IMCO

Power. Precision. Performance.

METALMORPHOSIS

POW•R•PATH
enDURO
STREAKERS
POW•R•FEED
OMEGA-6
INCONEX
truCORE

THE NEW FRONTIER OF ADVANCED END MILLS

THE NEW FRONTIER OF ADVANCED END MILLS.

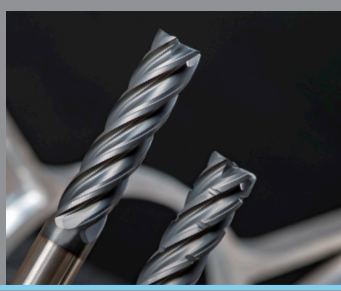
The tools in this catalog are made for a new age in metalworking, unique designs that run smarter, smoother and with incredible precision. Every innovation in each end mill series is the result of IMCO's advanced technology and our continuous drive for greater productivity. And the changes keep coming.

We're pushing boundaries and exploring technology to its outer edges. This is the new frontier, and the new age in metalworking — a metalmorphosis — is just ahead.

What's new?

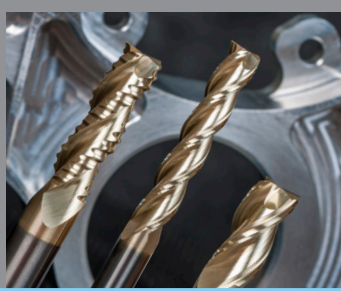
INTRODUCING AP5

Our new AP5 POW•R•PATH series end mills bring the benefits of HEM tool paths to machining aluminum. The advanced design plus taC coating means these tools are built for speed.



INTRODUCING M223/M233

Introducing new designs in the M2 STREAKERS series end mills that cover the spectrum for machining aluminum — new grinds for better surface finishes and a new line of roughing end mills for better chip control. Both styles offered with ZrN coating for maximum tool life.



UPDATE TO THE IP PRODUCT LINE

Take metal removal rates to a higher level with the new IP11 and IP13 POW•R•PATH end mills for HEM tool paths in ferrous materials and hi-temp alloys. More flutes on our advanced tool design for higher feed rates and longer tool life.

Pictorial Index

POW•R•PATH®

enDURO®

OMEGA-6™

INCONEX®

POW•R•FEED®

STREAKERS®

truCORE®

Technical Resources 129

Information on tips and adjustments for the following milling operations can be found in our Technical Resources section.

- HEM slotting
- Face milling
- Helical entry ramping
- Straight line ramping
- Long tool projection adjustments
- Ball nose milling adjustments
- Other helpful tips and calculations

IMCO's High-Performance End Mill Families

Driven to meet your cutting tool needs.

The world of metalworking is constantly bombarded with tougher demands, from working in difficult-to-machine materials to making parts faster. Even new advancements, like those in CAM software packages, create challenges for today's users of cutting tools.

The team at IMCO helps our customers meet those demands and turn them into opportunities. Our innovative designs create families of tools made to maximize performance in a wide range of materials by utilizing high-quality substrates, coatings and grinds. In-house development and testing with both traditional and high-efficiency CAM tool paths ensure that all IMCO tools excel in a wide variety of applications.

POW•R•PATH® IP

- Designed specifically for high-efficiency machining in ferrous materials and hi-temp alloys.
- New 11- and 13-flute tools for maximum metal removal rates.
- The "go-to" tool when using today's advanced machining techniques.

POW•R•PATH® AP

- New tool for advanced HEM tool paths in aluminum.
- Innovative 5-flute design and coating maximizes output without chip packing, yielding high output and long tool life.

DEEP WALL FINISHER AFC5/IFC5

- Unique cutting edge geometry and thick core, minimizing wall taper in deep cuts.

enDURO® M5

- Most versatile tool on the market – machines in both traditional and HEM tool paths.
- 5- and 7-flute designs for roughing and finishing in a wide range of materials.

OMEGA-6™ M7

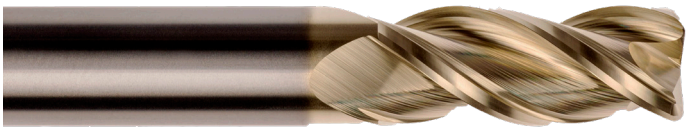
- Advanced geometry and coating for hard milling applications.
- High-helix 5- and 6-flute end mills, great for machining materials > 48 HRC and for finish milling in a wide range of materials.

INCONEX® M8

- Unique design for long tool life when machining hi-temp alloys.
- 6 flutes for longer tool life in traditional cuts in difficult-to-machine materials.

POW•R•FEED® M9

- Brings high performance to 4- and 5-flute end mills with a vibration-dampening design for slotting, pocketing and roughing in many materials in traditional cuts.



STREAKERS® M2

- Advanced 2- and 3-flute designs for machining aluminum.
- New 3-flute designs with ZrN coating for longer tool life and better part finishes.

truCORE® E SERIES

- Traditional 2-, 3- and 4-flute end mills for reliable and consistent performance in general machining.

imcousa.com

Point. Click. Game changed.

User-focused navigation – Start with machining type then you choose how you want to look further – by tool family, by application or by end type, whatever works best for you.

Complete tool info – Dimensions and drawings, flutes, coatings, end cuts, sizes ... everything you need to know. Downloadable catalogs, too.

Real-time data for distributors – Password-protected access 24/7 for secure online ordering, real-time inventory checks, pricing and more. With 24/7 access to real-time information, you can respond to customer needs on the spot, anytime. When priorities shift from minute to minute, **speed and flexibility** are game changers.

Like us on Facebook
@IMCO Carbide Tool

Follow us on Instagram
@imcousa

"Our information technology should be as advanced, intuitive and productivity-driven as our cutting tool technology. Now, it is."

– IMCO President Perry Osburn

Tool Selection Guide Introduction

Choose the right tool for your job.

Deciding which end mill to use in an application now goes beyond matching the end mill to the material. The programming style – high-efficiency machining or traditional – plays a key role in determining which tool will decrease cycle time and maximize tool life.

Our tool selection charts on pages 10–13 can help you pick the best tool for the material and the programming you use. Detailed speed, feed and tool engagement information can be found at the end of each product section.

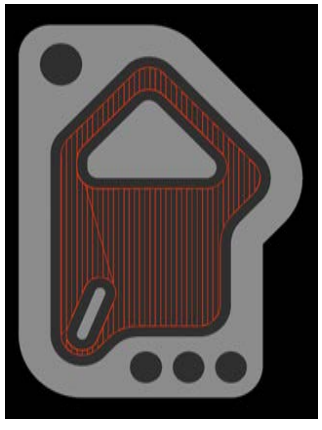
HEM vs. Traditional: Which is best?

HEM Tool Path

High-efficiency machining (HEM) can greatly reduce the cycle time of a job AND improve tool life. HEM uses advanced tool paths that maintain consistent pressure on cutting tools and the machine spindle. Common characteristics of these tool paths are:

- Light radial cuts (step-overs)
- Deep axial cuts
- Elliptical tool paths when slotting and pocketing

Traditional tool paths use straight-line moves that generate heavy tool engagement, intense pressure in the corners, and the potential for the tool to break. That means the machine "looks ahead" and slows down the tool or requires programming speeds and feeds that allow the end mill to survive sharp turns.



Traditional Tool Path

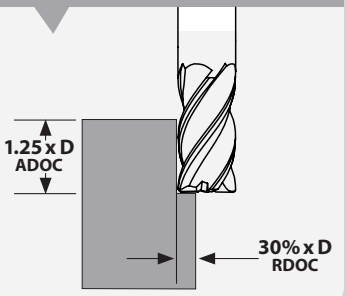
With HEM, the potential for reduced costs through faster cycle times and increased tool life is *huge.*

See example in sidebar at right:

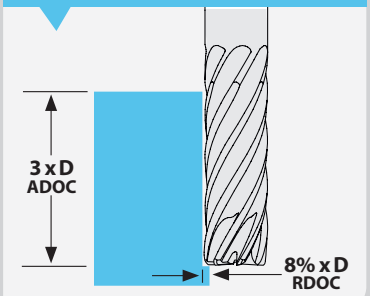
MACHINING 316 STAINLESS STEEL

Must remove .150" from a wall 1.5" tall.

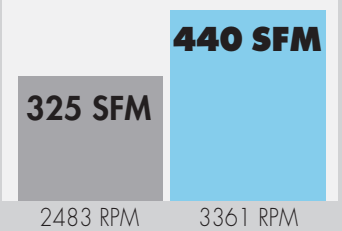
Traditional method using IMCO M924 Series ½" OD 4-flute end mill, taking a radial DOC of 30% of the diameter and an axial DOC of 1.25 x D (.625" in this example).



HEM method roughing out the same part using the IPT 7-flute end mill, taking a radial DOC of 8% of the diameter and an axial DOC of 3 x D (the full 1.5" of the wall in this example).

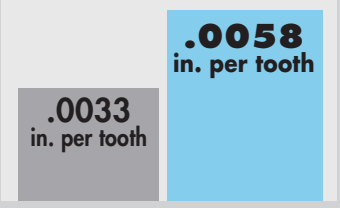


SPEED



2483 RPM 3361 RPM

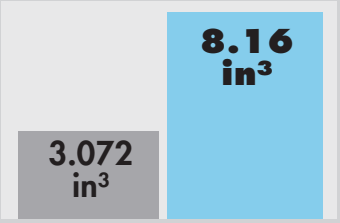
CHIP LOAD



FEED RATE

2483 RPM x [.0033 IPT x 4-flutes] | 3361 RPM x [.0058 IPT x 7-flutes]

METAL REMOVAL RATE



32.77 IPM x .150" radial cut per pass x .625" axial cut per pass | 136 IPM x .040" radial cut per pass x 1.5" axial cut per pass

In this example, material is removed 2.5 x faster using the HEM IPT end mill versus a traditional path. The metal removal rate is measured in cubic inches: at IMCO, "It's all about the cubes."

Do all end mills run well in HEM tool paths?

All end mills are **not** created equal when it comes to HEM. End mills with multiple flutes, thick cores and strong corner radii are much more effective than traditional 4-flute tools. IMCO has created end mills specifically for HEM tool paths and others that can run both HEM and traditional cuts. It's all indicated in our tool selection guide.

Is HEM the best method to run on every job?

No. In general, **HEM does show significant savings** in most applications, but it really shines when you can run an axial depth of cut that is 1.25 x the tool diameter or greater. Traditional tool paths run well on very short runs and simple, shallow cuts.

An easy way to check if HEM will run a job faster is to calculate the metal removal rate, or MRR. The MRR takes the tool feed rate and multiplies that by the tool engagement to determine how many cubic inches or centimeters the tool removes in one minute.

MRR = Feed rate of the tool x width of cut x depth of cut

OR

MRR = (RPM x (IPT x # of flutes) x radial DOC x axial DOC

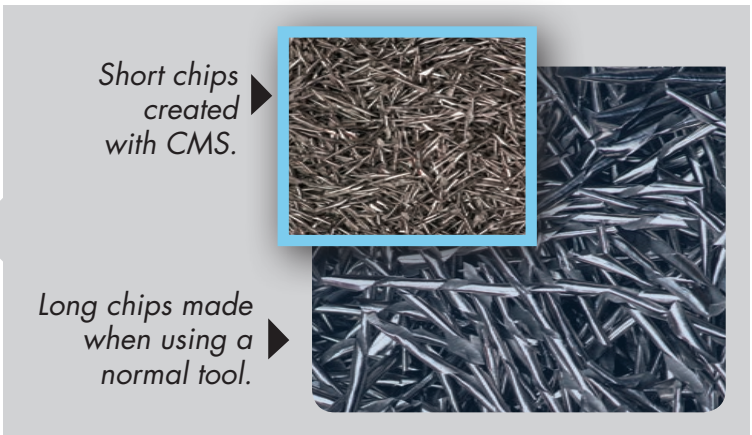
Plug in the numbers for the feed rate, step-over (RDOC) and the axial depth of cut (ADOC) the tool manufacturer recommends to compare the MRRs of both programming techniques. **On parts that require cutting at least 1.25 x the tool diameter deep, you will find that HEM shines.** Use the chart below to determine the best tool and path to use based on the axial depths (ADOC).

MRR Ranking	1.25 x D axial depths	1.5 - 2 x D axial depths	2.5 x D axial depths	3 x D axial depths
1	IP13 - HEM	IP13 - HEM	IP9 - HEM	IP9 - HEM
2	IP9 - HEM	IP9 - HEM	IP11 - HEM	IP7 - HEM
3	IP11 - HEM	IP11 - HEM	IP7 - HEM	M527 - HEM
4	M525 - Traditional	IP7 - HEM	IP13 - HEM	IP13 - HEM
5	M527 - Traditional	M527 - HEM	M527 - HEM	M525 - HEM
6	IP7 - HEM	M525 - HEM	M525 - HEM	IP11 - HEM
7	M527 - HEM	-	-	-
8	M525 - HEM	-	-	-

1=highest MRR, 8=lowest MRR
Chart assumes adequate coolant and no chip pollution in the cut. Chart is typical for most ferrous materials and hi-temp alloys.

Will the deep cuts used in HEM create chip pollution?

Yes, HEM can generate long chips based on the light step-over and deep cuts. The chips of some materials tend to break easily, and the coolant is effective in taking them out of the cutting zone. Other materials can cause issues. IMCO has developed special grinds that break the chips for easy removal without reducing tool life. Our ***Chip Management System (CMS)*** is available as a standard feature on many of our high-performance end mill designs. Look for the "C" in the series number to find them.



Tool Selection Guide

Pick the right tool for your material and application.

ISO Code	Work Material	Type of Cut	POW•R•PATH							
			IPT7	IPC7	IPT9	IPC9	IPT11	IPC11	IPT13	IPC13
										
K	Cast Iron - Gray	Traditional Roughing								
		Traditional Finishing								
		HEM	●●●●	●●●	●●●●	●●●	●●●●	●●●	●●●●	●●●
	Cast Iron - Malleable	Traditional Roughing								
		Traditional Finishing	●●●		●●●					
		HEM	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●
P	Low Carbon Steels < 48 HRC	Traditional Roughing								
		Traditional Finishing	●●●		●●●					
		HEM	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●
	Medium Carbon Steels < 48 HRC	Traditional Roughing								
		Traditional Finishing	●●●		●●●					
		HEM	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●
	Tool & Die Steels < 48 HRC	Traditional Roughing								
		Traditional Finishing	●●●		●●●					
		HEM	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●
H	Tool & Die Steels 48 - 62 HRC	Traditional Roughing								
		Traditional Finishing								
M	Austenitic Stainless Steels	Traditional Roughing								
		Traditional Finishing	●●●		●●●					
		HEM	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●
	Martensitic Stainless Steels	Traditional Roughing								
		Traditional Finishing	●●●		●●●					
		HEM	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●
	PH Stainless Steels	Traditional Roughing								
		Traditional Finishing	●●●		●●●					
		HEM	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●
S	Titanium Alloys	Traditional Roughing								
		Traditional Finishing	●●●		●●●					
		HEM	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●
	Hi-Temperature Alloys	Traditional Roughing								
		Traditional Finishing	●●●		●●●					
		HEM	●●●●		●●●		●●		●	
N	Aluminum Alloys	Traditional Roughing								
		Traditional Finishing								
		HEM								
	Copper Alloys, Brass, Bronze	Traditional Roughing								
		Traditional Finishing								
	Composites, Plastics, Fiberglass	Traditional Roughing								
		Traditional Finishing								

Maximum Performance: ●●●● Superior Performance: ●●● Excellent Performance: ●● Good Performance: ●

POW•R•PATH				enDURO					OMEGA-6		INCONEX
APT5	APC5	AFC5	IFC5	M525	M525C	M527	M527C	M503	M725/6	M706	M806
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Tool Selection Guide

Pick the right tool for your material and application.

ISO Code	Work Material	Type of Cut	STREAKERS			
			M223	M233	M203	M202
						
K	Cast Iron - Gray	Traditional Roughing				
		Traditional Finishing				
		HEM				
	Cast Iron - Malleable	Traditional Roughing				
		Traditional Finishing				
		HEM				
P	Low Carbon Steels < 48 HRC	Traditional Roughing				
		Traditional Finishing				
		HEM				
	Medium Carbon Steels < 48 HRC	Traditional Roughing				
		Traditional Finishing				
		HEM				
	Tool & Die Steels < 48 HRC	Traditional Roughing				
		Traditional Finishing				
		HEM				
H	Tool & Die Steels 48 - 62 HRC	Traditional Roughing				
		Traditional Finishing				
M	Austenitic Stainless Steels	Traditional Roughing				
		Traditional Finishing				
		HEM				
	Martensitic Stainless Steels	Traditional Roughing				
		Traditional Finishing				
		HEM				
	PH Stainless Steels	Traditional Roughing				
		Traditional Finishing				
		HEM				
S	Titanium Alloys	Traditional Roughing				
		Traditional Finishing				
		HEM				
	Hi-Temperature Alloys	Traditional Roughing				
		Traditional Finishing				
		HEM				
N	Aluminum Alloys	Traditional Roughing	●●●●	●●●●	●●●	●●●
		Traditional Finishing	●●●		●●	
		HEM				
	Copper Alloys, Brass, Bronze	Traditional Roughing	●●●●	●●●●	●●	●●
		Traditional Finishing	●●●		●	
	Composites, Plastics, Fiberglass	Traditional Roughing	●●●●	●●●	●●	
		Traditional Finishing	●●●		●●	

POW•R•FEED				truCORE					
M924	M924C	M904	M905	E12	E13	E14	E24	E520B	M104
									
●●●		●●	●●		●	●	●		
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POW•R•PATH®

MACHINING REBOOTED. PRODUCTIVITY RELOADED.

Push your productivity to the max with IMCO's POW•R•PATH IP/AP series end mills, designed specifically for high-efficiency machining (HEM). This dynamic combination of unique tool design features along with HEM tool paths increases your metal removal rates while decreasing wear on your tool. The proof is in the savings!

POW•R•PATH Series Features

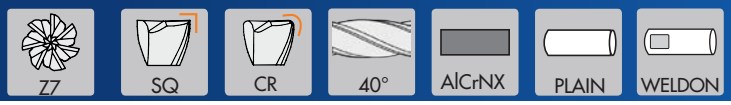
New tools for the new age of machining.

Amplify the benefits of high-efficiency machining with POW•R•PATH IP/AP series cutting tools. Every aspect of POW•R•PATH end mills is optimized specifically for HEM methods to make sure you get every advantage this modern machining system can provide.

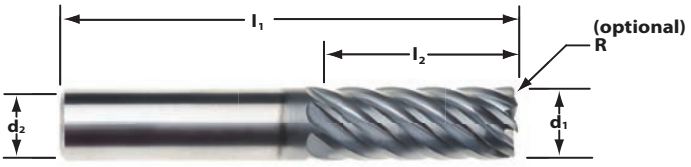
The POW•R•PATH line is the most complete offering of end mills dedicated to HEM tool paths in the market, ranging from 7 to 13 flutes for steels and hi-temp alloys, and a 5-flute design for aluminum — all available with or without the unique Chip Management System (CMS).

	IPT7	IPC7	IPT9 IPC9	IPT11 IPC11	IPT13 IPC13	APT5	APC5	AFC5	IFC5
NUMBER OF FLUTES	Z7	Z7	Z9	Z11	Z13	Z5	Z5	Z5	Z5
END TYPES	SQ, CR	CR	CR	CR	CR	SQ, CR	CR	CR	CR
HELIX ANGLE	40°	40°	36°	34°	30°	35°	35°	35°	35°
COATING	AlCrNX	AlCrNX	AlCrNX	AlCrNX	AlCrNX	taC	taC	taC	AlCrNX
SHANK TYPES	PLAIN	PLAIN	PLAIN	PLAIN	PLAIN	PLAIN	PLAIN	PLAIN	PLAIN
APPLICATIONS	HEM, FINISH			HEM		HEM, ROUGH, FINISH		FINISH	FINISH
MATERIAL(S)	K P M S					N		N	K P M S

IPT7
POW•R•PATH



For high-efficiency machining (HEM) in materials ranging from low carbon steels to hi-temp alloys. The IPT7 is the most versatile of the POW•R•PATH end mills. Engineered specifically for HEM tool paths, the IPT7's unique design runs up to 4.5 x the tool diameter deep at elevated feed and metal removal rates.



in: *d1: +0.000 / -0.002* *d2: -0.0001 / -0.0004*
mm: *d1: +0.000 / -0.050* *d2: -0.0025 / -0.0100*

K P M S

Cutter Dia d1	Shank Dia d2	Max Axial Depth xD	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius .015 CR	.030 CR	.060 CR	.090 CR	.125 CR	.187 CR	.250 CR
3/16	3/16	2	3/8	2	63476	63477	63478	-	-	-	-	-
		3	9/16	2	63479	63480	63481	-	-	-	-	-
		4	3/4	2-1/2	63482	63483	63484	-	-	-	-	-
1/4	1/4	2	1/2	2	63485	63486	63487	63488	-	-	-	-
		3	3/4	2-1/2	63489	63490	63491	63492	-	-	-	-
		4	1	3	63493	63494	63495	63496	-	-	-	-
3/8	3/8	2	3/4	2-1/2	63497	63498	63499	63500	63501	-	-	-
		2.5	15/16	2-1/2	63502	63503	63504	63505	63506	-	-	-
		3	1-1/8	3	63507	63508	63509	63510	63511	-	-	-
		4	1-1/2	3-1/2	63512	63513	63514	63515	-	-	-	-
1/2	1/2	2	1	3	63516	-	63517	63518	63519	63520	-	-
		2.5	1-1/4	3-1/4	63214	-	63215	63216	63217	63218	-	-
		3	1-1/2	3-1/2	63526	-	63527	63528	63529	63530	-	-
		3.5	1-3/4	4	63219	-	63220	63234	63236	63238	-	-
		4	2	4	63536	-	63537	63538	63539	63540	-	-
		4.5	2-1/4	4	63541	-	63542	63543	63544	63545	-	-
5/8	5/8	2	1-1/4	3-1/2	63546	-	63547	63548	63549	63550	63551	-
		2.5	1-9/16	4	63240	-	63242	63244	63246	63247	63251	-
		3	1-7/8	4	63558	-	63559	63560	63561	63562	63563	-
		3.5	2-3/16	4-1/2	63253	-	63258	63262	-	63264	-	-
		4	2-1/2	5	63568	-	63569	63570	-	63571	-	-
3/4	3/4	2	1-1/2	4	63572	-	63573	63574	-	63575	63576	63577
		2.5	1-7/8	4-1/2	63269	-	63270	63271	63273	63275	63280	63282
		3	2-1/4	5	63585	-	63586	63587	63588	63589	63590	63591
		3.5	2-5/8	5	63592	-	63593	63594	63595	63596	-	-
		4	3	6	63597	-	63598	63599	-	63600	-	-
1	1	2	2	5	63284	-	63288	63290	63305	63306	63307	63312
		2.5	2-1/2	5-1/2	63313	-	63314	63319	63320	63321	63332	63333
		3	3	6	63615	-	63616	63617	-	63618	-	-
		3.5	3-1/2	6-1/2	63334	-	63335	63336	-	63337	-	-
		4	4	7	63623	-	63624	63625	-	63626	-	-

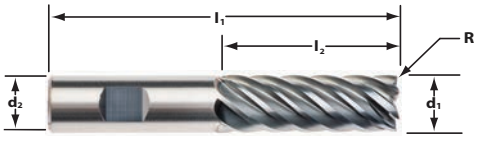
D = Tool Diameter

Cutter Dia d1	Shank Dia d2	Max Axial Depth xD	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius 0.5 CR	1.0 CR	1.5 CR	2.0 CR	3.0 CR
6	6	2	12	57	63670	63671	-	-	-	-
		3	18	63	63672	63673	-	-	-	-
		4	24	75	63674	63675	-	-	-	-
8	8	2	16	58	64007	64008	-	-	-	-
		3	24	63	63678	63679	-	-	-	-
		4	32	75	63680	63681	-	-	-	-
10	10	2	20	66	63682	63683	63684	-	-	-
		2.5	25	72	63685	63686	63687	-	-	-
		3	30	75	63688	63689	63690	-	-	-
		4	40	88	63691	63692	63693	-	-	-
12	12	2	24	75	64015	-	64016	64023	64024	64029
		2.5	30	83	63699	-	63700	63701	63702	63703
		3	36	88	64036	-	64037	64043	64050	64051
		3.5	42	93	64057	-	64058	64064	64070	64071
		4	48	100	63714	-	63715	63716	63717	63718
16	16	2	32	92	64075	-	64076	64081	64085	64086
		2.5	40	100	64087	-	64088	64090	64091	64092
		3	48	110	64093	-	64094	64096	64097	64098
		3.5	56	110	63734	-	63735	63736	63737	63738
		4	64	125	63739	-	63740	63741	63742	63743
20	20	2	40	104	63744	-	63745	63746	63747	63748
		2.5	50	115	64099	-	64100	64108	64115	64116
		3	60	125	63754	-	63755	63756	63757	63758
		3.5	70	135	64123	-	64124	64136	64137	64142
		4	80	150	63764	-	63765	63766	63767	63768
25	25	2	50	120	63769	-	63770	63771	63772	63773
		2.5	63	135	63399	-	63451	63453	63454	63627
		3	75	150	63779	-	63780	63781	63782	63783
		3.5	88	165	63628	-	63629	63810	63811	63812

D = Tool Diameter

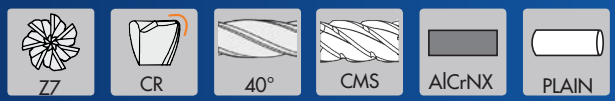
Cutter Dia d1	Shank Dia d2	Max Axial Depth xD	Length of Cut l2	Overall Length l1	Order Code by Corner Radius 1.0 CR	1.5 CR	3.0 CR
12	12	3	36	88	63002	-	63008
		3.5	42	93	63009	-	63015
		4	48	100	63017	-	63019
16	16	3	48	110	-	63021	63023
		3.5	56	110	-	63031	63033
		4	64	125	-	63035	63037
20	20	3	60	125	-	63039	63041
		3.5	70	135	-	63042	63053
		4	80	150	-	63055	63057

IPT7 w/WELDON

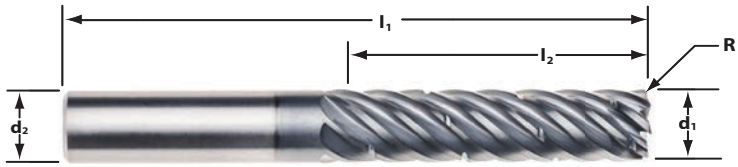


mm: *d1: +0.000 / -0.050* *d2: -0.0025 / -0.0100*

IPC7
POW•R•PATH



For high-efficiency machining (HEM) in materials ranging from low carbon steels to hi-temp alloys. Adds the benefits of the unique **Chip Management System (CMS)** to the versatility of the IPT7 design. Breaks up long, stringy chips, which eliminates recutting chips and chip packing, and allows for deep, free cutting tool movement in a variety of materials.



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mm: *d1: +0.000 / -0.050* *d2: -0.0025 / -0.0100*

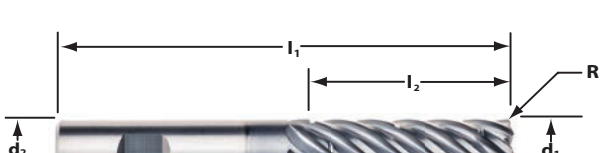
Cutter Dia d1	Shank Dia d2	Max Axial Depth xD	Length of Cut l2	Overall Length l1	Order Code by Corner Radius .030 CR	.060 CR
3/8	3/8	3	1-1/8	3	63630	-
		4	1-1/2	3-1/2	63631	-
1/2	1/2	2.5	1-1/4	3-1/4	63410	63411
		3	1-1/2	3-1/2	63634	63635
		3.5	1-3/4	4	63412	63413
		4	2	4	63638	63639
5/8	5/8	2	1-1/4	3-1/2	63640	63641
		2.5	1-9/16	4	63414	63415
		3	1-7/8	4	63644	63645
		3.5	2-3/16	4-1/2	63416	63417
		4	2-1/2	5	63648	63649
3/4	3/4	2	1-1/2	4	63650	63651
		2.5	1-7/8	4-1/2	63418	63419
		3	2-1/4	5	63654	63655
		3.5	2-5/8	5	63656	63657
		4	3	6	63658	63659
1	1	2	2	5	63424	63433
		2.5	2-1/2	5-1/2	63441	63442
		3	3	6	63664	63665
		3.5	3-1/2	6-1/2	63443	63461
		4	4	7	63668	63669

Cutter Dia d1	Shank Dia d2	Max Axial Depth xD	Length of Cut l2	Overall Length l1	Order Code 1.0 CR
10	10	3	30	75	63790
		4	40	88	63791
12	12	2.5	30	83	63792
		3	36	88	64042
		3.5	42	93	64063
		4	48	100	63795
16	16	2	32	92	64080
		2.5	40	100	64089
		3	48	110	64095
		3.5	56	110	63799
		4	64	125	63800
20	20	2	40	104	63801
		2.5	50	115	64107
		3	60	125	63803
		3.5	70	135	64129
		4	80	150	63805
25	25	2	50	120	63806
		2.5	63	135	63452
		3	75	150	63808
		3.5	88	165	63789

D = Tool Diameter

IPC7 w/WELDON
POW•R•PATH

For high-efficiency machining (HEM) in materials ranging from low carbon steels to hi-temp alloys. Adds the benefits of the unique **Chip Management System (CMS)** to the versatility of the IPT7 design. Breaks up long, stringy chips, which eliminates recutting chips and chip packing, and allows for deep, free cutting tool movement in a variety of materials.



mm: *d1: +0.000 / -0.050 d2: -0.0025 / -0.0100*

K P M S

Cutter Dia d1	Shank Dia d2	Max Axial Depth xD	Length of Cut l2	Overall Length l1	Order Code 1.0 CR
12	12	3	36	88	63339
		3.5	42	93	63341
		4	48	100	63352
16	16	3	48	110	63353
		3.5	56	110	63355
		4	64	125	63366
20	20	3	60	125	63367
		3.5	70	135	63368
		4	80	150	63369

TOOL TIP

HEM Tool Holder Recommendations.

HEM tool paths reduce the amount of radial cutting forces that are exerted on the end mill, allowing for more aggressive speeds and feeds and longer tool life. The axial cutting forces, however, are increased and work to pull the end mill out of the holder and into the part. Using a holder with a high level of gripping power is critical for successful machining in HEM tool paths. It is also important to choose a holder that minimizes the run-out of the end mill.

Holder Type	Use in HEM Programming?
Press Fit	Recommended
Shrink Fit	Recommended
Mechanical Chuck	Recommended
Hydraulic Chuck	Only if ADOC < 3xD
Advanced ER Collet	Only if ADOC < 3xD
Standard ER Collet	Not recommended
Side Lock Holder	MUST keep run-out minimized

IPT7/IPC7 Application Guide – Speed & Feed (inch)

ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	No. of Flutes	Speed (SFM)	Feed (Inches per Tooth) 3/16	1/4	3/8	1/2	5/8	3/4	1
K	Gray ASTM-A48 Class 20, 25, 30, 35 & 40	Peripheral - HEM	≤ 3 x D	.1 x D	7	400	.0027	.0036	.0054	.0072	.0090	.0108	.0144
		Peripheral - HEM	> 3 x D - 4 x D	.08 x D	7	400	.0024	.0032	.0049	.0065	.0081	.0097	.0130
		Peripheral - HEM	> 4 x D - 5 x D	.08 x D	7	390	.0022	.0029	.0043	.0058	.0072	.0086	.0115
		Finish	3 x D	.015 x D	7	450	.0010	.0013	.0020	.0026	.0033	.0039	.0052
	Cast Iron Malleable	Peripheral - HEM	≤ 3 x D	.08 x D	7	390	.0022	.0029	.0044	.0058	.0073	.0087	.0116
		Peripheral - HEM	> 3 - 4 x D	.08 x D	7	390	.0020	.0026	.0039	.0052	.0065	.0078	.0104
		Peripheral - HEM	> 4 - 5 x D	.08 x D	7	375	.0017	.0023	.0035	.0046	.0058	.0070	.0093
		Finish	3 x D	.015 x D	7	350	.0008	.0011	.0016	.0021	.0026	.0032	.0042
P	Low Carbon Steels ≤ 38 Rc 1018, 1020, 12L14, 5120, 8620	Peripheral - HEM	≤ 3 x D	.08 x D	7	485	.0028	.0038	.0056	.0075	.0094	.0113	.0150
		Peripheral - HEM	> 3 - 4 x D	.08 x D	7	485	.0025	.0034	.0051	.0068	.0084	.0101	.0135
		Peripheral - HEM	> 4 - 5 x D	.08 x D	7	465	.0023	.0030	.0045	.0060	.0075	.0090	.0120
		Finish	3 x D	.015 x D	7	420	.0011	.0014	.0021	.0028	.0035	.0042	.0056
	Medium Carbon Steels ≤ 48 HRC 1045, 4140, 4340, 5140	Peripheral - HEM	≤ 3 x D	.08 x D	7	450	.0027	.0036	.0053	.0071	.0089	.0107	.0142
		Peripheral - HEM	> 3 - 4 x D	.08 x D	7	450	.0024	.0032	.0048	.0064	.0080	.0096	.0128
		Peripheral - HEM	> 4 - 5 x D	.08 x D	7	425	.0021	.0028	.0043	.0057	.0071	.0085	.0114
		Finish	3 x D	.015 x D	7	390	.0009	.0013	.0019	.0025	.0031	.0038	.0050
	Tool and Die Steels ≤ 48 Rc A2, D2, O1, S7, P20, H13	Peripheral - HEM	≤ 3 x D	.08 x D	7	420	.0024	.0032	.0048	.0064	.0080	.0096	.0128
		Peripheral - HEM	> 3 - 4 x D	.08 x D	7	420	.0022	.0029	.0043	.0058	.0072	.0086	.0115
		Peripheral - HEM	> 4 - 5 xD	.08 x D	7	395	.0019	.0026	.0038	.0051	.0064	.0077	.0102
		Finish	3 x D	.015 x D	7	365	.0008	.0011	.0016	.0021	.0026	.0032	.0042
M	Martensitic & Ferritic Stainless Steels 410, 416, 440	Peripheral - HEM	≤ 3 x D	.08 x D	7	450	.0028	.0038	.0056	.0075	.0094	.0113	.0150
		Peripheral - HEM	> 3 - 4 x D	.08 x D	7	450	.0025	.0034	.0051	.0068	.0084	.0101	.0135
		Peripheral - HEM	> 4 - 5 x D	.08 x D	7	425	.0023	.0030	.0045	.0060	.0075	.0090	.0120
		Finish	3 x D	.015 x D	7	390	.0009	.0013	.0019	.0025	.0031	.0038	.0050
	Austenitic Stainless Steels, FeNi Alloys 303, 304, 316, Invar, Kovar	Peripheral - HEM	≤ 3 x D	.08 x D	7	450	.0024	.0032	.0048	.0064	.0080	.0096	.0128
		Peripheral - HEM	> 3 - 4 x D	.08 x D	7	440	.0022	.0029	.0043	.0058	.0072	.0086	.0115
		Peripheral - HEM	> 4 - 5 x D	.07 x D	7	425	.0019	.0026	.0038	.0051	.0064	.0077	.0102
		Finish	3 x D	.015 x D	7	390	.0009	.0012	.0018	.0024	.0030	.0036	.0048
	Precipitation Hardening Stainless Steels 17-4, 15-5	Peripheral - HEM	≤ 3 x D	.08 x D	7	440	.0023	.0031	.0047	.0062	.0078	.0093	.0124
		Peripheral - HEM	> 3 - 4 x D	.08 x D	7	440	.0021	.0028	.0042	.0056	.0070	.0084	.0112
		Peripheral - HEM	> 4 - 5 x D	.07 x D	7	415	.0019	.0025	.0037	.0050	.0062	.0074	.0099
		Finish	3 x D	.015 x D	7	380	.0008	.0010	.0015	.0020	.0025	.0030	.0040
S	Titanium Alloys 6Al-4V, 6-2-4	Peripheral - HEM	≤ 3 x D	.1 x D	7	405	.0015	.0021	.0031	.0041	.0051	.0062	.0082
		Peripheral - HEM	> 3 - 4 x D	.08 x D	7	405	.0014	.0018	.0028	.0037	.0046	.0055	.0074
		Peripheral - HEM	> 4 - 5 x D	.08 x D	7	390	.0012	.0016	.0025	.0033	.0041	.0049	.0066
		Finish	3 x D	.015 x D	7	350	.0006	.0008	.0012	.0016	.0020	.0024	.0032
	Difficult-to-Machine Titanium Alloys 10-2-3 Precipitation Hardening Stainless Steel M 13-8	Peripheral - HEM	≤ 2.5 x D	.08 x D	7	335	.0015	.0020	.0030	.0040	.0050	.0060	.0080
		Peripheral - HEM	> 2.5 - 3.5 x D	.07 x D	7	325	.0014	.0018	.0027	.0036	.0045	.0054	.0072
		Peripheral - HEM	> 3.5 - 4 x D	.06 x D	7	305	.0012	.0016	.0024	.0032	.0040	.0048	.0064
		Finish	3 x D	.01 x D	7	290	.0005	.0007	.0011	.0014	.0018	.0021	.0028
	Hastalloy, Waspalloy	Peripheral - HEM	≤ 1.5 x D	.08 x D	7	100	.0035	.0047	.0071	.0094	.0118	.0141	.0188
		Peripheral - HEM	> 1.5 - 2.5 x D	.08 x D	7	95	.0032	.0042	.0063	.0085	.0106	.0127	.0169
		Peripheral - HEM	> 2.5 - 3.5 x D	.06 x D	7	85	.0028	.0038	.0056	.0075	.0094	.0113	.0150
		Finish	2 x D	.01 x D	7	90	.0019	.0025	.0038	.0050	.0063	.0075	.0100
	Inconel 718, Rene 88	Peripheral - HEM	≤ 1.5 x D	.07 x D	7	95	.0035	.0047	.0070	.0093	.0116	.0140	.0186
		Peripheral - HEM	> 1.5 - 2.5 x D	.06 x D	7	90	.0031	.0042	.0063	.0084	.0105	.0126	.0167
		Peripheral - HEM	> 2.5 - 3 x D	.06 x D	7	85	.0028	.0037	.0056	.0074	.0093	.0112	.0149
		Finish	2 x D	.01 x D	7	85	.0018	.0024	.0036	.0048	.0060	.0072	.0096

