



TOOLING
YOUR
WORLD.

Carbide End Mills – Speeds & Feeds



2-Flute Square End for Aluminum

Side Milling

Slotting

Work Material		Aluminum		Aluminum	
Hardness					
Depth of Cut					
Mill Dia. (inch)	mm	V=660 SFM		V=660 SFM	
		Speed RPM	Feed in/min	Speed RPM	Feed in/min
1/4	6	10,000	60	10,000	30
5/16	8	8,000	64	8,000	32
3/8	10	8,000	80	8,000	40
1/2	12	8,000	96	8,000	48
5/8	16	6,000	84	6,000	42
3/4	20	4,000	64	4,000	32
1	25	4,000	64	4,000	32

2-Flute Corner Radius for Aluminum

Chip load per tooth					
Material	SFM	1/8"	1/4"	1/2"	1"
Aluminum Alloys	600/1,200	0.0010	0.0020	0.0040	0.0080

$RPM = 3.82 \times sfm \div dia$ $SFM = rpm \times 0.262 \div dia$ $IPM = chip\ load \times No.\ of\ teeth \times rpm$

3-Flute Square End for Aluminum

Chip Load Per Tooth					
Material	SFM	1/8"	1/4"	1/2"	1"
Aluminum Alloys	600/1,200	0.0010	0.0020	0.0040	0.0080

$RPM = 3.82 \times sfm \div dia$ $SFM = rpm \times 0.262 \div dia$ $IPM = chip\ load \times No.\ of\ teeth \times rpm$

3-Flute Corner Radius for Aluminum

Chip load per tooth					
Material	SFM	1/8"	1/4"	1/2"	1"
Aluminum Alloys	600/1,200	0.0010	0.0020	0.0040	0.0080

$RPM = 3.82 \times sfm \div dia$ $SFM = rpm \times 0.262 \div dia$ $IPM = chip\ load \times No.\ of\ teeth \times rpm$

2 & 3-Flute Square End Uncoated Carbide End Mills Slot Milling — 2-Flute Stub Length, 2-Flute Regular Length

- For side milling, increase Feeds 25% or more

2-Flute Long & Extra Long Length

- Reduce Speeds and Feeds 25% for 2-Flute Long Length
- Reduce Speeds and Feeds 50% for 2-Flute Extra Long Length

3-Flute Regular Length

- Increase Speeds and Feeds 20% for 3-Flute Regular Length

Hardness		Tensile Strength: Up to 750N/mm ²		Up to 30 HRC		30 to 38 HRC		38 to 45 HRC					
Work Material		Cast Iron		Mild Steels, Carbon Steels		Alloy Steels, Tool Steels, Ti Alloys (Annealed)		Hardened Steels, Prehardened Steels, Ti Alloys (Solution Treated and Aged)		Hardened Steels, Prehardened Steels, Stainless Steels, Inconel, Ni Based Alloys		Aluminum Alloys	
Depth of Cut				$D < 1/8$ $Ad = 0.3D$ $1/8 \leq D$ $Ad = 0.5D$									
Dia. (in)	(mm)	170 SFM		155 SFM		130 SFM		110 SFM		90 SFM		390 SFM	
		Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min
	0.5	32,000	6.6	30,000	4.5	25,230	1.9	21,350	1.4	16,890	1.2	50,000	9.4
1/32	0.8	20,790	6.6	18,950	4.5	15,900	1.9	13,450	1.4	10,640	1.2	47,700	9.4
	1	16,800	6.6	15,000	4.5	12,600	1.9	10,680	1.4	8,400	1.2	37,800	9.4
3/64		15,225	6.6	13,590	4.5	11,430	1.9	9,660	1.4	7,595	1.2	34,140	9.4
1/16	1.5	11,970	6.6	10,660	4.6	9,000	2.0	7,540	1.4	5,925	1.2	26,520	9.4
5/64	2	8,705	6.6	7,730	4.7	6,570	2.1	5,415	1.4	4,260	1.2	18,900	9.4
3/32		7,480	6.8	6,635	4.7	5,650	2.4	4,650	1.4	3,645	1.2	16,305	9.4
7/64		6,335	6.9	5,610	4.7	4,790	2.6	3,935	1.4	3,075	1.2	13,925	9.4
1/8	3	5,445	7.1	4,815	4.7	4,125	3.0	3,375	1.4	2,640	1.2	12,060	10.3
9/64		4,870	7.3	4,310	4.7	3,700	3.4	3,020	1.4	2,380	1.2	10,845	12.1
5/32	4	4,300	7.5	3,815	4.7	3,270	3.7	2,660	1.4	2,115	1.2	9,630	14.0
11/64		3,945	7.6	3,490	4.7	2,990	3.8	2,440	1.4	1,940	1.2	8,835	14.2
3/16		3,615	7.7	3,180	4.7	2,735	3.8	2,225	1.4	1,775	1.2	8,075	14.2
13/64	5	3,320	8.0	2,920	4.7	2,505	3.8	2,040	1.4	1,630	1.2	7,415	14.2
7/32		3,080	8.6	2,730	4.7	2,345	3.8	1,895	1.4	1,510	1.2	6,915	14.2
1/4	6	2,690	9.5	2,400	4.7	2,060	3.8	1,660	1.4	1,320	1.2	6,070	14.2
9/32		2,405	10.2	2,140	4.7	1,845	3.8	1,490	1.4	1,185	1.2	5,430	14.2
5/16	8	2,115	10.8	1,875	4.7	1,630	3.8	1,330	1.4	1,055	1.2	4,785	14.2
11/32		1,940	10.9	1,725	4.7	1,485	3.8	1,220	1.4	970	1.2	4,385	14.2
3/8		1,775	10.9	1,580	4.7	1,340	3.8	1,120	1.4	885	1.2	4,005	14.2
13/32	10	1,630	10.9	1,455	4.7	1,230	3.8	1,035	1.4	815	1.2	3,680	14.2
7/16		1,510	10.9	1,360	4.7	1,155	3.8	965	1.4	755	1.2	3,440	14.2
1/2	12	1,310	10.9	1,190	4.7	1,020	3.8	840	1.4	660	1.2	3,010	14.2
9/16		1,175	10.9	1,060	4.7	905	3.8	740	1.4	585	1.2	2,645	14.2
5/8	16	1,080	11.1	960	4.7	815	3.8	670	1.6	520	1.2	2,355	14.2
11/16		980	11.1	870	4.7	740	3.8	610	1.7	470	1.2	2,160	14.2
3/4	20	880	11.1	780	4.7	665	3.8	545	1.7	425	1.2	1,920	14.2
7/8	22	765	11.1	675	4.7	580	3.8	480	1.7	370	1.2	1,660	14.2
1	25	670	10.9	590	4.7	500	3.8	420	1.7	330	1.2	1,475	14.2



2 & 3-Flute Square End **TiAlN** Coated Carbide End Mills

Slot Milling — 2-Flute Stub Length, 2-Flute Regular Length

2-Flute Long & Extra Long Length

- Reduce Speeds and Feeds 25% for 2-Flute Long Length
- Reduce Speeds and Feeds 50% for 2-Flute Extra Long Length
- For side milling, increase Feeds 25% or more.

