

**MILLING RECOMMENDATIONS - GENERAL PURPOSE ENDMILLS**



**PROFILING**

Workpiece Material Group	Hardness	Surface Feet Per Minute (SFM) Radial Depth of Cut (RDOC)					Inches Per Tooth (IPT)					
		SFM based on RDOC					IPT *(BASELINE)					
		Cutting Diameter Engaged					Cutting Diameter					
		5%	10%	20%	30%	50%	5/16	3/8	1/2	5/8	3/4	1
<b>Steels</b> Free Machining & Low Carbon: 10XX, 11XX, 12XX, 12LXX, ASTM A27, ASTM A36 Medium Carbon, High Carbon Steels, Alloy Steels & Easy to Machine Tool: 13XX, 41XX, 43XX, 51XX, 86XX, 93XX	P ≤ 28 Rc	1050	700	385	375	350						
	P 28-38 Rc	630	420	320	250	210	0.0027	0.0032	0.0045	0.0054	0.0063	0.0090
<b>Tool &amp; Die Steels</b> A2, H13, L6, P20, S7	P 28-44 Rc	525	350	300	275	250	0.0027	0.0032	0.0045	0.0054	0.0063	0.0090
<b>Stainless Steel</b> Easy to Machine, 430F, 301, 303, 410, 416 Annealed, 420F, 430, 430F Moderately Difficult to Machine, Nitronic 50, Nitronic 60, 301, 303 304, 304L Incoloy 27-7MO, 316 316L, 321, 347 Difficult to Machine, 302B, 304B, 309, 310, 316, 316B, 316L, 316Ti, 317, 317L, 321, PH13-8Mo, Nitronics	M ≤ 28 Rc	650	600	550	500	450						
	M ≤ 28 Rc	525	400	350	300	250	0.0027	0.0032	0.0045	0.0054	0.0063	0.0090
	M > 28 Rc	525	400	350	300	250						
<b>Super Alloys</b> High Temp, Nimonic, Inconel, Monel, Hastelloy Titanium: Ti 3Al-2.5V, Ti 6Al-4V Ti 10V-2Fe-3Al	S ≤ 42 Rc	265	200	175	150	100	0.0014	0.0016	0.0023	0.0027	0.0032	0.0045
	S ≤ 42 Rc	230	200	175	150	125						
<b>Hardened Materials</b>	H 45-55 Rc	250	240	230	210	200	0.0018	0.0021	0.0030	0.0036	0.0042	0.0060
	H 55-65 Rc	200	180	160	150	100	0.0013	0.0014	0.0021	0.0024	0.0029	0.0041
<b>Cast-Iron</b> Gray: SAE J431, ASTM A48 Ductile & Malleable: ASTM A536, ASTM 897, ASTM A47, ASTM A220 ASTM A602	K ≤ 240 HB	425	400	375	350	300	0.0027	0.0032	0.0045	0.0054	0.0063	0.0090
	K > 240 HB	320	300	250	225	200						
<b>Non-Ferrous</b> Aluminum, Brass, Bronze, Copper, Plastics, Graphite	N	1000	960	920	880	840	0.0027	0.0032	0.0045	0.0054	0.0063	0.0090

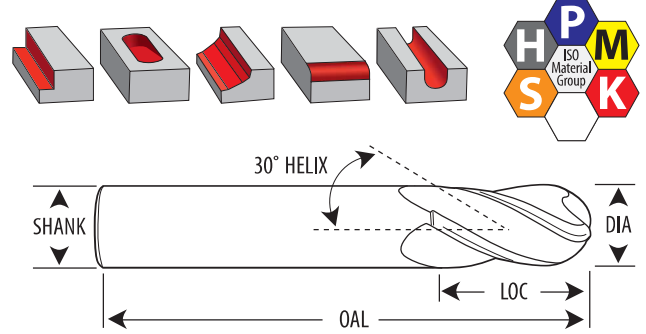
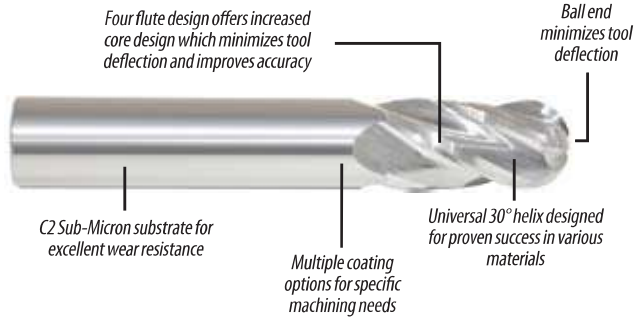
*CHIP THINNING Adjustments	
RDOC	Increase IPT
50%	None
30%	1.1 x
25%	1.2 x
20%	1.3 x
15%	1.4 x
10%	1.8 x
7%	2.0 x
5%	2.3 x
3%	3.0 x
2%	3.5 x
1%	5.0 x