D = Tool Diameter HEM = High-efficiency machining (chip thinning calculations have already been applied to HEM parameters)

≈ Approximately Equals
≤ Less Than or Equal To
≥ Greater Than or Equal To
× Multiply
< Less Than
> Greater Than
= Equals

Common Machining Formulas

$$RPM = \frac{SFM \times 3.82}{D}$$

$$SFM = RPM \times D \times .262$$

$$IPM = RPM \times IPT \times Z$$

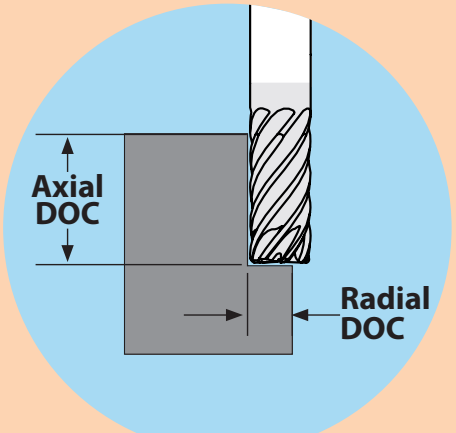
$$MRR = RDOC \times ADOC \times IPM$$

$$RPM = \frac{M/min \times 318.3}{D}$$

$$M/min = RPM \times D \times .00314$$

$$MMPM = RPM \times MMPT \times Z$$

$$MRR = RDOC \times ADOC \times MMPM$$



IPT7/IPC7 Application Guide – Speed & Feed (metric)

ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	No. of Flutes	Speed (M/min)	Feed (MM per Tooth) 6.0	8.0	10.0	12.0	16.0	20.0	25.0
K	Gray ASTM-A48 Class 20, 25, 30, 35 & 40	Peripheral - HEM	≤ 3 x D	.1 x D	7	122	.0864	.1152	.1434	.1728	.2298	.2868	.3456
		Peripheral - HEM	> 3 - 4 x D	.08 x D	7	122	.0778	.1037	.1291	.1555	.2068	.2581	.3110
		Peripheral - HEM	> 4 - 5 x D	.08 x D	7	119	.0691	.0922	.1147	.1382	.1838	.2295	.2765
		Finish	3 x D	.015 x D	7	137	.0312	.0416	.0518	.0624	.0830	.1036	.1248
	Cast Iron Malleable	Peripheral - HEM	≤ 3 x D	.08 x D	7	119	.0696	.0928	.1155	.1392	.1851	.2311	.2784
		Peripheral - HEM	> 3 - 4 x D	.08 x D	7	119	.0626	.0835	.1040	.1253	.1666	.2079	.2505
		Peripheral - HEM	> 4 - 5 x D	.08 x D	7	114	.0557	.0742	.0924	.1114	.1481	.1848	.2227
		Finish	3 x D	.015 x D	7	107	.0252	.0336	.0418	.0504	.0670	.0837	.1008
P	Low Carbon Steels ≤ 38 Rc 1018, 1020, 12L14, 5120, 8620	Peripheral - HEM	≤ 3 x D	.08 x D	7	148	.0900	.1200	.1494	.1800	.2394	.2988	.3600
		Peripheral - HEM	> 3 - 4 x D	.08 x D	7	148	.0810	.1080	.1344	.1620	.2154	.2689	.3240
		Peripheral - HEM	> 4 - 5 x D	.08 x D	7	142	.0720	.0960	.1195	.1440	.1915	.2390	.2880
		Finish	3 x D	.015 x D	7	128	.0336	.0448	.0558	.0672	.0894	.1115	.1344
	Medium Carbon Steels ≤ 48 HRC 1045, 4140, 4340, 5140	Peripheral - HEM	≤ 3 x D	.08 x D	7	137	.0852	.1136	.1414	.1704	.2266	.2828	.3408
		Peripheral - HEM	> 3 - 4 x D	.08 x D	7	137	.0767	.1022	.1273	.1533	.2040	.2546	.3067
		Peripheral - HEM	> 4 - 5 x D	.08 x D	7	130	.0682	.0909	.1131	.1363	.1813	.2263	.2726
		Finish	3 x D	.015 x D	7	119	.0300	.0400	.0498	.0600	.0798	.0996	.1200
	Tool and Die Steels ≤ 48 Rc A2, D2, O1, S7, P20, H13	Peripheral - HEM	≤ 3 x D	.08 x D	7	128	.0768	.1024	.1275	.1536	.2043	.2550	.3072
		Peripheral - HEM	> 3 - 4 x D	.08 x D	7	128	.0691	.0922	.1147	.1382	.1838	.2295	.2765
		Peripheral - HEM	> 4 - 5 x D	.08 x D	7	120	.0614	.0819	.1020	.1229	.1634	.2040	.2457
		Finish	3 x D	.015 x D	7	111	.0252	.0336	.0418	.0504	.0670	.0837	.1008
M	Martensitic & Ferritic Stainless Steels 410, 416, 440	Peripheral - HEM	≤ 3 x D	.08 x D	7	137	.0900	.1200	.1494	.1800	.2394	.2988	.3600
		Peripheral - HEM	> 3 - 4 x D	.08 x D	7	137	.0810	.1080	.1344	.1620	.2154	.2689	.3240
		Peripheral - HEM	> 4 - 5 x D	.08 x D	7	130	.0720	.0960	.1195	.1440	.1915	.2390	.2880
		Finish	3 x D	.015 x D	7	119	.0300	.0400	.0498	.0600	.0798	.0996	.1200
	Austenitic Stainless Steels, FeNi Alloys 303, 304, 316, Invar, Kovar	Peripheral - HEM	≤ 3 x D	.08 x D	7	137	.0768	.1024	.1275	.1536	.2043	.2550	.3072
		Peripheral - HEM	> 3 - 4 x D	.08 x D	7	134	.0691	.0922	.1147	.1382	.1838	.2295	.2765
		Peripheral - HEM	> 4 - 5 x D	.07 x D	7	130	.0614	.0819	.1020	.1229	.1634	.2040	.2457
		Finish	3 x D	.015 x D	7	119	.0288	.0384	.0478	.0576	.0766	.0956	.1152
	Precipitation Hardening Stainless Steels 17-4, 15-5	Peripheral - HEM	≤ 3 x D	.08 x D	7	134	.0744	.0992	.1235	.1488	.1979	.2470	.2976
		Peripheral - HEM	> 3 - 4 x D	.08 x D	7	134	.0670	.0893	.1111	.1339	.1781	.2223	.2678
		Peripheral - HEM	> 4 - 5 x D	.07 x D	7	126	.0595	.0794	.0988	.1190	.1583	.1976	.2381
		Finish	3 x D	.015 x D	7	116	.0240	.0320	.0398	.0480	.0638	.0797	.0960
S	Titanium Alloys 6Al-4V, 6-2-4	Peripheral - HEM	≤ 3 x D	.1 x D	7	123	.0492	.0656	.0817	.0984	.1309	.1633	.1968
		Peripheral - HEM	> 3 - 4 x D	.08 x D	7	123	.0443	.0590	.0735	.0886	.1178	.1470	.1771
		Peripheral - HEM	> 4 - 5 x D	.08 x D	7	119	.0394	.0525	.0653	.0787	.1047	.1307	.1574
		Finish	3 x D	.015 x D	7	107	.0192	.0256	.0319	.0384	.0511	.0637	.0768
	Difficult-to-Machine Titanium Alloys 10-2-3 Precipitation Hardening Stainless Steel M 13-8	Peripheral - HEM	≤ 2.5 x D	.08 x D	7	102	.0480	.0640	.0797	.0960	.1277	.1593	.1920
		Peripheral - HEM	> 2.5 - 3.5 x D	.07 x D	7	99	.0432	.0576	.0717	.0864	.1149	.1434	.1728
		Peripheral - HEM	> 3.5 - 4 x D	.06 x D	7	93	.0384	.0512	.0637	.0768	.1021	.1275	.1536
		Finish	3 x D	.01 x D	7	88	.0168	.0224	.0279	.0336	.0447	.0558	.0672
	Hastalloy, Waspalloy	Peripheral - HEM	≤ 1.5 x D	.08 x D	7	30	.1128	.1504	.1872	.2256	.3000	.3745	.4512
		Peripheral - HEM	> 1.5 - 2.5 x D	.08 x D	7	29	.1015	.1353	.1685	.2030	.2700	.3370	.4060
		Peripheral - HEM	> 2.5 - 3.5 x D	.06 x D	7	26	.0902	.1203	.1498	.1805	.2400	.2996	.3609
		Finish	2 x D	.01 x D	7	27	.0600	.0800	.0996	.1200	.1596	.1992	.2400
	Inconel 718, Rene 88	Peripheral - HEM	≤ 1.5 x D	.07 x D	7	29	.1116	.1488	.1852	.2232	.2968	.3705	.4464
		Peripheral - HEM	> 1.5 - 2.5 x D	.06 x D	7	27	.1004	.1339	.1667	.2009	.2671	.3334	.4017
		Peripheral - HEM	> 2.5 - 3 x D	.06 x D	7	26	.0893	.1190	.1482	.1785	.2375	.2964	.3571
		Finish	2 x D	.01 x D	7	26	.0576	.0768	.0956	.1152	.1532	.1912	.2304

D = Tool Diameter HEM = High-efficiency machining (chip thinning calculations have already been applied to HEM parameters shown)

D Tool Diameter
Z Number of Flutes
RPM Revolutions per Minute
SFM Surface Feet per Minute
M/min Surface Meters per Minute
IPM Inches per Minute
MMPM Millimeters per Minute
IPT Inch per Tooth
MMPT Millimeters per Tooth
MRR Metal Removal Rate
RDOC Radial Depth of Cut
ADOC Axial Depth of Cut

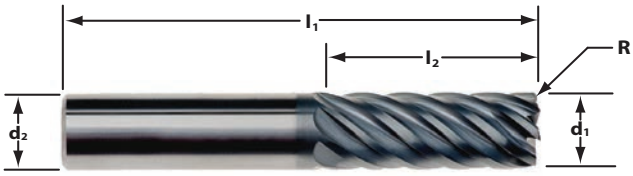
Technical Resources

Information on tips and adjustments for the following milling operations can be found in our Technical Resources section beginning on page 129.

- HEM slotting
- Face milling
- Helical entry ramping
- Straight line ramping
- Long tool projection adjustments
- Ball nose milling adjustments
- Other helpful tips and calculations

IPT9
POW•R•PATH

For high-efficiency machining (HEM) in materials ranging from low carbon steels to hi-temp alloys. The IPT9 POW•R•PATH end mill is engineered specifically for HEM tool paths with great core strength and 9 flutes for increased feed rates and excellent surface finishes. The unique design runs up to 3.5 x the tool diameter deep, generating high metal removal rates.



in: *d1: +0.000 / -0.002* *d2: -0.0001 / -0.0004*
mm: *d1: +0.000 / -0.050* *d2: -0.0025 / -0.0100*

K P M S

Cutter Dia d1	Shank Dia d2	Max Axial Depth xD	Length of Cut l2	Overall Length l1	Order Code by Corner Radius .015 CR	.030 CR	.060 CR	.125 CR
1/4	1/4	2	1/2	2	63932	63933	-	-
		2.5	5/8	2-1/2	63934	63935	-	-
		3	3/4	2-1/2	63936	63937	-	-
		3.5	7/8	3	63938	63939	-	-
3/8	3/8	2	3/4	2-1/2	63940	63941	-	-
		2.5	15/16	2-1/2	63942	63943	-	-
		3	1-1/8	3	63944	63945	-	-
		3.5	1-5/16	3-1/2	63946	63947	-	-
1/2	1/2	2	1	3	-	63948	63949	-
		2.5	1-1/4	3-1/4	-	63950	63951	-
		3	1-1/2	3-1/2	-	63952	63953	-
		3.5	1-3/4	4	-	63954	63955	-
5/8	5/8	2	1-1/4	3-1/2	-	63956	63957	-
		2.5	1-9/16	4	-	63958	63959	-
		3	1-7/8	4	-	63960	63961	-
		3.5	2-3/16	4-1/2	-	63962	63963	-
3/4	3/4	2	1-1/2	4	-	63964	63965	63966
		2.5	1-7/8	4-1/2	-	63967	63968	63969
		3	2-1/4	5	-	63970	63971	63972
		3.5	2-5/8	5	-	63973	63974	63975
1	1	2	2	5	-	63976	63977	63978
		2.5	2-1/2	5-1/2	-	63979	63980	63981
		3	3	6	-	63982	63983	63984
		3.5	3-1/2	6-1/2	-	63985	63986	63987

D = Tool Diameter

Cutter Dia d1	Shank Dia d2	Max Axial Depth xD	Length of Cut l2	Overall Length l1	Order Code by Corner Radius 0.5 CR	1.0 CR	1.5 CR	3.0 CR
6	6	2	12	57	64357	64358	-	-
		2.5	15	57	64359	64360	-	-
		3	18	63	64361	64362	-	-
		3.5	21	75	64363	64364	-	-
8	8	2.5	20	63	64365	64366	-	-
		3	24	63	64367	64368	-	-
		3.5	28	75	64369	64370	-	-
10	10	2	20	66	64371	64372	-	-
		2.5	25	72	64373	64374	-	-
		3	30	75	64375	64376	-	-
		3.5	35	88	64377	64378	-	-
12	12	2	24	75	-	64379	64380	-
		2.5	30	83	-	64381	64382	-
		3	36	88	-	64383	64384	-
		3.5	42	93	-	64385	64386	-
16	16	2	32	92	-	64387	64388	-
		2.5	40	100	-	64389	64390	-
		3	48	110	-	64391	64392	-
		3.5	56	110	-	64393	64394	-
20	20	2	40	104	-	64395	64396	64397
		2.5	50	115	-	64398	64399	64400
		3	60	125	-	64401	64402	64403
		3.5	70	135	-	64404	64405	64406
25	25	2	50	120	-	64407	-	64408
		2.5	63	135	-	64409	-	64410
		3	75	150	-	64411	-	64412
		3.5	88	165	-	64413	-	64414

D = Tool Diameter

TOOL TIP

Determining Power Requirements.

It can be helpful to understand the power requirements for an application. The following formulas calculate spindle and motor horsepower and spindle torque.

STEP 1: Metal Removal Rate (MRR) = (Tool Feed Rate) x Radial DOC x Axial DOC

STEP 2: Spindle HP = Metal Removal Rate x UHP

STEP 3: Motor HP = Spindle HP / Efficiency

STEP 4: Spindle Torque (ft. lbs.) = (Spindle HP x 63,030) / RPM

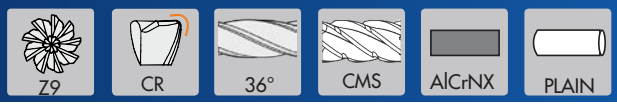
UHP Factors Rating

Material	Factor
Aluminum	0.3
Cast iron	0.8
Carbon steel	1
Alloy steel	1.1
Mold steel	1.2
Tool steel	1.2
Stainless steel	1.5
Titanium	1.8
Hi-temp alloys	2

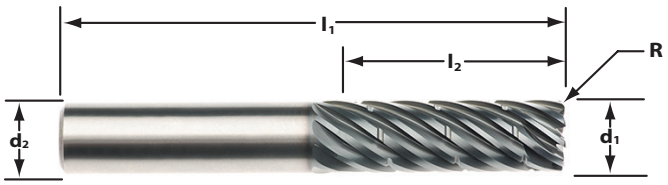
Efficiency Ratings

Spindle Type	%
Direct drive	90%
Gear drive	85%
2 Belt	70%
1 Belt	50%
Average	80%

IPC9
POW•R•PATH



For high-efficiency machining (HEM) in materials ranging from low carbon steels to hi-temp alloys. Adds the benefits of the unique **Chip Management System (CMS)** to the versatility of the IPT9 design. Breaks up long, stringy chips, which eliminates recutting chips and chip packing, and allows for deep, free cutting tool movement in a variety of materials.



in: *d1: +0.000 / -0.002* *d2: -0.0001 / -0.0004*
mm: *d1: +0.000 / -0.050* *d2: -0.0025 / -0.0100*

K P M S

Cutter Dia d1	Shank Dia d2	Max Axial Depth xD	Length of Cut l2	Overall Length l1	Order Code by Corner Radius .030 CR	.060 CR	.125 CR
1/2	1/2	2	1	3	63831	-	-
		2.5	1-1/4	3-1/4	63999	-	-
		3	1-1/2	3-1/2	63835	63919	-
		3.5	1-3/4	4	63988	63920	-
5/8	5/8	2	1-1/4	3-1/2	63839	-	-
		2.5	1-9/16	4	63989	63921	-
		3	1-7/8	4	63843	63922	-
		3.5	2-3/16	4-1/2	63990	63923	-
3/4	3/4	2	1-1/2	4	63847	63924	63848
		2.5	1-7/8	4-1/2	63991	63925	63992
		3	2-1/4	5	63851	63926	63852
		3.5	2-5/8	5	63853	63927	63854
1	1	2	2	5	63993	63928	63994
		2.5	2-1/2	5-1/2	63995	63929	63996
		3	3	6	63859	63930	63860
		3.5	3-1/2	6-1/2	63997	63931	63998

Cutter Dia d1	Shank Dia d2	Max Axial Depth xD	Length of Cut l2	Overall Length l1	Order Code by Corner Radius 1.0 CR	1.5 CR	3.0 CR
12	12	2	24	75	64143	-	-
		2.5	30	83	63889	-	-
		3	36	88	64150	64415	-
		3.5	42	93	64151	64416	-
16	16	2	32	92	64157	-	-
		2.5	40	100	64158	64417	-
		3	48	110	64163	64418	-
		3.5	56	110	63901	64419	-
20	20	2	40	104	63903	64420	63904
		2.5	50	115	64164	64421	64170
		3	60	125	63907	64422	63908
		3.5	70	135	64171	64423	64175
25	25	2	50	120	63911	-	63912
		2.5	63	135	63813	-	63814
		3	75	150	63915	-	63916
		3.5	88	165	63863	-	63864

D = Tool Diameter

IPT9/IPC9 Application Guide – Speed & Feed (inch)

ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	No. of Flutes	Speed (SFM)	Feed (Inches per Tooth) 1/4	3/8	1/2	5/8	3/4	1
K	Gray ASTM-A48 Class 20, 25, 30, 35 & 40	Peripheral - HEM	≤ 3 x D	.1 x D	9	400	.0036	.0054	.0072	.0090	.0108	.0144
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	400	.0032	.0049	.0065	.0081	.0097	.0130
		Peripheral - HEM	> 4 - 5 x D	.08 x D	9	390	.0029	.0043	.0058	.0072	.0086	.0115
		Finish	3 x D	.015 x D	9	450	.0013	.0020	.0026	.0033	.0039	.0052
	Cast Iron Malleable	Peripheral - HEM	≤ 3 x D	.08 x D	9	390	.0029	.0044	.0058	.0073	.0087	.0116
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	390	.0026	.0039	.0052	.0065	.0078	.0104
		Peripheral - HEM	> 4 - 5 x D	.08 x D	9	375	.0023	.0035	.0046	.0058	.0070	.0093
		Finish	3 x D	.015 x D	9	350	.0011	.0016	.0021	.0026	.0032	.0042
P	Low Carbon Steels ≤ 38 Rc 1018, 1020, 12L14, 5120, 8620	Peripheral - HEM	≤ 3 x D	.08 x D	9	485	.0038	.0056	.0075	.0094	.0113	.0150
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	485	.0034	.0051	.0068	.0084	.0101	.0135
		Peripheral - HEM	> 4 - 5 x D	.08 x D	9	465	.0030	.0045	.0060	.0075	.0090	.0120
		Finish	3 x D	.015 x D	9	420	.0014	.0021	.0028	.0035	.0042	.0056
	Medium Carbon Steels ≤ 48 HRC 1045, 4140, 4340, 5140	Peripheral - HEM	≤ 3 x D	.08 x D	9	450	.0036	.0053	.0071	.0089	.0107	.0142
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	450	.0032	.0048	.0064	.0080	.0096	.0128
		Peripheral - HEM	> 4 - 5 x D	.08 x D	9	425	.0028	.0043	.0057	.0071	.0085	.0114
		Finish	3 x D	.015 x D	9	390	.0013	.0019	.0025	.0031	.0038	.0050
	Tool and Die Steels ≤ 48 Rc A2, D2, O1, S7, P20, H13	Peripheral - HEM	≤ 3 x D	.08 x D	9	420	.0032	.0048	.0064	.0080	.0096	.0128
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	420	.0029	.0043	.0058	.0072	.0086	.0115
		Peripheral - HEM	> 4 - 5 x D	.08 x D	9	395	.0026	.0038	.0051	.0064	.0077	.0102
		Finish	3 x D	.015 x D	9	365	.0011	.0016	.0021	.0026	.0032	.0042
M	Martensitic & Ferritic Stainless Steels 410, 416, 440	Peripheral - HEM	≤ 3 x D	.08 x D	9	450	.0038	.0056	.0075	.0094	.0113	.0150
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	450	.0034	.0051	.0068	.0084	.0101	.0135
		Peripheral - HEM	> 4 - 5 x D	.08 x D	9	425	.0030	.0045	.0060	.0075	.0090	.0120
		Finish	3 x D	.015 x D	9	390	.0013	.0019	.0025	.0031	.0038	.0050
	Austenitic Stainless Steels, FeNi Alloys 303, 304, 316, Invar, Kovar	Peripheral - HEM	≤ 3 x D	.08 x D	9	450	.0032	.0048	.0064	.0080	.0096	.0128
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	440	.0029	.0043	.0058	.0072	.0086	.0115
		Peripheral - HEM	> 4 - 5 x D	.07 x D	9	425	.0026	.0038	.0051	.0064	.0077	.0102
		Finish	3 x D	.015 x D	9	390	.0012	.0018	.0024	.0030	.0036	.0048
	Precipitation Hardening Stainless Steels 17-4, 15-5	Peripheral - HEM	≤ 3 x D	.08 x D	9	440	.0031	.0047	.0062	.0078	.0093	.0124
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	440	.0028	.0042	.0056	.0070	.0084	.0112
		Peripheral - HEM	> 4 - 5 x D	.07 x D	9	415	.0025	.0037	.0050	.0062	.0074	.0099
		Finish	3 x D	.015 x D	9	380	.0010	.0015	.0020	.0025	.0030	.0040
S	Titanium Alloys 6Al-4V, 6-2-4	Peripheral - HEM	≤ 3 x D	.1 x D	9	405	.0021	.0031	.0041	.0051	.0062	.0082
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	405	.0018	.0028	.0037	.0046	.0055	.0074
		Peripheral - HEM	> 4 - 5 x D	.08 x D	9	390	.0016	.0025	.0033	.0041	.0049	.0066
		Finish	3 x D	.015 x D	9	350	.0008	.0012	.0016	.0020	.0024	.0032
	Difficult-to-Machine Titanium Alloys 10-2-3	Peripheral - HEM	≤ 2.5 x D	.08 x D	9	335	.0020	.0030	.0040	.0050	.0060	.0080
		Peripheral - HEM	> 2.5 - 3.5 x D	.07 x D	9	325	.0018	.0027	.0036	.0045	.0054	.0072
	Precipitation Hardening Stainless Steel M 13-8	Peripheral - HEM	> 3.5 - 4 x D	.06 x D	9	305	.0016	.0024	.0032	.0040	.0048	.0064
		Finish	3 x D	.01 x D	9	290	.0007	.0011	.0014	.0018	.0021	.0028
	Hastalloy, Waspalloy	Peripheral - HEM	≤ 1.5 x D	.08 x D	9	100	.0045	.0068	.0090	.0113	.0135	.0180
		Peripheral - HEM	> 1.5 - 2.5 x D	.08 x D	9	95	.0041	.0061	.0081	.0101	.0122	.0162
		Peripheral - HEM	> 2.5 - 3.5 x D	.06 x D	9	85	.0036	.0054	.0072	.0090	.0108	.0144
		Finish	2 x D	.01 x D	9	90	.0024	.0036	.0048	.0060	.0072	.0096
	Inconel 718, Rene 88	Peripheral - HEM	≤ 1.5 x D	.07 x D	9	95	.0046	.0068	.0091	.0114	.0137	.0182
		Peripheral - HEM	> 1.5 - 2.5 x D	.06 x D	9	90	.0041	.0061	.0082	.0102	.0123	.0164
		Peripheral - HEM	> 2.5 - 3 x D	.06 x D	9	85	.0036	.0055	.0073	.0091	.0109	.0146
		Finish	2 x D	.01 x D	9	85	.0023	.0035	.0046	.0058	.0069	.0092

D = Tool Diameter HEM = High-efficiency machining (chip thinning calculations have already been applied to HEM parameters)

≈ Approximately Equals < Less Than
≤ Less Than or Equal To > Greater Than
≥ Greater Than or Equal To = Equals
× Multiply

Common Machining Formulas

$$RPM = \frac{SFM \times 3.82}{D}$$

$$SFM = RPM \times D \times .262$$

$$IPM = RPM \times IPT \times Z$$

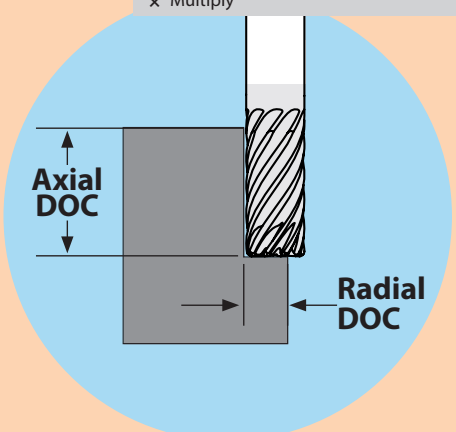
$$MRR = RDOC \times ADOC \times IPM$$

$$RPM = \frac{M/min \times 318.3}{D}$$

$$M/min = RPM \times D \times .00314$$

$$MMPM = RPM \times MMPT \times Z$$

$$MRR = RDOC \times ADOC \times MMPM$$



IPT9/IPC9 Application Guide – Speed & Feed (metric)

ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	No. of Flutes	Speed (M/min)	Feed (MM per Tooth) 6.0	8.0	10.0	12.0	16.0	20.0	25.0
K	Gray ASTM-A48 Class 20, 25, 30, 35 & 40	Peripheral - HEM	≤ 3 x D	.1 x D	9	122	.0864	.1152	.1434	.1728	.2298	.2868	.3456
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	122	.0778	.1037	.1291	.1555	.2068	.2581	.3110
		Peripheral - HEM	> 4 - 5 x D	.08 x D	9	119	.0691	.0922	.1147	.1382	.1838	.2295	.2765
		Finish	3 x D	.015 x D	9	137	.0312	.0416	.0518	.0624	.0830	.1036	.1248
	Cast Iron Malleable	Peripheral - HEM	≤ 3 x D	.08 x D	9	119	.0696	.0928	.1155	.1392	.1851	.2311	.2784
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	119	.0626	.0835	.1040	.1253	.1666	.2079	.2505
		Peripheral - HEM	> 4 - 5 x D	.08 x D	9	114	.0557	.0742	.0924	.1114	.1481	.1848	.2227
		Finish	3 x D	.015 x D	9	107	.0252	.0336	.0418	.0504	.0670	.0837	.1008
P	Low Carbon Steels ≤ 38 Rc 1018, 1020, 12L14, 5120, 8620	Peripheral - HEM	≤ 3 x D	.08 x D	9	148	.0900	.1200	.1494	.1800	.2394	.2988	.3600
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	148	.0810	.1080	.1344	.1620	.2154	.2689	.3240
		Peripheral - HEM	> 4 - 5 x D	.08 x D	9	142	.0720	.0960	.1195	.1440	.1915	.2390	.2880
		Finish	3 x D	.015 x D	9	128	.0336	.0448	.0558	.0672	.0894	.1115	.1344
	Medium Carbon Steels ≤ 48 HRC 1045, 4140, 4340, 5140	Peripheral - HEM	≤ 3 x D	.08 x D	9	137	.0852	.1136	.1414	.1704	.2266	.2828	.3408
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	137	.0767	.1022	.1273	.1533	.2040	.2546	.3067
		Peripheral - HEM	> 4 - 5 x D	.08 x D	9	130	.0682	.0909	.1131	.1363	.1813	.2263	.2726
		Finish	3 x D	.015 x D	9	119	.0300	.0400	.0498	.0600	.0798	.0996	.1200
	Tool and Die Steels ≤ 48 Rc A2, D2, O1, S7, P20, H13	Peripheral - HEM	≤ 3 x D	.08 x D	9	128	.0768	.1024	.1275	.1536	.2043	.2550	.3072
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	128	.0691	.0922	.1147	.1382	.1838	.2295	.2765
		Peripheral - HEM	> 4 - 5 x D	.08 x D	9	120	.0614	.0819	.1020	.1229	.1634	.2040	.2457
		Finish	3 x D	.015 x D	9	111	.0252	.0336	.0418	.0504	.0670	.0837	.1008
M	Martensitic & Ferritic Stainless Steels 410, 416, 440	Peripheral - HEM	≤ 3 x D	.08 x D	9	137	.0900	.1200	.1494	.1800	.2394	.2988	.3600
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	134	.0810	.1080	.1344	.1620	.2154	.2689	.3240
		Peripheral - HEM	> 4 - 5 x D	.07 x D	9	130	.0720	.0960	.1195	.1440	.1915	.2390	.2880
		Finish	3 x D	.015 x D	9	119	.0300	.0400	.0498	.0600	.0798	.0996	.1200
	Austenitic Stainless Steels, FeNi Alloys 303, 304, 316, Invar, Kovar	Peripheral - HEM	≤ 3 x D	.08 x D	9	137	.0768	.1024	.1275	.1536	.2043	.2550	.3072
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	137	.0691	.0922	.1147	.1382	.1838	.2295	.2765
		Peripheral - HEM	> 4 - 5 x D	.08 x D	9	130	.0614	.0819	.1020	.1229	.1634	.2040	.2457
		Finish	3 x D	.015 x D	9	119	.0288	.0384	.0478	.0576	.0766	.0956	.1152
	Precipitation Hardening Stainless Steels 17-4, 15-5	Peripheral - HEM	≤ 3 x D	.08 x D	9	134	.0744	.0992	.1235	.1488	.1979	.2470	.2976
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	134	.0670	.0893	.1111	.1339	.1781	.2223	.2678
		Peripheral - HEM	> 4 - 5 x D	.07 x D	9	126	.0595	.0794	.0988	.1190	.1583	.1976	.2381
		Finish	3 x D	.015 x D	9	116	.0240	.0320	.0398	.0480	.0638	.0797	.0960
S	Titanium Alloys 6Al-4V, 6-2-4	Peripheral - HEM	≤ 3 x D	.1 x D	9	123	.0492	.0656	.0817	.0984	.1309	.1633	.1968
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	123	.0443	.0590	.0735	.0886	.1178	.1470	.1771
		Peripheral - HEM	> 4 - 5 x D	.08 x D	9	119	.0394	.0525	.0653	.0787	.1047	.1307	.1574
		Finish	3 x D	.015 x D	9	107	.0192	.0256	.0319	.0384	.0511	.0637	.0768
	Difficult-to-Machine Titanium Alloys 10-2-3	Peripheral - HEM	≤ 2.5 x D	.08 x D	9	102	.0480	.0640	.0797	.0960	.1277	.1593	.1920
		Peripheral - HEM	> 2.5 - 3.5 x D	.07 x D	9	99	.0432	.0576	.0717	.0864	.1149	.1434	.1728
	Precipitation Hardening Stainless Steel M 13-8	Peripheral - HEM	> 3.5 - 4 x D	.06 x D	9	93	.0384	.0512	.0637	.0768	.1021	.1275	.1536
		Finish	3 x D	.01 x D	9	88	.0168	.0224	.0279	.0336	.0447	.0558	.0672
	Hastalloy, Waspalloy	Peripheral - HEM	≤ 1.5 x D	.08 x D	9	30	.1080	.1440	.1793	.2160	.2873	.3585	.4320
		Peripheral - HEM	> 1.5 - 2.5 x D	.08 x D	9	29	.0972	.1296	.1613	.1944	.2585	.3227	.3888
		Peripheral - HEM	> 2.5 - 3.5 x D	.06 x D	9	26	.0864	.1152	.1434	.1728	.2298	.2868	.3456
		Finish	2 x D	.01 x D	9	27	.0576	.0768	.0956	.1152	.1532	.1912	.2304
	Inconel 718, Rene 88	Peripheral - HEM	≤ 1.5 x D	.07 x D	9	29	.1092	.1456	.1813	.2184	.2904	.3625	.4368
		Peripheral - HEM	> 1.5 - 2.5 x D	.06 x D	9	27	.0983	.1310	.1631	.1965	.2614	.3263	.3931
		Peripheral - HEM	> 2.5 - 3 x D	.06 x D	9	26	.0874	.1165	.1450	.1747	.2324	.2900	.3494
		Finish	2 x D	.01 x D	9	26	.0552	.0736	.0916	.1104	.1468	.1832	.2208

D = Tool Diameter HEM = High-efficiency machining (chip thinning calculations have already been applied to HEM parameters)

D Tool Diameter
Z Number of Flutes
RPM Revolutions per Minute
SFM Surface Feet per Minute
M/min Surface Meters per Minute
IPM Inches per Minute
MMPM Millimeters per Minute
IPT Inch per Tooth
MMPT Millimeters per Tooth
MRR Metal Removal Rate
RDOC Radial Depth of Cut
ADOC Axial Depth of Cut

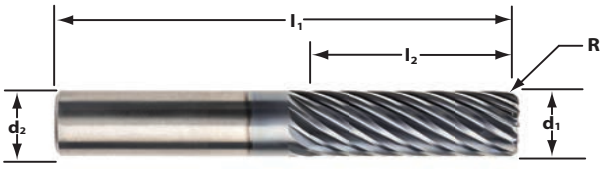
Technical Resources

Information on tips and adjustments for the following milling operations can be found in our Technical Resources section beginning on page 129.