3-Flute Regular Length

- Increase Speeds and Feeds 20% for 3-Flute Regular Length

Hardness				Tensile Strength: Up to 750N/mm ²		Up to 30 HRC		30 to 38 HRC		38 to 45 HRC							
Work Material		Cast Iron		Mild Steels, Carbon Steels		Alloy Steels, Tool Steels, Ti Alloys (Annealed)		Hardened Steels, Prehardened Steels, Ti Alloys (Solution Treated and Aged)		Hardened Steels, Prehardened Steels, Stainless Steels, Inconel, Ni Based Alloys		Aluminum Alloys					
Depth of Cut				<table border="1"> <tr> <td>$D < 1/8$</td> <td>0.3D</td> </tr> <tr> <td>$1/8 \leq D$</td> <td>0.5D</td> </tr> </table>		$D < 1/8$	0.3D	$1/8 \leq D$	0.5D								
$D < 1/8$	0.3D																
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Dia. (in)	(mm)	220 SFM		200 SFM		170 SFM		140 SFM		110 SFM		500 SFM					
		Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min				
1/32	0.5	40,000	8.25	37,500	5.63	31,537	2.38	26,687	1.75	21,112	1.50	62,500	11.75				
	0.8	25,987.	8.25	23,687	5.63	19,875	2.38	16,812	1.75	13,300	1.50	59,625	11.75				
	1	21,000	8.25	18,750	5.63	15,750	2.38	13,350	1.75	10,500	1.50	47,250	11.75				
3/64		19,031	8.25	16,987	5.63	14,287	2.38	12,075	1.75	9,493	1.50	42,675	11.75				
1/16	1.5	14,962	8.25	13,325	5.75	11,250	2.50	9,425	1.75	7,406	1.50	33,150	11.75				
5/64	2	10,881	8.25	9,662	5.88	8,212	2.63	6,768	1.75	5,325	1.50	23,625	11.75				
3/32		9,350	8.50	8,293	5.88	7,062	3.00	5,812	1.75	4,556	1.50	20,381	11.75				
7/64		7,918	8.63	7,012	5.88	5,987	3.25	4,918	1.75	3,843	1.50	17,406	11.75				
1/8	3	6,806	8.88	6,018	5.88	5,156	3.75	4,218	1.75	3,300	1.50	15,075	12.88				
9/64		6,087	9.13	5,387	5.88	4,625	4.25	3,775	1.75	2,975	1.50	13,556	15.13				
5/32	4	5,375	9.38	4,768	5.88	4,087	4.63	3,325	1.75	2,643	1.50	12,037	17.50				
11/64		4,931	9.50	4,362	5.88	3,737	4.75	3,050	1.75	2,425	1.50	11,043	17.75				
3/16		4,518	9.63	3,975	5.88	3,418	4.75	2,781	1.75	2,218	1.50	10,093	17.75				
13/64	5	4,150	10.00	3,650	5.88	3,131	4.75	2,550	1.75	2,037	1.50	9,268	17.75				
7/32		3,850	10.75	3,412	5.88	2,931	4.75	2,368	1.75	1,887	1.50	8,643	17.75				
1/4	6	3,362	11.88	3,000	5.88	2,575	4.75	2,075	1.75	1,650	1.50	7,587	17.75				
9/32		3,006	12.75	2,675	5.88	2,306	4.75	1,862	1.75	1,481	1.50	6,787	17.75				
5/16	8	2,643	13.50	2,343	5.88	2,037	4.75	1,662	1.75	1,318	1.50	5,981	17.75				
11/32		2,425	13.63	2,156	5.88	1,856	4.75	1,525	1.75	1,212	1.50	5,481	17.75				
3/8		2,218	13.63	1,975	5.88	1,675	4.75	1,400	1.75	1,106	1.50	5,006	17.75				
13/32	10	2,037	13.63	1,818	5.88	1,537	4.75	1,293	1.75	1,018	1.50	4,600	17.75				
7/16		1,887	13.63	1,700	5.88	1,443	4.75	1,206	1.75	943	1.50	4,300	17.75				
1/2	12	1,637	13.63	1,487	5.88	1,275	4.75	1,050	1.75	825	1.50	3,762	17.75				
9/16		1,468	13.63	1,325	5.88	1,131	4.75	925	1.75	731	1.50	3,306	17.75				
5/8	16	1,350	13.88	1,200	5.88	1,018	4.75	837	2.00	650	1.50	2,943	17.75				
11/16		1,225	13.88	1,087	5.88	925	4.75	762	2.13	587	1.50	2,700	17.75				
3/4	20	1,100	13.88	975	5.88	831	4.75	681	2.13	531	1.50	2,400	17.75				
7/8	22	956	13.88	843	5.88	725	4.75	600	2.13	462	1.50	2,075	17.75				
1	25	837	13.63	737	5.88	625	4.75	525	2.13	412	1.50	1,843	17.75				

Speeds and feeds are critical to tool life, machining time and surface finish. What we have provided is a general starting point for machining certain materials under standard machining conditions. Please keep in mind that the workpiece material, how the workpiece is held, the coolant used, the tool holder and the machine horsepower has a tremendous impact on cutting tool effectiveness and tool life. You may find greater results at much more aggressive speeds and feeds in some set ups than others for the same material. These charts are intended to give the machinist a starting point and it is up to the machinist to understand the variables that can impact material removal efficiency.

2-Flute Square End High Performance Modified **AlTiN** Carbide End Mills – Slot Milling

Hardness		Tensile Strength: Up to 750N/mm ²		Up to 30 HRC		30 to 38 HRC		38 to 45 HRC		45 to 55 HRC		55 to 60 HRC																											
Work Material		Cast Iron		Mild Steels, Carbon Steels		Alloy Steels, Tool Steels, Ti Alloys (Annealed)		Hardened Steels, Prehardened Steels, Ti Alloys (Solution Treated and Aged)		Hardened Steels, Prehardened Steels, Stainless Steels, Inconel, Ni Based Alloys		Hardened Steels		Hardened Steels																									
Depth of Cut												<table border="1"> <tr><th colspan="2">Ad</th></tr> <tr><td>D < 1/16</td><td>0.1D</td></tr> <tr><td>1/16 ≤ D < 1/8</td><td>0.3D</td></tr> <tr><td>1/8 ≤ D</td><td>0.5D</td></tr> </table>		Ad		D < 1/16	0.1D	1/16 ≤ D < 1/8	0.3D	1/8 ≤ D	0.5D	<table border="1"> <tr><th colspan="2">Ad</th></tr> <tr><td>D < 1/16</td><td>0.02D</td></tr> <tr><td>1/16 ≤ D</td><td>0.05D</td></tr> </table>		Ad		D < 1/16	0.02D	1/16 ≤ D	0.05D	<table border="1"> <tr><th colspan="2">Ad</th></tr> <tr><td>D < 1/16</td><td>0.01D</td></tr> <tr><td>1/16 ≤ D < 1/8</td><td>0.02D</td></tr> <tr><td>1/8 ≤ D</td><td>0.05D</td></tr> </table>		Ad		D < 1/16	0.01D	1/16 ≤ D < 1/8	0.02D	1/8 ≤ D	0.05D
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Dia. (in)	(mm)	360 SFM		330 SFM		260 SFM		220 SFM		280 SFM		120 SFM		80 SFM																									
		Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min																								
1/16	1.5	19,145	6.9	17,405	6.2	13,095	5.9	11,115	4.2	9,915	3.2	6,245	1.7	4,430	1.2																								
3/32		12,710	8.3	11,550	7.6	9,135	6.3	7,620	4.3	6,750	3.4	4,185	2.0	2,950	1.2																								
1/8	3	9,450	10.7	8,570	9.8	7,310	7.4	6,135	4.9	5,135	3.7	3,180	2.2	2,300	1.4																								
5/32	4	7,910	12.2	7,190	11.1	5,930	8.6	5,145	5.8	4,230	4.2	2,655	2.4	1,870	1.4																								
3/16		7,190	15.4	6,540	14.0	5,325	10.5	4,455	6.0	3,785	4.5	2,360	2.6	1,590	1.4																								
7/32		6,365	16.3	5,790	14.7	4,690	11.1	3,855	6.1	3,285	4.7	2,045	2.6	1,365	1.3																								
1/4	6	5,600	16.0	5,090	14.5	4,125	11.1	3,375	6.0	2,870	4.7	1,775	2.6	1,205	1.2																								
9/32		5,000	15.6	4,545	14.2	3,700	11.1	3,020	6.0	2,585	4.7	1,580	2.5	1,080	1.2																								
5/16	8	4,395	15.3	4,000	13.9	3,270	11.1	2,660	5.9	2,295	4.7	1,390	2.4	960	1.2																								
11/32		4,035	15.0	3,670	13.7	2,990	11.1	2,440	5.9	2,100	4.6	1,290	2.4	880	1.2																								
3/8		3,695	14.7	3,360	13.3	2,735	11.0	2,225	5.9	1,910	4.5	1,200	2.4	800	1.2																								
13/32	10	3,400	14.5	3,090	13.2	2,505	10.9	2,040	5.9	1,750	4.4	1,110	2.4	735	1.1																								
7/16		3,160	14.5	2,870	13.2	2,345	10.9	1,895	5.9	1,630	4.4	1,035	2.3	690	1.0																								
1/2	12	2,760	14.5	2,510	13.2	2,030	10.6	1,655	5.6	1,415	4.4	900	2.1	600	0.9																								
9/16		2,460	14.2	2,230	13.0	1,770	10.1	1,480	5.1	1,240	4.3	795	1.9	530	0.8																								
5/8		2,195	12.6	1,995	12.3	1,625	9.5	1,330	4.7	1,150	4.0	720	1.7	470	0.7																								
11/16		1,980	12.1	1,800	11.2	1,485	8.7	1,215	4.3	1,040	3.7	650	1.5	430	0.7																								
3/4	20	1,760	11.1	1,605	10.0	1,305	7.6	1,095	3.8	935	3.2	580	1.4	380	0.6																								
7/8	22	1,565	9.8	1,420	8.9	1,140	6.8	960	3.3	815	2.8	510	1.2	340	0.5																								
1	25	1,360	8.5	1,240	7.7	1,020	6.0	840	3.0	720	2.6	440	0.9	300	0.5																								

