620	.0780	.0930	.1250	.1870	.2500
							14%-Dia. ap			35%-Dia. ap					
			Max.	Air	MMS	vc - SFM Increase speed by 30% for ALtima® coated tools.	fz - in/tooth								
Free Machining & Low Carbon Steels 1006, 1008, 1015, 1018, 1020, 1022, 1025, 1117, 1140, 1141, 11L08, 11L14, 1213, 12L13, 12L14, 1215, 1330	P	up to 28 Rc	•	•	•	400	.0001	.0002	.0002	.0003	.0003	.0004	.0005	.0008	.0010
Medium Carbon & High Carbon Steels, Alloy Steels & Easy to Machine Tool Steels 1030, 1035, 1040, 1045, 1050, 1052, 1055, 1060, 1085, 1095, 1541, 1551, 9255, 2515, 3135, 3415, 4130, 4137, 4140, 4150, 4320, 4340, 4520, 5015, 5115, 5120, 5132, 5140, 5155, 6150, 8620, 9262, 9840, 52100, O1, O2, O6, S2, W1 to W310	P	28 to 38 Rc	•	•	•	300	.0001	.0001	.0002	.0002	.0003	.0004	.0005	.0007	.0010
Tool Steels & Die Steels O7, M1, M2, M3, M4, M7, T1, T2, T4, T5, T8, T15, A2, A3, A6, A7, H10, H11, H12, H13, H19, H21, L3, L6, L7, P2, P20, S1, S5, S7, 52100, A 128, D2, D3, D4, D5, D7	P	28 to 44 Rc	•	•	•	200	.0001	.0001	.0002	.0002	.0002	.0003	.0004	.0006	.0008
Hardened Steels	H	35-45 Rc	•	o	o	100	.0001	.0001	.0001	.0001	.0001	.0002	.0002	.0003	.0004
Stainless Steel - Easy to Machine 430F, 301, 303, 410, 416 Annealed, 420F, 430, 430F	M	up to 28 Rc	•	x	o	400	.0001	.0001	.0002	.0002	.0003	.0004	.0005	.0007	.0010
Stainless Steel - Moderately Difficult 301, 302, 303 High Tensile, 304, 304L, 305, 420, 15-5PH, 17-4PH, 17-7PH	M	up to 28 Rc	•	x	o	200	.0001	.0001	.0002	.0002	.0003	.0003	.0004	.0007	.0009
Stainless Steel - Difficult to Machine 302B, 304B, 309, 310, 316, 316B, 316L, 316Ti, 317, 317L, 321, PH13-8Mo, Nitronics	M	over 28 Rc	•	x	o	150	.0001	.0001	.0001	.0001	.0002	.0002	.0003	.0004	.0005
Cast Iron	K	160-200 HB	•	o	o	400	.0001	.0002	.0002	.0003	.0003	.0004	.0005	.0008	.0010
Malleable / Ductile Cast Iron	K	200-250 HB	•	o	o	250	.0001	.0001	.0002	.0002	.0003	.0004	.0005	.0007	.0010
High Temp Alloys Nimonics, Inconel, Monel, Hastelloy	S	up to 42 Rc	•	x	x	70	.0001	.0001	.0001	.0001	.0002	.0002	.0003	.0004	.0005
Titanium Alloys 6Al-4V, 5Al-2.5 Sn, 6Al-2 Sn-4Zr-6Mo, 3Al-8V-6Cr4Mo-4Zr, 10V-2Fe-3Al, 13V-11Cr-3Al	S	up to 42 Rc	•	x	x	150	.0001	.0001	.0001	.0001	.0002	.0002	.0003	.0004	.0005
Aluminum < 10 % Si	N		•			750	.0002	.0003	.0005	.0006	.0007	.0008	.0011	.0017	.0022
Aluminum > 10 % Si	N														

Micro End Mill Recommended Cutting Data - Slotting

Length	4 Flute Series			
Standard	111	140	117	114
Long Length	122			132

Inch - Standard / Long Length 4 Flute

Ball Nose End Mills - If axial depth (ap) is less than the ball diameter, the speed is figured using the effective cutting diameter.

For diameters > 1/4", see Charts Starting on page 360.