**SLOTTING**

Workpiece Material Group	Hardness	Surface Feet Per Minute (SFM) Radial Depth of Cut (RDOC)			Inches Per Tooth (IPT)					
		SFM			IPT *(BASELINE)					
		Cutting Diameter Engaged			Cutting Diameter					
		25%	50%	100%	5/16	3/8	1/2	5/8	3/4	1
<b>Steels</b> Free Machining & Low Carbon: 10XX, 11XX, 12XX, 12LXX, ASTM A27, ASTM A36 Medium Carbon, High Carbon Steels, Alloy Steels & Easy to Machine Tool: 13XX, 41XX, 43XX, 51XX, 86XX, 93XX	P ≤ 28 Rc	385	370	350						
	P 28-38 Rc	245	230	2210	0.0016	0.0019	0.0025	0.0031	0.0038	0.0050
<b>Tool &amp; Die Steels</b> A2, H13, L6, P20, S7	P 28-44 Rc	210	195	175	0.0016	0.0019	0.0025	0.0031	0.0038	0.0050
<b>Stainless Steel</b> Easy to Machine, 430F, 301, 303, 410, 416 Annealed, 420F, 430, 430F Moderately Difficult to Machine, Nitronic 50, Nitronic 60, 301, 303 304, 304L Incoloy 27-7MO, 316 316L, 321, 347 Difficult to Machine, 302B, 304B, 309, 310, 316, 316B, 316L, 316Ti, 317, 317L, 321, PH13-8Mo, Nitronics	M ≤ 28 Rc	385	370	350						
	M ≤ 28 Rc	245	210	175	0.0016	0.0019	0.0025	0.0031	0.0038	0.0050
	M > 28 Rc	210	195	175						
<b>Super Alloys</b> High Temp, Nimonic, Inconel, Monel, Hastelloy Titanium: Ti 3Al-2.5V, Ti 6Al-4V Ti 10V-2Fe-3Al	S ≤ 42 Rc	125	105	90	0.0008	0.0010	0.0013	0.0016	0.0017	0.0026
	S ≤ 42 Rc	100	90	80						
<b>Hardened Materials</b>	H 34-45 Rc	245	230	210	0.0016	0.0019	0.0025	0.0031	0.0038	0.0050
	H 45-55 Rc	175	160	140	0.0008	0.0010	0.0013	0.0016	0.0020	0.0025
	H 55-65 Rc	150	125	100	0.0004	0.0005	0.0008	0.0008	0.0010	0.0012
<b>Cast-Iron</b> Gray: SAE J431, ASTM A48 Ductile & Malleable: ASTM A536, ASTM 897, ASTM A47, ASTM A220 ASTM A602	K ≤ 240 HB	450	400	350	0.0016	0.0019	0.0025	0.0031	0.0038	0.0050
	K > 240 HB	300	250	225						
<b>Non-Ferrous</b> Aluminum, Brass, Bronze, Copper, Plastics, Graphite	N	750	600	450	0.0016	0.0019	0.0025	0.0031	0.0038	0.0050

# 4 FLUTE - SINGLE END BALLNOSE



DIAMETER TOLERANCE: +0.000 / -0.002" SHANK TOLERANCE: +0.0000 / -0.0005"