2-Flute High Performance Modified **AlTiN** Mold Mills

Mold Mills for Profile Milling

Hardness		Tensile Strength: Up to 750N/mm ²		Up to 30 HRC		30 to 38 HRC		38 to 45 HRC		45 to 55 HRC		55 to 60 HRC							
Work Material		Cast Iron		Mild Steels, Carbon Steels		Alloy Steels, Tool Steels, Ti Alloys (Annealed)		Hardened Steels, Prehardened Steels, Ti Alloys (Solution Treated and Aged)		Hardened Steels, Prehardened Steels, Stainless Steels, Inconel, Ni Based Alloys		Hardened Steels		Hardened Steels					
Depth of Cut												<table border="1"> <tr><th colspan="2">Ad</th></tr> <tr><td>D < 5/8</td><td>0.05D</td></tr> <tr><td>5/8 ≤ D</td><td>0.03"</td></tr> </table>		Ad		D < 5/8	0.05D	5/8 ≤ D	0.03"
Ad																			
D < 5/8	0.05D																		
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Dia. (in)	(mm)	550 SFM		550 SFM		450 SFM		360 SFM		270 SFM		230 SFM		200 SFM					
		Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min				
1/8	3	14,400	40.8	14,400	34.8	12,720	28.8	10,200	19.2	7,680	14.4	6,528	10.5	5,683	9.4				
3/16	5	11,520	43.2	11,520	34.8	9,600	28.8	7,680	21.6	5,760	16.8	4,896	12.3	4,262	10.9				
1/4	6	9,120	43.2	9,120	34.8	7,680	28.8	6,120	22.8	4,560	16.8	3,876	12.3	3,374	10.9				
5/16	8	7,680	43.2	7,680	36.0	6,360	28.8	5,040	24.0	3,840	18.0	3,264	13.1	2,842	11.7				
3/8	10	5,760	32.4	5,760	27.6	4,800	22.8	3,840	18.0	2,880	13.2	2,448	9.6	2,131	8.6				
7/16	11	4,560	25.2	4,560	21.6	3,840	18.0	3,000	14.4	2,280	10.8	1,938	7.9	1,687	7.0				
1/2	12	4,200	24.0	4,200	19.2	3,480	16.8	2,760	13.2	2,040	9.6	1,734	7.0	1,510	6.2				
9/16	14	3,840	21.6	3,840	18.0	3,120	15.6	2,520	12.0	1,920	9.6	1,632	7.0	1,421	6.2				
5/8	16	2,880	16.8	2,880	13.2	2,400	10.8	1,920	9.6	1,440	7.2	1,224	5.3	1,066	4.7				
3/4	20	2,280	13.2	2,280	10.8	1,920	9.6	1,560	7.2	1,140	6.0	969	4.4	844	3.9				
1	25	1,800	10.8	1,800	8.4	1,560	7.2	1,200	6.0	912	4.8	775	3.5	675	3.1				



2, 3 & 4-Flute Ball Nose **Uncoated** Carbide End Mills

Profiling — 2-Flute Stub Length, 2-Flute Regular Length

2-Flute Ball Nose Long & Extra Long Length

- Reduce Speeds and Feeds 25% for 2-Flute Ball Nose Long Length
- Reduce Speeds and Feeds 50% for 2-Flute Ball nose Extra Long Length

3-Flute Regular Length

- Increase Speeds and Feeds 20% for 3-Flute Ball Nose Regular Length

4-Flute Ball Nose

- Increase Speeds and Feeds 40% for 4-Flute Ball Nose Regular & Stub Length, also 4-Flute Double End Stub Length
- Reduce Speeds 25% and Increase Feeds 10% for 4-Flute Ball Nose Long Length
- Reduce Speeds 50% and Increase Feeds 10% for 4-Flute Ball Nose Extra Long Length

Hardness				Tensile Strength: Up to 750N/mm ²		Up to 30 HRC		30 to 38 HRC		38 to 45 HRC														
Work Material		Cast Iron		Mild Steels, Carbon Steels		Alloy Steels, Tool Steels, Ti Alloys (Annealed)		Hardened Steels, Prehardened Steels, Ti Alloys (Solution Treated and Aged)		Hardened Steels, Prehardened Steels, Stainless Steels, Inconel, Ni Based Alloys		Aluminum Alloys												
Depth of Cut																								
						<table border="1"> <tr> <td></td> <td>Ad</td> <td>pf</td> </tr> <tr> <td>D < 1/8</td> <td>0.1D</td> <td>0.2D</td> </tr> <tr> <td>1/8 ≤ D</td> <td>0.3D</td> <td>0.7D</td> </tr> </table>			Ad	pf	D < 1/8	0.1D	0.2D	1/8 ≤ D	0.3D	0.7D								
	Ad	pf																						
D < 1/8	0.1D	0.2D																						
1/8 ≤ D	0.3D	0.7D																						
Dia. (in)	(mm)	160 SFM		160 SFM		120 SFM		100 SFM		80 SFM		490 SFM												
		Speed	Feed	Speed	Feed	Speed	Feed	Speed	Feed	Speed	Feed	Speed	Feed											
		RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min											
1/32	0.5	31,000	4.8	31,000	4.5	23,300	2.5	19,400	1.2	15,500	0.9	50,000	6.8											
	0.8	19,600	4.8	19,600	4.5	14,680	2.5	12,200	1.2	9,780	0.9	50,000	6.8											
	1	15,600	5.0	15,600	4.7	11,400	2.8	9,540	1.4	7,620	0.9	38,400	7.1											
3/64		14,140	5.2	14,140	4.8	10,305	3.0	8,620	1.5	6,885	1.0	35,535	8.0											
1/16	1.5	11,115	5.8	11,115	5.1	8,045	3.4	6,720	1.7	5,360	1.2	29,585	9.8											
5/64	2	8,090	6.3	8,090	5.4	5,780	3.7	4,810	1.8	3,840	1.4	23,630	11.7											
3/32		6,970	6.5	6,970	5.7	4,965	3.9	4,140	1.9	3,290	1.4	20,420	11.8											
7/64		5,920	6.7	5,920	6.0	4,205	4.1	3,520	1.9	2,795	1.4	17,325	11.8											
1/8	3	5,090	7.2	5,090	6.1	3,610	4.3	3,030	1.9	2,400	1.4	14,945	11.8											
9/64		4,545	7.9	4,545	6.2	3,225	4.3	2,690	1.9	2,140	1.4	13,470	11.8											
5/32	4	4,000	8.6	4,000	6.3	2,850	4.3	2,360	1.9	1,875	1.4	11,990	11.8											
11/64		3,670	9.2	3,670	6.6	2,620	4.3	2,160	1.9	1,725	1.4	11,020	12.7											
3/16		3,360	9.6	3,360	6.9	2,405	4.4	1,970	1.9	1,580	1.4	10,090	13.6											
13/64	5	3,090	10.1	3,090	7.1	2,205	4.4	1,810	1.9	1,455	1.4	9,275	14.2											
7/32		2,870	10.4	2,870	7.1	2,045	4.3	1,690	1.9	1,360	1.4	8,630	14.2											
1/4	6	2,520	11.3	2,520	6.9	1,775	4.2	1,490	1.9	1,205	1.4	7,570	14.6											
9/32		2,260	12.5	2,260	6.4	1,580	4.1	1,350	1.9	1,080	1.4	6,785	15.5											
5/16	8	1,995	13.6	1,995	5.9	1,390	4.0	1,200	1.9	960	1.4	6,000	16.4											
11/32		1,820	13.7	1,820	5.8	1,290	4.0	1,100	1.9	880	1.4	5,495	16.5											
3/8		1,655	13.7	1,655	5.7	1,200	4.0	1,005	1.9	800	1.4	5,020	16.5											
13/32	10	1,515	13.7	1,515	5.6	1,110	3.9	920	1.9	735	1.4	4,610	16.9											
7/16		1,420	13.7	1,420	5.4	1,035	3.7	855	1.9	690	1.4	4,300	17.8											
1/2	12	1,250	13.7	1,250	5.2	900	3.5	750	1.9	600	1.4	3,750	18.9											
9/16		1,120	13.9	1,120	5.2	795	3.5	660	1.9	530	1.4	3,290	18.5											
5/8	16	1,005	13.9	1,005	5.2	720	3.5	590	1.9	470	1.4	2,960	16.7											
11/16		915	13.9	915	5.2	650	3.5	540	1.9	430	1.4	2,715	16.5											
3/4	20	820	12.9	820	5.2	580	3.5	485	1.9	380	1.4	2,415	16.5											
7/8	22	710	11.2	710	5.2	510	3.5	425	1.8	335	1.4	2,100	16.5											
1	25	630	9.8	630	5.1	440	3.5	370	1.6	300	1.4	1,830	16.3											

Speeds and feeds are critical to tool life, machining time and surface finish. What we have provided is a general starting point for machining certain materials under standard machining conditions. Please keep in mind that the workpiece material, how the workpiece is held, the coolant used, the tool holder and the machine horsepower has a tremendous impact on cutting tool effectiveness and tool life. You may find greater results at much more aggressive speeds and feeds in some set ups than others for the same material. These charts are intended to give the machinist a starting point and it is up to the machinist to understand the variables that can impact material removal efficiency.