- HEM slotting
- Face milling
- Helical entry ramping
- Straight line ramping
- Long tool projection adjustments
- Ball nose milling adjustments
- Other helpful tips and calculations

IPT11
POW•R•PATH

For high-efficiency machining (HEM) in materials ranging from low carbon steels to hi-temp alloys. Built for results with 11 cutting edges to yield incredible feed rates. Engineered specifically for HEM tool paths, the IPT11 has a very thick core for extra stability when machining materials up to 3.5 x the tool diameter deep.



in: *d1: +0.000 / -0.002* *d2: -0.0001 / -0.0004*
mm: *d1: +0.000 / -0.050* *d2: -0.0025 / -0.0100*

K P M S

Cutter Dia d1	Shank Dia d2	Max Axial Depth xD	Length of Cut l2	Overall Length l1	Order Code by Corner Radius .030 CR	.060 CR	.125 CR
1/2	1/2	2	1	3	64185	64186	-
		2.5	1-1/4	3-1/4	64187	64188	-
		3	1-1/2	3-1/2	64189	64190	-
		3.5	1-3/4	4	64191	64192	-
5/8	5/8	2	1-1/4	3-1/2	64193	64194	-
		2.5	1-9/16	4	64195	64196	-
		3	1-7/8	4	64197	64198	-
		3.5	2-3/16	4-1/2	64199	64200	-
3/4	3/4	2	1-1/2	4	64201	64202	64203
		2.5	1-7/8	4-1/2	64204	64205	64206
		3	2-1/4	5	64207	64208	64209
		3.5	2-5/8	5	64210	64211	64212
1	1	2	2	5	64213	64214	64215
		2.5	2-1/2	5-1/2	64216	64217	64218
		3	3	6	64219	64220	64221
		3.5	3-1/2	6-1/2	64222	64223	64224
1-1/4	1-1/4	2	2-1/2	5-1/2	64225	64226	64227
		2.5	3-1/8	6-1/2	64228	64229	64230

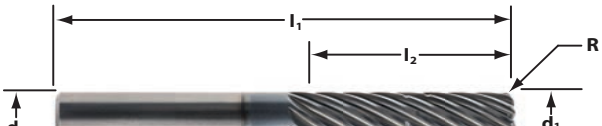
Cutter Dia d1	Shank Dia d2	Max Axial Depth xD	Length of Cut l2	Overall Length l1	Order Code by Corner Radius 1.0 CR	1.5 CR	3.0 CR
12	12	2	24	75	64424	64425	-
		2.5	30	83	64426	64427	-
		3	36	88	64428	64429	-
		3.5	42	93	64430	64431	-
16	16	2	32	92	64432	64433	-
		2.5	40	100	64434	64435	-
		3	48	110	64436	64437	-
		3.5	56	110	64438	64439	-
20	20	2	40	104	64440	64441	64442
		2.5	50	115	64443	64444	64445
		3	60	125	64446	64447	64448
		3.5	70	135	64449	64450	64451

D = Tool Diameter

Note that the IPT11 is not designed for light-duty machines and should only be run in machines with adequate spindle torque and horsepower.

IPC11
POW•R•PATH

For high-efficiency machining (HEM) in materials ranging from low carbon steels to hi-temp alloys. Adds the benefits of the unique **Chip Management System (CMS)** to the versatility of the IPT11 design. Breaks up long, stringy chips, which eliminates recutting chips and chip packing, and allows for deep, free cutting tool movement in a variety of materials. The results are great chip control and very high metal removal rates.



in: *d1: +0.000 / -0.002* *d2: -0.0001 / -0.0004*
mm: *d1: +0.000 / -0.050* *d2: -0.0025 / -0.0100*

K P M S

Cutter Dia d1	Shank Dia d2	Max Axial Depth xD	Length of Cut l2	Overall Length l1	Order Code by Corner Radius .030 CR	.060 CR	.125 CR
1/2	1/2	3	1-1/2	3-1/2	64231	64232	-
		3.5	1-3/4	4	64233	64234	-
5/8	5/8	2.5	1-9/16	4	64235	64236	-
		3	1-7/8	4	64237	64238	-
		3.5	2-3/16	4-1/2	64239	64240	-
3/4	3/4	2	1-1/2	4	64241	64242	64243
		2.5	1-7/8	4-1/2	64244	64245	64246
		3	2-1/4	5	64247	64248	64249
		3.5	2-5/8	5	64250	64251	64252
1	1	2	2	5	64253	64254	64255
		2.5	2-1/2	5-1/2	64256	64257	64258
		3	3	6	64259	64260	64261
		3.5	3-1/2	6-1/2	64262	64263	64264
1-1/4	1-1/4	2	2-1/2	5-1/2	64265	64266	64267
		2.5	3-1/8	6-1/2	64268	64269	64270

Cutter Dia d1	Shank Dia d2	Max Axial Depth xD	Length of Cut l2	Overall Length l1	Order Code by Corner Radius 1.0 CR	1.5 CR	3.0 CR
12	12	3	36	88	64452	64453	-
		3.5	42	93	64454	64455	-
16	16	2.5	40	100	64456	64457	-
		3	48	110	64458	64459	-
		3.5	56	110	64460	64461	-
20	20	2	40	104	64462	64463	64464
		2.5	50	115	64465	64466	64467
		3	60	125	64468	64469	64470
		3.5	70	135	64471	64472	64473

D = Tool Diameter

Note that the IPC11 is not designed for light-duty machines and should only be run in machines with adequate spindle torque and horsepower.

IPT11/IPC11 Application Guide – Speed & Feed (inch)

ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	No. of Flutes	Speed (SFM)	1/2	5/8	3/4	1	1-1/4
K	Gray ASTM-A48 Class 20, 25, 30, 35 & 40	Peripheral - HEM	≤ 2 x D	.08 x D	11	365	.0053	.0066	.0080	.0106	.0133
		Peripheral - HEM	> 2 - 3 x D	.07 x D	11	365	.0046	.0058	.0069	.0092	.0115
		Peripheral - HEM	> 3 - 3.5 x D	.07 x D	11	350	.0040	.0050	.0060	.0080	.0100
		Peripheral - HEM	> 3.5 - 4 x D	.065 x D	11	350	.0034	.0043	.0051	.0068	.0085
		Finish	3 x D	.01 x D	11	370	.0022	.0028	.0033	.0044	.0055
	Cast Iron Malleable	Peripheral - HEM	≤ 2 x D	.07 x D	11	375	.0063	.0079	.0095	.0126	.0158
		Peripheral - HEM	> 2 - 3 x D	.07 x D	11	375	.0056	.0070	.0084	.0112	.0140
		Peripheral - HEM	> 3 - 3.5 x D	.07 x D	11	360	.0048	.0060	.0072	.0096	.0120
		Peripheral - HEM	> 3.5 - 4 x D	.07 x D	11	360	.0040	.0050	.0060	.0080	.0100
		Finish	3 x D	.01 x D	11	335	.0023	.0029	.0035	.0046	.0058
P	Low Carbon Steels ≤ 38 Rc 1018, 1020, 12L14, 5120, 8620	Peripheral - HEM	≤ 2 x D	.07 x D	11	550	.0055	.0069	.0083	.0110	.0138
		Peripheral - HEM	> 2 - 3 x D	.07 x D	11	530	.0048	.0060	.0072	.0096	.0120
		Peripheral - HEM	> 3 - 3.5 x D	.07 x D	11	515	.0042	.0053	.0063	.0084	.0105
		Peripheral - HEM	> 3.5 - 4 x D	.07 x D	11	505	.0036	.0045	.0054	.0072	.0090
		Finish	3 x D	.01 x D	11	475	.0020	.0025	.0030	.0040	.0050
	Medium Carbon Steels ≤ 48 HRC 1045, 4140, 4340, 5140	Peripheral - HEM	≤ 2 x D	.07 x D	11	530	.0054	.0068	.0081	.0108	.0135
		Peripheral - HEM	> 2 - 3 x D	.07 x D	11	515	.0047	.0059	.0071	.0094	.0118
		Peripheral - HEM	> 3 - 3.5 x D	.07 x D	11	500	.0041	.0051	.0062	.0082	.0103
		Peripheral - HEM	> 3.5 - 4 x D	.07 x D	11	490	.0035	.0044	.0053	.0070	.0088
		Finish	3 x D	.01 x D	11	455	.0019	.0024	.0029	.0038	.0048
	Tool and Die Steels ≤ 48 Rc A2, D2, O1, S7, P20, H13	Peripheral - HEM	≤ 2 x D	.06 x D	11	445	.0063	.0079	.0095	.0126	.0158
		Peripheral - HEM	> 2 - 3 x D	.06 x D	11	430	.0055	.0069	.0083	.0110	.0138
		Peripheral - HEM	> 3 - 3.5 x D	.06 x D	11	415	.0048	.0060	.0072	.0096	.0120
		Peripheral - HEM	> 3.5 - 4 x D	.06 x D	11	410	.0041	.0051	.0062	.0082	.0103
		Finish	3 x D	.01 x D	11	385	.0020	.0025	.0030	.0040	.0050
M	Martensitic & Ferritic Stainless Steels 410, 416, 440	Peripheral - HEM	≤ 2 x D	.06 x D	11	450	.0068	.0085	.0102	.0136	.0170
		Peripheral - HEM	> 2 - 3 x D	.06 x D	11	450	.0060	.0075	.0090	.0120	.0150
		Peripheral - HEM	> 3 - 3.5 x D	.06 x D	11	425	.0054	.0068	.0081	.0108	.0135
		Peripheral - HEM	> 3.5 - 4 x D	.06 x D	11	425	.0044	.0055	.0066	.0088	.0110
		Finish	3 x D	.01 x D	11	390	.0023	.0029	.0035	.0046	.0058
	Austenitic Stainless Steels, FeNi Alloys 303, 304, 316, Invar, Kovar	Peripheral - HEM	≤ 2 x D	.06 x D	11	445	.0067	.0084	.0101	.0134	.0168
		Peripheral - HEM	> 2 - 3 x D	.06 x D	11	430	.0059	.0074	.0089	.0118	.0148
		Peripheral - HEM	> 3 - 3.5 x D	.06 x D	11	415	.0052	.0065	.0078	.0104	.0130
		Peripheral - HEM	> 3.5 - 4 x D	.06 x D	11	410	.0043	.0054	.0065	.0086	.0108
		Finish	3 x D	.01 x D	11	385	.0025	.0031	.0038	.0050	.0063
	Precipitation Hardening Stainless Steels 17-4, 15-5	Peripheral - HEM	≤ 2 x D	.06 x D	11	435	.0068	.0085	.0102	.0136	.0170
		Peripheral - HEM	> 2 - 3 x D	.06 x D	11	420	.0060	.0075	.0090	.0120	.0150
		Peripheral - HEM	> 3 - 3.5 x D	.06 x D	11	405	.0052	.0065	.0078	.0104	.0130
		Peripheral - HEM	> 3.5 - 4 x D	.06 x D	11	400	.0043	.0054	.0065	.0086	.0108
		Finish	3 x D	.01 x D	11	375	.0022	.0028	.0033	.0044	.0055
S	Titanium Alloys 6Al-4V, 6-2-4	Peripheral - HEM	≤ 2 x D	.06 x D	11	425	.0060	.0075	.0090	.0120	.0150
		Peripheral - HEM	> 2 - 3 x D	.06 x D	11	415	.0043	.0054	.0065	.0086	.0108
		Peripheral - HEM	> 3 - 3.5 x D	.06 x D	11	395	.0042	.0053	.0063	.0084	.0105
		Peripheral - HEM	> 3.5 - 4 x D	.06 x D	11	395	.0039	.0049	.0059	.0078	.0098
		Finish	3 x D	.015 x D	11	370	.0023	.0029	.0035	.0046	.0058
	Difficult-to-Machine Titanium Alloys 10-2-3 Precipitation Hardening Stainless Steel M 13-8	Peripheral - HEM	≤ 2 x D	0.06 x D	11	350	.0059	.0074	.0089	.0118	.0148
		Peripheral - HEM	> 2 - 3 x D	0.06 x D	11	330	.0042	.0053	.0063	.0084	.0105
		Peripheral - HEM	> 3 - 3.5 x D	0.055 x D	11	315	.0041	.0051	.0062	.0082	.0103
		Peripheral - HEM	> 3.5 - 4 x D	0.05 x D	11	310	.0038	.0048	.0057	.0076	.0095
		Finish	3 x D	.01 x D	11	300	.0020	.0025	.0030	.0040	.0050
	Hastalloy, Waspalloy	Peripheral - HEM	≤ 2 x D	.07 X D	11	105	.0090	.0113	.0135	.0180	.0225
		Peripheral - HEM	> 2 - 3 x D	.065 x D	11	100	.0081	.0101	.0122	.0162	.0203
		Peripheral - HEM	> 3 - 3.5 x D	.055 x D	11	90	.0072	.0090	.0108	.0144	.0180
		Peripheral - HEM	> 3.5 - 4 x D	.055 x D	11	90	.0065	.0081	.0097	.0130	.0162
		Finish	3 x D	.01 x D	11	90	.0047	.0059	.0071	.0094	.0118
	Inconel 718, Rene 88	Peripheral - HEM	≤ 2 x D	.065 x D	11	100	.0062	.0078	.0093	.0124	.0155
		Peripheral - HEM	> 2 - 3 x D	.06 x D	11	95	.0060	.0075	.0090	.0120	.0150
		Peripheral - HEM	> 3 - 3.5 x D	.05 x D	11	95	.0060	.0075	.0090	.0120	.0150
		Peripheral - HEM	> 3.5 - 4 x D	.05 x D	11	95	.0052	.0065	.0078	.0104	.0130
		Finish	3 x D	.01 x D	11	90	.0032	.0040	.0048	.0064	.0080

D = Tool Diameter HEM = High-efficiency machining (chip thinning calculations have already been applied to HEM parameters)

≈ Approximately Equals < Less Than
≤ Less Than or Equal To > Greater Than
≥ Greater Than or Equal To = Equals
× Multiply

IPT11/IPC11 Application Guide – Speed & Feed (metric)

ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	No. of Flutes	Speed (M/min)	12.0	16.0	20.0
K	Gray ASTM-A48 Class 20, 25, 30, 35 & 40	Peripheral - HEM	≤ 2 x D	.08 x D	11	111	.1272	.1692	.2111
		Peripheral - HEM	> 2 - 3 x D	.07 x D	11	111	.1104	.1468	.1832
		Peripheral - HEM	> 3 - 3.5 x D	.07 x D	11	107	.0960	.1277	.1593
		Peripheral - HEM	> 3.5 - 4 x D	.065 x D	11	107	.0816	.1085	.1354
		Finish	3 x D	.01 x D	11	113	.0528	.0702	.0876
	Cast Iron Malleable	Peripheral - HEM	≤ 2 x D	.07 x D	11	114	.1512	.2011	.2510
		Peripheral - HEM	> 2 - 3 x D	.07 x D	11	114	.1344	.1787	.2231
		Peripheral - HEM	> 3 - 3.5 x D	.07 x D	11	110	.1152	.1532	.1912
		Peripheral - HEM	> 3.5 - 4 x D	.07 x D	11	110	.0960	.1277	.1593
		Finish	3 x D	.01 x D	11	102	.0552	.0734	.0916
P	Low Carbon Steels ≤ 38 Rc 1018, 1020, 12L14, 5120, 8620	Peripheral - HEM	≤ 2 x D	.07 x D	11	168	.1320	.1755	.2191
		Peripheral - HEM	> 2 - 3 x D	.07 x D	11	162	.1152	.1532	.1912
		Peripheral - HEM	> 3 - 3.5 x D	.07 x D	11	157	.1008	.1341	.1673
		Peripheral - HEM	> 3.5 - 4 x D	.07 x D	11	154	.0864	.1149	.1434
		Finish	3 x D	.01 x D	11	145	.0480	.0638	.0797
	Medium Carbon Steels ≤ 48 HRC 1045, 4140, 4340, 5140	Peripheral - HEM	≤ 2 x D	.07 x D	11	162	.1296	.1724	.2151
		Peripheral - HEM	> 2 - 3 x D	.07 x D	11	157	.1128	.1500	.1872
		Peripheral - HEM	> 3 - 3.5 x D	.07 x D	11	152	.0984	.1309	.1633
		Peripheral - HEM	> 3.5 - 4 x D	.07 x D	11	149	.0840	.1117	.1394
		Finish	3 x D	.01 x D	11	139	.0456	.0606	.0757
	Tool and Die Steels ≤ 48 Rc A2, D2, O1, S7, P20, H13	Peripheral - HEM	≤ 2 x D	.06 x D	11	136	.1512	.2011	.2510
		Peripheral - HEM	> 2 - 3 x D	.06 x D	11	131	.1320	.1755	.2191
		Peripheral - HEM	> 3 - 3.5 x D	.06 x D	11	126	.1152	.1532	.1912
		Peripheral - HEM	> 3.5 - 4 x D	.06 x D	11	125	.0984	.1309	.1633
		Finish	3 x D	.01 x D	11	117	.0480	.0638	.0797
M	Martensitic & Ferritic Stainless Steels 410, 416, 440	Peripheral - HEM	≤ 2 x D	.06 x D	11	137	.1608	.2138	.2669
		Peripheral - HEM	> 2 - 3 x D	.06 x D	11	137	.1416	.1883	.2350
		Peripheral - HEM	> 3 - 3.5 x D	.06 x D	11	130	.1248	.1660	.2072
		Peripheral - HEM	> 3.5 - 4 x D	.06 x D	11	130	.1032	.1372	.1713
		Finish	3 x D	.01 x D	11	119	.0600	.0798	.0996
	Austenitic Stainless Steels, FeNi Alloys 303, 304, 316, Invar, Kovar	Peripheral - HEM	≤ 2 x D	.06 x D	11	136	.1632	.2170	.2709
		Peripheral - HEM	> 2 - 3 x D	.06 x D	11	131	.1440	.1915	.2390
		Peripheral - HEM	> 3 - 3.5 x D	.06 x D	11	126	.1296	.1724	.2151
		Peripheral - HEM	> 3.5 - 4 x D	.06 x D	11	125	.1056	.1404	.1753
		Finish	3 x D	.01 x D	11	117	.0552	.0734	.0916
	Precipitation Hardening Stainless Steels 17-4, 15-5	Peripheral - HEM	≤ 2 x D	.06 x D	11	133	.1632	.2170	.2709
		Peripheral - HEM	> 2 - 3 x D	.06 x D	11	128	.1440	.1915	.2390
		Peripheral - HEM	> 3 - 3.5 x D	.06 x D	11	123	.1248	.1660	.2072
		Peripheral - HEM	> 3.5 - 4 x D	.06 x D	11	122	.1032	.1372	.1713
		Finish	3 x D	.01 x D	11	114	.0528	.0702	.0876
S	Titanium Alloys 6Al-4V, 6-2-4	Peripheral - HEM	≤ 2 x D	.06 x D	11	130	.1440	.1915	.2390
		Peripheral - HEM	> 2 - 3 x D	.06 x D	11	126	.1032	.1372	.1713
		Peripheral - HEM	> 3 - 3.5 x D	.06 x D	11	120	.1008	.1341	.1673
		Peripheral - HEM	> 3.5 - 4 x D	.06 x D	11	120	.0936	.1245	.1554
		Finish	3 x D	.015 x D	11	113	.0552	.0734	.0916
	Difficult-to-Machine Titanium Alloys 10-2-3 Precipitation Hardening Stainless Steel M 13-8	Peripheral - HEM	≤ 2 x D	0.06 x D	11	107	.1416	.1883	.2350
		Peripheral - HEM	> 2 - 3 x D	0.06 x D	11	101	.1008	.1341	.1673
		Peripheral - HEM	> 3 - 3.5 x D	0.055 x D	11	96	.0984	.1309	.1633
		Peripheral - HEM	> 3.5 - 4 x D	0.05 x D	11	94	.0912	.1213	.1514
		Finish	3 x D	.01 x D	11	91	.0480	.0638	.0797
	Hastalloy, Waspalloy	Peripheral - HEM	≤ 2 x D	.07 X D	11	32	.2160	.2873	.3585
		Peripheral - HEM	> 2 - 3 x D	.065 x D	11	30	.1944	.2585	.3227
		Peripheral - HEM	> 3 - 3.5 x D	.055 x D	11	27	.1728	.2298	.2868
		Peripheral - HEM	> 3.5 - 4 x D	.055 x D	11	27	.1555	.2068	.2581
		Finish	3 x D	.01 x D	11	27	.1128	.1500	.1872
	Inconel 718, Rene 88	Peripheral - HEM	≤ 2 x D	.065 x D	11	30	.1488	.1979	.2470
		Peripheral - HEM	> 2 - 3 x D	.06 x D	11	29	.1440	.1915	.2390
		Peripheral - HEM	> 3 - 3.5 x D	.05 x D	11	29	.1440	.1915	.2390
		Peripheral - HEM	> 3.5 - 4 x D	.05 x D	11	29	.1248	.1660	.2072
		Finish	3 x D	.01 x D	11	27	.0768	.1021	.1275

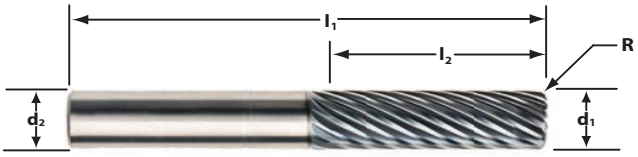
D = Tool Diameter HEM = High-efficiency machining (chip thinning calculations have already been applied to HEM parameters)

Information on tips and adjustments can be found in our Technical Resources section beginning on page 129.

IPT13
POW•R•PATH

Z13 | CR | 30° | AlCrNX | PLAIN

For high-efficiency machining (HEM) in materials ranging from low carbon steels to hi-temp alloys. The IPT13 offers the most cutting edges available in the POW•R•PATH line. The 13 flutes yield incredible metal removal rates and tool life. Engineered specifically for HEM tool paths, the IPT13 has a very thick core for extra stability when machining materials up to 3.5 x the tool diameter deep.



in: *d1: +0.000 / -0.002* *d2: -0.0001 / -0.0004*
mm: *d1: +0.000 / -0.050* *d2: -0.0025 / -0.0100*

K P M S

Cutter Dia d1	Shank Dia d2	Max Axial Depth xD	Length of Cut l2	Overall Length l1	Order Code by Corner Radius .030 CR	.060 CR	.125 CR
1/2	1/2	2	1	3	64271	64272	-
		2.5	1-1/4	3-1/4	64273	64274	-
		3	1-1/2	3-1/2	64275	64276	-
		3.5	1-3/4	4	64277	64278	-
5/8	5/8	2	1-1/4	3-1/2	64279	64280	-
		2.5	1-9/16	4	64281	64282	-
		3	1-7/8	4	64283	64284	-
		3.5	2-3/16	4-1/2	64285	64286	-
3/4	3/4	2	1-1/2	4	64287	64288	64289
		2.5	1-7/8	4-1/2	64290	64291	64292
		3	2-1/4	5	64293	64294	64295
		3.5	2-5/8	5	64296	64297	64298
1	1	2	2	5	64299	64300	64301
		2.5	2-1/2	5-1/2	64302	64303	64304
		3	3	6	64305	64306	64307
		3.5	3-1/2	6-1/2	64308	64309	64310
1-1/4	1-1/4	2	2-1/2	5-1/2	64311	64312	64313
		2.5	3-1/8	6-1/2	64314	64315	64316

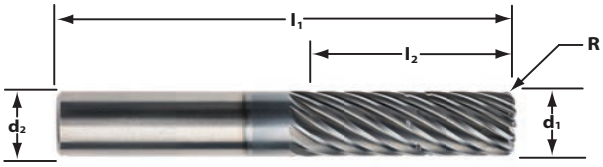
Note that the IPT13 is not designed for light-duty machines and should only be run in machines with adequate spindle torque and horsepower.

Cutter Dia d1	Shank Dia d2	Max Axial Depth xD	Length of Cut l2	Overall Length l1	Order Code by Corner Radius 1.0 CR	1.5 CR	3.0 CR
12	12	2	24	75	64474	64475	-
		2.5	30	83	64476	64477	-
		3	36	88	64478	64479	-
		3.5	42	93	64480	64481	-
16	16	2	32	92	64482	64483	-
		2.5	40	100	64484	64485	-
		3	48	110	64486	64487	-
		3.5	56	110	64488	64489	-
20	20	2	40	104	64490	64491	64492
		2.5	50	115	64493	64494	64495
		3	60	125	64496	64497	64498
		3.5	70	135	64499	64500	64501

D = Tool Diameter

IPC13
POW•R•PATH

For high-efficiency machining (HEM) in materials ranging from low carbon steels to hi-temp alloys. Adds the benefits of the unique **Chip Management System (CMS)** to the versatility of the IPT13 design. Breaks up long, stringy chips, which eliminates recutting chips and chip packing, and allows for deep, free cutting tool movement in a variety of materials. The results are great chip control and very high metal removal rates.



in: *d1: +0.000 / -0.002* *d2: -0.0001 / -0.0004*
mm: *d1: +0.000 / -0.050* *d2: -0.0025 / -0.0100*

Cutter Dia d1	Shank Dia d2	Max Axial Depth xD	Length of Cut l2	Overall Length l1	Order Code by Corner Radius .030 CR	.060 CR	.125 CR
1/2	1/2	3	1-1/2	3-1/2	64317	64318	-
		3.5	1-3/4	4	64319	64320	-
5/8	5/8	2.5	1-9/16	4	64321	64322	-
		3	1-7/8	4	64323	64324	-
		3.5	2-3/16	4-1/2	64325	64326	-
3/4	3/4	2	1-1/2	4	64327	64328	64329
		2.5	1-7/8	4-1/2	64330	64331	64332
		3	2-1/4	5	64333	64334	64335
		3.5	2-5/8	5	64336	64337	64338
1	1	2	2	5	64339	64340	64341
		2.5	2-1/2	5-1/2	64342	64343	64344
		3	3	6	64345	64346	64347
		3.5	3-1/2	6-1/2	64348	64349	64350
1-1/4	1-1/4	2	2-1/2	5-1/2	64351	64352	64353
		2.5	3-1/8	6-1/2	64354	64355	64356

Note that the IPC13 is not designed for light-duty machines and should only be run in machines with adequate spindle torque and horsepower.

Cutter Dia d1	Shank Dia d2	Max Axial Depth xD	Length of Cut l2	Overall Length l1	Order Code by Corner Radius 1.0 CR	1.5 CR	3.0 CR
12	12	3	36	88	64502	64503	-
		3.5	42	93	64504	64505	-
16	16	2.5	40	100	64506	64507	-
		3	48	110	64508	64509	-
		3.5	56	110	64510	64511	-
20	20	2	40	104	64512	64513	64514
		2.5	50	115	64515	64516	64517
		3	60	125	64518	64519	64520
		3.5	70	135	64521	64522	64523

D = Tool Diameter

IPT13/IPC13 Application Guide – Speed & Feed (inch)

ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	No. of Flutes	Speed (SFM)	Feed (Inches per Tooth) 1/2	5/8	3/4	1	1-1/4
K	Gray ASTM-A48 Class 20, 25, 30, 35 & 40	Peripheral - HEM	≤ 2 x D	.07 x D	13	370	.0045	.0056	.0068	.0090	.0113
		Peripheral - HEM	> 2 - 3 x D	.07 x D	13	370	.0040	.0050	.0060	.0080	.0100
		Peripheral - HEM	> 3 - 3.5 x D	.07 x D	13	360	.0034	.0043	.0051	.0068	.0085
		Peripheral - HEM	> 3.5 - 4 x D	.06 x D	13	360	.0030	.0038	.0045	.0060	.0075
		Finish	3 x D	.01 x D	13	365	.0020	.0025	.0030	.0040	.0050
	Cast Iron Malleable	Peripheral - HEM	≤ 2 x D	.07 x D	13	380	.0048	.0060	.0072	.0096	.0120
		Peripheral - HEM	> 2 - 3 x D	.07 x D	13	380	.0042	.0053	.0063	.0084	.0105
		Peripheral - HEM	> 3 - 3.5 x D	.07 x D	13	365	.0039	.0049	.0059	.0078	.0098
		Peripheral - HEM	> 3.5 - 4 x D	.07 x D	13	365	.0036	.0045	.0054	.0072	.0090
		Finish	3 x D	.01 x D	13	340	.0017	.0021	.0026	.0034	.0043
P	Low Carbon Steels ≤ 38 Rc 1018, 1020, 12L14, 5120, 8620	Peripheral - HEM	≤ 2 x D	.07 x D	13	450	.0044	.0055	.0066	.0088	.0110
		Peripheral - HEM	> 2 - 3 x D	.07 x D	13	430	.0039	.0049	.0059	.0078	.0098
		Peripheral - HEM	> 3 - 3.5 x D	.07 x D	13	420	.0036	.0045	.0054	.0072	.0090
		Peripheral - HEM	> 3.5 - 4 x D	.07 x D	13	410	.0034	.0043	.0051	.0068	.0085
		Finish	3 x D	.01 x D	13	395	.0017	.0021	.0026	.0034	.0043
	Medium Carbon Steels ≤ 48 HRC 1045, 4140, 4340, 5140	Peripheral - HEM	≤ 2 x D	.06 x D	13	405	.0044	.0055	.0066	.0088	.0110
		Peripheral - HEM	> 2 - 3 x D	.06 x D	13	405	.0041	.0051	.0062	.0082	.0103
		Peripheral - HEM	> 3 - 3.5 x D	.05 x D	13	405	.0039	.0049	.0059	.0078	.0098
		Peripheral - HEM	> 3.5 - 4 x D	.05 x D	13	405	.0036	.0045	.0054	.0072	.0090
		Finish	3 x D	.01 x D	13	370	.0017	.0021	.0026	.0034	.0043
	Tool and Die Steels ≤ 48 Rc A2, D2, O1, S7, P20, H13	Peripheral - HEM	≤ 2 x D	.06 x D	13	420	.0045	.0056	.0068	.0090	.0113
		Peripheral - HEM	> 2 - 3 x D	.06 x D	13	420	.0040	.0050	.0060	.0080	.0100
		Peripheral - HEM	> 3 - 3.5 x D	.05 x D	13	415	.0037	.0046	.0056	.0074	.0093
		Peripheral - HEM	> 3.5 - 4 x D	.05 x D	13	415	.0035	.0044	.0053	.0070	.0088
		Finish	3 x D	.01 x D	13	385	.0015	.0019	.0023	.0030	.0038
M	Martensitic & Ferritic Stainless Steels 410, 416, 440	Peripheral - HEM	≤ 2 x D	.06 x D	13	460	.0050	.0063	.0075	.0100	.0125
		Peripheral - HEM	> 2 - 3 x D	.06 x D	13	460	.0048	.0060	.0072	.0096	.0120
		Peripheral - HEM	> 3 - 3.5 x D	.06 x D	13	450	.0040	.0050	.0060	.0080	.0100
		Peripheral - HEM	> 3.5 - 4 x D	.06 x D	13	445	.0035	.0044	.0053	.0070	.0088
		Finish	3 x D	.01 x D	13	390	.0018	.0023	.0027	.0036	.0045
	Austenitic Stainless Steels, FeNi Alloys 303, 304, 316, Invar, Kovar	Peripheral - HEM	≤ 2 x D	.06 x D	13	450	.0041	.0051	.0062	.0082	.0103
		Peripheral - HEM	> 2 - 3 x D	.06 x D	13	450	.0040	.0050	.0060	.0080	.0100
		Peripheral - HEM	> 3 - 3.5 x D	.05 x D	13	450	.0037	.0046	.0056	.0074	.0093
		Peripheral - HEM	> 3.5 - 4 x D	.05 x D	13	445	.0035	.0044	.0053	.0070	.0088
		Finish	3 x D	.01 x D	13	415	.0015	.0019	.0023	.0030	.0038
	Precipitation Hardening Stainless Steels 17-4, 15-5	Peripheral - HEM	> 2 - 3 x D	.06 x D	13	440	.0041	.0051	.0062	.0082	.0103
		Peripheral - HEM	> 3 - 3.5 x D	.05 x D	13	435	.0038	.0048	.0057	.0076	.0095
		Peripheral - HEM	> 3.5 - 4 x D	.05 x D	13	435	.0034	.0043	.0051	.0068	.0085
		Finish	3 x D	.01 x D	13	400	.0017	.0021	.0026	.0034	.0043
S	Titanium Alloys 6Al-4V, 6-2-4	Peripheral - HEM	≤ 2 x D	.08 x D	13	395	.0050	.0063	.0075	.0100	.0125
		Peripheral - HEM	> 2 - 3 x D	.07 x D	13	390	.0045	.0056	.0068	.0090	.0113
		Peripheral - HEM	> 3 - 3.5 x D	.06 x D	13	380	.0041	.0051	.0062	.0082	.0103
		Peripheral - HEM	> 3.5 - 4 x D	.06 x D	13	380	.0034	.0043	.0051	.0068	.0085
		Finish	3 x D	.015 x D	13	355	.0022	.0028	.0033	.0044	.0055
	Difficult-to-Machine Titanium Alloys 10-2-3	Peripheral - HEM	≤ 2 x D	.06 x D	13	350	.0050	.0063	.0075	.0100	.0125
		Peripheral - HEM	> 2 - 3 x D	.06 x D	13	330	.0036	.0045	.0054	.0072	.0090
	Precipitation Hardening Stainless Steels M 13-8	Peripheral - HEM	> 3 - 3.5 x D	.055 x D	13	315	.0035	.0044	.0053	.0070	.0088
		Peripheral - HEM	> 3.5 - 4 x D	.05 x D	13	310	.0032	.0040	.0048	.0064	.0080
		Finish	3 x D	.01 x D	13	300	.0017	.0021	.0026	.0034	.0043
	Hastalloy, Waspalloy	Peripheral - HEM	≤ 2 x D	.07 X D	13	105	.0071	.0089	.0107	.0142	.0178
		Peripheral - HEM	> 2 - 3 x D	.065 x D	13	100	.0064	.0080	.0096	.0128	.0160
		Peripheral - HEM	> 3 - 3.5 x D	.055 x D	13	90	.0062	.0078	.0093	.0124	.0155
		Peripheral - HEM	> 3.5 - 4 x D	.05 x D	13	90	.0057	.0071	.0086	.0114	.0143
		Finish	3 x D	.01 x D	13	90	.0044	.0055	.0066	.0088	.0110
	Inconel 718, Rene 88	Peripheral - HEM	≤ 2 x D	.06 x D	13	100	.0052	.0065	.0078	.0104	.0130
		Peripheral - HEM	> 2 - 3 x D	.05 x D	13	95	.0052	.0065	.0078	.0104	.0130
		Peripheral - HEM	> 3 - 3.5 x D	.05 x D	13	95	.0048	.0060	.0072	.0096	.0120
		Peripheral - HEM	> 3.5 - 4 x D	.04 x D	13	95	.0048	.0060	.0072	.0096	.0120
		Finish	3 x D	.01 x D	13	90	.0023	.0029	.0035	.0046	.0058

D = Tool Diameter HEM = High-efficiency machining (chip thinning calculations have already been applied to HEM parameters)

≈ Approximately Equals < Less Than
≤ Less Than or Equal To > Greater Than
≥ Greater Than or Equal To = Equals
× Multiply

IPT13/IPC13 Application Guide – Speed & Feed (metric)