Workpiece Material Group	ISO	Hardness	Coolant • Preferred o Possible x Not Possible			Slotting	End Mill Diameter (Inch)								
							.0150	.0310	.0470	.0620	.0780	.0930	.1250	.1870	.2500
							14%-Dia. ap			35%-Dia. ap					
			Max.	Air	MMS	vc - SFM Increase speed by 30% for ALtima® coated tools.	fz - in/tooth								
Free Machining & Low Carbon Steels 1006, 1008, 1015, 1018, 1020, 1022, 1025, 1117, 1140, 1141, 11L08, 11L14, 1213, 12L13, 12L14, 1215, 1330	P	up to 28 Rc	•	•	•	400	.0001	.0001	.0002	.0002	.0003	.0004	.0005	.0007	.0010
Medium Carbon & High Carbon Steels, Alloy Steels & Easy to Machine Tool Steels 1030, 1035, 1040, 1045, 1050, 1052, 1055, 1060, 1085, 1095, 1541, 1551, 9255, 2515, 3135, 3415, 4130, 4137, 4140, 4150, 4320, 4340, 4520, 5015, 5115, 5120, 5132, 5140, 5155, 6150, 8620, 9262, 9840, 52100, O1, O2, O6, S2, W1 to W310	P	28 to 38 Rc	•	•	•	300	.0001	.0001	.0002	.0002	.0003	.0003	.0004	.0007	.0009
Tool Steels & Die Steels O7, M1, M2, M3, M4, M7, T1, T2, T4, T5, T8, T15, A2, A3, A6, A7, H10, H11, H12, H13, H19, H21, L3, L6, L7, P2, P20, S1, S5, S7, 52100, A 128, D2, D3, D4, D5, D7	P	28 to 44 Rc	•	•	•	200	.0001	.0001	.0002	.0002	.0002	.0003	.0004	.0006	.0008
Hardened Steels	H	35-45 Rc	•	o	o	100	.0001	.0001	.0001	.0001	.0001	.0002	.0002	.0003	.0004
Stainless Steel - Easy to Machine 430F, 301, 303, 410, 416 Annealed, 420F, 430, 430F	M	up to 28 Rc	•	x	o	400	.0001	.0001	.0002	.0002	.0003	.0004	.0005	.0007	.0010
Stainless Steel - Moderately Difficult 301, 302, 303 High Tensile, 304, 304L, 305, 420, 15-5PH, 17-4PH, 17-7PH	M	up to 28 Rc	•	x	o	200	.0001	.0001	.0002	.0002	.0003	.0003	.0004	.0007	.0009
Stainless Steel - Difficult to Machine 302B, 304B, 309, 310, 316, 316B, 316L, 316Ti, 317, 317L, 321, PH13-8Mo, Nitronics	M	over 28 Rc	•	x	o	150	.0001	.0001	.0001	.0001	.0002	.0002	.0003	.0004	.0005
Cast Iron	K	160-200 HB	•	o	o	400	.0001	.0001	.0002	.0002	.0003	.0004	.0005	.0007	.0010
Malleable / Ductile Cast Iron	K	200-250 HB	•	o	o	250	.0001	.0001	.0002	.0002	.0003	.0003	.0004	.0007	.0009
High Temp Alloys Nimonics, Inconel, Monel, Hastelloy	S	up to 42 Rc	•	x	x	70	.0001	.0001	.0001	.0001	.0002	.0002	.0003	.0004	.0005
Titanium Alloys 6Al-4V, 5Al-2.5 Sn, 6Al-2 Sn-4Zr-6Mo, 3Al-8V-6Cr4Mo-4Zr, 10V-2Fe-3Al, 13V-11Cr-3Al	S	up to 42 Rc	•	x	x	150	.0001	.0001	.0001	.0001	.0002	.0002	.0003	.0004	.0005
Aluminum < 10 % Si	N		•			750	.0002	.0003	.0005	.0006	.0007	.0008	.0011	.0017	.0022
Aluminum > 10 % Si	N														

Micro End Mill Recommended Cutting Data - Slotting

Length	4 Flute Series	
Stub	163	165

Inch - Stub Length 4 Flute

Ball Nose End Mills - If axial depth (ap) is less than the ball diameter, the speed is figured using the effective cutting diameter.