2, 3 & 4-Flute Ball Nose TiAlN Coated Carbide End Mills

Profiling — 2-Flute Regular Length

2-Flute Long & Extra Long Length

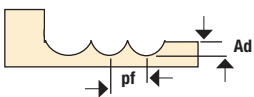
- Reduce Speeds and Feeds 25% for 2-Flute Ball Nose Long Length
- Reduce Speeds and Feeds 50% for 2-Flute Ball Nose Extra Long Length

3-Flute Regular Length

- Increase Speeds and Feeds 20% for 3-Flute Ball Nose Regular Length

4-Flute Ball Nose

- Increase Speeds and Feeds 40% for 4-Flute Ball Nose Regular Length
- Reduce Speeds 25% and Increase Feeds 10% for 4-Flute Ball Nose Long Length
- Reduce Speeds 50% and Increase Feeds 10% for 4-Flute Ball Nose Extra Long Length

Hardness		Tensile Strength: Up to 750N/mm ²		Up to 30 HRC		30 to 38 HRC		38 to 45 HRC					
Work Material		Cast Iron		Mild Steels, Carbon Steels		Alloy Steels, Tool Steels, Ti Alloys (Annealed)		Hardened Steels, Prehardened Steels, Ti Alloys (Solution Treated and Aged)		Hardened Steels, Prehardened Steels, Stainless Steels, Inconel, Ni Based Alloys		Aluminum Alloys	
Depth of Cut													
		D < 1/8		Ad		pf							
		1/8 ≤ D		0.1D		0.2D							
		0.3D		0.7D									
Dia. (in)	(mm)	200 SFM		205 SFM		150 SFM		125 SFM		100 SFM		600 SFM	
		Speed	Feed	Speed	Feed	Speed	Feed	Speed	Feed	Speed	Feed	Speed	Feed
		RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min
	0.5	38,750	6.00	38,750	5.63	29,125	3.13	24,250	1.50	14,375	1.13	62,500	8.50
1/32	0.8	24,500	6.00	24,500	5.63	18,350	3.13	15,250	1.50	12,225	1.13	62,500	8.50
	1	19,500	6.25	19,500	5.88	14,250	3.50	11,925	1.75	9,525	1.13	48,000	8.88
3/64		17,675	6.50	17,675	6.00	12,881	3.75	10,775	1.88	8,606	1.25	44,418	10.00
1/16	1.5	13,893	7.25	13,893	6.38	10,056	4.25	8,400	2.13	6,700	1.50	36,981	12.25
5/64	2	10,112	7.88	10,112	6.75	7,225	4.63	6,012	2.25	4,800	1.75	29,537	14.63
3/32		8,712	8.13	8,712	7.13	6,206	4.88	5,175	2.38	4,112	1.75	25,525	14.75
7/64		7,400	8.38	7,400	7.50	5,256	5.13	4,400	2.38	3,493	1.75	21,656	14.75
1/8	3	6,362	9.00	6,362	7.63	4,512	5.38	3,787	2.38	3,000	1.75	18,681	14.75
9/64		5,681	9.88	5,681	7.75	4,031	5.38	3,362	2.38	2,675	1.75	16,837	14.75
5/32	4	5,000	10.75	5,000	7.88	3,562	5.38	2,950	2.38	2,343	1.75	14,987	14.75
11/64		4,587	11.50	4,587	8.25	3,275	5.38	2,700	2.38	2,156	1.75	13,775	15.88
3/16		4,200	12.00	4,200	8.63	3,006	5.50	2,462	2.38	1,975	1.75	12,612	17.00
13/64	5	3,862	12.63	3,862	8.88	2,756	5.50	2,262	2.38	1,818	1.75	11,593	17.75
7/32		3,587	13.00	3,587	8.88	2,556	5.38	2,112	2.38	1,700	1.75	10,787	17.75
1/4	6	3,150	14.13	3,150	8.63	2,218	5.25	1,862	2.38	1,506	1.75	9,462	18.25
9/32		2,825	15.63	2,825	8.00	1,975	5.13	1,687	2.38	1,350	1.75	8,481	19.38
5/16	8	2,493	17.00	2,493	7.38	1,737	5.00	1,500	2.38	1,200	1.75	7,500	20.50
11/32		2,275	17.13	2,275	7.25	1,612	5.00	1,375	2.38	1,100	1.75	6,868	20.63
3/8		2,068	17.13	2,068	7.13	1,500	5.00	1,256	2.38	1,000	1.75	6,275	20.63
13/32	10	1,893	17.13	1,893	7.00	1,387	4.88	1,150	2.38	918	1.75	5,762	21.13
7/16		1,775	17.13	1,775	6.75	1,293	4.63	1,068	2.38	862	1.75	5,375	22.25
1/2	12	1,562	17.13	1,562	6.50	1,125	4.38	937	2.38	750	1.75	4,687	23.63
9/16		1,400	17.38	1,400	6.50	993	4.38	825	2.38	662	1.75	4,112	23.13
5/8	16	1,256	17.38	1,256	6.50	900	4.38	737	2.38	587	1.75	3,700	20.88
11/16		1,143	17.38	1,143	6.50	812	4.38	675	2.38	537	1.75	3,393	20.63
3/4	20	1,025	16.13	1,025	6.50	725	4.38	606	2.38	475	1.75	3,018	20.63
7/8	22	887	14.00	887	6.50	637	4.38	531	2.25	418	1.75	2,625	20.63
1	25	787	12.25	787	6.38	550	4.38	462	2.00	375	1.75	2,287	20.38

Speeds and feeds are critical to tool life, machining time and surface finish. What we have provided is a general starting point for machining certain materials under standard machining conditions. Please keep in mind that the workpiece material, how the workpiece is held, the coolant used, the tool holder and the machine horsepower has a tremendous impact on cutting tool effectiveness and tool life. You may find greater results at much more aggressive speeds and feeds in some set ups than others for the same material.

These charts are intended to give the machinist a starting point and it is up to the machinist to understand the variables that can impact material removal efficiency.