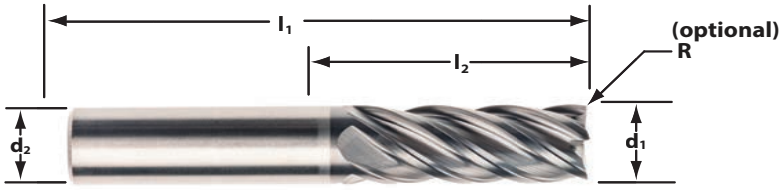
ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	No. of Flutes	Speed (M/min)	Feed (MM per Tooth) 12.0	16.0	20.0
K	Gray ASTM-A48 Class 20, 25, 30, 35 & 40	Peripheral - HEM	≤ 2 x D	.07 x D	13	113	.1080	.1436	.1793
		Peripheral - HEM	> 2 - 3 x D	.07 x D	13	113	.0960	.1277	.1593
		Peripheral - HEM	> 3 - 3.5 x D	.07 x D	13	110	.0816	.1085	.1354
		Peripheral - HEM	> 3.5 - 4 x D	.06 x D	13	110	.0720	.0958	.1195
		Finish	3 x D	.01 x D	13	111	.0480	.0638	.0797
	Cast Iron Malleable	Peripheral - HEM	≤ 2 x D	.07 x D	13	116	.1152	.1532	.1912
		Peripheral - HEM	> 2 - 3 x D	.07 x D	13	116	.1008	.1341	.1673
		Peripheral - HEM	> 3 - 3.5 x D	.07 x D	13	111	.0936	.1245	.1554
		Peripheral - HEM	> 3.5 - 4 x D	.07 x D	13	111	.0864	.1149	.1434
		Finish	3 x D	.01 x D	13	104	.0408	.0543	.0677
P	Low Carbon Steels ≤ 38 Rc 1018, 1020, 12L14, 5120, 8620	Peripheral - HEM	≤ 2 x D	.07 x D	13	137	.1056	.1404	.1753
		Peripheral - HEM	> 2 - 3 x D	.07 x D	13	131	.0936	.1245	.1554
		Peripheral - HEM	> 3 - 3.5 x D	.07 x D	13	128	.0864	.1149	.1434
		Peripheral - HEM	> 3.5 - 4 x D	.07 x D	13	125	.0816	.1085	.1354
		Finish	3 x D	.01 x D	13	120	.0408	.0543	.0677
	Medium Carbon Steels ≤ 48 HRC 1045, 4140, 4340, 5140	Peripheral - HEM	≤ 2 x D	.06 x D	13	123	.1056	.1404	.1753
		Peripheral - HEM	> 2 - 3 x D	.06 x D	13	123	.0984	.1309	.1633
		Peripheral - HEM	> 3 - 3.5 x D	.05 x D	13	123	.0936	.1245	.1554
		Peripheral - HEM	> 3.5 - 4 x D	.05 x D	13	123	.0864	.1149	.1434
		Finish	3 x D	.01 x D	13	113	.0408	.0543	.0677
	Tool and Die Steels ≤ 48 Rc A2, D2, O1, S7, P20, H13	Peripheral - HEM	≤ 2 x D	.06 x D	13	128	.1080	.1436	.1793
		Peripheral - HEM	> 2 - 3 x D	.06 x D	13	128	.0960	.1277	.1593
		Peripheral - HEM	> 3 - 3.5 x D	.05 x D	13	126	.0888	.1181	.1474
		Peripheral - HEM	> 3.5 - 4 x D	.05 x D	13	126	.0840	.1117	.1394
		Finish	3 x D	.01 x D	13	117	.0360	.0479	.0598
M	Martensitic & Ferritic Stainless Steels 410, 416, 440	Peripheral - HEM	≤ 2 x D	.06 x D	13	140	.0984	.1309	.1633
		Peripheral - HEM	> 2 - 3 x D	.06 x D	13	140	.0960	.1277	.1593
		Peripheral - HEM	> 3 - 3.5 x D	.06 x D	13	137	.0888	.1181	.1474
		Peripheral - HEM	> 3.5 - 4 x D	.06 x D	13	136	.0840	.1117	.1394
		Finish	3 x D	.01 x D	13	119	.0360	.0479	.0598
	Austenitic Stainless Steels, FeNi Alloys 303, 304, 316, Invar, Kovar	Peripheral - HEM	≤ 2 x D	.06 x D	13	137	.1200	.1596	.1992
		Peripheral - HEM	> 2 - 3 x D	.06 x D	13	137	.1152	.1532	.1912
		Peripheral - HEM	> 3 - 3.5 x D	.05 x D	13	137	.0960	.1277	.1593
		Peripheral - HEM	> 3.5 - 4 x D	.05 x D	13	136	.0840	.1117	.1394
		Finish	3 x D	.01 x D	13	126	.0432	.0575	.0717
	Precipitation Hardening Stainless Steels 17-4, 15-5	Peripheral - HEM	≤ 2 x D	.06 x D	13	134	.1080	.1436	.1793
		Peripheral - HEM	> 2 - 3 x D	.06 x D	13	134	.0984	.1309	.1633
		Peripheral - HEM	> 3 - 3.5 x D	.05 x D	13	133	.0912	.1213	.1514
		Peripheral - HEM	> 3.5 - 4 x D	.05 x D	13	133	.0816	.1085	.1354
		Finish	3 x D	.01 x D	13	122	.0408	.0543	.0677
S	Titanium Alloys 6Al-4V, 6-2-4	Peripheral - HEM	≤ 2 x D	.08 x D	13	120	.1200	.1596	.1992
		Peripheral - HEM	> 2 - 3 x D	.07 x D	13	119	.1080	.1436	.1793
		Peripheral - HEM	> 3 - 3.5 x D	.06 x D	13	116	.0984	.1309	.1633
		Peripheral - HEM	> 3.5 - 4 x D	.06 x D	13	116	.0816	.1085	.1354
		Finish	3 x D	.015 x D	13	108	.0528	.0702	.0876
	Difficult-to-Machine Titanium Alloys 10-2-3 Precipitation Hardening Stainless Steel M 13-8	Peripheral - HEM	≤ 2 x D	.06 x D	13	107	.1200	.1596	.1992
		Peripheral - HEM	> 2 - 3 x D	.06 x D	13	101	.0864	.1149	.1434
		Peripheral - HEM	> 3 - 3.5 x D	.055 x D	13	96	.0840	.1117	.1394
		Peripheral - HEM	> 3.5 - 4 x D	.05 x D	13	94	.0768	.1021	.1275
		Finish	3 x D	.01 x D	13	91	.0408	.0543	.0677
	Hastalloy, Waspalloy	Peripheral - HEM	≤ 2 x D	.07 X D	13	32	.1704	.2266	.2828
		Peripheral - HEM	> 2 - 3 x D	.065 x D	13	30	.1536	.2043	.2550
		Peripheral - HEM	> 3 - 3.5 x D	.055 x D	13	27	.1488	.1979	.2470
		Peripheral - HEM	> 3.5 - 4 x D	.05 x D	13	27	.1368	.1819	.2271
		Finish	3 x D	.01 x D	13	27	.1056	.1404	.1753
	Inconel 718, Rene 88	Peripheral - HEM	≤ 2 x D	.06 x D	13	30	.1248	.1660	.2072
		Peripheral - HEM	> 2 - 3 x D	.05 x D	13	29	.1248	.1660	.2072
		Peripheral - HEM	> 3 - 3.5 x D	.05 x D	13	29	.1152	.1532	.1912
		Peripheral - HEM	> 3.5 - 4 x D	.04 x D	13	29	.1152	.1532	.1912
		Finish	3 x D	.01 x D	13	27	.0552	.0734	.0916

D = Tool Diameter HEM = High-efficiency machining (chip thinning calculations have already been applied to HEM parameters)

Information on tips and adjustments can be found in our Technical Resources section beginning on page 129.

APT5
POW•R•PATH

For high-efficiency machining (HEM) in aluminum alloys. The APT5 is the POW•R•PATH tool that applies to aluminum alloys the same HEM tool paths that work very well in ferrous materials. Engineered with both a solid core for stability and chip evacuation space for high feed rates. The unique cutting edge design combined with 5 flutes and the extra-durable taC coating generates incredibly high metal removal rates.



in: *d1: -0.0001 / -0.0004* *d2: -0.0001 / -0.0004*
mm: *d1: -0.0025 / -0.0100* *d2: -0.0025 / -0.0100*

N

Cutter Dia d1	Shank Dia d2	Max Axial Depth xD	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius .015 CR	.030 CR	.060 CR	.090 CR	.125 CR	.187 CR	.250 CR
1/4	1/4	2	1/2	2	61500	61501	61502	61503	-	-	-	-
		3	3/4	2-1/2	61504	61505	61506	61507	-	-	-	-
		4	1	3	61508	61509	61510	-	-	-	-	-
3/8	3/8	2	3/4	2-1/2	61511	61512	61513	61514	61515	-	-	-
		3	1-1/8	3	61516	61517	61518	61519	61520	-	-	-
		4	1-1/2	3-1/2	61521	61522	61523	-	-	-	-	-
1/2	1/2	2	1	3	61524	61525	61526	61527	61528	61529	-	-
		2.5	1-1/4	3-1/4	61530	61531	61532	61533	61534	61535	-	-
		3	1-1/2	3-1/2	61536	61537	61538	61539	61540	61541	-	-
		3.5	1-3/4	4	61542	61543	61544	61545	-	61546	-	-
		4	2	4	61547	61548	61549	61550	-	61551	-	-
5/8	5/8	2	1-1/4	3-1/2	61552	-	61553	61554	61555	61556	61557	-
		3	1-7/8	4	61558	-	61559	61560	61561	61562	61563	-
		4	2-1/2	5	61564	-	61565	-	-	61566	-	-
3/4	3/4	2	1-1/2	4	61567	-	61568	61569	61570	61571	61572	61573
		2.5	1-7/8	4-1/2	61574	-	61575	61576	-	61577	-	-
		3	2-1/4	5	61578	-	61579	61580	61581	61582	61583	61584
		3.5	2-5/8	5	61585	-	61586	61587	-	61588	-	-
		4	3	6	61589	-	61590	61591	61592	61593	-	61594
1	1	2	2	5	61595	-	61596	-	-	61597	61598	61599
		3	3	6	61600	-	61601	-	-	61602	61603	61604
		4	4	7	61605	-	61606	-	-	61607	-	61608

D = Tool Diameter

Cutter Dia d1	Shank Dia d2	Max Axial Depth xD	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius 0.5 CR	1.0 CR	1.5 CR	2.0 CR	2.5 CR	3.0 CR	4.0 CR
6	6	2	12	57	61700	61701	61702	61703	-	-	-	-
		3	18	63	61704	61705	61706	61707	-	-	-	-
		4	24	75	61708	61709	61710	61711	-	-	-	-
8	8	2	16	58	61712	61713	61714	61715	-	-	-	-
		3	24	63	61716	61717	61718	61719	-	-	-	-
		4	32	75	61720	61721	61722	61723	-	-	-	-
10	10	2	20	66	61724	61725	61726	61727	61728	-	-	-
		3	30	75	61729	61730	61731	61732	61733	-	-	-
		4	40	88	61734	61735	61736	61737	61738	-	-	-
12	12	2	24	75	61739	61740	61741	61742	61743	61744	61745	-
		2.5	30	83	61746	61747	61748	61749	61750	61751	61752	-
		3	36	88	61753	61754	61755	61756	61757	61758	61759	-
		3.5	42	93	61760	61761	61762	61763	-	-	61764	-
		4	48	100	61765	61766	61767	61768	61769	61770	61771	-
16	16	2	32	92	61772	-	61773	61774	61775	61776	61777	61778
		3	48	110	61779	-	61780	61781	61782	61783	61784	-
		4	64	125	61785	-	61786	61787	61788	61789	61790	61791
20	20	2	40	104	61792	-	61793	61794	61795	61796	61797	61798
		2.5	50	115	61799	-	61800	61801	-	-	61802	-
		3	60	125	61803	-	61804	61805	61806	61807	61808	61809
		3.5	70	135	61810	-	61811	61812	-	-	61813	-
		4	80	150	61814	-	61815	61816	61817	61818	61819	61820

D = Tool Diameter

TOOL TIP

AP5:
Pushing the Limits of Productivity.

The APT5 and APC5 POW•R•PATH end mills bring the concept of HEM tool paths to machining aluminum alloys. The unique AP design cleaves through aluminum at very high metal removal rates without needing a lot of horsepower, making the AP end mills extremely versatile. Adding to the AP's versatility are:

- Many corner radius options.
- 5 flutes for excellent surface finishes.
- The taC coating that protects the cutting edges to ensure long tool life — even in high-silicon aluminums.
- The Chip Management System (CMS) option that stops chip pollution by breaking the cut material into manageable lengths, eliminating chip packing.

APT5N
POW•R•PATH

For high-efficiency machining (HEM) in aluminum alloys. Adding a necked shank to the APT5 design offers a high-performance tool that permits clearance in deeper cavities and easier machining against tight walls. Neck relief and short flute length combine to increase end mill stability in the cut for more precise tolerances. Great for work in pockets.

in: *d1: -0.0001 / -0.0004* *d2: -0.0001 / -0.0004*
mm: *d1: -0.0025 / -0.0100* *d2: -0.0025 / -0.0100*

N

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Reach LBS l3	Overall Length l1	Order Code SQ	Order Code by Corner Radius .015 CR	.030 CR	.060 CR	.090 CR	.125 CR	.250 CR
1/4	1/4	3/8	7/8	2-1/2	61609	61610	61611	61612	-	-	-
		3/8	1-3/8	3	61613	61614	61615	61616	-	-	-
		3/8	2-1/4	4	61617	61618	61619	-	-	-	-
3/8	3/8	9/16	1-1/16	2-1/2	61620	61621	61622	61623	61624	-	-
		9/16	1-1/8	3	61625	61626	61627	61628	61629	-	-
		9/16	2-3/16	4	61630	61631	61632	-	-	-	-
1/2	1/2	3/4	1-1/4	3	61633	61634	61635	61636	61637	61638	-
		3/4	2-1/8	4	61639	61640	61641	61642	61643	61644	-
		3/4	3-1/8	5	61645	61646	61647	61648	61649	61650	-
		3/4	4-1/8	6	61651	61652	61653	61654	-	61655	-
5/8	5/8	15/16	1-9/16	4	61656	-	61657	61658	61659	61660	-
		15/16	2-3/16	5	61661	-	61662	61663	61664	61665	-
		15/16	3-3/16	6	61666	-	61667	-	-	61668	-
3/4	3/4	1-1/8	1-5/8	4	61669	-	61670	61671	61672	61673	61674
		1-1/8	2-1/4	5	61675	-	61676	61677	61678	61679	61680
		1-1/8	3-1/4	6	61681	-	61682	61683	-	61684	61685
1	1	1-1/2	2-3/8	5	61686	-	61687	-	-	61688	61689
		1-1/2	3-1/8	6	61690	-	61691	-	-	61692	61693
		1-1/2	4-1/8	7	61694	-	61695	-	-	61696	61697

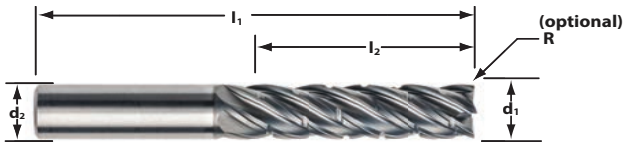
Cutter Dia d1	Shank Dia d2	Length of Cut l2	Reach LBS l3	Overall Length l1	Order Code SQ	Order Code by Corner Radius 0.5 CR	1.0 CR	1.5 CR	2.0 CR	2.5 CR	3.0 CR	4.0 CR
6	6	9	26	63	61821	61822	61823	61824	-	-	-	-
			32	75	61825	61826	61827	61828	-	-	-	-
8	8	12	34	75	61829	61830	61831	61832	-	-	-	-
10	10	15	32	75	62211	62214	62215	62219	62223	-	-	-
			42	88	61833	61834	61835	61836	61837	-	-	-
			52	100	61838	61839	61840	61841	61842	-	-	-
12	12	18	38	88	61843	61844	61845	61846	61847	61848	61849	-
			50	100	61850	61851	61852	61853	61854	61855	61856	-
			62	125	62228	62229	62230	62231	62239	62244	62245	-
16	16	24	50	110	61857	-	61858	61859	61860	61861	61862	-
			66	125	61863	-	61864	61865	61866	61867	61868	-
			82	150	62246	-	62247	62251	62252	62253	62254	-
20	20	30	62	125	61869	-	61870	61871	61872	61873	61874	61875
			82	135	62255	-	62258	62259	62281	62286	62295	62298
			102	150	61876	-	61877	61878	61879	61880	61881	61882

D = Tool Diameter

APC5
POW•R•PATH

Z5 | SQ | CR | 35° | CMS | taC | PLAIN

For high-efficiency machining (HEM) in aluminum alloys. Adds the benefits of the unique **Chip Management System (CMS)** to the versatility of the APT5 design. Breaks up long, stringy chips, which eliminates recutting chips and chip packing, and allows for deep, free cutting tool movement in aluminum. The results are great chip control and very high metal removal rates.



in: *d1: -0.0001 / -0.0004 d2: -0.0001 / -0.0004*
mm: *d1: -0.0025 / -0.0100 d2: -0.0025 / -0.0100*

N

Cutter Dia d1	Shank Dia d2	Max Axial Depth xD	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius .015 CR	.030 CR
3/8	3/8	3	1-1/8	3	61420	61421	-
		4	1-1/2	3-1/2	61422	61423	-
1/2	1/2	2.5	1-1/4	3-1/4	61424	-	61425
		3	1-1/2	3-1/2	61426	-	61427
		3.5	1-3/4	4	61428	-	61429
		4	2	4	61430	-	61431
5/8	5/8	2	1-1/4	3-1/2	61432	-	61433
		3	1-7/8	4	61434	-	61435
		4	2-1/2	5	61436	-	61437
3/4	3/4	2.5	1-7/8	4-1/2	61438	-	61439
		3	2-1/4	5	61440	-	61441
		3.5	2-5/8	5	61442	-	61443
		4	3	6	61444	-	61445
1	1	2	2	5	61446	-	61447
		3	3	6	61448	-	61449
		4	4	7	61450	-	61451

Cutter Dia d1	Shank Dia d2	Max Axial Depth xD	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius 0.5 CR	1.0 CR
10	10	3	30	75	61452	61453	-
		4	40	88	61454	61455	-
12	12	2.5	30	83	61456	-	61457
		3	36	88	61458	-	61459
		3.5	42	93	61460	-	61461
		4	48	100	61462	-	61463
16	16	2	32	92	61464	-	61465
		3	48	110	61466	-	61467
		4	64	125	61468	-	61469
20	20	2	40	104	61470	-	61471
		2.5	50	115	61472	-	61473
		3	60	125	61474	-	61475
		3.5	70	135	61476	-	61477
		4	80	150	61478	-	61479

D = Tool Diameter

APT5/APC5 Application Guide – Speed & Feed (inch)

ISO Code	Work Material	Tool LBS/d1	Type of Cut	Axial DOC	Radial DOC	No. of Flutes	Speed (SFM)	Feed (Inch per Tooth) 1/4	3/8	1/2	5/8	3/4	1
N	Aluminum Alloys 6061, 7075, 2024	≤ 2	Slotting	1 x D	1 x D	5	600	.0015	.0023	.0030	.0038	.0045	.0060
		≤ 2	Peripheral - HEM	≤ 2 x D	.25 x D	5	850	.0050	.0075	.0100	.0125	.0150	.0200
		2 - 2.5	Peripheral - HEM	> 2 - 2.5 x D	.25 x D	5	800	.0050	.0075	.0100	.0125	.0150	.0200
		2.5 - 3	Peripheral - HEM	> 2.5 - 3 x D	.25 x D	5	800	.0050	.0075	.0100	.0125	.0150	.0200
		3 - 3.5	Peripheral - HEM	> 3 - 3.5 x D	.25 x D	5	800	.0048	.0071	.0095	.0119	.0143	.0190
		3.5 - 4	Peripheral - HEM	> 3.5 - 4 x D	.20 x D	5	780	.0048	.0071	.0095	.0119	.0143	.0190
		≤ 2	Peripheral - Rough	≤ 2 x D	.45 x D	5	1000	.0024	.0036	.0048	.0060	.0072	.0096
		>2 - 3	Peripheral - Rough	> 2 - 3 x D	.375 x D	5	900	.0023	.0035	.0046	.0058	.0069	.0092
		>3	Peripheral - Rough	> 3 - 4 x D	.35 x D	5	800	.0023	.0034	.0045	.0056	.0068	.0090
		≤ 4 x D	Finish	≤ 4 x D	.01 x D	5	650	.0015	.0023	.0030	.0038	.0045	.0060

D = Tool Diameter HEM = High-efficiency machining

APT5/APC5 Application Guide – Speed & Feed (metric)

ISO Code	Work Material	Tool LBS/d1	Type of Cut	Axial DOC	Radial DOC	Number of Flutes	Speed (M/min)	Feed (MM per Tooth) 6.0	8.0	10.0	12.0	16.0	20.0
N	Aluminum Alloys 6061, 7075, 2024	≤ 2	Slotting	1 x D	1 x D	5	183	.0360	.0480	.0598	.0720	.0958	.1195
		≤ 2	Peripheral - HEM	≤ 2 x D	.25 x D	5	259	.1200	.1600	.1992	.2400	.3192	.3984
		2 - 2.5	Peripheral - HEM	> 2 - 2.5 x D	.25 x D	5	244	.1200	.1600	.1992	.2400	.3192	.3984
		2.5 - 3	Peripheral - HEM	> 2.5 - 3 x D	.25 x D	5	244	.1200	.1600	.1992	.2400	.3192	.3984
		3 - 3.5	Peripheral - HEM	> 3 - 3.5 x D	.25 x D	5	244	.1140	.1520	.1892	.2280	.3032	.3784
		3.5 - 4	Peripheral - HEM	> 3.5 - 4 x D	.20 x D	5	238	.1140	.1520	.1892	.2280	.3032	.3784
		≤ 2	Peripheral - Rough	≤ 2 x D	.45 x D	5	305	.0576	.0768	.0956	.1152	.1532	.1912
		>2 - 3	Peripheral - Rough	> 2 - 3 x D	.375 x D	5	274	.0552	.0736	.0916	.1104	.1468	.1832
		> 3	Peripheral - Rough	> 3 - 4 x D	.35 x D	5	244	.0540	.0720	.0896	.1080	.1436	.1793
		≤ 4 x D	Finish	≤ 4 x D	.01 x D	5	198	.0360	.0480	.0598	.0720	.0958	.1195

D = Tool Diameter HEM = High-efficiency machining (chip thinning calculations have already been applied to HEM parameters)

≈ Approximately Equals
≤ Less Than or Equal To
≥ Greater Than or Equal To
× Multiply
< Less Than
> Greater Than
= Equals

Common Machining Formulas

$$RPM = \frac{SFM \times 3.82}{D}$$

$$SFM = RPM \times D \times .262$$

$$IPM = RPM \times IPT \times Z$$

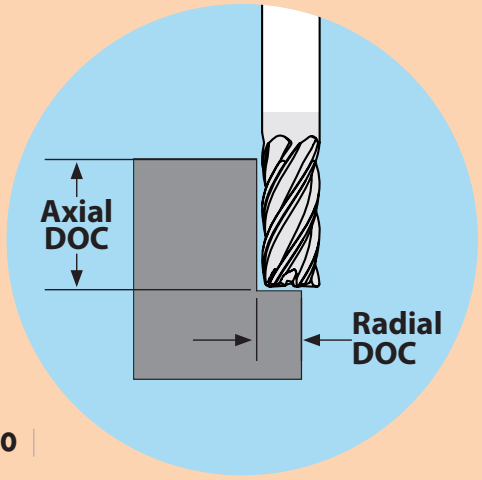
$$MRR = RDOC \times ADOC \times IPM$$

$$RPM = \frac{M/min \times 318.3}{D}$$

$$M/min = RPM \times D \times .00314$$

$$MMPM = RPM \times MMPT \times Z$$

$$MRR = RDOC \times ADOC \times MMPM$$



D Tool Diameter
Z Number of Flutes
RPM Revolutions per Minute
SFM Surface Feet per Minute
M/min Surface Meters per Minute
IPM Inches per Minute
MMPM Millimeters per Minute
IPT Inch per Tooth
MMPT Millimeters per Tooth
MRR Metal Removal Rate
RDOC Radial Depth of Cut
ADOC Axial Depth of Cut

Technical Resources

Information on tips and adjustments for the following milling operations can be found in our Technical Resources section beginning on page 129.

- HEM slotting
- Face milling
- Helical entry ramping
- Straight line ramping
- Long tool projection adjustments
- Ball nose milling adjustments
- Other helpful tips and calculations

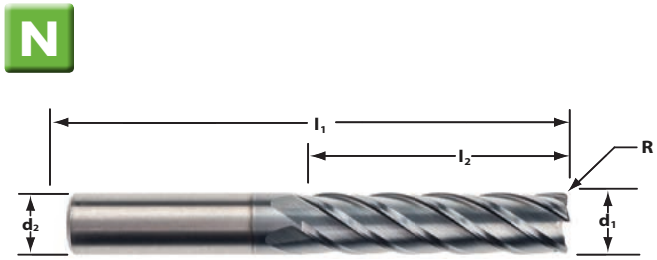
AFC5/IFC5 DEEP WALL FINISHER

Designed to address difficulties in meeting straightness and surface finish requirements in deep reach applications in aluminum (AFC5) and in steels and hi-temp alloys (IFC5). Built with the ultimate core thickness, the AFC5/IFC5 design tackles deflection issues that occur when machining deep cuts, minimizing wall taper. Combined with the unique cutting edge geometry, the AFC5/IFC5 generates superior wall and floor finishes.

AFC5

Cutter Dia d1	Shank Dia d2	Max Axial Depth xD	Length of Cut l2	Overall Length l1	Order Code by Corner Radius .030 CR	.060 CR
1/2	1/2	4	2	4	62480	-
		6	3	6	62481	-
5/8	5/8	4	2-1/2	5	-	62482
		6	3-3/4	6-1/2	-	62483
3/4	3/4	4	3	6	-	62484
		6	4-1/2	7	-	62485
1	1	4	4	8	-	62486
		6	6	12	-	62487

D = Tool Diameter

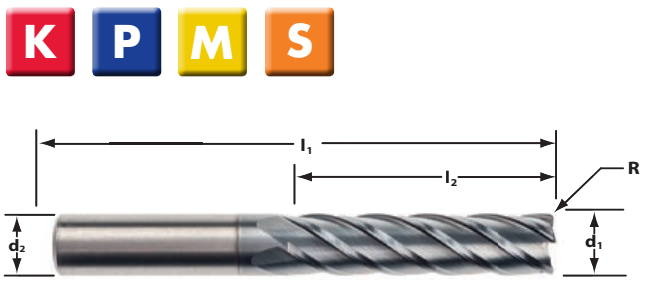


in: *d1: +0.000 / -0.002* *d2: -0.0001 / -0.0004*
mm: *d1: +0.000 / -0.050* *d2: -0.0025 / -0.0100*

IFC5

Cutter Dia d1	Shank Dia d2	Max Axial Depth xD	Length of Cut l2	Overall Length l1	Order Code by Corner Radius .030 CR	.060 CR
1/2	1/2	4	2	4	62488	-
		6	3	6	62489	-
5/8	5/8	4	2-1/2	5	-	62490
		6	3-3/4	6-1/2	-	62491
3/4	3/4	4	3	6	-	62492
		6	4-1/2	7	-	62493
1	1	4	4	8	-	62494
		6	6	12	-	62495

D = Tool Diameter



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mm: *d1: +0.000 / -0.050* *d2: -0.0025 / -0.0100*

Standard dimensions are shown above, but IMCO recognizes that all machine parts are unique so they require unique tools to finish mill. Variations of the AFC and IFC end mills with different flute lengths and overall lengths are possible. Contact IMCO for quotations with the specifications needed to finish your application at 1-800-765-4626.

AFC5/IFC5 Application Guide – Speed & Feed (inch)

AFC5 Application Guide – Speed & Feed (inch)

ISO Code	Work Material	Type of Cut	Tool LC/Dia.	Axial DOC	Radial DOC	No. of Flutes	Speed (SFM)	Feed (Inch per Tooth) 1/2	5/8	3/4	1
N	Aluminum Alloys 6061, 7075, 2024	Peripheral - Finish	3 - 4	4 x D	.01 x D	5	425	.0021	.0026	.0032	.0042
		Peripheral - Finish	< 4 - 6	6 x D	.01 x D	5	350	.0017	.0022	.0026	.0035

D = Tool Diameter

IFC5 Application Guide – Speed & Feed (inch)

ISO Code	Work Material	Type of Cut	Tool LC/Dia.	Axial DOC	Radial DOC	No. of Flutes	Speed (SFM)	Feed (Inch per Tooth) 1/2	5/8	3/4	1
K	Cast Iron - Gray ASTM - A48, Class 20, 25, 30, 35 & 40	Peripheral - Finish	3 - 4	4 x D	.01 x D	5	290	.0017	.0021	.0026	.0034
		Peripheral - Finish	< 4 - 6	6 x D	.01 x D	5	235	.0014	.0017	.0021	.0028
	Cast Iron - Malleable	Peripheral - Finish	3 - 4	4 x D	.01 x D	5	275	.0017	.0021	.0026	.0034
		Peripheral - Finish	< 4 - 6	6 x D	.01 x D	5	220	.0014	.0017	.0020	.0027
P	Low Carbon Steel ≤ 38 HRc 1018, 1020, 12L14, 5120, 8620	Peripheral - Finish	3 - 4	4 x D	.01 x D	5	300	.0018	.0023	.0027	.0036
		Peripheral - Finish	< 4 - 6	6 x D	.01 x D	5	240	.0014	.0018	.0022	.0029
	Medium Carbon Steel ≤ 48 HRc 1045, 4140, 4340, 5140	Peripheral - Finish	3 - 4	4 x D	.01 x D	5	290	.0017	.0021	.0026	.0034
		Peripheral - Finish	< 4 - 6	6 x D	.01 x D	5	235	.0014	.0017	.0021	.0028
	Tool & Die Steels ≤ 40 HRc A2, D2, O1, S7, P20, H13	Peripheral - Finish	3 - 4	4 x D	.01 x D	5	275	.0016	.0020	.0024	.0032
		Peripheral - Finish	< 4 - 6	6 x D	.01 x D	5	220	.0013	.0016	.0019	.0026
M	Martensitic & Ferritic Stainless Steels 410, 416, 440	Peripheral - Finish	3 - 4	4 x D	.01 x D	5	280	.0017	.0021	.0026	.0034
		Peripheral - Finish	< 4 - 6	6 x D	.01 x D	5	227	.0014	.0017	.0021	.0028
	Austenitic Stainless Steels 303, 304, 316, Invar, Kovar	Peripheral - Finish	3 - 4	4 x D	.01 x D	5	275	.0016	.0020	.0024	.0032
		Peripheral - Finish	< 4 - 6	6 x D	.01 x D	5	220	.0013	.0016	.0019	.0026
	Precipitation Hardening Stainless Steel 17-4, 15-5, 13-8	Peripheral - Finish	3 - 4	4 x D	.01 x D	5	255	.0015	.0019	.0023	.0030
		Peripheral - Finish	< 4 - 6	6 x D	.01 x D	5	204	.0012	.0015	.0018	.0024
S	Titanium Alloys 6AL-4V, 6-2-4	Peripheral - Finish	3 - 4	4 x D	.01 x D	5	320	.0018	.0023	.0027	.0036
		Peripheral - Finish	< 4 - 6	6 x D	.01 x D	5	256	.0014	.0018	.0022	.0029

D = Tool Diameter

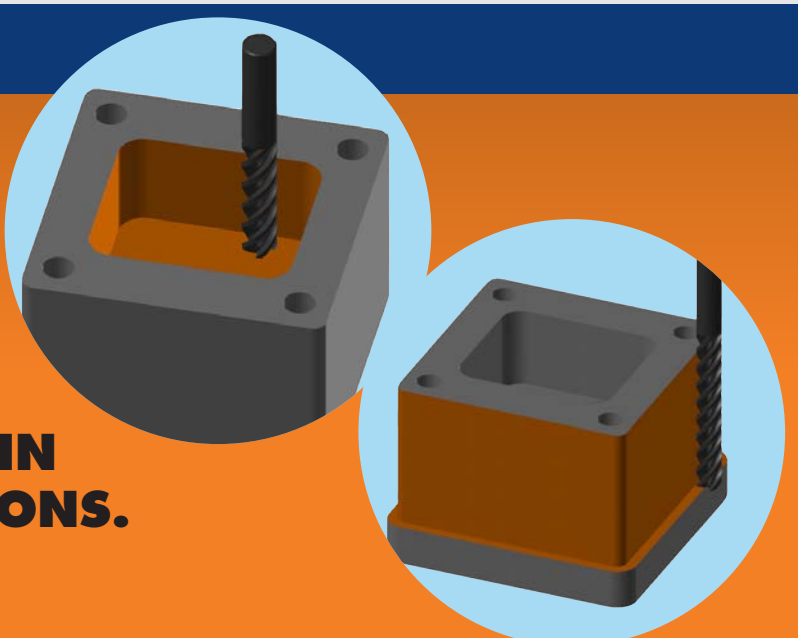
Information on tips and adjustments can be found in our Technical Resources section beginning on page 129.

≈ Approximately Equals
≤ Less Than or Equal To
≥ Greater Than or Equal To
× Multiply
< Less Than
> Greater Than
= Equals

TOOL TIP

AFC5/IFC5

- BIG CORE.
- LITTLE DEFLECTION.
- MINIMAL WALL TAPER IN DEEP REACH APPLICATIONS.



enDURO®

MUSCLE TO HUSTLE IN TITANIUM AND STAINLESS STEELS

Advanced high-shear cutting edges and amazing corner strength make enDURO end mills the best choice for milling hard-to-machine materials, whether you use high-efficiency machining or traditional techniques.

M5 Series Features

MUSCLE TO HUSTLE.

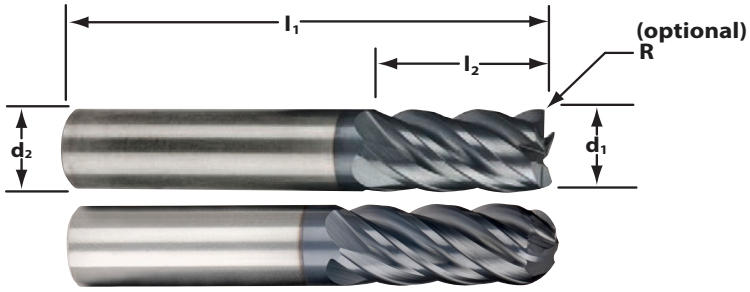
Truly a "go-to" tool for a wide range of applications, enDURO end mills are the ultimate combination of strength and flexibility. A solid core, reinforced cutting edges, variable indexed flutes and an advanced coating all come together in the M525 and M527 series to create an "everyday" high-performance end mill that excels in both traditional and high-efficiency milling tool paths.

	M525	M525C	M525N	M527	M527N	M527C	M503
NUMBER OF FLUTES	Z5	Z5	Z5	Z7	Z7	Z7	Z3
END TYPES	SQ CR BN	SQ CR	SQ CR BN	SQ CR	CR	SQ CR	SQ CR
HELIX ANGLE	40°	40°	40°	40°	40°	40°	40°
COATING	AlCrNX	AlCrNX	AlCrNX	AlCrNX	AlCrNX	AlCrNX	AlTiN
SHANK TYPES	PLAIN	PLAIN	PLAIN NECK	PLAIN	PLAIN NECK	PLAIN	PLAIN
APPLICATIONS	HEM ROUGH FINISH	HEM ROUGH	ROUGH FINISH	HEM ROUGH FINISH	HEM ROUGH FINISH	HEM ROUGH	ROUGH FINISH
MATERIAL(S)	K P M S						P M

M525 enDURO

For high-performance machining in materials ranging from low carbon steels to titanium. Engineered for both speed and tool life, the M525 series is extremely versatile. It optimizes tool performance in many materials and in many application environments, from short runs in job shops to long production runs.