DIA	Dec In	LOC	Shank	OAL	Length	Bright	TiN	TiCN	AlTiN
1/64	0.0156	3/64	1/8	1-1/2	Regular	223-000998	223-000995	223-020998	223-001007
		1/16	1/8	1-1/2	Stub	220-001001	220-001002	220-001003	220-001004
1/32	0.0313	1/8	1/8	1-1/2	Regular	223-000999	223-001003	223-000996	223-001009
		3/32	1/8	1-1/2	Stub	220-001010	220-001011	220-001012	220-001013
1.0mm	0.0394	4.0mm	3.0mm	39.0mm	Regular	223-001400	223-001400A	223-001400C	223-001400B
3/64	0.0469	1/8	1/8	1-1/2	Regular	223-001000	223-001004	223-021000	223-001014
		5/64	1/8	1-1/2	Stub	220-001020	220-001022	220-001021	220-001023
1.5mm	0.0591	4.5mm	3.0mm	39.0mm	Regular	223-001405	223-001410A	223-001410C	223-001410B
1/16	0.0625	1/4	1/8	1-1/2	Regular	223-001001	223-001002	223-001015	223-001016
		5/32	1/8	1-1/2	Stub	220-001025	220-011025	220-021025	220-031025
5/64	0.0781	1/4	1/8	1-1/2	Regular	223-001005	223-001006	223-001008	223-001019
		2.0mm	0.0787	8.0mm	3.0mm	39.0mm	Regular	223-001421	—
3/32	0.0938	3/16	1/8	1-1/2	Stub	220-001030	220-001032	220-001031	220-001033
		3/8	1/8	1-1/2	Regular	223-001010	223-001011	223-001012	223-001013
2.5mm	0.0984	9.5mm	3.0mm	39.0mm	Regular	223-001425	223-001425A	223-001425C	223-001425B
7/64	0.1094	7/32	1/8	1-1/2	Stub	220-001035	220-011035	220-021035	220-031035
		3/8	1/8	1-1/2	Regular	223-001017	223-001052	223-021051	223-001039
3.0mm	0.1181	12.0mm	3.0mm	39.0mm	Regular	223-001430	223-001430A	223-001430C	223-001430B
1/8	0.1250	1/4	1/8	1-1/2	Stub	220-001040	220-001042	220-001041	220-001043
		1/2	1/8	1-1/2	Regular	223-001020	223-001021	223-001023	223-001028
		3/4	1/8	2-1/4	Long	226-001001	226-001002	226-001003	226-001004
		1	1/8	3	X/Long	229-001001	229-001002	229-001003	229-001004
3.5mm	0.1378	12.0mm	4.0mm	51.0mm	Regular	223-001435	223-001435A	223-001435C	223-001435B
9/64	0.1406	9/32	3/16	2	Stub	220-001045	220-011045	220-021045	220-031045
		9/16	3/16	2	Regular	223-001025	223-001026	223-001027	223-001029