2 & 4-Flute Ball Nose High Performance Modified **AlTiN** Carbide End Mills

Profiling — 2-Flute Ball Nose

4-Flute Ball Nose: Increase Feeds 40% to 50%

Hardness		Tensile Strength: Up to 750N/mm ²		Up to 30 HRC		30 to 38 HRC		38 to 45 HRC		45 to 55 HRC		55 to 60 HRC									
Work Material		Cast Iron		Mild Steels, Carbon Steels		Alloy Steels, Tool Steels, Ti Alloys (Annealed)		Hardened Steels, Prehardened Steels, Ti Alloys (Solution Treated and Aged)		Hardened Steels, Prehardened Steels, Stainless Steels, Inconel, Ni Based Alloys		Hardened Steels									
Depth of Cut						<table border="1"> <tr><th>Ad</th><th>pf</th></tr> <tr><td>0.1D</td><td>0.2D</td></tr> </table>		Ad	pf	0.1D	0.2D			<table border="1"> <tr><th>Ad</th><th>pf</th></tr> <tr><td>0.05D</td><td>0.1D</td></tr> </table>		Ad	pf	0.05D	0.1D		
Ad	pf																				
0.1D	0.2D																				
Ad	pf																				
0.05D	0.1D																				
Dia. (in)	(mm)	575 SFM		460 SFM		375 SFM		310 SFM		260 SFM		230 SFM		165 SFM							
		Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min						
1/16	1.5	32,405	41.0	29,230	36.1	26,520	29.3	21,185	18.9	18,640	13.6	16,095	9.9	11,970	6.6						
3/32		24,540	44.4	19,820	36.1	16,305	29.4	13,145	18.9	11,550	13.7	9,950	9.9	7,480	6.6						
1/8	3	17,760	44.4	14,370	36.1	12,060	29.8	9,695	19.5	8,490	14.4	7,280	10.4	5,445	6.9						
5/32	4	13,950	44.4	11,505	36.1	9,630	29.8	7,695	20.9	6,725	17.3	5,760	12.7	4,300	8.2						
3/16		11,100	48.3	9,660	39.4	8,075	29.9	6,425	21.0	5,650	17.5	4,830	13.3	3,615	8.3						
7/32		10,360	49.6	8,280	40.4	6,915	30.9	5,490	21.5	4,835	18.0	4,120	13.7	3,080	8.5						
1/4	6	9,120	51.6	7,280	42.0	6,070	32.6	4,815	22.7	4,235	18.9	3,610	14.2	2,690	8.9						
9/32		8,165	56.3	6,520	45.6	5,430	34.9	4,310	24.4	3,785	20.2	3,225	14.7	2,405	9.4						
5/16	8	7,210	61.0	5,760	49.3	4,785	37.1	3,815	26.1	3,330	21.4	2,850	15.3	2,115	9.9						
11/32		6,610	59.7	5,280	48.0	4,385	36.5	3,490	25.7	3,050	21.0	2,620	15.5	1,940	9.9						
3/8		6,040	57.8	4,830	46.3	4,005	35.7	3,180	25.1	2,795	20.6	2,405	15.7	1,775	9.9						
13/32	10	5,540	55.9	4,430	44.6	3,680	34.8	2,920	24.5	2,565	20.3	2,205	15.6	1,630	9.8						
7/16		5,165	54.0	4,120	42.7	3,440	34.0	2,730	23.9	2,405	20.3	2,045	15.2	1,510	9.5						
1/2	12	4,505	51.1	3,585	40.7	3,010	32.6	2,390	22.9	2,090	19.7	1,775	14.5	1,310	9.1						
9/16		4,000	49.6	3,170	40.7	2,645	31.7	2,110	22.4	1,820	18.3	1,580	13.9	1,175	8.9						
5/8	16	3,570	49.6	2,840	39.7	2,355	30.5	1,875	22.4	1,630	18.0	1,390	12.8	1,080	8.7						
11/16		3,275	47.9	2,595	38.1	2,160	29.2	1,725	22.4	1,485	18.0	1,290	12.4	980	8.4						
3/4	20	2,915	45.2	2,340	36.5	1,920	27.4	1,545	21.5	1,350	17.6	1,175	11.9	880	8.1						
7/8	22	2,540	42.1	2,130	33.8	1,775	24.4	1,365	19.2	1,185	15.9	1,025	10.8	765	7.7						
1	25	2,240	36.8	1,775	31.5	1,475	21.8	1,180	16.8	1,050	13.7	900	9.8	670	6.7						

High-Speed Light Milling — 2-Flute Ball Nose






4-Flute Ball Nose: Increase Feeds 40% to 50%

Hardness		Tensile Strength: Up to 750N/mm ²		Up to 30 HRC		30 to 38 HRC		38 to 45 HRC		45 to 55 HRC		55 to 60 HRC													
Work Material		Mild Steels, Carbon Steels		Alloy Steels, Tool Steels, Ti Alloys (Annealed)		Hardened Steels, Prehardened Steels, Ti Alloys (Solution Treated and Aged)		Hardened Steels, Prehardened Steels, Stainless Steels, Inconel, Ni Based Alloys		Hardened Steels		Hardened Steels													
Depth of Cut						<table border="1"> <tr><th>Ad</th><th>pf</th></tr> <tr><td>0.02D</td><td>0.05D</td></tr> </table>		Ad	pf	0.02D	0.05D			<table border="1"> <tr><th>Ad</th><th>pf</th></tr> <tr><td>D < 5/8</td><td>0.02D</td><td>0.05D</td></tr> <tr><td>5/8 ≤ D</td><td>0.012"</td><td>0.05D</td></tr> </table>		Ad	pf	D < 5/8	0.02D	0.05D	5/8 ≤ D	0.012"	0.05D		
Ad	pf																								
0.02D	0.05D																								
Ad	pf																								
D < 5/8	0.02D	0.05D																							
5/8 ≤ D	0.012"	0.05D																							
Dia. (in)	(mm)	985 SFM		855 SFM		740 SFM		590 SFM		590 SFM		400 SFM													
		Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min												
1/16	1.5	39,125	126.4	35,305	110.2	35,010	98.4	33,400	88.6	88.6	59.4	17,650	39.4												
3/32		27,490	137.8	21,750	110.2	21,250	98.4	20,450	88.6	88.6	61.0	10,950	39.4												
1/8	3	20,475	139.2	16,325	114.4	15,825	100.1	15,150	90.0	90.0	63.4	8,355	40.0												
5/32	4	18,085	145.4	15,525	133.1	15,025	108.0	13,555	96.2	96.2	74.4	7,960	43.1												
3/16		16,085	154.6	15,110	153.3	14,230	112.8	11,585	91.9	91.9	80.8	7,675	46.3												
7/32		15,215	175.0	14,160	164.9	12,600	110.9	10,160	89.4	89.4	85.9	7,035	46.1												
1/4	6	14,380	181.0	12,880	161.7	11,050	103.8	9,080	84.8	84.8	84.8	6,305	43.5												
9/32		12,990	163.1	11,490	144.5	10,035	93.6	8,150	76.2	76.2	76.2	5,650	39.4												
5/16	8	11,600	145.1	10,100	127.3	9,025	83.5	7,215	67.6	67.6	67.6	5,000	35.4												
11/32		10,760	134.3	9,355	117.3	8,285	76.9	6,610	61.9	61.9	61.9	4,575	32.4												
3/8		9,975	124.2	8,660	108.0	7,575	70.7	6,035	56.4	56.4	56.4	4,180	29.6												
13/32	10	9,250	115.0	8,025	99.5	6,950	65.0	5,540	51.6	51.6	51.6	3,840	27.2												
7/16		8,630	107.1	7,465	92.5	6,475	60.4	5,165	47.6	47.6	47.6	3,580	25.3												
1/2	12	7,540	93.6	6,510	80.5	5,650	52.4	4,500	41.5	41.5	41.5	3,125	22.0												
9/16		6,675	83.2	5,785	71.4	5,000	46.4	3,975	37.5	37.5	37.5	2,740	19.3												
5/8	16	6,000	75.4	5,190	63.6	4,485	41.7	3,575	33.7	33.7	33.7	2,465	17.4												
11/16		5,465	67.6	4,705	58.7	4,075	38.3	3,250	30.7	30.7	30.7	2,260	16.0												
3/4	20	4,890	60.6	4,215	52.8	3,650	34.4	2,925	27.6	27.6	27.6	2,010	14.3												
7/8	22	4,255	53.2	3,710	46.3	3,190	30.2	2,550	24.0	24.0	24.1	1,755	12.3												
1	25	3,740	46.6	3,250	40.8	2,805	26.4	2,215	21.0	21.0	21.0	1,525	10.7												