K P M S



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mm: *d1: +0.000 / -0.050* *d2: -0.0025 / -0.0100*

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius .015 CR	.030 CR	.060 CR	.090 CR	.120 CR	.190 CR	.250 CR	Order Code BN
1/8	1/8	1/4	1-1/2	65001	65002	65003	-	-	-	-	-	65004
		1/2	1-1/2	65005	65006	65007	-	-	-	-	-	65008
		3/4	2-1/2	65009	65010	65011	-	-	-	-	-	65012
3/16	3/16	5/16	2	65013	65014	65015	-	-	-	-	-	65016
		9/16	2	65017	65018	65019	-	-	-	-	-	65020
		3/4	2-1/2	65021	65022	65023	-	-	-	-	-	65024
1/4	1/4	3/8	2	65025	65026	65027	65028	65029	-	-	-	65030
		3/4	2-1/2	65049	65050	65051	65052	65053	-	-	-	65054
		1-1/8	3	65055	65056	65057	65058	65059	-	-	-	65060
5/16	5/16	7/16	2	65061	65062	65063	65064	65065	-	-	-	65066
		13/16	2-1/2	65067	65068	65069	65070	65071	-	-	-	65072
		1-1/4	3	65073	65074	65075	65076	65077	-	-	-	65078
		2-1/8	4	65079	65080	65081	65082	65083	-	-	-	65084
3/8	3/8	1/2	2	65085	65086	65087	65088	65089	65090	-	-	65092
		1	2-1/2	65133	65134	65135	65136	65137	65138	-	-	65140
		1-1/4	3	65141	65142	65143	65144	65145	65146	-	-	65148
		1-5/8	3-1/2	65149	65150	65151	65152	65153	65154	-	-	65156
		1-5/8	4	65157	65158	65159	65160	65161	65162	-	-	65164
		2	4	65173	65174	65175	65176	65177	65178	-	-	65180
7/16	7/16	5/8	2-1/2	65189	65190	65191	-	-	-	-	-	65196
		1	2-3/4	65197	65198	65199	-	-	-	-	-	65204
		2	4	65205	65206	65207	-	-	-	-	-	65212
1/2	1/2	5/8	2-1/2	65213	65214	65215	65216	65217	65218	-	-	65221
		1	3	65258	65259	65260	65261	65262	65263	-	-	65266
		1-1/4	3	65267	65268	65269	65270	65271	65272	65274	-	65275
		1-5/8	4	65276	65277	65278	65279	65280	65281	-	-	65284
		1-5/8	6	65285	65286	65287	65288	65289	65290	-	-	65293
		2-1/8	4	65294	65295	65296	65297	65298	65299	65301	-	65302
		2-5/8	5	65303	65304	65305	65306	65307	65308	-	-	65311
		3-1/4	6	65312	65313	65314	65315	65316	65317	-	-	65320
5/8	5/8	3/4	3	65321	65322	65323	65324	-	65326	-	-	65330
		1-5/8	3-1/2	65361	65362	65363	65364	65365	65366	65368	-	65370
		2-1/8	4	65371	65372	65373	65374	-	65376	-	-	65380
		2-1/8	6	65381	65382	65383	65384	-	65386	-	-	65390
		2-5/8	5	65391	65392	65393	65394	65395	65396	65398	-	65400
		3-1/4	6	65401	65402	65403	65404	-	65406	-	-	65410
		4	6	65411	65412	65413	65414	-	65416	-	-	65420
3/4	3/4	1	3	65421	65422	65423	65424	-	65426	-	65429	65430
		1-5/8	4	65461	65462	65463	65464	65465	65466	65468	65469	65470
		2-3/8	5	65471	65472	65473	65474	65475	65476	65478	65479	65480
		2-3/8	6	65481	65482	65483	65484	-	65486	-	65489	65490
		3-1/4	6	65491	65492	65493	65494	-	65496	-	65499	65500
		4-1/8	7	65501	65502	65503	65504	-	65506	-	65509	65510
1	1	1-3/4	4	65555	65556	65557	65558	65559	65560	65562	65563	65565
		2-5/8	5	65566	65567	65568	65569	65570	65571	65573	65574	65576
		3-1/4	6	65588	65589	65590	65591	-	65593	-	65596	65598
		4-1/4	7	65599	65600	65601	65602	-	65604	-	65607	65609

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius 0.5 CR	0.75 CR	1.0 CR	1.5 CR	2.0 CR	3.0 CR	4.0 CR	5.0 CR
6	6	10	54	-	66825	-	-	-	-	-	-	-
		13	57	66655	66656	-	66658	66659	-	-	-	-
		25	75	66826	66828	-	66829	-	-	-	-	-
8	8	12	58	-	66830	-	-	-	-	-	-	-
		19	63	66660	66661	-	66663	66664	-	-	-	-
		32	75	66831	66832	-	66833	-	-	-	-	-
10	10	14	66	-	-	-	66834	-	-	-	-	-
		22	72	66665	66666	-	66668	66669	66670	-	-	-
		40	88	66836	66837	-	66838	66839	66840	-	-	-
12	12	16	73	-	-	-	66841	-	-	-	-	-
		26	83	66671	66672	66673	66674	66675	66676	66677	-	-
		50	100	66870	-	66871	66872	66873	66844	66845	-	-
		75	150	66874	-	66875	66876	66877	-	-	-	-
16	16	22	82	-	-	-	66846	-	-	-	-	-
		32	92	66678	-	66679	66680	66681	66682	66683	66684	-
		55	110	66878	-	66879	66880	66881	66847	66848	-	-
		75	150	66882	-	66883	66884	66885	-	-	-	-
20	20	26	92	-	-	-	66849	-	-	-	-	-
		38	104	66685	-	-	66687	66688	66689	66690	66691	66692
		65	125	66886	-	-	66888	66889	66850	66852	-	-
		85	150	66890	-	-	66892	66893	66853	66854	-	-
25	25	45	120	66693	-	-	66695	66696	66697	66698	66699	66700
		85	150	66894	-	-	66896	66897	66855	66856	66857	-

TOOL TIP

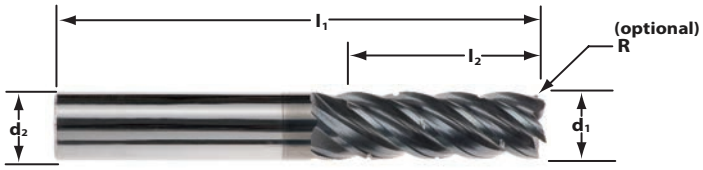
How Do You Spell Versatility? "e-n-D-U-R-O."

The M5 enDURO series of end mills are the definition of versatility. The 5- and 7-flute designs are made to rough and finish in traditional tool paths and in high-efficiency machining techniques. From job shops to high-production environments, the M5 is the "go-to" tool that saves you time and money.

- Many corner radius options.
- Optional necked shanks for pocket milling.
- Chip Managment System (CMS) to stop chip pollution for free cutting machining.
- Advanced grinds and coatings to machine carbon steels, stainless steels, titanium and hi-temp alloys.

M525C enDURO

For high-performance machining in materials ranging from low carbon steels to titanium. Adds the benefits of the unique **Chip Management System (CMS)** to the versatility of the M525 design. Breaks up long, stringy chips, which eliminates recutting chips and chip packing, and allows for free cutting tool movement in a variety of materials.



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mm: *d1: +0.000 / -0.050* *d2: -0.0025 / -0.0100*

K P M S

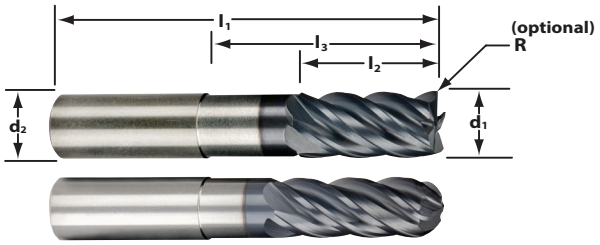
Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius .015 CR	.030 CR	.060 CR	.120 CR
1/2	1/2	2-1/8	4	68250	68251	68252	68253	-
		2-5/8	5	68255	68256	68257	68258	-
		3-1/4	6	68260	68261	68262	68263	-
5/8	5/8	2-1/8	4	68265	-	68267	68268	-
		2-5/8	5	68270	-	68272	68273	-
		3-1/4	6	68275	-	68277	68278	-
3/4	3/4	2-3/8	5	68280	-	68282	-	68284
		3-1/4	6	68285	-	68287	-	68289
		4-1/8	7	68290	-	68292	-	68294
1	1	2-5/8	5	68295	-	68297	-	68299
		3-1/4	6	68300	-	68302	-	68304
		4-1/4	7	68305	-	68307	-	68309

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius 0.75 CR	1.0 CR	1.5 CR
12	12	50	100	66900	66901	66902	66903
		75	150	66904	66905	66906	66907
16	16	55	110	66908	66909	66910	66911
		75	150	66912	66913	66914	66915
20	20	65	125	66916	-	66918	66919
		85	150	66920	-	66922	66923
25	25	55	120	66924	-	66926	66927
		85	150	66928	-	66930	66931

M525N enDURO

Z5 | SQ | CR | BN | 40° | NECK | AlCrNX | PLAIN

For high-performance machining in materials ranging from low carbon steels to titanium. Adding a necked shank to the M525 design offers a high-performance tool that permits clearance in deeper cavities and easier machining against tight walls. Neck relief and short flute length combine to increase end mill stability in the cut for more precise tolerances. Great for work in pockets.



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mm: *d1: +0.000 / -0.050* *d2: -0.0025 / -0.0100*

K P M S

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Reach LBS l3	Overall Length l1	Order Code SQ	Order Code by Corner Radius .015 CR	.030 CR	.060 CR	.120 CR	.250 CR	Order Code BN
1/4	1/4	3/8	1-1/8	2-1/2	65680	65681	65682	65683	-	-	65685
			1-3/8	3	65686	65687	65688	65689	-	-	65691
			2-3/8	4	65692	65693	65694	65695	-	-	65697
3/8	3/8	1/2	1-3/8	3	65706	65707	65708	65709	-	-	65713
			2-3/8	4	65714	65715	65716	65717	-	-	65721
			3-3/8	5	65722	65723	65724	65725	-	-	65729
1/2	1/2	5/8	1-3/8	3	65738	65739	65740	65741	65743	-	65746
			2-1/4	4	65747	65748	65749	65750	65752	-	65755
			3-1/4	5	65756	65757	65758	65759	65761	-	65764
			4-1/4	6	65765	65766	65767	65768	65770	-	65773
5/8	5/8	3/4	2-1/8	4	65774	-	65776	65777	65779	-	65783
			3-1/8	5	65784	-	65786	65787	65789	-	65793
			4-1/8	6	65794	-	65796	65797	65799	-	65803
3/4	3/4	1	2	4	65804	-	65806	65807	65809	65812	65813
			2-7/8	5	65814	-	65816	65817	65819	65822	65823
			3-7/8	6	65824	-	65826	65827	65829	65832	65833
			4-7/8	7	67061	-	67063	67064	67066	67069	67070
1	1	1-1/4	2-5/8	5	65845	-	65847	65848	65850	65853	-
			3-5/8	6	65856	-	65858	65859	65861	65864	-
			4-5/8	7	65867	-	65869	65870	65872	65875	-

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Reach LBS l3	Overall Length l1	Order Code SQ	Order Code by Corner Radius 0.5 CR	1.0 CR	1.5 CR	2.0 CR	3.0 CR	Order Code BN
6	6	8	27	63	66701	66835	66843	66851	-	-	66802
			39	75	66706	66859	66867	66702	-	-	66804
			64	100	66711	66703	66704	66705	-	-	66805
8	8	10	27	63	66716	66707	66708	66709	-	-	66806
			39	75	66721	66710	66712	66713	-	-	66807
			64	100	66727	66714	66715	66717	-	-	66808
10	10	12	32	72	66733	66718	66719	66720	-	-	66809
			60	100	66740	66723	66724	66725	-	-	66810
12	12	15	38	83	66754	66732	66734	66735	66736	66737	66813
			55	100	66761	66738	66739	66741	66742	66743	66814
			80	125	66768	66744	66745	66746	66748	66749	66815
			105	150	66775	66750	66751	66752	66753	66755	66816
16	16	20	62	110	66782	-	66756	66757	66758	66759	66817
			102	150	66789	-	66762	66763	66764	66765	66818
20	20	25	75	125	66803	-	66774	66776	66777	66778	66821
			100	150	66811	-	66781	66783	66784	66785	66822
25	25	32	64	120	66819	-	66788	66790	66791	66792	-
			94	150	66827	-	66795	66797	66798	66799	-

M525 Application Guide – Speed & Feed (inch)

ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	No. of Flutes	Speed (SFM)	Feed (Inches per Tooth) 1/8	3/16	1/4	5/16	3/8	7/16	1/2	5/8	3/4	1
K	Cast Iron Gray ASTM-A48 Class 20, 25, 30, 35 & 40	Slotting	.5 x D	1 x D	5	300	.0006	.0009	.0012	.0015	.0018	.0021	.0024	.0030	.0036	.0048
		Peripheral - Rough	1.25 x D	.3 x D	5	375	.0008	.0012	.0016	.0020	.0025	.0029	.0033	.0041	.0049	.0065
		Finish	2 x D	.015 x D	5	375	.0008	.0012	.0017	.0021	.0025	.0029	.0033	.0042	.0050	.0067
	Cast Iron Malleable	Slotting	.5 x D	1 x D	5	275	.0005	.0008	.0010	.0013	.0015	.0018	.0020	.0025	.0030	.0040
		Peripheral - Rough	1.25 x D	.3 x D	5	350	.0007	.0010	.0014	.0017	.0020	.0024	.0027	.0034	.0041	.0055
		Peripheral - HEM*	3 x D	.05 x D	5	390	.0020	.0030	.0040	.0050	.0060	.0070	.0081	.0101	.0121	.0161
		Finish	2 x D	.015 x D	5	350	.0007	.0010	.0014	.0017	.0021	.0024	.0028	.0035	.0042	.0056
P	Low Carbon Steels ≤ 38 Rc 1018, 1020, 12L14, 5120, 8620	Slotting	.5 x D	1 x D	5	325	.0007	.0011	.0014	.0018	.0021	.0025	.0028	.0035	.0042	.0056
		Peripheral - Rough	1.25 x D	.3 x D	5	400	.0010	.0014	.0019	.0024	.0029	.0033	.0038	.0048	.0057	.0076
		Peripheral - HEM*	3 x D	.07 x D	5	450	.0028	.0042	.0056	.0070	.0084	.0098	.0112	.0140	.0168	.0224
		Finish	2 x D	.015 x D	5	400	.0010	.0015	.0019	.0024	.0029	.0034	.0039	.0049	.0058	.0078
	Medium Carbon Steels ≤ 48 HRC 1045, 4140, 4340, 5140	Slotting	.5 x D	1 x D	5	300	.0006	.0010	.0013	.0016	.0019	.0022	.0026	.0032	.0038	.0051
		Peripheral - Rough	1.25 x D	.3 x D	5	375	.0009	.0013	.0017	.0022	.0026	.0031	.0035	.0044	.0052	.0070
		Peripheral - HEM*	3 x D	.05 x D	5	415	.0026	.0039	.0052	.0065	.0077	.0090	.0103	.0129	.0155	.0207
		Finish	2 x D	.015 x D	5	375	.0009	.0013	.0018	.0022	.0027	.0031	.0036	.0044	.0053	.0071
	Tool and Die Steels ≤ 48 Rc A2, D2, O1, S7, P20, H13	Slotting	.5 x D	1 x D	5	275	.0005	.0008	.0011	.0014	.0016	.0019	.0022	.0027	.0032	.0043
		Peripheral - Rough	1.25 x D	.3 x D	5	350	.0007	.0011	.0015	.0018	.0022	.0026	.0029	.0037	.0044	.0059
		Peripheral - HEM*	3 x D	.05 x D	5	390	.0022	.0032	.0043	.0054	.0065	.0076	.0087	.0108	.0130	.0173
		Finish	2 x D	.015 x D	5	350	.0007	.0011	.0015	.0019	.0022	.0026	.0030	.0037	.0045	.0060
M	Martensitic & Ferritic Stainless Steels 410, 416, 440	Slotting	.5 x D	1 x D	5	300	.0006	.0010	.0013	.0016	.0019	.0022	.0026	.0032	.0038	.0051
		Peripheral - Rough	1.25 x D	.3 x D	5	375	.0009	.0013	.0017	.0022	.0026	.0031	.0035	.0044	.0052	.0070
		Peripheral - HEM*	3 x D	.05 x D	5	415	.0026	.0039	.0052	.0065	.0077	.0090	.0103	.0129	.0155	.0207
		Finish	2 x D	.015 x D	5	375	.0009	.0013	.0018	.0022	.0027	.0031	.0036	.0044	.0053	.0071
	Austenitic Stainless Steels, FeNi Alloys 303, 304, 316, Invar, Kovar	Slotting	.5 x D	1 x D	5	275	.0006	.0009	.0012	.0015	.0018	.0021	.0024	.0030	.0036	.0048
		Peripheral - Rough	1.25 x D	.3 x D	5	350	.0008	.0012	.0016	.0020	.0025	.0029	.0033	.0041	.0049	.0065
		Peripheral - HEM*	3 x D	.05 x D	5	390	.0025	.0037	.0049	.0062	.0074	.0086	.0099	.0123	.0148	.0198
		Finish	2 x D	.015 x D	5	350	.0008	.0012	.0017	.0021	.0025	.0029	.0033	.0042	.0050	.0067
	Precipitation Hardening Stainless Steels 17-4, 15-5	Slotting	.5 x D	1 x D	5	250	.0005	.0008	.0010	.0013	.0015	.0018	.0020	.0025	.0030	.0040
		Peripheral - Rough	1.25 x D	.3 x D	5	325	.0007	.0010	.0014	.0017	.0020	.0024	.0027	.0034	.0041	.0055
		Peripheral - HEM*	3 x D	.05 x D	5	360	.0020	.0030	.0040	.0049	.0059	.0069	.0079	.0099	.0119	.0158
		Finish	1.5 x D	.015 x D	5	325	.0007	.0010	.0014	.0017	.0021	.0024	.0028	.0035	.0042	.0056
S	Titanium Alloys 6Al-4V, 6-2-4	Slotting	.5 x D	1 x D	5	250	.0005	.0007	.0009	.0012	.0014	.0016	.0018	.0023	.0028	.0037
		Peripheral - Rough	1 x D	.3 x D	5	300	.0006	.0009	.0013	.0016	.0019	.0022	.0025	.0031	.0038	.0050
		Peripheral - HEM*	3 x D	.05 x D	5	330	.0018	.0027	.0036	.0046	.0055	.0064	.0073	.0091	.0109	.0146
		Finish	1.5 x D	.015 x D	5	300	.0006	.0010	.0013	.0016	.0019	.0022	.0026	.0032	.0038	.0051
	Difficult-to-Machine Titanium Alloys 10-2-3 Precipitation Hardening Stainless Steels M 13-8	Slotting	.25 x D	1 x D	5	200	.0003	.0005	.0007	.0009	.0010	.0012	.0014	.0017	.0020	.0027
		Peripheral - Rough	1 x D	.25 x D	5	250	.0005	.0007	.0010	.0012	.0015	.0017	.0020	.0025	.0029	.0039
		Peripheral - HEM*	3 x D	.05 x D	5	275	.0015	.0022	.0030	.0037	.0045	.0052	.0059	.0074	.0089	.0119
		Finish	1.5 x D	.01 x D	5	250	.0006	.0009	.0012	.0014	.0017	.0020	.0023	.0029	.0035	.0046

D = Tool Diameter *HEM = High-efficiency machining (chip thinning calculations have already been applied to HEM parameters shown).

≈ Approximately Equals	< Less Than
≤ Less Than or Equal To	> Greater Than
≥ Greater Than or Equal To	= Equals
x Multiply	

Common Machining Formulas

$$RPM = \frac{SFM \times 3.82}{D}$$

$$SFM = RPM \times D \times .262$$

$$IPM = RPM \times IPT \times Z$$

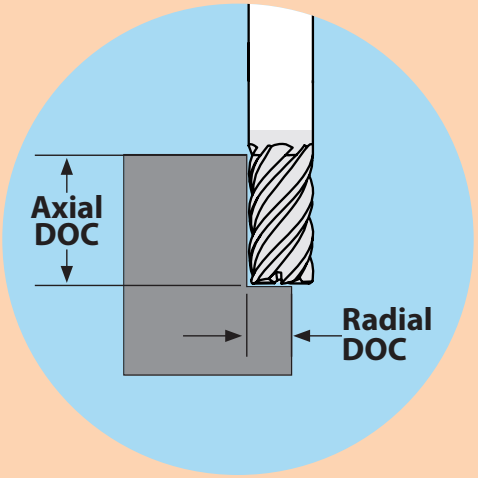
$$MRR = RDOC \times ADOC \times IPM$$

$$RPM = \frac{M/min \times 318.3}{D}$$

$$M/min = RPM \times D \times .00314$$

$$MMPM = RPM \times MMPT \times Z$$

$$MRR = RDOC \times ADOC \times MMPM$$



M525 Application Guide – Speed & Feed (metric)

ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	No. of Flutes	Speed (M/min)	Feed (MM per Tooth) 6.0	8.0	10.0	12.0	16.0	20.0	25.0
K	Cast Iron Gray ASTM-A48 Class 20, 25, 30, 35 & 40	Slotting	.5 x D	1 x D	5	91	.0288	.0384	.0478	.0576	.0766	.0956	.1200
		Peripheral - Rough	1.25 x D	.3 x D	5	114	.0393	.0524	.0652	.0786	.1045	.1304	.1636
		Finish	2 x D	.015 x D	5	114	.0400	.0533	.0664	.0800	.1063	.1327	.1666
	Cast Iron Malleable	Slotting	.5 x D	1 x D	5	84	.0240	.0320	.0398	.0480	.0638	.0797	.1000
		Peripheral - Rough	1.25 x D	.3 x D	5	107	.0327	.0436	.0543	.0655	.0871	.1087	.1364
		Peripheral - HEM*	3 x D	.05 x D	5	119	.0966	.1288	.1604	.1932	.2570	.3207	.4025
		Finish	2 x D	.015 x D	5	107	.0333	.0444	.0553	.0666	.0886	.1106	.1388
P	Low Carbon Steels ≤ 38 Rc 1018, 1020, 12L14, 5120, 8620	Slotting	.5 x D	1 x D	5	99	.0336	.0448	.0558	.0672	.0894	.1115	.1400
		Peripheral - Rough	1.25 x D	.3 x D	5	122	.0458	.0611	.0761	.0916	.1219	.1521	.1909
		Peripheral - HEM*	3 x D	.07 x D	5	137	.1344	.1792	.2231	.2688	.3575	.4463	.5601
		Finish	2 x D	.015 x D	5	122	.0466	.0622	.0774	.0933	.1241	.1549	.1943
	Medium Carbon Steels ≤ 48 HRC 1045, 4140, 4340, 5140	Slotting	.5 x D	1 x D	5	91	.0307	.0410	.0510	.0614	.0817	.1020	.1280
		Peripheral - Rough	1.25 x D	.3 x D	5	114	.0419	.0559	.0695	.0838	.1114	.1391	.1746
		Peripheral - HEM*	3 x D	.05 x D	5	126	.1239	.1652	.2057	.2478	.3296	.4114	.5163
		Finish	2 x D	.015 x D	5	114	.0426	.0569	.0708	.0853	.1134	.1416	.1777
	Tool and Die Steels ≤ 48 Rc A2, D2, O1, S7, P20, H13	Slotting	.5 x D	1 x D	5	84	.0259	.0346	.0430	.0518	.0689	.0860	.1080
		Peripheral - Rough	1.25 x D	.3 x D	5	107	.0353	.0471	.0587	.0707	.0940	.1174	.1473
		Peripheral - HEM*	3 x D	.05 x D	5	119	.1040	.1386	.1726	.2079	.2765	.3452	.4332
		Finish	2 x D	.015 x D	5	107	.0360	.0480	.0597	.0720	.0957	.1195	.1499
M	Martensitic & Ferritic Stainless Steels 410, 416, 440	Slotting	.5 x D	1 x D	5	91	.0307	.0410	.0510	.0614	.0817	.1020	.1280
		Peripheral - Rough	1.25 x D	.3 x D	5	114	.0419	.0559	.0695	.0838	.1114	.1391	.1746
		Peripheral - HEM*	3 x D	.05 x D	5	126	.1239	.1652	.2057	.2478	.3296	.4114	.5163
		Finish	2 x D	.015 x D	5	114	.0426	.0569	.0708	.0853	.1134	.1416	.1777
	Austenitic Stainless Steels, FeNi Alloys 303, 304, 316, Invar, Kovar	Slotting	.5 x D	1 x D	5	84	.0288	.0384	.0478	.0576	.0766	.0956	.1200
		Peripheral - Rough	1.25 x D	.3 x D	5	107	.0393	.0524	.0652	.0786	.1045	.1304	.1636
		Peripheral - HEM*	3 x D	.05 x D	5	119	.1185	.1580	.1967	.2370	.3152	.3934	.4937
		Finish	2 x D	.015 x D	5	107	.0400	.0533	.0664	.0800	.1063	.1327	.1666
	Precipitation Hardening Stainless Steels 17-4, 15-5	Slotting	.5 x D	1 x D	5	76	.0240	.0320	.0398	.0480	.0638	.0797	.1000
		Peripheral - Rough	1.25 x D	.3 x D	5	99	.0327	.0436	.0543	.0655	.0871	.1087	.1364
		Peripheral - HEM*	3 x D	.05 x D	5	110	.0950	.1267	.1577	.1900	.2527	.3154	.3958
		Finish	1.5 x D	.015 x D	5	99	.0333	.0444	.0553	.0666	.0886	.1106	.1388
S	Titanium Alloys 6Al-4V, 6-2-4	Slotting	.5 x D	1 x D	5	76	.0221	.0294	.0366	.0442	.0587	.0733	.0920
		Peripheral - Rough	1 x D	.3 x D	5	91	.0301	.0401	.0500	.0602	.0801	.1000	.1255
		Peripheral - HEM*	3 x D	.05 x D	5	101	.0875	.1167	.1452	.1750	.2327	.2905	.3646
		Finish	1.5 x D	.015 x D	5	91	.0307	.0409	.0509	.0613	.0815	.1018	.1277
	Difficult-to-Machine Titanium Alloys 10-2-3 Precipitation Hardening Stainless Steels M 13-8	Slotting	.25 x D	1 x D	5	61	.0163	.0218	.0271	.0326	.0434	.0542	.0680
		Peripheral - Rough	1 x D	.25 x D	5	76	.0236	.0314	.0391	.0471	.0627	.0782	.0981
		Peripheral - HEM*	3 x D	.05 x D	5	84	.0712	.0950	.1183	.1425	.1895	.2365	.2968
		Finish	1.5 x D	.01 x D	5	76	.0277	.0369	.0459	.0554	.0736	.0919	.1153

D = Tool Diameter *HEM = High-efficiency machining (chip thinning calculations have already been applied to HEM parameters shown).

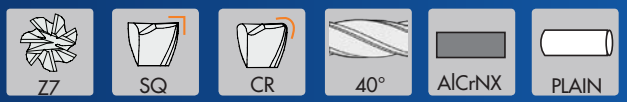
D Tool Diameter
Z Number of Flutes
RPM Revolutions per Minute
SFM Surface Feet per Minute
M/min Surface Meters per Minute
IPM Inches per Minute
MMPM Millimeters per Minute
IPT Inch per Tooth
MMPT Millimeters per Tooth
MRR Metal Removal Rate
RDOC Radial Depth of Cut
ADOC Axial Depth of Cut

Technical Resources

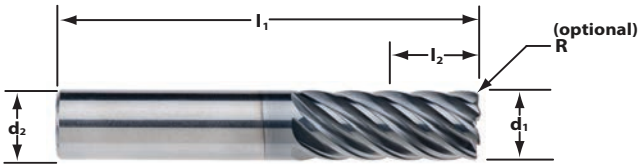
Information on tips and adjustments for the following milling operations can be found in our Technical Resources section beginning on page 129.

- HEM slotting
- Face milling
- Helical entry ramping
- Straight line ramping
- Long tool projection adjustments
- Ball nose milling adjustments
- Other helpful tips and calculations

M527 enDURO



For high-performance machining in materials ranging from low carbon steels to titanium. The M527 takes the best features of the M525 and adds two cutting edges to improve metal removal rates – especially in HEM tool paths – without losing any versatility. The 7 cutting edges also make the M527 an excellent choice for finishing applications.



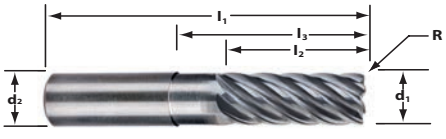
in: *d1: +0.000 / -0.002* *d2: -0.0001 / -0.0004*
mm: *d1: +0.000 / -0.050* *d2: -0.0025 / -0.0100*

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius .015 CR	.030 CR	.060 CR	.125 CR
3/8	3/8	1/2	2	65920	65921	65922	65923	-
		7/8	2-1/2	65968	65969	65970	65971	-
		1-1/4	3	65976	65977	65978	65979	-
1/2	1/2	5/8	2-1/2	66000	66001	66002	66003	66005
		1-1/4	3	66045	66046	66047	66048	66050
		1-5/8	3-1/2	66054	66055	66056	66057	66059
		2-1/8	4	66072	66073	66074	66075	66077
		2-5/8	5	66081	66082	66083	66084	66086
5/8	5/8	3/4	3	66090	-	66092	66093	66095
		1-3/8	3-1/2	66130	-	66132	66133	66135
		2-1/8	4	66140	-	66142	66143	66145
		2-5/8	5	66160	-	66162	66163	66165
		3-1/4	6	66170	-	66172	66173	66175
3/4	3/4	1	3	66180	-	66182	66183	66185
		1-5/8	4	66220	-	66222	66223	66225
		2-3/8	5	66230	-	66232	66233	66235
		3-1/4	6	66250	-	66252	66253	66255
		4-1/8	7	66260	-	66262	66263	66265
1	1	1-3/4	4	66314	-	66316	66317	66319
		2-1/4	5	66325	-	66327	66328	66330
		3-1/4	6	66347	-	66349	66350	66352
		4-1/8	7	66358	-	66360	66361	66363

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius 0.5 CR	1.0 CR	1.5 CR	2.0 CR	3.0 CR	4.0 CR
10	10	22	72	66440	66441	66442	66443	-	-	-
12	12	26	83	66448	66449	66450	66451	-	-	-
		32	83	-	66575	66576	66577	66578	66579	66580
16	16	34	92	66460	66461	66462	66463	-	-	-
		42	92	-	66581	66582	-	66583	66584	66585
20	20	42	104	66472	66473	66474	66475	-	-	-
		52	104	-	66586	66587	-	66588	66589	66590

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Reach LBS	Overall Length l1	Order Code by Corner Radius 0.5 CR	1.0 CR	3.0 CR
12	12	26	55	100	66591	66592	66593
16	16	34	75	125	66594	66595	66596
20	20	42	100	150	66597	66598	66599

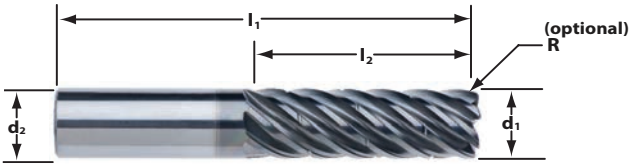
M527N



mm: *d1: +0.000 / -0.050* *d2: -0.0025 / -0.0100*

M527C enDURO

For high-performance machining in materials ranging from low carbon steels to titanium. Adds the benefits of the unique **Chip Management System (CMS)** to the versatility of the M527 design. Breaks up long, stringy chips, which eliminates recutting chips and chip packing, and allows for free cutting tool movement in a variety of materials. The results are great chip control and very high metal removal rates.



in: *d1: +0.000 / -0.002 d2: -0.0001 / -0.0004*

K P M S

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius .015 CR	.030 CR	.060 CR
1/2	1/2	2-1/8	4	66492	66493	66494	-
		2-5/8	5	66497	66498	66499	-
5/8	5/8	2-1/8	4	66502	-	66504	66505
		2-5/8	5	66507	-	66509	66510
		3-1/4	6	66512	-	66514	66515
3/4	3/4	2-3/8	5	66517	-	66519	66520
		3-1/4	6	66522	-	66524	66525
		4-1/8	7	66527	-	66529	66530
1	1	2-1/4	5	66532	-	66534	66535
		3-1/4	6	66537	-	66539	66540
		4-1/8	7	66542	-	66544	66545

TOOL TIP

CMS: Stop Chip Pollution.

Controlling chip size and clearing the chips from the cutting zone are important when machining in all tools paths, but they become critical in traditional slotting and when using HEM paths. IMCO's CMS is a unique edge treatment design that breaks materials into smaller, more manageable chips. CMS helps improve the effectiveness of the coolant or air blasts in evacuating the chips from the cutting zone, preventing chip packing and recutting – improving tool life and performance.

Chip pollution caused by a non-CMS tool. ▶

M527 Application Guide – Speed & Feed (inch)

ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	No. of Flutes	Speed (SFM)	Feed (Inch per Tooth) 3/8	1/2	5/8	3/4	1
K	Cast Iron Gray	Slotting	.5 x D	1 x D	7	300	.0013	.0018	.0022	.0027	.0035
		Peripheral - Rough	1.25 x D	.3 x D	7	375	.0018	.0023	.0029	.0035	.0047
		Finish	2 x D	.015 x D	7	450	.0018	.0024	.0030	.0036	.0048
	Cast Iron	Slotting	.5 x D	1 x D	7	275	.0011	.0014	.0018	.0021	.0029
		Peripheral - Rough	1.25 x D	.3 x D	7	350	.0015	.0019	.0024	.0029	.0039
		Peripheral - HEM*	3 x D	.05 x D	7	390	.0043	.0057	.0071	.0085	.0114
		Finish	2 x D	.015 x D	7	350	.0015	.0020	.0025	.0030	.0040
P	Low Carbon Steels ≤ 38 Rc 1018, 1020, 12L14, 5120, 8620	Slotting	.5 x D	1 x D	7	325	.0015	.0020	.0025	.0030	.0040
		Peripheral - Rough	1.25 x D	.3 x D	7	400	.0020	.0027	.0034	.0041	.0055
		Peripheral - HEM*	3 x D	.05 x D	7	450	.0066	.0088	.0109	.0131	.0175
		Finish	2 x D	.015 x D	7	400	.0021	.0028	.0035	.0042	.0056
	Medium Carbon Steels ≤ 48 HRC 1045, 4140, 4340, 5140	Slotting	.5 x D	1 x D	7	300	.0014	.0018	.0023	.0027	.0037
		Peripheral - Rough	1.25 x D	.3 x D	7	375	.0019	.0025	.0031	.0037	.0050
		Peripheral - HEM*	3 x D	.05 x D	7	415	.0064	.0086	.0107	.0129	.0172
		Finish	2 x D	.015 x D	7	375	.0019	.0025	.0032	.0038	.0051
	Tool and Die Steels ≤ 48 Rc A2, D2, O1, S7, P20, H13	Slotting	.5 x D	1 x D	7	275	.0012	.0015	.0019	.0023	.0031
		Peripheral - Rough	1.25 x D	.3 x D	7	350	.0016	.0021	.0026	.0032	.0042
		Peripheral - HEM*	3 x D	.05 x D	7	390	.0055	.0074	.0092	.0110	.0147
		Finish	2 x D	.015 x D	7	350	.0016	.0021	.0027	.0032	.0043
M	Martensitic & Ferritic Stainless Steels 410, 416, 440	Slotting	.5 x D	1 x D	7	300	.0014	.0018	.0023	.0027	.0037
		Peripheral - Rough	1.25 x D	.3 x D	7	375	.0019	.0025	.0031	.0037	.0050
		Peripheral - HEM*	3 x D	.05 x D	7	415	.0064	.0086	.0107	.0129	.0172
		Finish	2 x D	.015 x D	7	375	.0019	.0025	.0032	.0038	.0051
	Austenitic Stainless Steels, FeNi Alloys 303, 304, 316, Invar, Kovar	Slotting	.5 x D	1 x D	7	275	.0013	.0017	.0021	.0026	.0034
		Peripheral - Rough	1.25 x D	.3 x D	7	350	.0018	.0023	.0029	.0035	.0047
		Peripheral - HEM*	3 x D	.05 x D	7	390	.0063	.0083	.0104	.0125	.0167
		Finish	2 x D	.015 x D	7	350	.0018	.0024	.0030	.0036	.0048
	Precipitation Hardening Stainless Steels 17-4, 15-5	Slotting	.5 x D	1 x D	7	250	.0011	.0014	.0018	.0021	.0029
		Peripheral - Rough	1.25 x D	.3 x D	7	325	.0015	.0019	.0024	.0029	.0039
		Peripheral - HEM*	3 x D	.05 x D	7	360	.0050	.0067	.0083	.0100	.0133
		Finish	1.5 x D	.015 x D	7	325	.0015	.0020	.0025	.0030	.0040
S	Titanium Alloys 6Al-4V, 6-2-4	Slotting	.5 x D	1 x D	7	250	.0010	.0013	.0016	.0020	.0026
		Peripheral - Rough	1 x D	.3 x D	7	300	.0013	.0018	.0022	.0027	.0036
		Peripheral - HEM*	3 x D	.05 x D	7	330	.0047	.0063	.0079	.0095	.0126
		Finish	1.5 x D	.015 x D	7	300	.0014	.0018	.0023	.0027	.0036
	Difficult-to-Machine Titanium Alloys 10-2-3 Precipitation Hardening Stainless Steel M 13-8	Slotting	.25 x D	1 x D	7	200	.0007	.0010	.0012	.0015	.0019
		Peripheral - Rough	1 x D	.25 x D	7	250	.0011	.0014	.0018	.0021	.0028
		Peripheral - HEM*	3 x D	.05 x D	7	275	.0037	.0049	.0061	.0073	.0098
		Finish	1.5 x D	.01 x D	7	250	.0012	.0016	.0021	.0025	.0033

D = Tool Diameter *HEM = High-efficiency machining (chip thinning calculations have already been applied to HEM parameters shown).