4 FLUTE - SINGLE END - BALLNOSE CONTINUED

DIA	Dec In	LOC	Shank	OAL	Length	Bright	TiN	TiCN	AlTiN
5/32	0.1563	5/16	3/16	2	Stub	220-001050	220-001052	220-001051	220-001053
		9/16	3/16	2	Regular	223-001030	223-001031	223-001033	223-001032
		3/4	3/16	2-1/2	Long	226-001005	226-001006	226-001008	226-001007
		1-1/8	3/16	3	X/Long	229-001005	229-001006	229-001008	229-001009
4.0mm	0.1575	14.0mm	4.0mm	51.0mm	Regular	223-001440	223-001440A	223-001440C	223-001440B
11/64	0.1719	5/16	3/16	2	Stub	220-001055	220-011055	220-021055	220-031055
		9/16	3/16	2	Regular	223-001035	223-001055	223-021054	223-001043
4.5mm	0.1772	16.0mm	5.0mm	51.0mm	Regular	223-001445	223-001445A	223-001445C	223-001445B
3/16	0.1875	3/8	3/16	2	Stub	220-001060	220-001062	220-001061	220-001063
		5/8	3/16	2	Regular	223-001040	223-001041	223-001042	223-001034
		3/4	3/16	2-1/2	Long	226-001012	226-001013	226-001014	226-001016
		1	3/16	4	XX/Long	229-001015	—	—	—
		1-1/8	3/16	3	X/Long	229-001010	229-001011	229-001012	229-001014
5.0mm	0.1969	16.0mm	5.0mm	51.0mm	Regular	223-001450	223-001450A	223-001450C	223-001450B
13/64	0.2031	3/8	1/4	2	Stub	220-001065	220-011065	220-021065	220-031065
		5/8	1/4	2-1/2	Regular	223-001046	223-001059	223-021058	223-001047
7/32	0.2188	7/16	1/4	2	Stub	220-001070	220-001072	220-001071	220-001073
		5/8	1/4	2-1/2	Regular	223-001050	223-001056	223-001037	223-001036
15/64	0.2344	7/16	1/4	2	Stub	220-001075	220-011075	220-021075	220-031075
		3/4	1/4	2-1/2	Regular	223-001053	223-001057	223-021053	223-001045
6.0mm	0.2362	19.0mm	6.0mm	63.0mm	Regular	223-001460	223-001460A	223-001460C	223-001460B
1/4	0.2500	1/2	1/4	2	Stub	220-001080	220-001082	220-001081	220-001083
		3/4	1/4	2-1/2	Regular	223-001060	223-001062	223-001063	223-001066
		1	1/4	4	X/Long	229-001019	—	—	—
		1-1/8	1/4	3	Long	226-001020	226-001021	226-001022	226-001024
		1-1/2	1/4	4	X/Long	229-001020	229-001021	229-001022	229-001024
		1-1/2	1/4	6	Ext XX/Long	229-001026	229-001026A	229-001026C	229-001027
17/64	0.2656	3/4	5/16	2-1/2	Regular	223-001061	223-001064	223-021061	223-031061
7.0mm	0.2756	19.0mm	8.0mm	63.0mm	Regular	223-001470	223-001470A	223-001470C	223-001470B
9/32	0.2813	3/4	5/16	2-1/2	Regular	223-001070	223-001065	223-001067	223-001068
19/64	0.2969	13/16	5/16	2-1/2	Regular	223-001071	223-001072	223-021071	223-031071

4 FLUTE - SINGLE END - BALLNOSE CONTINUED

DIA	Dec In	LOC	Shank	OAL	Length	Bright	TiN	TiCN	AlTiN
5/16	0.3125	1/2	5/16	2	Stub	220-001090	220-001092	220-001091	220-001093
		13/16	5/16	2-1/2	Regular	223-001080	223-001082	223-001083	223-001073
		1-1/8	5/16	3	Long	226-001030	226-001031	226-001032	226-001034
		1-1/2	5/16	6	Ext XX/Long	229-001035	229-001035A	229-001035C	229-001036
		1-5/8	5/16	4	X/Long	229-001030	229-001031	229-001032	229-001034
8.0mm	0.3150	20.0mm	8.0mm	63.0mm	Regular	223-001480	223-001480A	223-001480C	223-001480B
21/64	0.3281	1	3/8	2-1/2	Regular	223-001084	223-001085	223-021084	223-031084
11/32	0.3438	1	3/8	2-1/2	Regular	223-001086	223-001087	223-001169	223-001115
9.0mm	0.3543	22.0mm	10.0mm	63.0mm	Regular	223-001490	223-001490A	223-001490C	223-001490B
23/64	0.3594	1	3/8	2-1/2	Regular	223-001088	223-001089	223-021088	223-031088
3/8	0.3750	5/8	3/8	2	Stub	220-001100	220-001101	220-001102	220-001103
		1	3/8	2-1/2	Regular	223-001090	223-001092	223-001093	223-001116
		1-1/8	3/8	3	Long	226-001040	226-001041	226-001042	226-001044
		1-1/2	3/8	6	Ext XX/Long	229-001046	229-001048	229-001049	229-001047
		1-3/4	3/8	4	X/Long	229-001040	229-001041	229-001042	229-001044
25/64	0.3906	1	7/16	2-3/4	Regular	223-001094	223-001096	223-021094	223-031094
10.0mm	0.3937	22.0mm	10.0mm	76.0mm	Regular	223-001500	223-001500A	223-001500C	223-001500B
13/32	0.4063	1	7/16	2-3/4	Regular	223-001095	223-001097	223-021095	223-001117
27/64	0.4219	1	7/16	2-3/4	Regular	223-001098	223-001099	223-021098	223-031098
11.0mm	0.4331	25.0mm	12.0mm	76.0mm	Regular	223-001510	223-001510A	223-001510C	223-001510B
7/16	0.4375	5/8	7/16	2-1/2	Stub	220-001110	220-001111	220-001112	220-001113
		1	7/16	2-3/4	Regular	223-001100	223-001101	223-001102	223-001118
		2	7/16	4	Long	226-001050	226-001051	226-001052	226-001054
		3	7/16	6	X/Long	229-001050	229-001051	229-001052	229-001053
29/64	0.4531	1	1/2	3	Regular	223-001103	223-001104	223-021103	223-031103
15/32	0.4688	1	1/2	3	Regular	223-001105	223-001107	223-001121	223-001119
12.0mm	0.4724	25.0mm	12.0mm	76.0mm	Regular	223-001520	223-001520A	223-001520C	223-001520B
31/64	0.4844	1	1/2	3	Regular	223-001109	223-001108	223-021108	223-031108
1/2	0.5000	5/8	1/2	2-1/2	Stub	220-001120	220-001121	220-001122	220-001123
		1	1/2	3	Regular	223-001110	223-001111	223-001112	223-001114
		1-1/2	1/2	4	Medium	226-001059	226-001057	226-001058	226-001059A
		1-1/2	1/2	6	Ext X/Long	229-001053A	229-001055	229-001056	229-001057
		2	1/2	4	Long	226-001060	226-001061	226-001062	226-001064
		3	1/2	6	X/Long	229-001053AA	229-001066	229-001067	229-001068