3-Flute 60° High-Helix Carbide End Mills

Side Milling

Slotting

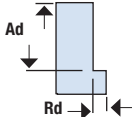
Work Material	Aluminum	Medium Carbon Steels Mild Steels	Pre-hardened Steels Stainless Steels Die & Alloy Steels	Pre-hardened Steels Stainless Steels Die & Alloy Steels	Hardened Steels	Medium Carbon Steels Mild Steels	Pre-hardened Steels Stainless Steels Die & Alloy Steels	Pre-hardened Steels Stainless Steels Die & Alloy Steels	Hardened Steels										
Hardness			< 35 HRC	35-45 HRC	45-55 HRC		< 35 HRC	35-45 HRC	45-55 HRC										
Depth of Cut	 Ad = 1.5D Rd = 0.1D			 Ad = 1.5D Rd = 0.1D		 up to 1/2" Ad = 1.0D over 1/2" Ad = 0.5D		 Ad=0.5D		 Ad=0.5D									
Mill Dia. (inch)	mm	390-460 SFM		130-164 SFM		Up to 100 SFM		Up to 66 SFM		Up to 50 SFM		110-140 SFM		Up to 85 SFM		Up to 56 SFM		Up to 43 SFM	
		Speed	Feed	Speed	Feed	Speed	Feed	Speed	Feed	Speed	Feed	Speed	Feed	Speed	Feed	Speed	Feed	Speed	Feed
		RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min
1/4	6	6,900	21.7	2,400	10.6	1,600	6.7	1,060	3.0	800	1.2	2,040	7.9	1,360	4.7	900	2.0	680	0.8
5/16	8	5,200	21.7	1,800	10.6	1,200	6.7	800	3.0	600	1.2	1,530	7.9	1,020	4.7	680	2.0	510	0.8
3/8	10	4,200	23.6	1,400	13.4	950	6.7	640	3.0	480	1.2	1,190	9.1	810	4.7	540	2.0	410	0.8
1/2	12	3,500	23.6	1,200	14.2	800	7.1	530	3.0	400	1.2	1,020	9.8	680	5.1	450	2.0	340	0.8
5/8	16	2,600	23.6	900	15.7	600	7.1	400	3.0	300	1.2	760	10.6	510	5.1	340	2.0	260	0.8
3/4	20	2,100	23.6	720	16.1	480	7.9	320	3.0	240	1.2	620	11.0	410	5.5	270	2.0	200	0.8
1	25	1,700	23.6	580	13.8	380	7.1	250	3.0	190	1.2	500	9.4	320	5.1	210	2.0	160	0.8

4-Flute Square End, 4-Flute Corner Radius, & 3-Flute 60° Uncoated Carbide End Mills

Side Milling — 4-Flute Stub Length, 4-Flute Regular Length, 4-Flute Corner Radius, 4-Flute Double End Stub Length

4-Flute Long & Extra Long Length

- Reduce Speeds and Feeds 25% for 4-Flute Long Length
- Reduce Speeds and Feeds 50% for 4-Flute Extra Long Length
- For slot milling, reduce Feeds 20% to 50%


Hardness	Tensile Strength: Up to 750N/mm ²		Up to 30 HRC		30 to 38 HRC		38 to 45 HRC		Aluminum Alloys				
Work Material	Cast Iron		Mild Steels, Carbon Steels		Alloy Steels, Tool Steels, Ti Alloys (Annealed)		Hardened Steels, Prehardened Steels, Ti Alloys (Solution Treated and Aged)		Hardened Steels, Prehardened Steels, Stainless Steels, Inconel, Ni Based Alloys				
Depth of Cut	 Ad = 1.5D Rd = 0.1D												
Dia. (in)	(mm)	160 SFM		175 SFM		130 SFM		120 SFM		95 SFM		470 SFM	
		Speed	Feed	Speed	Feed	Speed	Feed	Speed	Feed	Speed	Feed	Speed	Feed
		RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min
	0.5	32,000	23.9	32,000	11.8	25,240	10.9	23,300	4.5	19,400	3.5	50,000	39.4
1/32	0.8	21,150	23.9	23,240	11.8	15,900	10.9	14,600	4.5	12,200	3.5	50,000	39.4
	1	15,600	23.9	17,400	11.8	12,600	10.9	11,400	4.5	9,000	3.5	44,400	39.4
3/64		14,140	23.9	15,680	11.8	11,390	10.9	10,305	4.5	8,145	3.5	40,275	39.4
1/16	1.5	11,115	23.9	12,105	11.8	8,895	10.9	8,045	4.5	6,390	3.5	31,710	39.4
5/64	2	8,090	23.9	8,535	11.8	6,395	10.9	5,780	4.5	4,625	3.5	23,135	39.4
3/32		6,970	23.9	7,320	12.6	5,495	10.9	4,965	4.4	3,960	3.4	19,820	40.6
7/64		5,920	23.9	6,200	13.5	4,660	10.9	4,205	4.3	3,340	3.4	16,725	41.8
1/8	3	5,090	24.6	5,330	14.4	4,005	10.9	3,610	4.3	2,870	3.3	14,370	42.9
9/64		4,545	26.3	4,785	15.4	3,580	10.9	3,225	4.3	2,585	3.3	12,935	43.8
5/32	4	4,000	28.0	4,240	16.4	3,150	10.9	2,850	4.3	2,295	3.3	11,505	44.8
11/64		3,670	28.1	3,885	16.9	2,895	11.2	2,620	4.3	2,100	3.3	10,565	45.2
3/16		3,360	28.1	3,555	17.2	2,655	11.6	2,405	4.3	1,910	3.3	9,660	45.6
13/64	5	3,090	28.1	3,260	17.6	2,445	11.8	2,205	4.3	1,750	3.3	8,880	46.0
7/32		2,870	28.1	3,020	17.9	2,285	11.8	2,045	4.3	1,630	3.3	8,280	46.3
1/4	6	2,520	28.1	2,640	18.2	2,000	11.8	1,775	4.3	1,430	3.3	7,280	46.8
9/32		2,260	28.1	2,380	18.3	1,785	11.8	1,580	4.3	1,295	3.3	6,520	47.0
5/16	8	1,995	28.1	2,115	18.4	1,570	11.8	1,390	4.3	1,150	3.3	5,760	47.2
11/32		1,820	28.3	1,940	19.4	1,445	11.8	1,290	4.3	1,055	3.3	5,280	47.2
3/8		1,655	28.6	1,775	20.4	1,325	11.8	1,200	4.3	965	3.3	4,830	47.2
13/32	10	1,515	28.9	1,630	21.0	1,220	11.8	1,110	4.3	885	3.3	4,430	48.0
7/16		1,420	29.1	1,510	21.1	1,140	11.8	1,035	4.3	825	3.3	4,120	49.8
1/2	12	1,250	30.9	1,310	22.5	995	12.2	900	4.3	720	3.3	3,585	52.0
9/16		1,120	34.3	1,175	24.9	880	13.1	795	4.3	635	3.3	3,170	52.0
5/8	16	1,005	35.5	1,055	25.7	790	13.8	720	4.3	570	3.3	2,840	52.0
11/16		915	38.4	960	25.9	720	13.9	650	4.3	515	3.3	2,595	52.0
3/4	20	820	39.4	860	26.3	640	13.9	580	4.1	465	3.3	2,340	52.0
7/8	22	710	35.5	750	23.6	560	12.6	510	3.7	405	3.0	2,015	49.1
1	25	630	31.2	660	20.7	490	10.9	440	3.3	360	2.6	1,775	43.5

4-Flute Square End & 4-Flute Corner Radius **TiAlN** Coated Carbide End Mills

Side Milling — 4-Flute Regular Length, 4-Flute Corner Radius, 4-Flute Double End Stub Length

4-Flute Long & Extra Long Length

- Reduce Speeds and Feeds 25% for 4-Flute Long Length
- Reduce Speeds and Feeds 50% for 4-Flute Extra Long Length
- For slot milling, reduce Feeds 20% to 50%.