≈ Approximately Equals < Less Than
≤ Less Than or Equal To > Greater Than
≥ Greater Than or Equal To = Equals
× Multiply

Common Machining Formulas

$$RPM = \frac{SFM \times 3.82}{D}$$

$$SFM = RPM \times D \times .262$$

$$IPM = RPM \times IPT \times Z$$

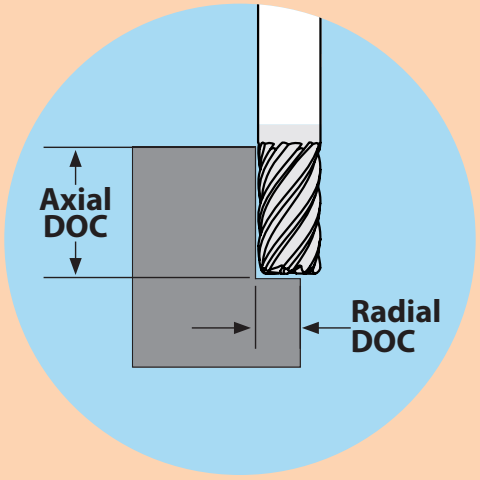
$$MRR = RDOC \times ADOC \times IPM$$

$$RPM = \frac{M/min \times 318.3}{D}$$

$$M/min = RPM \times D \times .00314$$

$$MMPM = RPM \times MMPT \times Z$$

$$MRR = RDOC \times ADOC \times MMPM$$



M527 Application Guide – Speed & Feed (metric)

ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	No. of Flutes	Speed (M/min)	Feed (MM per Tooth) 10.0	12.0	16.0	20.0	25.0
K	Cast Iron Gray	Slotting	.5 x D	1 x D	7	91	.0353	.0425	.0566	.0706	.0886
		Peripheral - Rough	1.25 x D	.3 x D	7	114	.0467	.0563	.0749	.0935	.1173
		Finish	2 x D	.015 x D	7	137	.0476	.0573	.0762	.0951	.1194
	Cast Iron	Slotting	.5 x D	1 x D	7	84	.0285	.0343	.0456	.0569	.0714
		Peripheral - Rough	1.25 x D	.3 x D	7	107	.0388	.0468	.0622	.0776	.0974
		Peripheral - HEM*	3 x D	.05 x D	7	119	.1133	.1365	.1816	.2266	.2844
		Finish	2 x D	.015 x D	7	107	.0395	.0476	.0633	.0790	.0992
P	Low Carbon Steels ≤ 38 Rc 1018, 1020, 12L14, 5120, 8620	Slotting	.5 x D	1 x D	7	99	.0398	.0480	.0638	.0797	.1000
		Peripheral - Rough	1.25 x D	.3 x D	7	122	.0543	.0655	.0871	.1087	.1364
		Peripheral - HEM*	3 x D	.05 x D	7	137	.1743	.2100	.2793	.3486	.4375
		Finish	2 x D	.015 x D	7	122	.0553	.0666	.0886	.1106	.1388
	Medium Carbon Steels ≤ 48 HRC 1045, 4140, 4340, 5140	Slotting	.5 x D	1 x D	7	91	.0364	.0439	.0584	.0729	.0914
		Peripheral - Rough	1.25 x D	.3 x D	7	114	.0497	.0599	.0796	.0994	.1247
		Peripheral - HEM*	3 x D	.05 x D	7	126	.1708	.2058	.2737	.3417	.4288
		Finish	2 x D	.015 x D	7	114	.0506	.0609	.0810	.1011	.1269
	Tool and Die Steels ≤ 48 Rc A2, D2, O1, S7, P20, H13	Slotting	.5 x D	1 x D	7	84	.0307	.0370	.0493	.0615	.0772
		Peripheral - Rough	1.25 x D	.3 x D	7	107	.0419	.0505	.0672	.0838	.1052
		Peripheral - HEM*	3 x D	.05 x D	7	119	.1464	.1764	.2346	.2929	.3675
		Finish	2 x D	.015 x D	7	107	.0427	.0514	.0684	.0853	.1071
M	Martensitic & Ferritic Stainless Steels 410, 416, 440	Slotting	.5 x D	1 x D	7	91	.0364	.0439	.0584	.0729	.0914
		Peripheral - Rough	1.25 x D	.3 x D	7	114	.0497	.0599	.0796	.0994	.1247
		Peripheral - HEM*	3 x D	.05 x D	7	126	.1708	.2058	.2737	.3417	.4288
		Finish	2 x D	.015 x D	7	114	.0506	.0609	.0810	.1011	.1269
	Austenitic Stainless Steels, FeNi Alloys 303, 304, 316, Invar, Kovar	Slotting	.5 x D	1 x D	7	84	.0341	.0411	.0547	.0683	.0857
		Peripheral - Rough	1.25 x D	.3 x D	7	107	.0466	.0561	.0746	.0931	.1169
		Peripheral - HEM*	3 x D	.05 x D	7	119	.1660	.2000	.2660	.3320	.4166
		Finish	2 x D	.015 x D	7	107	.0474	.0571	.0760	.0948	.1190
	Precipitation Hardening Stainless Steels 17-4, 15-5	Slotting	.5 x D	1 x D	7	76	.0285	.0343	.0456	.0569	.0714
		Peripheral - Rough	1.25 x D	.3 x D	7	99	.0388	.0468	.0622	.0776	.0974
		Peripheral - HEM*	3 x D	.05 x D	7	110	.1328	.1600	.2128	.2656	.3333
		Finish	1.5 x D	.015 x D	7	99	.0395	.0476	.0633	.0790	.0992
S	Titanium Alloys 6Al-4V, 6-2-4	Slotting	.5 x D	1 x D	7	76	.0262	.0315	.0420	.0524	.0657
		Peripheral - Rough	1 x D	.3 x D	7	91	.0357	.0430	.0572	.0714	.0896
		Peripheral - HEM*	3 x D	.05 x D	7	101	.1257	.1515	.2015	.2515	.3156
		Finish	1.5 x D	.015 x D	7	91	.0363	.0438	.0582	.0727	.0912
	Difficult-to-Machine Titanium Alloys 10-2-3 Precipitation Hardening Stainless Steels M13-8	Slotting	.25 x D	1 x D	7	61	.0193	.0233	.0310	.0387	.0486
		Peripheral - Rough	1 x D	.25 x D	7	76	.0279	.0336	.0447	.0558	.0701
		Peripheral - HEM*	3 x D	.05 x D	7	84	.0975	.1175	.1563	.1950	.2448
		Finish	1.5 x D	.01 x D	7	76	.0328	.0395	.0526	.0656	.0824

D = Tool Diameter *HEM = High-efficiency machining (chip thinning calculations have already been applied to HEM parameters shown)

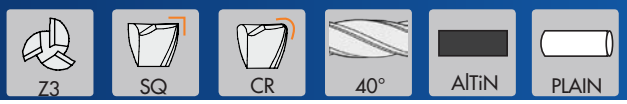
D Tool Diameter
Z Number of Flutes
RPM Revolutions per Minute
SFM Surface Feet per Minute
M/min Surface Meters per Minute
IPM Inches per Minute
MMPM Millimeters per Minute
IPT Inch per Tooth
MMPT Millimeters per Tooth
MRR Metal Removal Rate
RDOC Radial Depth of Cut
ADOC Axial Depth of Cut

Technical Resources

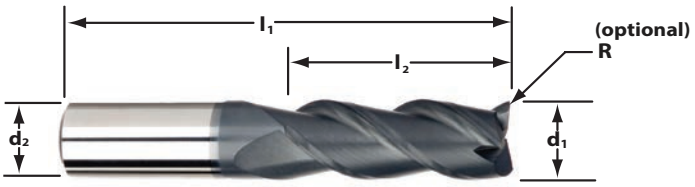
Information on tips and adjustments for the following milling operations can be found in our Technical Resources section beginning on page 129.

- HEM slotting
- Face milling
- Helical entry ramping
- Straight line ramping
- Long tool projection adjustments
- Ball nose milling adjustments
- Other helpful tips and calculations

M503 enDURO



For general machining in carbon and stainless steels, as well as copper alloys. The 3-flute design of the M503 combines the strength of high-shear cutting edges and advanced AlTiN coating with the flute spacing to help evacuate gummy chips. Use with traditional machining techniques only.



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P M N

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius .015 CR	.020 CR	.030 CR
1/8	1/8	1/4	1-1/2	-	62942	-	-
		1/2	1-1/2	62308	62208	-	-
3/16	3/16	5/16	2	-	62943	-	-
		9/16	2	62312	62212	-	-
1/4	1/4	3/8	2	-	-	62944	-
		3/4	2-1/2	62316	-	62216	-
3/8	3/8	1/2	2	-	-	-	62945
		1	2-1/2	62324	-	-	62224
1/2	1/2	5/8	2-1/2	-	-	-	62946
		1-1/4	3	62332	-	-	62232

M503 Application Guide – Speed & Feed (inch)

ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	No. of Flutes	Speed (SFM)	Feed (inch per Tooth) 1/8	3/16	1/4	3/8	1/2
P	Low Carbon Steels 1018, 12L14, 8620	Slotting	1 x D	1 x D	3	325	.0006	.0009	.0012	.0018	.0024
		Rough	1.25 x D	.5 x D	3	375	.0008	.0011	.0015	.0023	.0030
		Finish	1.5 x D	.01 x D	3	425	.0010	.0014	.0019	.0029	.0038
	Medium Carbon Steels 4140, 4340	Slotting	.75 x D	1 x D	3	275	.0005	.0008	.0011	.0016	.0021
		Rough	1.25 x D	.3 x D	3	350	.0006	.0009	.0012	.0018	.0024
		Finish	1.5 x D	.01 x D	3	375	.0007	.0011	.0014	.0021	.0028
M	Martensitic Stainless Steels 416, 410, 440C	Slotting	.75 x D	1 x D	3	275	.0006	.0008	.0011	.0017	.0022
		Rough	1.25 x D	.3 x D	3	350	.0007	.0011	.0014	.0021	.0028
		Finish	1.5 x D	.01 x D	3	375	.0009	.0013	.0018	.0026	.0035
	Austenitic Stainless Steels 303, 304, 316	Slotting	.75 x D	1 x D	3	250	.0005	.0007	.0009	.0014	.0018
		Rough	1.25 x D	.3 x D	3	300	.0006	.0009	.0012	.0018	.0024
		Finish	1.5 x D	.01 x D	3	350	.0008	.0011	.0015	.0023	.0030
	Precipitation Hardening Stainless Steels 17-4, 15-5	Slotting	.5 x D	1 x D	3	225	.0004	.0005	.0007	.0011	.0014
		Rough	1.25 x D	.3 x D	3	275	.0004	.0006	.0009	.0013	.0017
		Finish	1.5 x D	.01 x D	3	325	.0006	.0009	.0013	.0019	.0025
N	Copper, Brass,& Bronze	Slotting	1 x D	1 x D	3	450	.0008	.0011	.0015	.0023	.0030
		Rough	1.25 x D	.5 x D	3	550	.0009	.0013	.0018	.0026	.0035
		Finish	1.5 x D	.01 x D	3	600	.0010	.0015	.0021	.0031	.0041
	Bronze & Berylium Copper	Slotting	.5 x D	1 x D	3	275	.0005	.0008	.0010	.0015	.0020
		Rough	1.25 x D	.5 x D	3	350	.0006	.0009	.0013	.0019	.0025
		Finish	1.5 x D	.01 x D	3	375	.0007	.0011	.0015	.0022	.0029

D = Tool Diameter

Information on tips and adjustments can be found in our Technical Resources section beginning on page 129.

≈ Approximately Equals < Less Than
≤ Less Than or Equal To > Greater Than
≥ Greater Than or Equal To = Equals
× Multiply

Common Machining Formulas

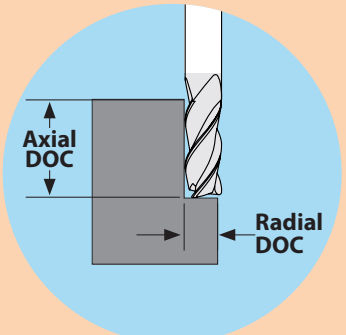
$$RPM = \frac{SFM \times 3.82}{D}$$

SFM = RPM x D x .262

IPM = RPM x IPT x Z

MRR = RDOC x ADOC x IPM

D Tool Diameter
Z Number of Flutes
RPM Revolutions per Minute
SFM Surface Feet per Minute
IPM Inches per Minute
IPT Inch per Tooth
MRR Metal Removal Rate
RDOC Radial Depth of Cut
ADOC Axial Depth of Cut



OMEGA-6™

PERFORMANCE TO THE SIXTH POWER.

The Omega-6 end mill demonstrates remarkably longer tool life in hardened steels, even up to 58-62 HRC, running wet or dry. This tool excels in hardened materials, and it provides superior finishes in a wide range of non-hardened materials.

M7 Series Features

HARD CORE FOR HARD WORK.

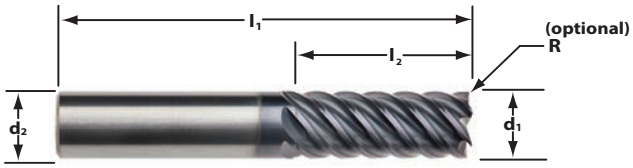
The Omega-6 is a purpose-driven end mill for machining in hard metal applications. Available in both the second (M725/726) and first (M706) generations. Engineered with strong cutting edges and a thick core for long tool life when machining steels up to 62 HRC. Heat-resistant coating yields great tool performance in both wet and dry machining conditions. An excellent tool for finishing applications in a wide range of materials.

	M725	M726	M725N	M726N	M706	M706N
NUMBER OF FLUTES	Z5	Z6	Z5	Z6	Z6	Z6
END TYPES	SQ, CR	SQ, CR	CR	CR	SQ, CR	SQ, CR
HELIX ANGLE	50°	50°	50°	50°	40°	40°
COATING	AlTiNX	AlTiNX	AlTiNX	AlTiNX	AlTiN	AlTiN
SHANK TYPES	PLAIN	PLAIN, WELDON	PLAIN, NECK	PLAIN, NECK	PLAIN, WELDON	PLAIN, WELDON, NECK
APPLICATIONS	ROUGH, FINISH					
MATERIAL(S)	K, P, M, H					

M725/M726 OMEGA-6

Z5 | Z6 | SQ | CR | 50° | AlTiNX | PLAIN | WELDON

For hardened steels and general finishing applications. The second generation of the Omega-6 end mill. The M725/726 series uses a high-strength core, reinforced cutting edges, and a heat-resistant coating to yield long tool life in difficult machining conditions. Best when hard milling in materials up to 62 HRC and when finishing in a wide range of materials.



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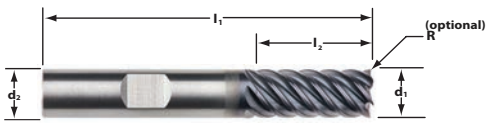
K P M H

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Number of Flutes	Order Code SQ	Order Code by Corner Radius .015 CR	.030 CR	.060 CR
1/8	1/8	1/4	1-1/2	5	69050	69051	-	-
		1/2	1-1/2	5	69052	69053	-	-
3/16	3/16	5/16	2	5	69054	69055	-	-
		9/16	2	5	69056	69057	-	-
1/4	1/4	3/4	2-1/2	6	69058	69059	69060	-
		1-1/4	3	6	69061	69062	69063	-
3/8	3/8	7/8	2-1/2	6	69070	69071	69072	-
		1-1/4	3	6	69073	69074	69075	-
		2	4	6	69076	69077	69078	-
1/2	1/2	1	3	6	69079	69080	69081	69082
		1-1/4	3	6	69083	69084	69085	69086
		1-5/8	3-1/2	6	69087	69088	69089	69090
		2-1/8	4	6	69091	69092	69093	69094
		2-5/8	5	6	69095	69096	69097	69098
5/8	5/8	1-3/8	3-1/2	6	69099	-	69101	69102
		1-7/8	4	6	69103	-	69105	69106
		2-5/8	5	6	69107	-	69109	69110
3/4	3/4	1-5/8	4	6	69111	-	69113	69114
		2-5/8	5	6	69115	-	69117	69118
		3-3/8	6	6	69119	-	69121	69122

M726 w/WELDON

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Number of Flutes	Order Code SQ	Order Code by Corner Radius .015 CR	.030 CR	.060 CR
3/8	3/8	7/8	2-1/2	6	69220	69221	69222	-
		1-1/4	3	6	69223	69224	69225	-
		2	4	6	69226	69227	69228	-
1/2	1/2	1	3	6	69229	69230	69231	69232
		1-1/4	3	6	69233	69234	69235	69236
		1-5/8	3-1/2	6	69237	69238	69239	69240
		2-1/8	4	6	69241	69242	69243	69244
		2-5/8	5	6	69245	69246	69247	69248
5/8	5/8	1-3/8	3-1/2	6	69249	-	69251	69252
		1-7/8	4	6	69253	-	69255	69256
		2-5/8	5	6	69257	-	69259	69260
3/4	3/4	1-5/8	4	6	69261	-	69263	69264
		2-5/8	5	6	69265	-	69267	69268
		3-3/8	6	6	69269	-	69271	69272



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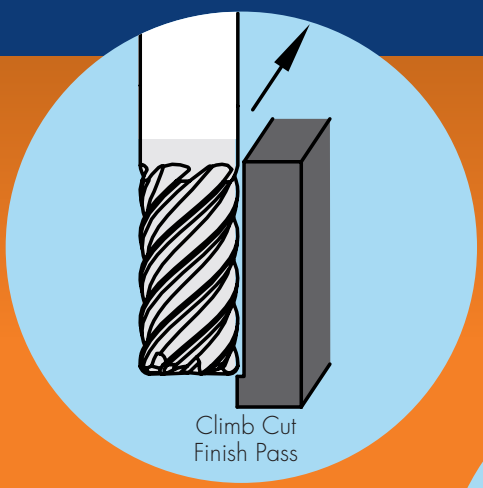
Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Number of Flutes	Order Code SQ	Order Code by Corner Radius 0.3 CR	0.5 CR	1.0 CR	1.5 CR
3	3	6	38	5	69138	69139	-	-	-
		8	38	5	69140	69141	-	-	-
4	4	7	50	5	69142	69143	-	-	-
		11	50	5	69144	69145	-	-	-
5	5	8	50	5	69146	69147	-	-	-
		13	50	5	69148	69149	-	-	-
6	6	13	57	6	69150	-	69151	-	-
		25	75	6	69152	-	69153	-	-
8	8	19	63	6	69154	-	69155	-	-
		32	75	6	69156	-	69157	-	-
10	10	22	72	6	69158	-	69159	69160	-
		40	88	6	69161	-	69162	69163	-
		46	100	6	69164	-	69165	69166	-
12	12	26	83	6	69167	-	69168	69169	69170
		50	100	6	69171	-	69172	69173	69174
		65	125	6	69175	-	69176	69177	69178
16	16	32	92	6	69179	-	-	69181	69182
		55	110	6	69183	-	-	69185	69186
		65	125	6	69187	-	-	69189	69190
20	20	38	104	6	69191	-	-	69193	69194
		65	125	6	69195	-	-	69197	69198
		85	150	6	69199	-	-	69201	69202

TOOL TIP

Eliminate Wall Taper when Finishing.

Step 1

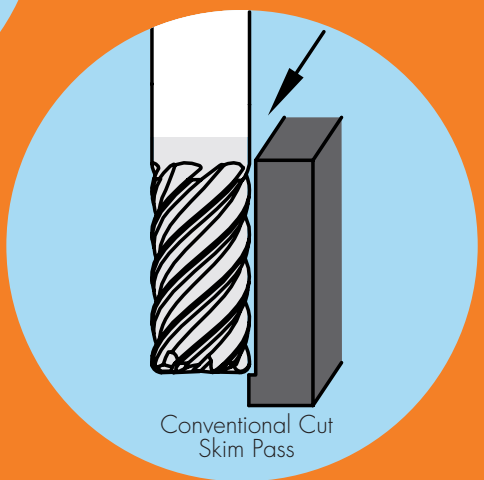
Run finish pass using speed, feed, step-over (RDOC) and depth of cut (ADOC) values shown in the speed and feed charts.



Climb Cut
Finish Pass

Step 2

Re-run the finish pass using the same speeds and feeds but in the CONVENTIONAL direction. Simply retrace the prior finish pass – do not program to remove more stock. This skim pass will help eliminate taper caused by tool deflection during the first finish pass.

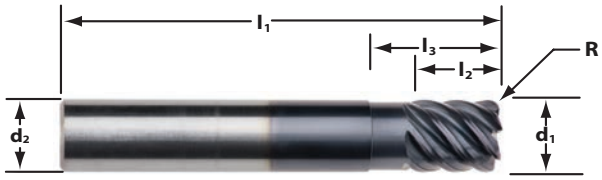


Conventional Cut
Skim Pass

M725N/M726N
OMEGA-6

Z5 | Z6 | CR | 50° | NECK | AlTiNX | PLAIN

For hardened steels and general finishing applications. Adding a necked shank to the M725/M726 design offers a high-performance tool that permits clearance in deeper cavities and easier machining against tight walls. Neck relief and short flute length combine to increase end mill stability in the cut for more precise tolerances. Great for work in pockets.



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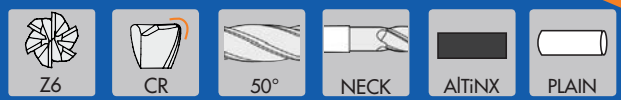
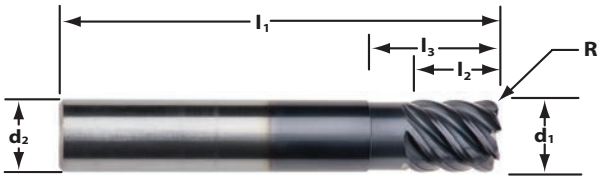
K P M H

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Reach LBS l3	Overall Length l1	Number of Flutes	Order Code by Corner Radius .015 CR	.030 CR
1/8	1/8	1/4	1/2	1-1/2	5	69351	-
		1/4	1-1/8	2-1/2	5	69491	-
3/16	3/16	5/16	9/16	2	5	69355	-
		3/8	1-3/8	3	5	69493	-
1/4	1/4	3/8	5/8	2-1/2	6	69359	-
		5/8	1-3/8	3	6	69495	-
		5/8	2-3/8	4	6	69498	-
3/8	3/8	1/2	3/4	2-1/2	6	-	69369
		7/8	1-3/8	3	6	-	69502
		7/8	2-3/8	4	6	-	69505
1/2	1/2	5/8	1-3/8	3	6	-	69508
		1-1/8	1-3/4	3-1/2	6	-	69512
		1-1/8	2-1/4	4	6	-	69516
		1-1/8	3-1/4	5	6	-	69520
5/8	5/8	1-1/8	2-1/8	4	6	-	69528
		1-3/8	3-1/8	5	6	-	69532
3/4	3/4	1-1/8	2	4	6	-	69536
		1-5/8	2-7/8	5	6	-	69540
		1-5/8	3-7/8	6	6	-	69544

M726N
OMEGA-6



For hardened steels and general finishing applications. Adding a necked shank to the M726 design offers a high-performance tool that permits clearance in deeper cavities and easier machining against tight walls. Neck relief and short flute length combine to increase end mill stability in the cut for more precise tolerances. Great for work in pockets.



mm: *d1: +0.000 / -0.050 d2: -0.0025 / -0.0100*

K P M H

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Reach LBS l3	Overall Length l1	Number of Flutes	Order Code by Corner Radius 0.5 CR	1.0 CR
6	6	9	15	57	6	69421	-
		15	39	75	6	69557	-
		15	64	100	6	69559	-
8	8	11	17	63	6	69427	-
		19	39	75	6	69563	-
		19	64	100	6	69565	-
10	10	13	32	72	6	69567	-
		23	48	88	6	69570	-
		23	60	100	6	69573	-
12	12	15	38	83	6	-	69577
		27	55	100	6	-	69581
		27	80	125	6	-	69585
16	16	20	44	92	6	-	69589
		35	62	110	6	-	69593
		35	77	125	6	-	69597
20	20	24	54	104	6	-	69601
		43	75	125	6	-	69605
		43	100	150	6	-	69609

TOOL TIP

OMEGA-6:
MAX Heat. MAX Hardness. MAX Performance.

Some tools are just made for tough cutting conditions. The M7 series of end mills are that kind of tool. The Omega-6 is designed for hard milling in dry conditions — something that makes many tools have a meltdown.

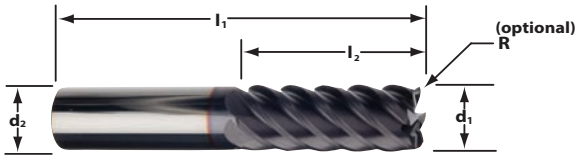
High-shear cutting action, reinforced cutting edges, and a heat-resistant coating combine to allow Omega-6 end mills to machine hardened tool steels with just an air blast – without sacrificing tool life – making it great for machining new molds or repairing used ones.

M7 tools are also versatile – they can run wet or dry – giving you the option of what best fits your shop. Omega-6 can also generate a great finish in a wide variety of materials.

M706 OMEGA-6

Z6 | SQ | CR | 45° | AlTiN | PLAIN | WELDON

For hardened steels and general finishing applications. The first-generation Omega-6 design offers reliable tool life in hardened steels. The M706 is a proven winner in wet or dry machining of materials up to 62 HRC.



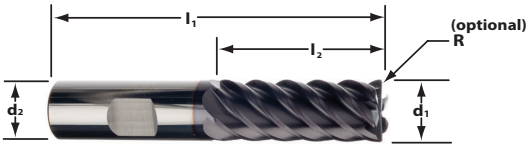
in: *d1: +0.000 / -0.002* *d2: -0.0001 / -0.0004*

K P M H

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius .015 CR	.020 CR	.030 CR
1/8	1/8	1/4	1-1/2	63190	62983	-	-
		1/2	1-1/2	62781	62791	-	-
3/16	3/16	5/16	2	63192	62984	-	-
		9/16	2	62782	62792	-	-
1/4	1/4	3/8	2-1/2	63194	-	62985	-
		3/4	2-1/2	62783	-	62793	62838
5/16	5/16	13/16	2-1/2	62784	-	-	62794
3/8	3/8	1/2	2-1/2	63196	-	-	62986
		1	2-1/2	62785	-	-	62795
1/2	1/2	5/8	3	63198	-	-	62987
		1-1/4	3	62787	-	-	62797
5/8	5/8	3/4	3-1/2	63199	-	-	62988
		1-5/8	3-1/2	62788	-	-	62798
3/4	3/4	1	4	63200	-	-	62989
		1-5/8	4	62789	-	-	62799
1	1	2	4	62790	-	-	62800

M706 w/WELDON

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius .020 CR	.030 CR
1/4	1/4	3/4	2-1/2	30491	30568	62847
3/8	3/8	1	2-1/2	30493	-	30570
1/2	1/2	1-1/4	3	30495	-	30572
5/8	5/8	1-5/8	3-1/2	30497	-	30574
3/4	3/4	1-5/8	4	30498	-	30575
1	1	2	4	30499	-	62801

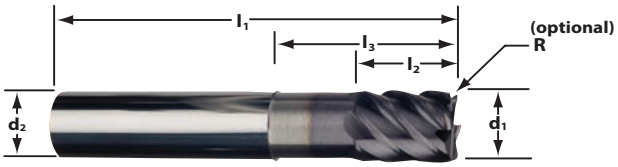


in: *d1: +0.000 / -0.002* *d2: -0.0001 / -0.0004*

M706N OMEGA-6

Z6 | SQ | CR | 45° | NECK | AlTiN | PLAIN | WELDON

For hardened steels and general finishing applications. Adding a necked shank to the M706 design offers a high-performance tool that permits clearance in deeper cavities and easier machining against tight walls. Neck relief and short flute length combine to increase end mill stability in the cut for more precise tolerances. Great for work in pockets.



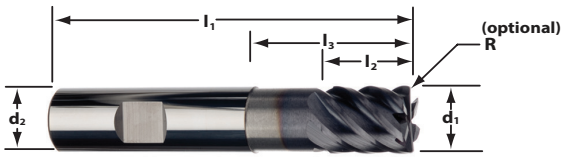
in: *d1: +0.000 / -0.002* *d2: -0.0001 / -0.0004*

K P M H

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Reach LBS l3	Overall Length l1	Order Code SQ	Order Code by Corner Radius .015 CR	.020 CR	.030 CR	.060 CR
1/8	1/8	1/4	1/2	1-1/2	62820	62901	-	-	-
3/16	3/16	5/16	9/16	2	62821	62902	-	-	-
1/4	1/4	3/8	1-1/8	2-1/2	62822	-	62903	62904	-
5/16	5/16	7/16	1-1/8	2-1/2	62823	-	62905	62906	-
3/8	3/8	1/2	1-1/8	2-1/2	62824	-	62907	62908	62909
1/2	1/2	5/8	1-3/8	3	62825	-	62910	62911	62912
3/4	3/4	1	1-3/4	4	62827	-	-	62914	62915

M706N w/WELDON

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Reach LBS l3	Overall Length l1	Order Code SQ	Order Code by Corner Radius .020 CR	.030 CR	.060 CR
3/8	3/8	1/2	1-1/8	2-1/2	31092	31103	31104	-
1/2	1/2	5/8	1-3/8	3	31093	31192	31193	31194
3/4	3/4	1	1-3/4	4	31095	-	31197	31198



in: *d1: +0.000 / -0.002* *d2: -0.0001 / -0.0004*

M725/M726 Series Application Guide – Speed & Feed (inch and metric)

			INCH							METRIC						
	No. of Flutes	Type of Cut	Tool Dia.	Axial Max	Radial Max	Speed (SFM)	RPM	IPT	IPM	Tool Dia.	Axial Max	Radial Max	Speed (M/Min)	RPM	MMPT	MM/Min
H 51 HRC–63 HRC	5	Rough	1/8	.1250	.0075	350	10,696	.00035	18.7	3.0	3.0	.18	106	11,318	.0089	5039
		Rough < 10,000		.1250	.0075	325	9,932	.00035	17.4		3.0	.18	94	9,973	.0089	443
		Finish		.2500	.001	300	9,168	.00030	13.7		6.0	.025	91	9,701	.0075	363
	5	Rough	3/16	.1875	.0130	250	5,093	.00070	17.8	4.0	4.0	.275	64	5,093	.0180	458
		Finish		.3750	.0015	300	6,112	.00040	12.2		8.0	.032	91	7,241	.0097	351
	6	Rough	1/4	.2500	.0150	400	6,112	.00100	36.6	5.0	5.0	.345	80	5,093	.0200	509
		Finish		.5000	.0020	300	4,584	.00050	13.8		10.0	.050	91	5,793	.0107	309
	6	Rough	5/16	.3125	.0220	400	4,890	.00125	36.6	6.0	6.0	.380	122	6,472	.0254	986
		Finish		.6250	.0020	300	3,667	.00060	13.2		12.0	.050	91	4,828	.0127	367
	6	Rough	3/8	.3750	.0300	400	4,074	.00150	36.6	8.0	8.0	.558	121	4,814	.0330	953
		Finish		.7500	.0030	300	3,056	.00070	12.8		16.0	.050	91	3,621	.0152	330
	6	Rough	1/2	.5000	.0400	400	3,056	.00200	36.6	10.0	10.0	.800	121	3,851	.0400	924
		Finish		1.000	.0030	300	2,292	.00100	13.7		20.0	.076	91	2,897	.0200	347
	6	Rough	5/8	.6250	.0500	400	2,445	.00250	36.6	12.0	12.0	.960	121	3,210	.0480	924
		Finish		1.250	.0050	300	1,833	.00130	14.3		24.0	.076	91	2,414	.0240	347
	6	Rough	3/4	.750	.0600	400	2,037	.00300	36.6	16.0	16.0	1.270	121	2,407	.0635	917
		Finish		1.500	.0050	300	1,528	.00150	13.7		32.0	.127	91	1,810	.0330	358
	6	Rough	1	1.000	.0800	400	1,528	.00400	36.6	20.0	20.0	1.524	121	1,926	.0760	878
		Finish		2.000	.0080	300	1,146	.00200	13.7		40.0	.127	91	1,448	.0380	330
K H 43 HRC–50 HRC	5	Rough	1/8	.1250	.010	500	15,280	.0006	45.8	3.0	3.0	.254	152	16,127	.0152	1225
		Rough < 10,000		.1250	.010	325	9,932	.0006	29.8		3.0	.254	94	9,973	.0152	758
		Finish		.2500	.001	400	12,224	.0003	18.3		6.0	.025	121	12,838	.0076	487
		Finish < 10,000		.2500	.001	325	9,932	.0003	14.9		6.0	.025	94	9,973	.0076	379
	5	Rough	3/16	.1875	.015	500	10,186	.0009	45.8	4.0	4.0	.320	152	12,095	.0192	1161
		Rough < 10,000		.1875	.015	480	9,780	.0009	44.0		4.0	.320	125	9,947	.0192	954
		Finish		.3750	.0015	400	8,150	.0005	20.4		8.0	.025	121	9,629	.0103	495
	6	Rough	1/4	.2500	.020	500	7,640	.0012	55.0	5.0	5.0	.400	152	9,676	.0239	1156
		Finish		.5000	.003	400	6,112	.0007	25.7		10.0	.040	121	7,703	.0132	508
	6	Rough	5/16	.3125	.025	500	6,112	.0014	51.3	6.0	6.0	.480	152	8,064	.0305	1475
		Finish		.6250	.003	400	4,889	.0007	20.5		12.0	.075	121	6,419	.0170	654
	6	Rough	3/8	.7500	.030	500	5,093	.0017	52.0	8.0	8.0	.640	152	6,048	.0355	1288
		Finish		.7500	.005	400	4,074	.0010	24.4		16.0	.080	121	4,814	.0175	505
	6	Rough	1/2	.5000	.040	500	3,820	.0023	52.7	10.0	10.0	.800	152	4,838	.0453	1315
		Finish		1.0000	.007	400	3,056	.0014	25.6		20.0	.130	121	3,851	.0266	614
	6	Rough	5/8	.6250	.050	500	3,056	.0029	53.2	12.0	12.0	.970	152	4,032	.0552	1335
		Finish		1.2500	.008	400	2,445	.0018	26.4		24.0	.180	121	3,210	.0336	647
	6	Rough	3/4	.7500	.060	500	2,547	.0034	52.0	16.0	16.0	1.280	152	3,024	.0736	1335
		Finish		1.5000	.009	400	2,037	.0020	24.4		32.0	.200	121	2,407	.0455	657
	6	Rough	1	1.0000	.080	500	1,910	.0046	52.7	20.0	20.0	1.600	152	2,419	.0863	1252
		Finish		2.0000	.010	400	1,528	.0023	21.0		40.0	.230	121	1,926	.0508	587
P M 36 HRC–42 HRC	5	Rough	1/8	.1250	.0100	600	18,336	.0010	91.7	3.0	3.0	.240	182	19,310	.0254	2452
		Rough < 10,000		.1250	.0100	325	9,932	.0010	49.6		3.0	.240	94	9,973	.0254	1266
		Finish		.2500	.0015	450	13,752	.0005	34.4		6.0	.038	137	14,536	.0127	923
		Finish < 10,000		.2500	.0015	325	9,932	.0005	24.8		6.0	.038	94	9,973	.0127	633
	5	Rough	3/16	.1875	.0150	600	12,224	.0013	79.5	4.0	4.0	.320	182	14,483	.0280	2027
		Rough < 10,000		.1875	.0150	475	9,677	.0013	63.0		4.0	.320	125	9,947	.0280	1392
		Finish		.3750	.0020	450	9,168	.0008	36.7		8.0	.043	125	9,947	.0170	845
	6	Rough	1/4	.2500	.0250	600	9,168	.0020	110.0	5.0	5.0	.400	182	11,586	.0345	1998
		Rough < 10,000		–	–	–	–	–	–		5.0	.400	157	9,995	.0345	1724
		Finish		.5000	.0030	500	7,640	.0010	45.8		10.0	.053	137	8,721	.0212	924
	6	Rough	5/16	.3125	.0310	600	7,334	.0025	110.0	6.0	6.0	.600	183	9,708	.0510	2970
		Finish		.6250	.0030	500	6,112	.0013	47.6		12.0	.076	152	8,064	.0254	1228
	6	Rough	3/8	.3750	.0370	600	6,112	.0030	110.0	8.0	8.0	.800	183	7,281	.0635	2774
		Finish		.7500	.0030	500	5,093	.0015	45.8		16.0	.076	152	6,048	.0330	1197
	6	Rough	1/2	.5000	.0500	600	4,584	.0040	110.0	10.0	10.0	1.000	183	5,825	.0800	2795
		Finish		1.0000	.0050	500	3,820	.0020	45.8		20.0	.076	152	4,838	.0400	1161
	6	Rough	5/8	.6250	.0625	600	3,667	.0050	110.0	12.0	12.0	1.200	183	4,854	.0960	2795
		Finish		1.2500	.0050	500	3,056	.0025	45.8		24.0	120	152	4,032	.0480	1161
	6	Rough	3/4	.7500	.0750	600	3,056	.0060	110.0	16.0	16.0	1.600	183	3,641	.1270	2774
		Finish		1.5000	.0050	500	2,546	.0030	45.8		32.0	.127	152	3,024	.0635	1152
	6	Rough	1	1.0000	.1000	600	2,292	.0080	110.0	20.0	20.0	2.000	183	2,912	.1524	2663
		Finish		2.0000	.0070	500	1,910	.0040	45.8		40.0	.127	152	2,419	.0762	1106