For diameters > 1/4", see Charts Starting on page 360.

Workpiece Material Group	ISO	Hardness	Coolant • Preferred o Possible x Not Possible			Slotting	End Mill Diameter (Inch)								
							.0150	.0310	.0470	.0620	.0780	.0930	.1250	.1870	.2500
							14%-Dia. ap			35%-Dia. ap					
			Max.	Air	MMS	vc - SFM Increase speed by 30% for ALtima® coated tools.	fz - in/tooth								
Free Machining & Low Carbon Steels 1006, 1008, 1015, 1018, 1020, 1022, 1025, 1117, 1140, 1141, 11L08, 11L14, 1213, 12L13, 12L14, 1215, 1330	P	up to 28 Rc	•	•	•	400	.0001	.0001	.0002	.0002	.0003	.0004	.0005	.0007	.0010
Medium Carbon & High Carbon Steels, Alloy Steels & Easy to Machine Tool Steels 1030, 1035, 1040, 1045, 1050, 1052, 1055, 1060, 1085, 1095, 1541, 1551, 9255, 2515, 3135, 3415, 4130, 4137, 4140, 4150, 4320, 4340, 4520, 5015, 5115, 5120, 5132, 5140, 5155, 6150, 8620, 9262, 9840, 52100, O1, O2, O6, S2, W1 to W310	P	28 to 38 Rc	•	•	•	300	.0001	.0001	.0002	.0002	.0003	.0003	.0004	.0007	.0009
Tool Steels & Die Steels O7, M1, M2, M3, M4, M7, T1, T2, T4, T5, T8, T15, A2, A3, A6, A7, H10, H11, H12, H13, H19, H21, L3, L6, L7, P2, P20, S1, S5, S7, 52100, A 128, D2, D3, D4, D5, D7	P	28 to 44 Rc	•	•	•	200	.0001	.0001	.0002	.0002	.0002	.0003	.0004	.0006	.0008
Hardened Steels	H	35-45 Rc	•	o	o	100	.0001	.0001	.0001	.0001	.0001	.0002	.0002	.0003	.0004
Stainless Steel - Easy to Machine 430F, 301, 303, 410, 416 Annealed, 420F, 430, 430F	M	up to 28 Rc	•	x	o	400	.0001	.0001	.0002	.0002	.0003	.0004	.0005	.0007	.0010
Stainless Steel - Moderately Difficult 301, 302, 303 High Tensile, 304, 304L, 305, 420, 15-5PH, 17-4PH, 17-7PH	M	up to 28 Rc	•	x	o	200	.0001	.0001	.0002	.0002	.0003	.0003	.0004	.0007	.0009
Stainless Steel - Difficult to Machine 302B, 304B, 309, 310, 316, 316B, 316L, 316Ti, 317, 317L, 321, PH13-8Mo, Nitronics	M	over 28 Rc	•	x	o	150	.0001	.0001	.0001	.0001	.0002	.0002	.0003	.0004	.0005
Cast Iron	K	160-200 HB	•	o	o	400	.0001	.0001	.0002	.0002	.0003	.0004	.0005	.0007	.0010
Malleable / Ductile Cast Iron	K	200-250 HB	•	o	o	250	.0001	.0001	.0002	.0002	.0003	.0003	.0004	.0007	.0009
High Temp Alloys Nimonics, Inconel, Monel, Hastelloy	S	up to 42 Rc	•	x	x	70	.0001	.0001	.0001	.0001	.0002	.0002	.0003	.0004	.0005
Titanium Alloys 6Al-4V, 5Al-2.5 Sn, 6Al-2 Sn-4Zr-6Mo, 3Al-8V-6Cr4Mo-4Zr, 10V-2Fe-3Al, 13V-11Cr-3Al	S	up to 42 Rc	•	x	x	150	.0001	.0001	.0001	.0001	.0002	.0002	.0003	.0004	.0005
Aluminum < 10 % Si	N		•			750	.0002	.0003	.0005	.0006	.0007	.0008	.0011	.0017	.0022
Aluminum > 10 % Si	N														