Hardness				Tensile Strength: Up to 750N/mm ²		Up to 30 HRC		30 to 38 HRC		38 to 45 HRC			
Work Material		Cast Iron		Mild Steels, Carbon Steels		Alloy Steels, Tool Steels, Ti Alloys (Annealed)		Hardened Steels, Prehardened Steels, Ti Alloys (Solution Treated and Aged)		Hardened Steels, Prehardened Steels, Stainless Steels, Inconel, Ni Based Alloys		Aluminum Alloys	
Depth of Cut													
Dia. (in)	(mm)	200 SFM		215 SFM		165 SFM		150 SFM		120 SFM		590 SFM	
		Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min
1/32	0.5	40,000	29.88	40,000	14.75	31,550	13.63	29,125	5.63	24,250	4.38	62,500	49.25
	0.8	26,437	29.88	29,050	14.75	19,875	13.63	18,250	5.63	15,250	4.38	62,500	49.25
	1	19,500	29.88	21,750	14.75	15,750	13.63	14,250	5.63	11,250	4.38	55,500	49.25
3/64		17,675	29.88	19,600	14.75	14,237	13.63	12,881	5.63	10,181	4.38	50,343	49.25
1/16	1.5	13,893	29.88	15,131	14.75	11,118	13.63	10,056	5.63	7,987	4.38	39,637	49.25
5/64	2	10,112	29.88	10,668	14.75	7,993	13.63	7,225	5.63	5,781	4.38	28,918	49.25
3/32		8,712	29.88	9,150	15.75	6,868	13.63	6,206	5.50	4,950	4.25	24,775	50.75
7/64		7,400	29.88	7,750	16.88	5,825	13.63	5,256	5.38	4,175	4.25	20,906	52.25
1/8	3	6,362	30.75	6,662	18.00	5,006	13.63	4,512	5.38	3,587	4.13	17,962	53.63
9/64		5,681	32.88	5,981	19.25	4,475	13.63	4,031	5.38	3,231	4.13	16,168	54.75
5/32	4	5,000	35.00	5,300	20.50	3,937	13.63	3,562	5.38	2,868	4.13	14,381	56.00
11/64		4,587	35.13	4,856	21.13	3,618	14.00	3,275	5.38	2,625	4.13	13,206	56.50
3/16		4,200	35.13	4,443	21.50	3,318	14.50	3,006	5.38	2,387	4.13	12,075	57.00
13/64	5	3,862	35.13	4,075	22.00	3,056	14.75	2,756	5.38	2,187	4.13	11,100	57.50
7/32		3,587	35.13	3,775	22.38	2,856	14.75	2,556	5.38	2,037	4.13	10,350	57.88
1/4	6	3,150	35.13	3,300	22.75	2,500	14.75	2,218	5.38	1,787	4.13	9,100	58.50
9/32		2,825	35.13	2,975	22.88	2,231	14.75	1,975	5.38	1,618	4.13	8,150	58.75
5/16	8	2,493	35.13	2,643	23.00	1,962	14.75	1,737	5.38	1,437	4.13	7,200	59.00
11/32		2,275	35.38	2,425	24.25	1,806	14.75	1,612	5.38	1,318	4.13	6,600	59.00
3/8		2,068	35.75	2,218	25.50	1,656	14.75	1,500	5.38	1,206	4.13	6,037	59.00
13/32	10	1,893	36.13	2,037	26.25	1,525	14.75	1,387	5.38	1,106	4.13	5,537	60.00
7/16		1,775	36.38	1,887	26.38	1,425	14.75	1,293	5.38	1,031	4.13	5,150	62.25
1/2	12	1,562	38.63	1,637	28.13	1,243	15.25	1,125	5.38	900	4.13	4,481	65.00
9/16		1,400	42.88	1,468	31.13	1,100	16.38	993	5.38	793	4.13	3,962	65.00
5/8	16	1,256	44.38	1,318	32.13	987	17.25	900	5.38	712	4.13	3,550	65.00
11/16		1,143	48.00	1,200	32.38	900	17.38	812	5.38	643	4.13	3,243	65.00
3/4	20	1,025	49.25	1,075	32.88	800	17.38	725	5.13	581	4.13	2,925	65.00
7/8	22	887	44.38	937	29.50	700	15.75	637	4.63	506	3.75	2,518	61.38
1	25	787	39.00	825	25.88	612	13.63	550	4.13	450	3.25	2,218	54.38

Speeds and feeds are critical to tool life, machining time and surface finish. What we have provided is a general starting point for machining certain materials under standard machining conditions. Please keep in mind that the workpiece material, how the workpiece is held, the coolant used, the tool holder and the machine horsepower has a tremendous impact on cutting tool effectiveness and tool life. You may find greater results at much more aggressive speeds and feeds in some set ups than others for the same material. These charts are intended to give the machinist a starting point and it is up to the machinist to understand the variables that can impact material removal efficiency.

4-Flute Square End & Corner Radius High Performance Modified **AlTiN** Carbide End Mills – Side Milling

Hardness				Tensile Strength: Up to 750N/mm ²		Up to 30 HRC		30 to 38 HRC		38 to 45 HRC		45 to 55 HRC		55 to 60 HRC										
Work Material		Cast Iron		Mild Steels, Carbon Steels		Alloy Steels, Tool Steels, Ti Alloys (Annealed)		Hardened Steels, Prehardened Steels, Ti Alloys (Solution Treated and Aged)		Hardened Steels, Prehardened Steels, Stainless Steels, Inconel, Ni Based Alloys		Hardened Steels		Hardened Steels										
Depth of Cut		<table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td></td> <td>Ad</td> <td>Rd</td> </tr> <tr> <td>$D < 1/8$</td> <td>1.5D</td> <td>0.05D</td> </tr> <tr> <td>$1/8 \leq D$</td> <td>1.5D</td> <td>0.1D</td> </tr> </table>															Ad	Rd	$D < 1/8$	1.5D	0.05D	$1/8 \leq D$	1.5D	0.1D
	Ad	Rd																						
$D < 1/8$	1.5D	0.05D																						
$1/8 \leq D$	1.5D	0.1D																						
Dia. (in)	(mm)	390 SFM		330 SFM		270 SFM		220 SFM		190 SFM		120 SFM		80 SFM										
		Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min									
1/16	1.5	20,825	15.4	18,070	12.5	15,670	11.2	10,870	4.7	9,915	4.2	6,740	2.6	5,400	1.6									
3/32		16,305	21.5	13,720	18.1	11,550	14.5	8,075	5.4	6,885	4.9	4,185	2.9	2,950	2.0									
1/8	3	12,060	28.4	10,205	24.0	8,700	16.9	7,125	5.9	5,475	5.2	3,180	2.9	2,290	2.2									
5/32	4	9,630	29.9	8,060	25.0	7,890	17.5	5,170	6.3	4,475	5.3	2,655	3.3	1,815	2.2									
3/16		8,075	33.7	6,740	28.3	5,930	19.4	4,455	6.5	3,935	5.7	2,360	3.5	1,565	2.0									
7/32		7,580	34.8	5,790	29.1	4,835	20.0	3,855	6.7	3,440	6.0	2,045	3.4	1,360	1.9									
1/4	6	7,060	34.4	5,090	28.9	4,235	20.0	3,375	6.9	3,030	6.1	1,775	3.3	1,205	1.9									
9/32		5,945	34.0	4,545	28.3	3,785	19.9	3,020	6.9	2,690	6.1	1,580	3.3	1,080	1.8									
5/16	8	4,820	33.6	4,000	27.8	3,330	19.8	2,660	6.9	2,360	6.1	1,390	3.2	960	1.7									
11/32		4,385	33.6	3,670	27.8	3,050	19.8	2,440	6.9	2,160	6.1	1,290	3.5	880	1.7									
3/8		4,005	33.6	3,360	27.8	2,795	19.8	2,225	6.9	1,970	6.1	1,200	3.8	800	1.7									
13/32	10	3,680	33.6	3,090	27.8	2,565	19.8	2,040	6.9	1,810	6.1	1,110	3.9	735	1.7									
7/16		3,440	33.6	2,870	27.8	2,405	19.8	1,895	6.9	1,690	6.1	1,035	3.4	690	1.5									
1/2	12	3,010	32.7	2,510	27.5	2,090	19.7	1,655	6.9	1,475	6.0	900	2.7	600	1.3									
9/16		2,645	31.2	2,230	26.9	1,820	19.6	1,470	6.7	1,295	5.8	795	2.4	530	1.1									
5/8		2,355	31.4	1,995	26.1	1,630	19.6	1,325	6.1	1,200	5.4	720	2.3	470	0.9									
11/16		2,160	31.0	1,800	25.7	1,485	19.2	1,215	5.6	1,090	5.0	650	2.0	430	0.9									
3/4	20	1,920	29.7	1,605	24.9	1,350	15.7	1,095	5.0	975	4.5	580	1.7	380	0.9									
7/8	22	1,660	26.2	1,420	22.4	1,185	15.9	960	4.3	850	3.9	510	1.4	335	0.8									
1	25	1,485	23.3	1,240	19.5	1,050	14.0	840	3.9	750	3.5	440	1.4	300	0.7									

Multi-Flute 50° High Spiral High Performance Modified **AlTiN** Carbide End Mills – Side Milling