M706 Application Guide – Speed & Feed (inch)

ISO Code	Tool Dia	Type of Cut	Axial Max	Radial Max	Speed (SFM)	RPM	IPT	IPM
H 51 HRC–63 HRC	1/8	Roughing	.125	.025	65	1986	.00035	4
		Finishing	.1875	.0015	100	3056	.0004	7
	3/16	Roughing	.1875	.0375	65	1324	.0005	4
		Finishing	.28125	.002	100	2037	.0005	6
	1/4	Roughing	.250	.05	65	993	.0007	4
		Finishing	.375	.003	100	1528	.0007	6
	5/16	Roughing	.3125	.0625	65	795	.0009	4
		Finishing	.46875	.004	100	1222	.0009	6
	3/8	Roughing	.375	.075	65	662	.0011	4
		Finishing	.563	.005	100	1019	.0011	6
	1/2	Roughing	.5	.100	65	497	.0015	4
		Finishing	.375	.007	100	764	.0015	6
	5/8	Roughing	.625	.125	65	397	.0019	4
		Finishing	.938	.010	100	611	.0019	7
	3/4	Roughing	.750	.150	65	331	.0024	4
		Finishing	1.125	.012	100	509	.0024	7
	1	Roughing	1.000	.200	65	248	.003	4
		Finishing	1.500	.015	100	382	.003	6
K H 43 HRC–50 HRC	1/8	Roughing	.125	.031	200	6112	.0003	11
		Finishing	.1875	.0015	275	8404	.0003	15
	3/16	Roughing	.1875	.047	200	4075	.0005	12
		Finishing	.28125	.002	275	5603	.0005	16
	1/4	Roughing	.250	.063	200	3056	.0007	12
		Finishing	.375	.003	275	4202	.0007	17
	5/16	Roughing	.3125	.078	200	2445	.0009	13
		Finishing	.46875	.004	275	3362	.0009	18
	3/8	Roughing	.375	.094	200	2037	.0011	13
		Finishing	.563	.005	275	2801	.0011	18
	1/2	Roughing	.5	.125	200	1528	.0015	13
		Finishing	.375	.007	275	2101	.0015	18
	5/8	Roughing	.625	.156	200	1222	.0018	13
		Finishing	.938	.010	275	1681	.0018	18
	3/4	Roughing	.750	.188	200	1019	.0022	13
		Finishing	1.125	.012	275	1401	.0022	18
	1	Roughing	1.000	.250	200	764	.0030	13
		Finishing	1.500	.015	275	1051	.0030	18
P M 36 HRC–42 HRC	1/8	Roughing	.125	.044	250	7640	.0004	18.3
		Finishing	.1875	.002	325	9932	.0004	23.8
	3/16	Roughing	.1875	.065625	250	5093	.0005	15.3
		Finishing	.28125	.004	325	6621	.0006	23.8
	1/4	Roughing	.250	.0875	250	3820	.0007	16
		Finishing	.375	.005	325	4966	.0009	26.8
	5/16	Roughing	.3125	.109	250	3056	.0009	16.5
		Finishing	.46875	.007	325	3973	.0011	26.2
	3/8	Roughing	.375	.132	250	2547	.0011	16.8
		Finishing	.563	.01	325	3311	.0013	25.8
	1/2	Roughing	.5	.175	250	1910	.0015	17.2
		Finishing	.375	.012	325	2483	.0018	26.8
	5/8	Roughing	.625	.21875	250	1528	.0019	17.4
		Finishing	.938	.015	325	1986	.0022	26.2
	3/4	Roughing	.750	.2625	250	1273	.0024	18.3
		Finishing	1.125	.015	325	1655	.0027	26.8
	1	Roughing	1.000	.350	250	955	.003	17.2
		Finishing	1.500	.015	325	1242	.0036	26.8

D = Tool Diameter

≈ Approximately Equals
≤ Less Than or Equal To
≥ Greater Than or Equal To
× Multiply
< Less Than
> Greater Than
= Equals

Common Machining Formulas

$$RPM = \frac{SFM \times 3.82}{D}$$

$$SFM = RPM \times D \times .262$$

$$IPM = RPM \times IPT \times Z$$

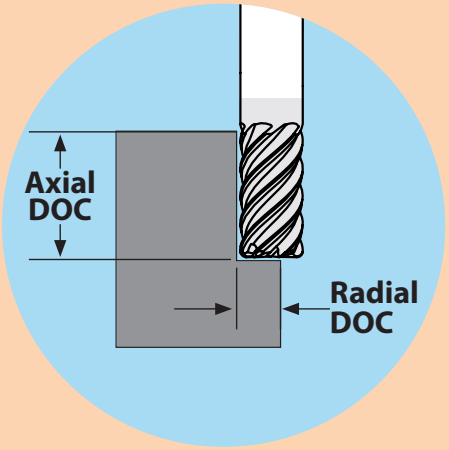
$$MRR = RDOC \times ADOC \times IPM$$

$$RPM = \frac{M/min \times 318.3}{D}$$

$$M/min = RPM \times D \times .00314$$

$$MMPM = RPM \times MMPT \times Z$$

$$MRR = RDOC \times ADOC \times MMPM$$



D Tool Diameter
Z Number of Flutes
RPM Revolutions per Minute
SFM Surface Feet per Minute
M/min Surface Meters per Minute
IPM Inches per Minute
MMPM Millimeters per Minute
IPT Inch per Tooth
MMPT Millimeters per Tooth
MRR Metal Removal Rate
RDOC Radial Depth of Cut
ADOC Axial Depth of Cut

Technical Resources

Information on tips and adjustments for the following milling operations can be found in our Technical Resources section beginning on page 129.

- HEM slotting
- Face milling
- Helical entry ramping
- Straight line ramping
- Long tool projection adjustments
- Ball nose milling adjustments
- Other helpful tips and calculations

INCONEX®

WORK EXTRA-LONG IN EXTRA-DIFFICULT METALS.

The INCONEX M8 end mills are designed specifically for higher productivity in all hi-temp alloys. Optimized geometries, advanced chip management and proven performance: INCONEX M8 end mills are the best choice for success in difficult-to-machine metals.

M8 Series Features

WORK EXTRA-LONG IN EXTRA-DIFFICULT MATERIALS.

Engineered to meet the challenge of machining hi-temp alloys, the M806 series includes features made specifically with tool life in mind. Great for roughing cuts when using traditional tool paths.

	M806	M806N
NUMBER OF FLUTES	Z6	Z6
END TYPES	CR	CR
HELIX ANGLE	30°	30°
COATING	AlCrNX	AlCrNX
SHANK TYPES	PLAIN, WELDON	PLAIN, NECK
APPLICATIONS	ROUGH	
MATERIAL(S)	S	

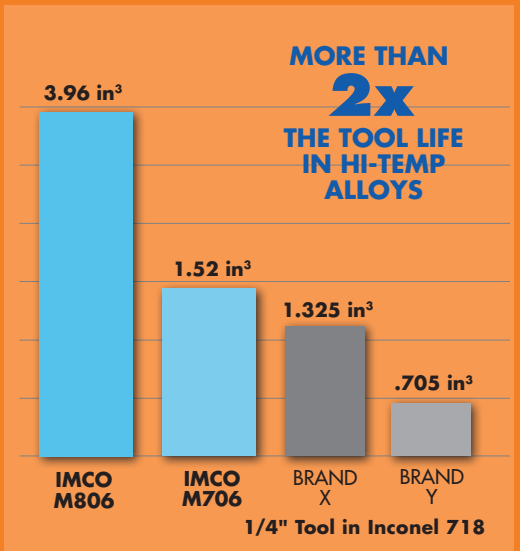
TOOL TIP

INCONEX: Going the Extra Mile in Hi-Temp Alloys.

In tool development tests against our own tool (M706) and the leading competitors' products for hi-temp alloys, the INCONEX far outlasted all challengers in tool life.

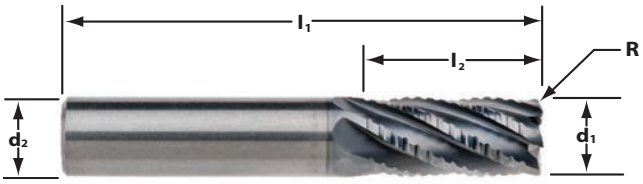
Using our competitors' suggested speeds and feeds (80 SFM at 6 IPM) the INCONEX tools averaged over 2x the tool life of the other brands – even surpassing our own Omega-6 M706.

Total Metal Removed



M806 INCONEX

For high-performance roughing in hi-temp alloys. The unique cutting edge design for chip control and the advanced coating reduces heat build-up in the cutting zone for optimized tool performance. The M806 is built for tool life when using traditional tool paths in very difficult-to-machine materials.



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mm: *d1: +0.000 / -0.050* *d2: -0.0025 / -0.0100*

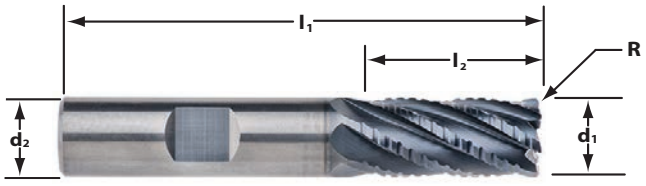
S

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code by Corner Radius .015 CR	.030 CR
1/4	1/4	3/8	2	68731	-
		3/4	2-1/2	68732	-
5/16	5/16	7/16	2	68733	-
		13/16	2-1/2	68734	-
3/8	3/8	1/2	2	-	68735
		7/8	2-1/2	-	68736
		1-1/4	3	-	68738
1/2	1/2	5/8	2-1/2	-	68740
		1	3	-	68891
		1-1/4	3	-	68741
		1-5/8	3-1/2	-	68743
5/8	5/8	1-3/8	3-1/2	-	68746
		2	4	-	68748
3/4	3/4	1-5/8	4	-	68751
		2-3/8	5	-	68753
1	1	1-1/2	4	-	68755
		2-1/2	5	-	68757

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code by Corner Radius 0.5 CR	1.0 CR
6	6	13	57	68759	-
		19	63	68761	-
8	8	19	63	68763	-
		25	75	68765	-
10	10	22	72	-	68767
		32	80	-	68769
12	12	26	83	-	68771
		38	93	-	68773
16	16	34	92	-	68775
		50	108	-	68777
20	20	42	104	-	68779
		62	125	-	68781
25	25	52	120	-	68783

M806 w/WELDON INCONEX

For high-performance roughing in hi-temp alloys. The unique cutting edge design for chip control and the advanced coating reduce heat build-up in the cutting zone for optimized tool performance. The M806 is built for tool life when using traditional tool paths in very difficult-to-machine materials.



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mm: *d1: +0.000 / -0.050* *d2: -0.0025 / -0.0100*

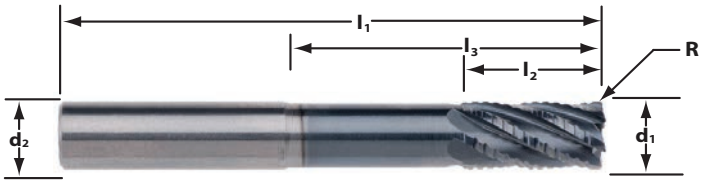
S

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code .030 CR
3/8	3/8	7/8	2-1/2	68737
		1-1/4	3	68739
1/2	1/2	1	3	68892
		1-1/4	3	68742
		1-5/8	3-1/2	68744
5/8	5/8	1-3/8	3-1/2	68747
		2	4	68749
3/4	3/4	1-5/8	4	68752
		2-3/8	5	68754
1	1	1-1/2	4	68756
		2-1/2	5	68758

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code by Corner Radius 0.5 CR	1.0 CR
6	6	13	57	68760	-
		19	63	68762	-
8	8	19	63	68764	-
		25	75	68766	-
10	10	22	72	-	68768
		32	80	-	68770
12	12	26	83	-	68772
		38	93	-	68774
16	16	34	92	-	68776
		50	108	-	68778
20	20	42	104	-	68780
		62	125	-	68782
25	25	52	120	-	68784

M806N INCONEX

For high-performance roughing in hi-temp alloys. Adding a necked shank to the M806 design offers a high-performance tool that permits clearance in deeper cavities and easier machining against tight walls. Neck relief and short flute length combine to increase end mill stability in the cut. Great for work in pockets.



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mm: *d1: +0.000 / -0.050* *d2: -0.0025 / -0.0100*

S

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Reach LBS l3	Overall Length l1	Order Code by Corner Radius .015 CR	.030 CR
1/4	1/4	1/2	1-3/8	3	68786	-
			2-3/8	4	68788	-
3/8	3/8	3/4	1-3/8	3	-	68791
			2-3/8	4	-	68795
1/2	1/2	1	2-1/4	4	-	68799
			3-1/4	5	-	68803
5/8	5/8	1-1/4	2-1/8	4	-	68811
			3-1/8	5	-	68815
3/4	3/4	1-1/2	2-7/8	5	-	68819
			3-7/8	6	-	68823

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Reach LBS l3	Overall Length l1	Order Code by Corner Radius 0.5 CR	1.0 CR
6	6	12	39	75	68833	-
			64	100	68837	-
8	8	16	39	75	68841	-
10	10	20	48	88	-	68849
			60	100	-	68853
12	12	24	55	100	-	68857
			80	125	-	68861
16	16	32	62	110	-	68869
			102	150	-	68873
20	20	40	75	125	-	68877
			100	150	-	68881

		INCH							METRIC						
ISO Code	Type of Cut	Tool Dia.	Axial Depth	Radial Depth	Speed (SFM)	RPM	IPT	IPM	Tool Dia.	Axial Depth	Radial Depth	Speed (M/Min)	RPM	MMPT	MM/Min
S Inconel, Hastalloy, Waspalloy Not recommended for titanium	Rough	1/4	1.25 x D	.2 x D	80	1222	.0008	5.87	6.0	1.25 x D	.2 x D	24.38	1239	.019	141.2
	Slot		0.165	1 x D	80	1222	.00050	3.67		4.15	1 x D	24.38	1239	.0127	94.4
	Rough	5/16	1.25 x D	.2 x D	80	978	.0010	5.87	8.0	1.25 x D	.2 x D	24.38	970	.025	145.5
	Slot		0.205	1 x D	80	978	.00063	3.67		5.20	1 x D	24.38	970	.0160	93.1
	Rough	3/8	1.25 x D	.2 x D	80	815	.0012	5.87	10.0	1.25 x D	.2 x D	24.38	776	.031	144.3
	Slot		0.250	1 x D	80	815	.00075	3.67		6.35	1 x D	24.38	776	.0190	88.5
	Rough	1/2	1.25 x D	.2 x D	80	611	.0016	5.87	12.0	1.25 x D	.2 x D	24.38	647	.037	143.6
	Slot		0.330	1 x D	80	611	.00100	3.67		8.35	1 x D	24.38	647	.0254	98.5
	Rough	5/8	1.25 x D	.2 x D	80	489	.0020	5.87	16.0	1.25 x D	.2 x D	24.38	485	.050	145.5
	Slot		0.415	1 x D	80	489	.00125	3.67		10.50	1 x D	24.38	485	.0317	92.2
	Rough	3/4	1.25 x D	.2 x D	80	407	.0024	5.87	20.0	1.25 x D	.2 x D	24.38	388	.061	142.1
	Slot		0.500	1 x D	80	407	.00150	3.67		12.70	1 x D	24.38	388	.0380	88.4
	Rough	1	1.25 x D	.2 x D	80	306	.0032	5.87	25.0	1.25 x D	.2 x D	24.38	310	.080	148.8
	Slot		0.665	1 x D	80	306	.00200	3.67		16.90	1 x D	24.38	310	.0508	94.4

For using HEM techniques in hi-temp alloys, please reference the POW•R•PATH line of end mills beginning on page 14.

≈ Approximately Equals
< Less Than
≤ Less Than or Equal To
> Greater Than
≥ Greater Than or Equal To
= Equals
× Multiply

Common Machining Formulas

RPM = $\frac{\text{SFM x 3.82}}{\text{D}}$

SFM = RPM x D x .262

IPM = RPM x IPT x Z

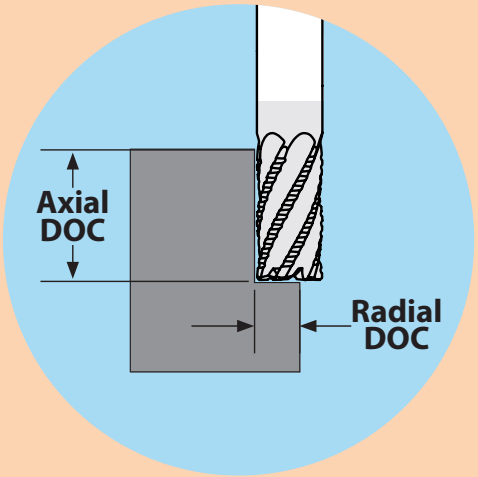
MRR = RDOC x ADOC x IPM

RPM = $\frac{\text{M/min x 318.3}}{\text{D}}$

M/min = RPM x D x .00314

MMPM = RPM x MMPT x Z

MRR = RDOC x ADOC x MMPM



D Tool Diameter
Z Number of Flutes
RPM Revolutions per Minute
SFM Surface Feet per Minute
M/min Surface Meters per Minute
IPM Inches per Minute
MMPM Millimeters per Minute
IPT Inch per Tooth
MMPT Millimeters per Tooth
MRR Metal Removal Rate
RDOC Radial Depth of Cut
ADOC Axial Depth of Cut

Technical Resources

Information on tips and adjustments for the following milling operations can be found in our Technical Resources section beginning on page 129.

- HEM slotting
- Face milling
- Helical entry ramping
- Straight line ramping
- Long tool projection adjustments
- Ball nose milling adjustments
- Other helpful tips and calculations

POW•R•FEED®

THE UNIVERSAL POWERHOUSE.

Get chatter-free machining, excellent surface finishes and incredible feed rates with POW•R•FEED M9 series end mills. They are beasts at virtually any machining task and material you throw at them.

M9 Series Features

REDEFINING HIGH PERFORMANCE AND VERSATILITY.

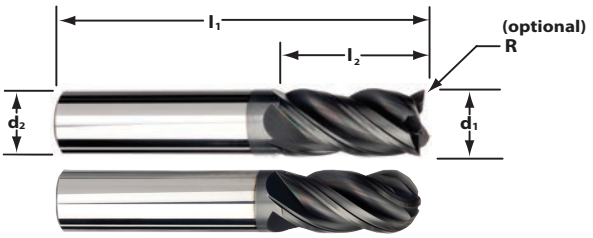
The M924, our second-generation POW•R•FEED end mill, is the merging of a 4-flute design with high-performance features and an advanced substrate, creating a tool with the combination of flexibility and output. The reinforced cutting edges, corner radii, variable cutting edge indexing and advanced coating increase metal removal rates and tool life across a wide range of materials.

	M924	M924C	M924N	M904	M905
NUMBER OF FLUTES	Z4	Z4	Z4	Z4	Z5
END TYPES	SQ CR BN	SQ CR	CR BN	SQ CR BN	SQ CR
HELIX ANGLE	38°	38°	38°	38°	38°
COATING	AlCrNX	AlCrNX	AlCrNX	AlTiN	AlTiN
SHANK TYPES	PLAIN WELDON	PLAIN	PLAIN NECK	PLAIN WELDON	PLAIN
APPLICATIONS	ROUGH FINISH				
MATERIAL(S)	K P M S				

M924
POW•R•FEED

Z4 | SQ | CR | BN | 38° | AlCrNX | PLAIN | WELDON

For high-performance machining in materials ranging from low carbon steels to titanium. The second-generation POW•R•FEED, the M924 design yields enhanced tool life through strengthened cutting edges and corner radii. Very versatile tool — roughing, slotting and finishing — in traditional tool paths in a variety of materials. Great tool in job shops and when used in production runs.



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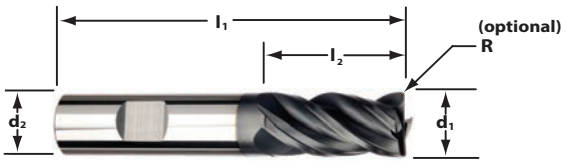
mm: *d1: +0.000 / -0.050* *d2: -0.0025 / -0.0100*

K P M S

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius .015 CR	.030 CR	.060 CR	.090 CR	.120 CR	Order Code BN
1/8	1/8	1/4	1-1/2	67494	67495	-	-	-	-	-
		1/2	1-1/2	67498	67499	-	-	-	-	67501
		3/4	2-1/4	67502	67503	-	-	-	-	-
5/32	3/16	5/16	2	67536	67538	-	-	-	-	-
		9/16	2	67537	67539	-	-	-	-	67540
3/16	3/16	5/16	2	67506	67507	67508	-	-	-	-
		9/16	2	67510	67511	67512	-	-	-	67513
		3/4	2-1/2	67514	67515	67516	-	-	-	-
7/32	1/4	3/8	2	67541	67543	-	-	-	-	-
		3/4	2-1/2	67542	67544	-	-	-	-	-
1/4	1/4	3/8	2	67518	67519	67520	-	-	-	-
		3/4	2-1/2	67524	67525	67526	67527	-	-	67529
		1-1/4	3	67530	67531	67532	-	-	-	-
		1-3/4	4	67546	67547	67548	-	-	-	-
9/32	5/16	3/4	2-1/2	67549	67550	67551	-	-	-	-
5/16	5/16	7/16	2	67092	67093	67094	-	-	-	-
		13/16	2-1/2	67098	67099	67100	67101	-	-	67103
		1-1/4	3	67104	67105	67106	-	-	-	-
		2-1/8	4	67110	67111	67112	-	-	-	-
11/32	3/8	7/8	2-1/2	67552	-	67553	-	-	-	-
3/8	3/8	1/2	2	67116	67117	67118	-	-	-	-
		7/8	2-1/2	67124	67125	67126	67127	67128	-	67131
		1-1/4	3	67132	67133	67134	67135	-	-	-
		1-5/8	4	67148	67149	67150	67151	-	-	-
		2	4	67164	67165	67166	67167	-	-	-
		2-1/2	5	67554	67555	67556	-	-	-	-
13/32	7/16	1	2-3/4	67557	-	67558	-	-	-	-
7/16	7/16	5/8	2-1/2	67180	-	67182	-	-	-	-
		1	2-3/4	67188	-	67190	-	-	-	67195
		2	4	67196	-	67198	-	-	-	-
1/2	1/2	5/8	2-1/2	67204	-	67206	67207	-	-	-
		1	3	67213	67214	67215	67216	67217	67218	67221
		1-1/4	3	67222	67223	67224	67225	67226	67227	67230
		1-5/8	4	67231	-	67233	67234	67235	67236	-
		2-1/8	4	67249	-	67251	67252	67253	67254	-
		2-5/8	5	67258	-	67260	67261	-	-	-
		3-1/4	6	67267	-	67269	67270	-	-	-
9/16	9/16	1-1/4	3-1/2	67559	-	67560	-	-	-	-
5/8	5/8	3/4	3	67276	-	67278	67279	-	-	-
		1-3/8	3-1/2	67286	-	67288	67289	-	-	67295
		2-1/8	4	67296	-	67298	67299	67300	67301	-
		2-5/8	5	67316	-	67318	67319	-	-	-
		3-1/4	6	67326	-	-	-	-	-	-
3/4	3/4	1	3	67346	-	67348	67349	-	-	-
		1-5/8	4	67356	-	67358	67359	67360	67361	67365
		2-3/8	5	67366	-	67368	67369	67370	67371	-
		3-1/4	6	67386	-	67388	67389	-	-	-
		4-1/8	7	67396	-	67398	67399	-	-	-
1	1	1-3/4	4	67406	-	67408	67409	-	-	-
		2-1/4	5	67417	-	67419	-	-	-	-
		3-1/4	6	67439	-	67441	-	-	-	-
		4-1/4	7	67450	-	67452	-	-	-	-

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius 0.3 CR	0.5 CR	0.75 CR	1.0 CR	1.5 CR	2.0 CR	3.0 CR	4.0 CR	Order Code BN
3	3	9	38	67900	-	-	-	-	-	-	-	-	-
		12	38	67902	67903	-	-	-	-	-	-	-	67736
	6	8	57	67908	67911	67737	-	-	-	-	-	-	68019
		12	57	67909	67910	-	-	-	-	-	-	-	-
3.5	6	10	57	67738	-	-	-	-	-	-	-	-	-
4	6	11	57	67914	67917	67739	-	-	-	-	-	-	68022
4.5	6	11	57	67938	-	-	-	-	-	-	-	-	-
5	6	13	57	67920	67923	67947	-	-	-	-	-	-	68096
6	6	10	54	-	-	67024	-	-	-	-	-	-	-
		13	57	67924	67925	67926	-	67025	67026	-	-	-	68013
		25	75	67932	67933	-	-	-	-	-	-	-	-
8	8	12	58	-	-	67027	-	-	-	-	-	-	-
		19	63	67939	-	67940	-	67028	67029	67973	-	-	68014
		32	75	67942	-	67943	-	-	-	-	-	-	-
10	10	14	66	-	-	67030	-	-	-	-	-	-	-
		22	72	67948	-	67949	-	67950	67031	67032	-	-	68015
		40	88	67953	-	67954	-	-	-	-	-	-	-
12	12	16	73	-	-	-	67033	-	-	-	-	-	-
		26	83	67959	-	67960	67034	67961	67035	67036	67038	-	68016
		50	100	67964	-	67965	-	-	-	-	-	-	-
		75	150	67967	-	67968	-	-	-	-	-	-	-
14	14	32	83	67970	-	-	-	67972	-	-	-	-	-
16	16	22	82	-	-	-	-	67039	-	-	-	-	-
		34	92	67975	-	67976	-	67977	67040	67041	67043	67974	68017
		55	110	67980	-	67981	-	-	-	-	-	-	-
		75	150	67983	-	67984	-	-	-	-	-	-	-
18	18	32	92	68064	-	-	-	68065	-	-	-	-	-
20	20	26	92	-	-	-	-	67044	-	-	-	-	-
		38	104	67986	-	-	-	67988	67045	67046	67048	68066	68018
		65	125	67996	-	-	-	68067	-	-	-	-	-
		85	150	67999	-	-	-	68068	-	-	-	-	-
25	25	38	104	68069	-	-	-	68099	-	-	-	-	-
		52	120	68002	-	-	-	68128	-	-	-	-	-
		85	150	68007	-	-	-	68130	-	-	-	-	-

M924 w/WELDON



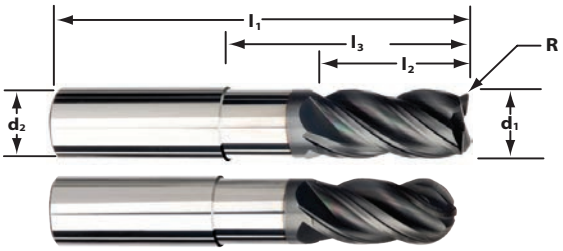
in: *d1: +0.000 / -0.002* *d2: -0.0001 / -0.0004*

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius .015 CR	.030 CR
3/8	3/8	7/8	2-1/2	68195	68116	68117
		1-1/4	3	68196	68119	68120
1/2	1/2	1	3	68710	68711	68712
		1-1/4	3	68201	68131	68132
		1-5/8	4	68202	-	68136
		2-1/8	4	68203	-	68139
5/8	5/8	1-3/8	3-1/2	68206	-	68147
		2-1/8	4	68207	-	68149
3/4	3/4	1-5/8	4	68210	-	68155
		2-3/8	5	68211	-	68158
1	1	1-3/4	4	68214	-	68167
		2-1/4	5	68215	-	68171

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code by Corner Radius 0.5 CR	1.0 CR	1.5 CR	2.0 CR	3.0 CR	4.0 CR
10	10	22	72	68977	68978	68979	68980	-	-
12	12	26	83	68981	68982	68983	68984	68985	-
16	16	34	92	68986	68987	68988	68989	68990	68991
20	20	38	104	-	68992	68993	68994	68995	68996

M924N
POW•R•FEED

For high-performance machining in materials ranging from low carbon steels to titanium. Adding a necked shank to the M924 design offers a high-performance tool that permits clearance in deeper cavities and easier machining against tight walls. Neck relief and short flute length combine to increase end mill stability in the cut for more precise tolerances. Great for work in pockets.



in: *d1: +0.000 / -0.002* *d2: -0.0001 / -0.0004*
mm: *d1: +0.000 / -0.050* *d2: -0.0025 / -0.0100*

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Reach LBS l3	Overall Length l1	Order Code by Corner Radius .015 CR	.030 CR	.060 CR	Order Code BN
1/8	1/8	1/4	1-1/8	2-1/2	67731	-	-	67732
3/16	3/16	3/8	1-3/8	3	67733	67734	-	67735
1/4	1/4	1/2	1-3/8	3	67740	67741	67742	67743
			2-3/8	4	67744	67745	67746	67747
3/8	3/8	1/2	1-3/8	3	67748	67749	67750	67752
			2-3/8	4	67753	67754	67755	67757
			3-3/8	5	67758	67759	67760	67762
			4-3/8	6	67763	67764	67765	67767
		3/4	2-3/8	4	68324	68325	68326	-
			3-3/8	5	68327	68328	68329	-
			4-3/8	6	68330	68331	68332	-
1/2	1/2	5/8	1-3/8	3	-	67768	67769	67772
			2-1/4	4	-	67773	67774	67777
			3-1/4	5	-	67778	67779	67782
			4-1/4	6	-	67783	67784	67787
		1	2-1/4	4	-	67858	67859	-
			3-1/4	5	-	67861	67862	-
			4-1/4	6	-	67864	67865	-
5/8	5/8	3/4	2-1/8	4	-	67788	67789	67792
			3-1/8	5	-	67793	67794	67797
			4-1/8	6	-	67798	67799	67802
3/4	3/4	1	2	4	-	67803	67804	67807
			2-7/8	5	-	67808	67809	67812
			3-7/8	6	-	67813	67814	67817
			4-7/8	7	-	67818	67819	67822
		1-1/2	2-7/8	5	-	67876	67877	-
			3-7/8	6	-	67879	67880	-
			4-7/8	7	-	67882	67883	-
1	1	1-1/4	2-1/4	4	-	67823	67824	67827
			2-5/8	5	-	67828	67829	67832
			3-5/8	6	-	67833	67834	67837
			4-5/8	7	-	67838	67839	67842

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Reach LBS l3	Overall Length l1	Order Code by Corner Radius 0.5 CR	1.0 CR	1.5 CR	Order Code BN
6	6	12	39	75	68020	-	-	68097
			64	100	68021	-	-	68098
8	8	16	39	75	68023	-	-	68100
			64	100	68024	-	-	68101
10	10	12	32	72	68025	68026	-	68102
			60	100	68027	68028	-	68103
			110	150	68029	68030	-	68104
12	12	15	38	83	68031	68032	68033	68105
			55	100	68034	68035	68036	68106
			80	125	68037	68038	68039	68107
			105	150	68040	68041	68042	68108
16	16	20	62	110	68043	68044	68045	68109
			102	150	68046	68047	68048	68110
20	20	25	50	100	68049	68050	68051	68111
			75	125	68052	68053	68054	68112
			100	150	68055	68056	68057	68113
25	25	32	64	120	68058	68059	68060	68114
			94	150	68061	68062	68063	68115

TOOL TIP

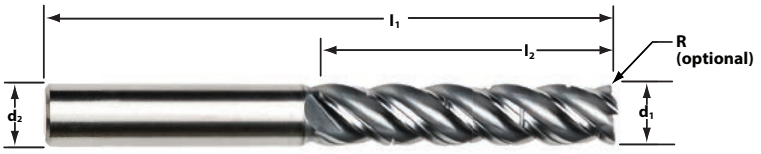
Got LBS?
Look For the Neck.

Reducing tool deflection is a key part of successfully milling deep pockets and slots. Using an end mill with a necked-down shank and a stub or standard flute length greatly improves tool stability in long-reach cuts. The necked shank retains much of the core strength of the carbide rod, increasing tool life and achieving more precise milled wall tolerances.

LBS, or Length Below Shank, designates the combined neck length plus the tool's flute length.