4 FLUTE - SINGLE END - BALLNOSE CONTINUED

DIA	Dec In	LOC	Shank	OAL	Length	Bright	TiN	TiCN	AlTiN
14.0mm	0.5512	32.0mm	14.0mm	90.0mm	Regular	223-001540	223-001540A	223-001540C	223-001540B
9/16	0.5625	1-1/4	9/16	3-1/2	Regular	223-001120	223-001125	223-001126	223-001127
		3/4	5/8	3	Stub	220-001130	220-001131	220-001132	220-001133
		1-1/4	5/8	3-1/2	Regular	223-001130	223-001131	223-001132	223-001135
5/8	0.6250	1-1/2	5/8	6	Ext X/Long	229-001076	229-001076A	229-001076C	229-001077
		2-1/4	5/8	5	Long	226-001070	226-001071	226-001072	226-001074
		3	5/8	6	X/Long	229-001070	229-001071	229-001072	229-001074
16.0mm	0.6299	32.0mm	16.0mm	102.0mm	Regular	223-001560	223-001560A	223-001560C	223-001560B
11/16	0.6875	1-1/2	3/4	4	Regular	223-001140	223-001155	223-021156	223-001167
18.0mm	0.7087	38.0mm	18.0mm	102.0mm	Regular	223-001580	223-001580A	223-001580C	223-001580B
		1	3/4	3	Stub	220-001140	220-001141	220-001142	220-001143
		1-1/2	3/4	4	Regular	223-001150	223-001151	223-001152	223-001154
3/4	0.7500	1-1/2	3/4	6	Ext X/Long	229-001085	229-001085A	229-001085C	229-001086
		2-1/4	3/4	5	Long	226-001080	226-001081	226-001082	226-001084
		3	3/4	6	X/Long	229-001080	229-001081	229-001082	229-001084
20.0mm	0.7874	38.0mm	20.0mm	102.0mm	Regular	223-001600	223-001600A	223-001600C	223-001600B
22.0mm	0.8661	38.0mm	22.0mm	102.0mm	Regular	223-001620	—	—	223-001620B
7/8	0.8750	1-1/2	7/8	4	Regular	223-001157	223-001159	223-021157	223-001165
25.0mm	0.9843	38.0mm	25.0mm	102.0mm	Regular	223-001650	—	—	223-001650B
		1-1/2	1	4	Regular	223-001160	223-001161	223-001162	223-001163
		1-1/2	1	6	Ext X/Long	229-001095	229-001095A	229-001095C	229-001096
1	1.0000	2-1/4	1	5	Long	226-001090	226-001091	226-001092	226-001097
		3	1	6	X/Long	229-001090	229-001091	229-001092	229-001094