Work Material		Mild Steel Carbon Steel Cast Iron		Alloy Steels Tool Steels		Hardened Steels Tool Steels		Hardened Steels Tool Steels		Titanium Alloy		Nickel Base High-Temp Alloy							
Hardness		Up to 25 HRC		25-45 HRC		45-55 HRC		55-60 HRC		30-40 HRC		25-45 HRC							
Depth of Cut		<table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>Ad= 1.5D</td> <td>Rd= 0.1D</td> </tr> <tr> <td>Ad= 1.5D</td> <td>Rd= 0.05D</td> </tr> <tr> <td>Ad= 1.5D</td> <td>Rd= 0.05D</td> </tr> </table>												Ad= 1.5D	Rd= 0.1D	Ad= 1.5D	Rd= 0.05D	Ad= 1.5D	Rd= 0.05D
Ad= 1.5D	Rd= 0.1D																		
Ad= 1.5D	Rd= 0.05D																		
Ad= 1.5D	Rd= 0.05D																		
Dia. (in)	(mm)	312-540 SFM		156-312 SFM		96-156 SFM		60-96 SFM		156-276 SFM		48-80 SFM							
		Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min	Speed RPM	Feed in/min						
1/8	3	11,400	70.8	6,360	19.2	3,240	7.2	2,280	4.8	5,040	33.6	1,680	2.4						
5/32	4	8,640	70.8	4,800	19.2	2,640	9.6	1,800	4.8	3,840	36.0	1,260	2.4						
3/16	5	6,840	61.2	3,840	19.2	2,160	10.8	1,560	4.8	3,000	36.0	984	3.6						
1/4	6	6,360	122.4	3,480	39.6	1,920	14.4	1,320	7.2	2,520	42.0	840	4.8						
5/16	8	4,800	112.8	2,640	39.6	1,440	14.4	996	7.2	1,920	42.0	624	4.8						
3/8	10	3,840	99.6	2,160	39.6	1,152	13.2	804	7.2	1,560	37.2	480	4.8						
1/2	12	3,480	99.6	1,920	36.0	960	13.2	672	6.0	1,260	36.0	408	3.6						
5/8	16	2,640	75.6	1,440	27.6	720	10.8	528	4.8	960	33.6	312	3.6						
3/4	20	2,160	61.2	1,140	21.6	576	7.2	420	3.6	780	28.8	240	3.6						
1	25	1,500	56.4	900	22.8	450	8.4	300	3.6	720	24.0	216	2.4						
1/8	3	11,400	70.8	6,360	19.2	3,240	7.2	2,280	4.8	5,040	33.6	1,680	2.4						
5/32	4	8,640	70.8	4,800	19.2	2,640	9.6	1,800	4.8	3,840	36.0	1,260	2.4						
3/16	5	6,840	61.2	3,840	19.2	2,160	10.8	1,560	4.8	3,000	36.0	984	3.6						
1/4	6	6,360	122.4	3,480	39.6	1,920	14.4	1,320	7.2	2,520	42.0	840	4.8						
5/16	8	4,800	112.8	2,640	39.6	1,440	14.4	996	7.2	1,920	42.0	624	4.8						
3/8	10	3,840	99.6	2,160	39.6	1,152	13.2	804	7.2	1,560	37.2	480	4.8						
1/2	12	3,480	99.6	1,920	36.0	960	13.2	672	6.0	1,260	36.0	408	3.6						
5/8	16	2,640	75.6	1,440	27.6	720	10.8	528	4.8	960	33.6	312	3.6						
3/4	20	2,160	61.2	1,140	21.6	576	7.2	420	3.6	780	28.8	240	3.6						
1	25	1,500	56.4	900	22.8	450	8.4	300	3.6	720	24.0	216	2.4						



4 & 5-Flute High Performance Modified **AlTiN** Variable Helix End Mills

Material	SFM	1/8"	1/4"	1/2"	1"
Aluminum Alloys	1120	0.0010	0.0020	0.0040	0.0080
Carbon Steel	300-600	0.0010	0.0015	0.0030	0.0060
Cast Iron	350-550	0.0010	0.0015	0.0030	0.0060
Copper Alloys	500-900	0.0010	0.0020	0.0030	0.0060
Steel - Annealed	350-500	0.0010	0.0020	0.0030	0.0050
Steel - 18-24 HRC	150-500	0.0004	0.0008	0.0015	0.0045
Steel - 25-37 HRC	125-200	0.0003	0.0005	0.0010	0.0030
Stainless Steel - Free Machining	250-400	0.0005	0.0010	0.0020	0.0030
Stainless Steel - Other	150-300	0.0005	0.0010	0.0020	0.0030
Inconel/Monel	60-100	0.0005	0.0010	0.0015	0.0030
Titanium	175-300	0.0005	0.0008	0.0015	0.0030

* All speeds and feeds are suggested starting points. They may be increased or decreased depending on machine condition, depth of cut, finish required, coolant, etc.

Multi-Flute **TiAlN** Coated Carbide Roughing End Mills — Side Milling

Hardness		Tensile Strength: Up to 750N/mm ²	Up to 30HRC	30 to 38 HRC	38 to 45 HRC						
Work Material	Cast Iron	Mild Steels, Carbon Steels	Alloy Steels, Tool Steels, Ti Alloys (Annealed)	Hardened Steels, Prehardened Steels	Hardened Steels, Stainless Steels						
Depth of Cut											
Dia. (in)	(mm)	420 SFM		350 SFM		300 SFM		225 SFM		175 SFM	
		Speed	Feed	Speed	Feed	Speed	Feed	Speed	Feed	Speed	Feed
		RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min
1/4	6	6,350	29.9	5,300	25.2	4,500	14.2	3,450	11.0	2,650	8.3
5/16	8	4,750	29.9	4,000	25.2	3,400	16.1	2,600	12.2	2,000	9.4
3/8	10	3,800	29.9	3,200	25.2	2,700	16.9	2,050	13.0	1,600	10.2
1/2	12	3,200	30.3	2,650	25.2	2,250	17.7	1,700	13.4	1,350	10.6
5/8	16	2,400	30.3	2,000	25.2	1,700	18.9	1,300	14.2	1,000	11.0
3/4	20	1,900	29.9	1,600	24.0	1,350	18.5	1,050	13.8	800	10.2
1	25	1,500	29.9	1,150	24.0	1,000	18.5	800	13.8	600	10.2

Multi-Flute **TiAlN** Coated Carbide Roughing End Mills — Slot Milling

Hardness		Tensile Strength: Up to 750N/mm ²	Up to 30HRC	30 to 38 HRC	38 to 45 HRC						
Work Material	Cast Iron	Mild Steels, Carbon Steels	Alloy Steels, Tool Steels, Ti Alloys (Annealed)	Hardened Steels, Prehardened Steels	Hardened Steels, Stainless Steels						
Depth of Cut											
Dia. (in)	(mm)	350 SFM		300 SFM		250 SFM		190 SFM		160 SFM	
		Speed	Feed	Speed	Feed	Speed	Feed	Speed	Feed	Speed	Feed
		RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min
1/4	6	5,300	25.2	4,500	21.3	3,700	11.8	2,900	9.1	2,400	7.5
5/16	8	4,000	25.2	3,400	21.3	2,800	13.4	2,200	10.2	1,800	8.7
3/8	10	3,200	25.2	2,700	21.3	2,250	14.2	1,750	11.0	1,450	9.1
1/2	12	2,650	25.2	2,250	21.3	1,850	14.6	1,450	11.4	1,200	9.4
5/8	16	2,000	25.2	1,700	21.3	1,400	15.4	1,100	12.2	900	9.8
3/4	20	1,600	25.2	1,350	20.1	1,100	15.4	900	11.8	700	9.1
1	25	1,150	25.2	950	20.1	800	15.4	700	11.8	500	9.1

Multi-Flute High Performance Modified **AlTiN** Carbide Roughing End Mills — Roughing Side Cutting

Hardness		Up to 30 HRC	30 to 38 HRC	38 to 45 HRC	45 to 55 HRC	55 to 65 HRC					
Work Material		Non-Alloyed Steels Alloy Steels Cast Iron	Alloys Steels Heat Resistant Steels	Alloys Steels Heat Resistant Steels	Hardened Steels	Hardened Steels					
Depth of Cut											
Dia. (in)	Strength (mm)	1,000 SFM		800 SFM		550 SFM		225 SFM		160 SFM	
		Up to 1,000N/mm ²		1,000 to 1,200N/mm ²		1,200 to 1,400N/mm ²		1,400 to 2,000N/mm ²		2,000N/mm ² ~	
		Speed	Feed	Speed	Feed	Speed	Feed	Speed	Feed	Speed	Feed
		RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min
1/4	6	15,600	91.35	12,400	33.10	8,400	22.45	3,400	10.25	2,400	7.50
5/16	8	11,600	91.35	9,200	33.10	6,300	22.45	2,400	9.50	1,800	7.10
3/8	10	9,200	91.35	7,600	33.10	5,100	22.45	2,000	11.40	1,300	7.50
1/2	12	8,000	94.50	6,000	31.50	4,200	22.45	1,680	10.25	1,200	7.50
5/8	16	6,000	94.50	4,800	29.90	3,300	20.05	1,200	6.30	800	4.35
3/4	20	5,200	91.35	4,400	28.35	2,700	16.55	1,100	5.90	700	3.95
1	25	4,800	85.05	3,600	22.05	2,400	14.15	1,000	5.90	660	3.95

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