M924C
POW•R•FEED

For high-performance machining in materials ranging from low carbon steels to titanium. Adds the benefits of the unique **Chip Management System (CMS)** to the versatility of the M924 design. Breaks up long, stringy chips, which eliminates recutting chips and chip packing, and allows for free cutting tool movement.



in: *d1: +0.000 / -0.002* *d2: -0.0001 / -0.0004*
mm: *d1: +0.000 / -0.050* *d2: -0.0025 / -0.0100*

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius .030 CR	.060 CR
1/2	1/2	2-1/8	4	68624	68625	68626
		2-5/8	5	68627	68628	68629
		3-1/4	6	68630	68631	68632
5/8	5/8	2-1/8	4	68633	68634	68635
		2-5/8	5	68636	68637	68638
		3-1/4	6	68639	-	-
3/4	3/4	2-3/8	5	68640	68641	68642
		3-1/4	6	68643	68644	68645
		4-1/8	7	68646	68647	68648
1	1	2-1/4	5	68649	68650	-
		3-1/4	6	68651	68652	-
		4-1/4	7	68653	68654	-

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius 0.5 CR
12	12	50	100	68655	68656
		75	150	68657	68658
16	16	55	110	68659	68660
		75	150	68661	68662
20	20	65	125	68663	68664
		85	150	68665	68666
25	25	85	150	68667	68668

ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	Number of Flutes	Speed (SFM)	Feed (Inches per Tooth) 1/8	5/32	3/16	7/32	1/4	5/16	3/8	7/16	1/2	5/8	3/4	1
K	Cast Iron Gray	Slotting	1 x D	1 x D	4	325	.0006	.0008	.0009	.0011	.0012	.0015	.0018	.0021	.0024	.0030	.0036	.0048
		Peripheral - Rough	1.25 x D	.5 x D	4	400	.0008	.0009	.0011	.0013	.0015	.0019	.0023	.0026	.0030	.0038	.0045	.0060
		Finish	1.5 x D	.015 x D	4	475	.0008	.0010	.0012	.0014	.0017	.0021	.0025	.0029	.0033	.0041	.0050	.0066
	Cast Iron Ductile	Slotting	1 x D	1 x D	4	300	.0006	.0007	.0008	.0010	.0011	.0014	.0017	.0019	.0022	.0028	.0033	.0044
		Peripheral - Rough	1.25 x D	.5 x D	4	375	.0007	.0008	.0010	.0012	.0014	.0017	.0020	.0024	.0027	.0034	.0041	.0054
		Finish	1.5 x D	.015 x D	4	450	.0008	.0009	.0011	.0013	.0015	.0019	.0023	.0026	.0030	.0038	.0045	.0060
	Cast Iron Malleable	Slotting	.75 x D	1 x D	4	250	.0006	.0007	.0008	.0010	.0011	.0014	.0017	.0019	.0022	.0028	.0033	.0044
		Peripheral - Rough	1.25 x D	.5 x D	4	325	.0007	.0008	.0010	.0012	.0014	.0017	.0020	.0024	.0027	.0034	.0041	.0054
		Finish	1.5 x D	.015 x D	4	400	.0008	.0009	.0011	.0013	.0015	.0019	.0023	.0026	.0030	.0038	.0045	.0060
P	Low Carbon Steels 1018, 12L14, 8620	Slotting	1 x D	1 x D	4	350	.0007	.0008	.0010	.0011	.0013	.0016	.0020	.0023	.0026	.0033	.0039	.0052
		Peripheral - Rough	1.25 x D	.5 x D	4	425	.0008	.0010	.0012	.0014	.0016	.0020	.0024	.0028	.0032	.0040	.0048	.0064
		Finish	1.5 x D	.015 x D	4	500	.0009	.0011	.0014	.0016	.0018	.0023	.0027	.0032	.0036	.0045	.0054	.0072
	Medium Carbon Steels 4140, 4340	Slotting	1 x D	1 x D	4	300	.0006	.0008	.0009	.0011	.0012	.0015	.0018	.0021	.0024	.0030	.0036	.0048
		Peripheral - Rough	1.25 x D	.5 x D	4	375	.0008	.0009	.0011	.0013	.0015	.0019	.0023	.0026	.0030	.0038	.0045	.0060
		Finish	1.5 x D	.015 x D	4	450	.0008	.0010	.0012	.0014	.0017	.0021	.0025	.0029	.0033	.0041	.0050	.0066
	Tool & Die Steels <48 Rc A2, D2, H13, P20	Slotting	.75 x D	1 x D	4	300	.0006	.0008	.0009	.0011	.0012	.0015	.0018	.0021	.0024	.0030	.0036	.0048
		Peripheral - Rough	1.25 x D	.3 x D	4	375	.0007	.0009	.0011	.0013	.0015	.0018	.0022	.0025	.0029	.0036	.0044	.0058
		Finish	1.5 x D	.015 x D	4	450	.0008	.0009	.0011	.0013	.0015	.0019	.0023	.0026	.0030	.0038	.0045	.0060
M	Martensitic Stainless Steels 416, 410, 440C	Slotting	.75 x D	1 x D	4	300	.0006	.0008	.0009	.0011	.0012	.0015	.0018	.0021	.0024	.0030	.0036	.0048
		Peripheral - Rough	1.25 x D	.3 x D	4	375	.0007	.0009	.0011	.0013	.0015	.0018	.0022	.0025	.0029	.0036	.0044	.0058
		Finish	1.5 x D	.015 x D	4	450	.0008	.0009	.0011	.0013	.0015	.0019	.0023	.0026	.0030	.0038	.0045	.0060
	Austenitic Stainless Steels 303, 304, 316	Slotting	.75 x D	1 x D	4	275	.0007	.0008	.0010	.0011	.0013	.0016	.0020	.0023	.0026	.0033	.0039	.0052
		Peripheral - Rough	1.25 x D	.3 x D	4	325	.0008	.0010	.0012	.0014	.0016	.0020	.0024	.0028	.0032	.0040	.0048	.0064
		Finish	1.5 x D	.015 x D	4	400	.0008	.0010	.0012	.0014	.0017	.0021	.0025	.0029	.0033	.0041	.0050	.0066
	Precipitation Hardening Stainless Steels 17-4, 15-5, 13-8	Slotting	.5 x D	1 x D	4	250	.0005	.0006	.0008	.0009	.0010	.0013	.0015	.0018	.0020	.0025	.0030	.0040
		Peripheral - Rough	1.25 x D	.3 x D	4	300	.0006	.0008	.0009	.0011	.0013	.0016	.0019	.0022	.0025	.0031	.0038	.0050
		Finish	1.5 x D	.015 x D	4	375	.0007	.0008	.0010	.0011	.0013	.0016	.0020	.0023	.0026	.0033	.0039	.0052
S	Titanium Alloys 6AL - 4V	Slotting	.5 x D	1 x D	4	250	.0005	.0006	.0008	.0009	.0010	.0013	.0015	.0018	.0020	.0025	.0030	.0040
		Peripheral - Rough	1.25 x D	.3 x D	4	300	.0006	.0008	.0009	.0011	.0013	.0016	.0019	.0022	.0025	.0031	.0038	.0050
		Finish	1.5 x D	.015 x D	4	375	.0007	.0008	.0010	.0011	.0013	.0016	.0020	.0023	.0026	.0033	.0039	.0052
	High Temperature Alloys Inconel, Haynes, Stellite, Hastalloy	Slotting	.25 x D	1 x D	4	60	.0005	.0007	.0008	.0009	.0011	.0013	.0016	.0018	.0021	.0026	.0032	.0042
		Peripheral - Rough	1.25 x D	.25 x D	4	90	.0007	.0008	.0010	.0012	.0014	.0017	.0020	.0024	.0027	.0034	.0041	.0054
		Finish	1.5 x D	.01 x D	4	125	.0008	.0010	.0012	.0014	.0016	.0019	.0023	.0027	.0031	.0039	.0047	.0062

D = Tool Diameter

≈ Approximately Equals
≤ Less Than or Equal To
≥ Greater Than or Equal To
× Multiply
< Less Than
> Greater Than
= Equals

Common Machining Formulas

$$RPM = \frac{SFM \times 3.82}{D}$$

$$SFM = RPM \times D \times .262$$

$$IPM = RPM \times IPT \times Z$$

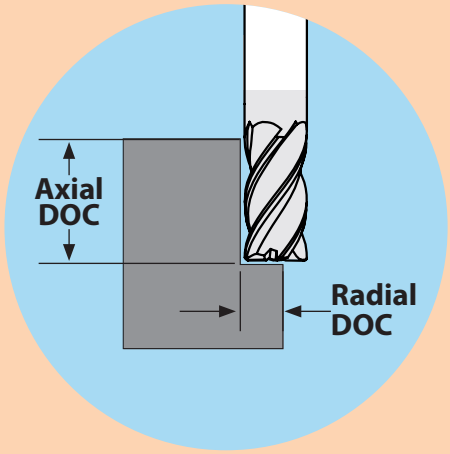
$$MRR = RDOC \times ADOC \times IPM$$

$$RPM = \frac{M/min \times 318.3}{D}$$

$$M/min = RPM \times D \times .00314$$

$$MMPM = RPM \times MMPT \times Z$$

$$MRR = RDOC \times ADOC \times MMPM$$



M924 Application Guide – Speed & Feed (metric)

ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	Number of Flutes	Speed (M/min)	Feed (MM per Tooth) 3.0	4.0	5.0	6.0	8.0	10.0	12.0	14.0	16.0	20.0	25.0
K	Cast Iron Gray	Slotting	1 x D	1 x D	4	99	.0144	.0192	.0240	.0288	.0384	.0478	.0576	.0672	.0766	.0956	.1198
		Peripheral - Rough	1.25 x D	.5 x D	4	122	.0180	.0240	.0300	.0360	.0480	.0598	.0720	.0840	.0958	.1195	.1497
		Finish	1.5 x D	.015 x D	4	145	.0198	.0264	.0330	.0396	.0528	.0657	.0792	.0924	.1053	.1315	.1647
	Cast Iron Ductile	Slotting	1 x D	1 x D	4	91	.0132	.0176	.0220	.0264	.0352	.0438	.0528	.0616	.0702	.0876	.1098
		Peripheral - Rough	1.25 x D	.5 x D	4	114	.0162	.0216	.0270	.0324	.0432	.0538	.0648	.0756	.0862	.1076	.1348
		Finish	1.5 x D	.015 x D	4	137	.0180	.0240	.0300	.0360	.0480	.0598	.0720	.0840	.0958	.1195	.1497
	Cast Iron Malleable	Slotting	.75 x D	1 x D	4	76	.0132	.0176	.0220	.0264	.0352	.0438	.0528	.0616	.0702	.0876	.1098
		Peripheral - Rough	1.25 x D	.5 x D	4	99	.0162	.0216	.0270	.0324	.0432	.0538	.0648	.0756	.0862	.1076	.1348
		Finish	1.5 x D	.015 x D	4	122	.0180	.0240	.0300	.0360	.0480	.0598	.0720	.0840	.0958	.1195	.1497
P	Low Carbon Steels 1018, 12L14, 8620	Slotting	1 x D	1 x D	4	107	.0156	.0208	.0260	.0312	.0416	.0518	.0624	.0728	.0830	.1036	.1298
		Peripheral - Rough	1.25 x D	.5 x D	4	130	.0192	.0256	.0320	.0384	.0512	.0637	.0768	.0896	.1021	.1275	.1597
		Finish	1.5 x D	.015 x D	4	152	.0216	.0288	.0360	.0432	.0576	.0717	.0864	.1008	.1149	.1434	.1797
	Medium Carbon Steels 4140, 4340	Slotting	1 x D	1 x D	4	91	.0144	.0192	.0240	.0288	.0384	.0478	.0576	.0672	.0766	.0956	.1198
		Peripheral - Rough	1.25 x D	.5 x D	4	114	.0180	.0240	.0300	.0360	.0480	.0598	.0720	.0840	.0958	.1195	.1497
		Finish	1.5 x D	.015 x D	4	137	.0198	.0264	.0330	.0396	.0528	.0657	.0792	.0924	.1053	.1315	.1647
	Tool & Die Steels <48 Rc A2, D2, H13, P20	Slotting	.75 x D	1 x D	4	91	.0144	.0192	.0240	.0288	.0384	.0478	.0576	.0672	.0766	.0956	.1198
		Peripheral -Rough	1.25 x D	.3 x D	4	114	.0174	.0232	.0290	.0348	.0464	.0578	.0696	.0812	.0926	.1155	.1448
		Finish	1.5 x D	.015 x D	4	137	.0180	.0240	.0300	.0360	.0480	.0598	.0720	.0840	.0958	.1195	.1497
M	Martensitic Stainless Steels 416, 410, 440C	Slotting	.75 x D	1 x D	4	91	.0144	.0192	.0240	.0288	.0384	.0478	.0576	.0672	.0766	.0956	.1198
		Peripheral - Rough	1.25 x D	.3 x D	4	114	.0174	.0232	.0290	.0348	.0464	.0578	.0696	.0812	.0926	.1155	.1448
		Finish	1.5 x D	.015 x D	4	137	.0180	.0240	.0300	.0360	.0480	.0598	.0720	.0840	.0958	.1195	.1497
	Austenitic Stainless Steels 303, 304, 316	Slotting	.75 x D	1 x D	4	84	.0156	.0208	.0260	.0312	.0416	.0518	.0624	.0728	.0830	.1036	.1298
		Peripheral - Rough	1.25 x D	.3 x D	4	99	.0192	.0256	.0320	.0384	.0512	.0637	.0768	.0896	.1021	.1275	.1597
		Finish	1.5 x D	.015 x D	4	122	.0198	.0264	.0330	.0396	.0528	.0657	.0792	.0924	.1053	.1315	.1647
	Precipitation Hardening Stainless Steels 17-4, 15-5, 13-8	Slotting	.5 x D	1 x D	4	76	.0120	.0160	.0200	.0240	.0320	.0398	.0480	.0560	.0638	.0797	.0998
		Peripheral - Rough	1.25 x D	.3 x D	4	91	.0150	.0200	.0250	.0300	.0400	.0498	.0600	.0700	.0798	.0996	.1248
		Finish	1.5 x D	.015 x D	4	114	.0156	.0208	.0260	.0312	.0416	.0518	.0624	.0728	.0830	.1036	.1298
S	Titanium Alloys 6AL-4V	Slotting	.5 x D	1 x D	4	76	.0120	.0160	.0200	.0240	.0320	.0398	.0480	.0560	.0638	.0797	.0998
		Peripheral - Rough	1.25 x D	.3 x D	4	91	.0150	.0200	.0250	.0300	.0400	.0498	.0600	.0700	.0798	.0996	.1248
		Finish	1.5 x D	.015 x D	4	114	.0156	.0208	.0260	.0312	.0416	.0518	.0624	.0728	.0830	.1036	.1298
	High Temperature Alloys Inconel, Haynes, Stellite, Hastalloy	Slotting	.25 x D	1 x D	4	18	.0126	.0168	.0210	.0252	.0336	.0418	.0504	.0588	.0670	.0837	.1048
		Peripheral - Rough	1.25 x D	.25 x D	4	27	.0162	.0216	.0270	.0324	.0432	.0538	.0648	.0756	.0862	.1076	.1348
		Finish	1.5 x D	.01 x D	4	38	.0186	.0248	.0310	.0372	.0496	.0617	.0744	.0868	.0989	.1235	.1547

D = Tool Diameter

D Tool Diameter
Z Number of Flutes
RPM Revolutions per Minute
SFM Surface Feet per Minute
M/min Surface Meters per Minute
IPM Inches per Minute
MMPM Millimeters per Minute
IPT Inch per Tooth
MMPT Millimeters per Tooth
MRR Metal Removal Rate
RDOC Radial Depth of Cut
ADOC Axial Depth of Cut

Technical Resources

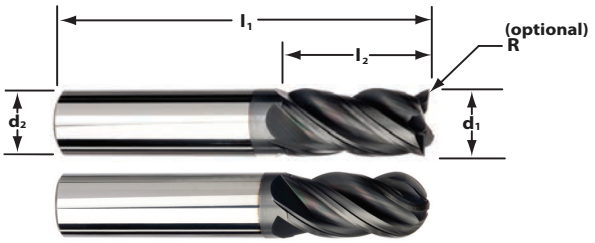
Information on tips and adjustments for the following milling operations can be found in our Technical Resources section beginning on page 129.

- HEM slotting
- Face milling
- Helical entry ramping
- Straight line ramping
- Long tool projection adjustments
- Ball nose milling adjustments
- Other helpful tips and calculations

M904
POW•R•FEED

Z4 | SQ | CR | BN | 38° | AlTiN | PLAIN | WELDON

For high-performance machining in materials ranging from low carbon steels to titanium. Our first-generation POW•R•FEED design, the M904 offers improved tool life and feed rates over general-purpose end mills by utilizing variable cutting edge indexing and advanced coating technology.



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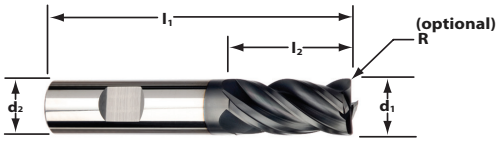
K P M S

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius .015 CR	.020 CR	.030 CR	.060 CR	.125 CR	Order Code BN
1/8	1/8	1/4	1-1/2	-	63248	-	-	-	-	-
		1/2	1-1/2	63010	63064	-	-	-	-	63139
5/32	3/16	9/16	2	63011	63118	-	-	-	-	-
3/16	3/16	5/16	2	-	63249	-	-	-	-	-
		5/8	2	63012	63065	-	-	-	-	63142
7/32	1/4	5/8	2-1/2	63013	-	63119	-	-	-	-
1/4	1/4	3/8	2	63003	-	63058	-	-	-	-
		3/4	2-1/2	63014	-	63066	63466	-	-	63144
		1-1/8	3	-	-	63420	-	-	-	-
		1-1/2	4	-	-	63425	-	-	-	-
5/16	5/16	13/16	2-1/2	63016	-	63067	-	-	-	-
3/8	3/8	1/2	2	63004	-	63059	-	-	-	-
		7/8	2-1/2	63018	-	63068	63390	-	-	63148
		1-1/8	3	-	-	63421	-	-	-	-
		1-3/4	4	-	-	63426	-	-	-	-
7/16	7/16	1	2-3/4	63020	-	63069	-	-	-	-
1/2	1/2	5/8	2-1/2	63005	-	-	63060	-	-	-
		1	3	63022	-	-	63070	-	-	63152
		1-1/4	3	63100	-	-	63098	63391	63393	63153
		2	4	-	-	-	63422	-	-	-
		2-1/2	5	-	-	-	63427	-	-	-
5/8	5/8	1-1/4	3-1/2	63024	-	-	63071	-	-	-
3/4	3/4	1-1/2	4	63025	-	-	63072	63395	63397	63156
		2-1/4	5	-	-	-	63423	-	-	-
		3	6	-	-	-	63428	-	-	-
1	1	1-1/2	4	63026	-	-	63073	-	-	-
		3	6	-	-	-	63429	-	-	-
		4-1/8	7	-	-	-	63432	-	-	-

M904 w/WELDON

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius .020 CR	.030 CR	.060 CR	.125 CR	Order Code BN
3/8	3/8	7/8	2-1/2	63043	63083	63400	-	-	63176
1/2	1/2	1	3	63045	-	63085	-	-	63180
		1-1/4	3	63101	-	63099	63401	63403	63181
5/8	5/8	1-1/4	3-1/2	63046	-	63086	-	-	-
3/4	3/4	1-1/2	4	63047	-	63087	63405	63407	-



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M904 Application Guide – Speed & Feed (inch)

ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	Number of Flutes	Speed (SFM)	Feed (Inches per Tooth) 1/8	5/32	3/16	7/32	1/4	5/16	3/8	7/16	1/2	5/8	3/4	1
K	Cast Iron Gray	Slotting	1 x D	1 x D	4	325	.0006	.0008	.0009	.0011	.0012	.0015	.0018	.0021	.0024	.0030	.0036	.0048
		Peripheral - Rough	1.25 x D	.5 x D	4	400	.0008	.0009	.0011	.0013	.0015	.0019	.0023	.0026	.0030	.0038	.0045	.0060
		Finish	1.5 x D	.015 x D	4	475	.0008	.0010	.0012	.0014	.0017	.0021	.0025	.0029	.0033	.0041	.0050	.0066
	Cast Iron Ductile	Slotting	1 x D	1 x D	4	300	.0006	.0007	.0008	.0010	.0011	.0014	.0017	.0019	.0022	.0028	.0033	.0044
		Peripheral - Rough	1.25 x D	.5 x D	4	375	.0007	.0008	.0010	.0012	.0014	.0017	.0020	.0024	.0027	.0034	.0041	.0054
		Finish	1.5 x D	.015 x D	4	450	.0008	.0009	.0011	.0013	.0015	.0019	.0023	.0026	.0030	.0038	.0045	.0060
	Cast Iron Malleable	Slotting	.75 x D	1 x D	4	250	.0006	.0007	.0008	.0010	.0011	.0014	.0017	.0019	.0022	.0028	.0033	.0044
		Peripheral - Rough	1.25 x D	.5 x D	4	325	.0007	.0008	.0010	.0012	.0014	.0017	.0020	.0024	.0027	.0034	.0041	.0054
		Finish	1.5 x D	.015 x D	4	400	.0008	.0009	.0011	.0013	.0015	.0019	.0023	.0026	.0030	.0038	.0045	.0060
P	Low Carbon Steels 1018, 12L14, 8620	Slotting	1 x D	1 x D	4	350	.0007	.0008	.0010	.0011	.0013	.0016	.0020	.0023	.0026	.0033	.0039	.0052
		Peripheral - Rough	1.25 x D	.5 x D	4	425	.0008	.0010	.0012	.0014	.0016	.0020	.0024	.0028	.0032	.0040	.0048	.0064
		Finish	1.5 x D	.015 x D	4	500	.0009	.0011	.0014	.0016	.0018	.0023	.0027	.0032	.0036	.0045	.0054	.0072
	Medium Carbon Steels 4140, 4340	Slotting	1 x D	1 x D	4	300	.0006	.0008	.0009	.0011	.0012	.0015	.0018	.0021	.0024	.0030	.0036	.0048
		Peripheral - Rough	1.25 x D	.5 x D	4	375	.0008	.0009	.0011	.0013	.0015	.0019	.0023	.0026	.0030	.0038	.0045	.0060
		Finish	1.5 x D	.015 x D	4	450	.0008	.0010	.0012	.0014	.0017	.0021	.0025	.0029	.0033	.0041	.0050	.0066
	Tool & Die Steels <48 Rc A2, D2, H13, P20	Slotting	.75 x D	1 x D	4	300	.0006	.0008	.0009	.0011	.0012	.0015	.0018	.0021	.0024	.0030	.0036	.0048
		Peripheral -Rough	1.25 x D	.3 x D	4	375	.0007	.0009	.0011	.0013	.0015	.0018	.0022	.0025	.0029	.0036	.0044	.0058
		Finish	1.5 x D	.015 x D	4	450	.0008	.0009	.0011	.0013	.0015	.0019	.0023	.0026	.0030	.0038	.0045	.0060
M	Martensitic Stainless Steels 416, 410, 440C	Slotting	.75 x D	1 x D	4	300	.0006	.0008	.0009	.0011	.0012	.0015	.0018	.0021	.0024	.0030	.0036	.0048
		Peripheral - Rough	1.25 x D	.3 x D	4	375	.0007	.0009	.0011	.0013	.0015	.0018	.0022	.0025	.0029	.0036	.0044	.0058
		Finish	1.5 x D	.015 x D	4	450	.0008	.0009	.0011	.0013	.0015	.0019	.0023	.0026	.0030	.0038	.0045	.0060
	Austenitic Stainless Steels 303, 304, 316	Slotting	.75 x D	1 x D	4	275	.0007	.0008	.0010	.0011	.0013	.0016	.0020	.0023	.0026	.0033	.0039	.0052
		Peripheral - Rough	1.25 x D	.3 x D	4	325	.0008	.0010	.0012	.0014	.0016	.0020	.0024	.0028	.0032	.0040	.0048	.0064
		Finish	1.5 x D	.015 x D	4	400	.0008	.0010	.0012	.0014	.0017	.0021	.0025	.0029	.0033	.0041	.0050	.0066
	Precipitation Hardening Stainless Steel 17-4, 15-5	Slotting	.5 x D	1 x D	4	250	.0005	.0006	.0008	.0009	.0010	.0013	.0015	.0018	.0020	.0025	.0030	.0040
		Peripheral - Rough	1.25 x D	.3 x D	4	300	.0006	.0008	.0009	.0011	.0013	.0016	.0019	.0022	.0025	.0031	.0038	.0050
		Finish	1.5 x D	.015 x D	4	375	.0007	.0008	.0010	.0011	.0013	.0016	.0020	.0023	.0026	.0033	.0039	.0052
S	Titanium Alloys 6AL - 4V	Slotting	.5 x D	1 x D	4	250	.0005	.0006	.0008	.0009	.0010	.0013	.0015	.0018	.0020	.0025	.0030	.0040
		Peripheral - Rough	1.25 x D	.3 x D	4	300	.0006	.0008	.0009	.0011	.0013	.0016	.0019	.0022	.0025	.0031	.0038	.0050
		Finish	1.5 x D	.015 x D	4	375	.0007	.0008	.0010	.0011	.0013	.0016	.0020	.0023	.0026	.0033	.0039	.0052
	High Temperature Alloys Inconel, Haynes, Stellite, Hastalloy	Slotting	.25 x D	1 x D	4	60	.0005	.0007	.0008	.0009	.0011	.0013	.0016	.0018	.0021	.0026	.0032	.0042
		Peripheral - Rough	1.25 x D	.25 x D	4	90	.0007	.0008	.0010	.0012	.0014	.0017	.0020	.0024	.0027	.0034	.0041	.0054
		Finish	1.5 x D	.01 x D	4	125	.0008	.0010	.0012	.0014	.0016	.0019	.0023	.0027	.0031	.0039	.0047	.0062

D = Tool Diameter

≈ Approximately Equals
≤ Less Than or Equal To
≥ Greater Than or Equal To
× Multiply
< Less Than
> Greater Than
= Equals

Common Machining Formulas

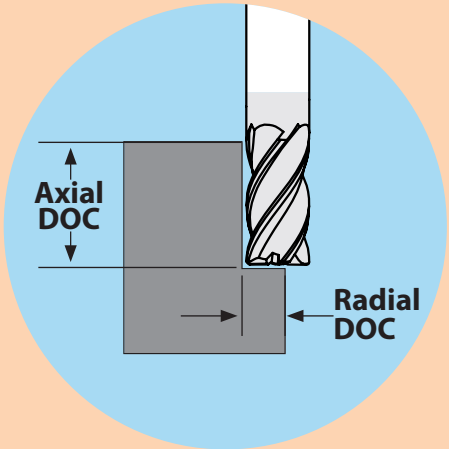
$$RPM = \frac{SFM \times 3.82}{D}$$

$$SFM = RPM \times D \times .262$$

$$IPM = RPM \times IPT \times Z$$

$$MRR = RDOC \times ADOC \times IPM$$

D Tool Diameter
Z Number of Flutes
RPM Revolutions per Minute
SFM Surface Feet per Minute
IPM Inches per Minute
IPT Inch per Tooth
MRR Metal Removal Rate
RDOC Radial Depth of Cut
ADOC Axial Depth of Cut

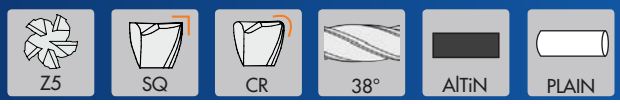


Tool Tech Support

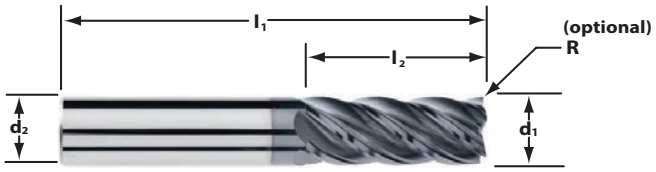
Information on tips and adjustments for the following milling operations can be found in our Technical Resources section beginning on page 129.

- HEM slotting
- Face milling
- Helical entry ramping
- Straight line ramping
- Long tool projection adjustments
- Ball nose milling adjustments
- Other helpful tips and calculations

M905
POW•R•FEED



For high-performance machining in materials ranging from low carbon steels to titanium. The 5-flute version of our first-generation POW•R•FEED design, the M905 offers improved tool life and feed rates over general-purpose end mills by utilizing variable cutting edge indexing and advanced coating technology.



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K P M S

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius .020 CR	.030 CR	.060 CR
1/4	1/4	3/4	2-1/2	63338	63287	63462	-
3/8	3/8	7/8	2-1/2	63340	63289	63370	-
1/2	1/2	1-1/4	3	63342	-	63291	63371
5/8	5/8	1-1/4	3-1/2	63343	-	63292	63374
3/4	3/4	1-1/2	4	63344	-	63293	63375

M905 Application Guide – Speed & Feed (inch)

ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	No. of Flutes	Speed (SFM)	Feed (Inches per Tooth) 1/4	3/8	1/2	5/8	3/4
K	Cast Iron Gray	Slotting	.5 x D	1 x D	5	350	.0011	.0016	.0022	.0027	.0032
		Peripheral - Rough	1.25 x D	.3 x D	5	450	.0014	.0020	.0027	.0034	.0041
		Finish	1.5 x D	.01 x D	5	450	.0018	.0027	.0037	.0046	.0055
	Cast Iron Malleable	Slotting	.5 x D	1 x D	5	300	.0010	.0014	.0019	.0024	.0029
		Peripheral - Rough	1.25 x D	.3 x D	5	375	.0012	.0018	.0024	.0030	.0036
		Finish	1.5 x D	.01 x D	5	450	.0016	.0024	.0033	.0041	.0049
P	Low Carbon Steels 1018, 12L14, 8620	Slotting	.5 x D	1 x D	5	350	.0012	.0017	.0023	.0029	.0035
		Peripheral - Rough	1.25 x D	.3 x D	5	425	.0015	.0022	.0029	.0036	.0044
		Finish	1.5 x D	.01 x D	5	500	.0020	.0030	.0039	.0049	.0059
	Medium Carbon Steels 4140, 4340	Slotting	.5 x D	1 x D	5	300	.0011	.0016	.0022	.0027	.0032
		Peripheral - Rough	1.25 x D	.3 x D	5	375	.0014	.0020	.0027	.0034	.0041
		Finish	1.5 x D	.01 x D	5	450	.0018	.0027	.0037	.0046	.0055
	Tool & Die Steels < 48 Rc A2, D2, H13, P20	Slotting	.5 x D	1 x D	5	300	.0010	.0016	.0021	.0026	.0031
		Peripheral - Rough	1.25 x D	.3 x D	5	375	.0013	.0020	.0026	.0033	.0039
		Finish	1.5 x D	.01 x D	5	450	.0016	.0024	.0033	.0041	.0049
M	Martensitic Stainless Steels 416, 410, 440C	Slotting	.5 x D	1 x D	5	300	.0010	.0016	.0021	.0026	.0031
		Peripheral - Rough	1.25 x D	.3 x D	5	375	.0013	.0020	.0026	.0033	.0039
		Finish	1.5 x D	.01 x D	5	450	.0016	.0024	.0033	.0041	.0049
	Austenitic Stainless Steels 303, 304, 316	Slotting	.5 x D	1 x D	5	275	.0012	.0018	.0024	.0029	.0035
		Peripheral - Rough	1.25 x D	.3 x D	5	325	.0015	.0022	.0029	.0037	.0044
		Finish	1.5 x D	.01 x D	5	400	.0018	.0027	.0037	.0046	.0055
	Precipition Hardening Stainless Steels 17-4 PH, 15-5 PH, 13-8 PH	Slotting	.5 x D	1 x D	5	250	.0008	.0012	.0017	.0021	.0025
		Peripheral - Rough	1.25 x D	.3 x D	5	300	.0010	.0016	.0021	.0026	.0031
		Finish	1.5 x D	.01 x D	5	375	.0013	.0019	.0026	.0032	.0039
S	Titanium Alloys	Slotting	.5 x D	1 x D	5	250	.0009	.0013	.0017	.0022	.0026
		Peripheral - Rough	1.25 x D	.3 x D	5	300	.0011	.0016	.0022	.0027	.0033
		Finish	1.5 x D	.01 x D	5	375	.0014	.0020	.0027	.0034	.0041

D = Tool Diameter

Information on tips and adjustments can be found in our Technical Resources section beginning on page 129.

Common Machining Formulas

$$RPM = \frac{SFM \times 3.82}{D}$$

$$SFM = RPM \times D \times .262$$

$$IPM = RPM \times IPT \times Z$$

$$MRR = RDOC \times ADOC \times IPM$$

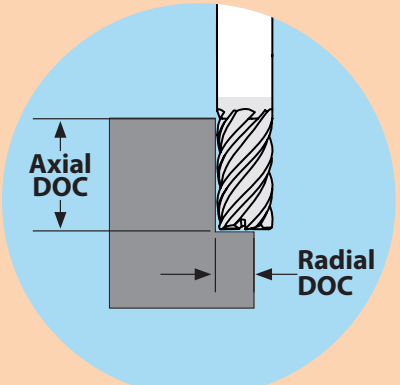
$$RPM = \frac{M/min \times 318.3}{D}$$

$$M/min = RPM \times D \times .00314$$

$$MMPM = RPM \times MMPT \times Z$$

$$MRR = RDOC \times ADOC \times MMPM$$

D Tool Diameter
Z Number of Flutes
RPM Revolutions per Minute
SFM Surface Feet per Minute
IPM Inches per Minute
IPT Inch per Tooth
MRR Metal Removal Rate
RDOC Radial Depth of Cut
ADOC Axial Depth of Cut



STREAKERS®

SHEAR IT AND CLEAR IT.

IMCO's unique design makes STREAKERS end mills first-rate roughers and excellent finishers. Get high metal removal rates without maxing out horsepower.

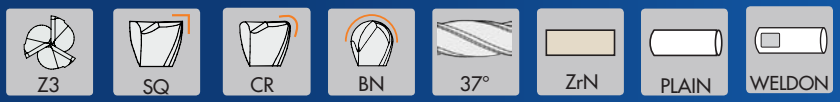
M2 Series Features

WON'T GUM UP THE WORKS.

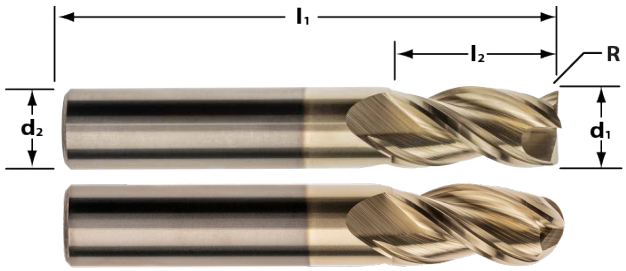
Introducing the new members of the STREAKERS family — the M223 and M233 end mills. The M223 STREAKERS end mills keep the best features of our original end mills and add new grinds for better part finishes and ZrN coating for extended tool life. The M233 is a true roughing end mill made to plow through gummy aluminum applications without packing up. The legacy members of the STREAKERS family retain their unique fluting and edge design to efficiently shear through aluminum alloys with great tool life.

	M223	M223N	M233	M203	M203N	M202	M202N
NUMBER OF FLUTES	Z3	Z3	Z3	Z3	Z3	Z2	Z2
END TYPES	SQ, CR, BN	SQ, CR, BN	CR	SQ, CR	SQ	SQ, CR, BN	SQ
HELIX ANGLE	37°	37°	37°	45°	45°	45°	45°
COATING	ZrN	ZrN	ZrN	NONE	NONE	NONE	NONE
SHANK TYPES	PLAIN, WELDON	PLAIN, NECK	PLAIN	PLAIN, WELDON	PLAIN, NECK	PLAIN, WELDON	PLAIN, NECK
APPLICATIONS	ROUGH, FINISH		ROUGH	ROUGH, FINISH		ROUGH	
MATERIAL(S)	N						

M223 STREAKERS



For high-performance machining in aluminum alloys. Improved floor and wall finishes, better ramping ability and longer tool life — all part of the new M223 STREAKERS design. The unique grinds curl and evacuate gummy aluminum chips, allowing high feed rates without chip packing. Excellent for roughing and finishing.



in: *d1: -0.0001 / -0.0004* *d2: -0.0001 / -0.0004*
mm: *d1: -0.025 / -0.0100* *d2: -0.0025 / -0.0100*

N

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius .015 CR	.030 CR	.060 CR	.125 CR	Order Code BN
1/8	1/8	1/4	1-1/2	61000	-	-	-	-	-
		3/8	1-1/2	61001	61002	-	-	-	61003
		1/2	2	61004	-	-	-	-	-
3/16	3/16	5/16	2	61005	-	-	-	-	-
		9/16	2	61006	61007	-	-	-	61008
		3/4	2-1/2	61009	-	-	-	-	-
1/4	1/4	1/2	2	61010	61011	-	-	-	-
		3/4	2-1/2	61012	61013	61014	-	-	61015
		1	3	61016	61017	61018	-	-	-
5/16	5/16	15/16	2-1/2	61019	61020	61021	-	-	-
		1-3/8	3	61022	-	-	-	-	-
3/8	3/8	1/2	2	61023	61024	-	-	-	-
		15/16	2-1/2	61025	61026	61027	61028	-	61029
		1-1/8	3	61030	61031	61032	61033	-	-
		1-1/2	3-1/2	61034	61035	61036	61037	-	-
		2	4	61038	-	-	-	-	-
1/2	1/2	5/8	2-1/2	61039	-	61040	-	-	-
		5/8	3	61041	-	61042	-	61043	-
		1	3	61044	61045	61046	61047	61048	61049
		1-1/4	3	61050	61051	61052	61053	61054	-
		1-1/2	3-1/2	61055	-	61056	61057	61058	-
		2	4	61059	61060	61061	61062	61063	-
		2-1/2	5	61064	-	61065	-	-	-
5/8	5/8	1-1/4	3-1/2	61066	-	61067	-	61068	-
		1-7/8	4	61069	-	61070	-	61071	61072
		2-1/2	5	61073	-	61074	-	-	-
3/4	3/4	1-5/8	4	61075	-	61076	61077	61078	61079
		2-1/4	5	61080	-	61081	61082	61083	-
		3-1/4	6	61084	-	61085	-	61086	-
1	1	1-1/4	4	61087	-	61088	-	-	-
		2	5	61089	-	61090	-	-	-
		3-1/4	6	61091	-	61092	-	-	-
		4-1/4	7	61093	-	61094	-	-	-

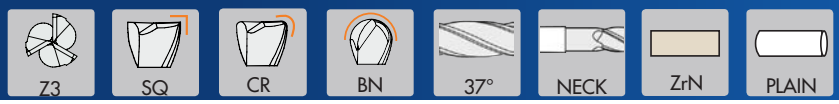
Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius 0.3 CR	0.5 CR	1.0 CR	1.5 CR	2.0 CR	3.0 CR	Order Code BN
3	3	9	38	61220	61221	-	-	-	-	-	61222
4	4	12	50	61223	61224	-	-	-	-	-	61225
5	5	15	50	61226	61227	-	-	-	-	-	61228
6	6	13	57	61229	61230	61231	61232	-	-	-	61233
		18	63	61234	-	61235	61236	-	-	-	-
		24	75	61237	-	61238	61239	-	-	-	-
8	8	20	63	61240	-	61241	61242	-	-	-	61243
		32	75	61244	-	61245	61246	-	-	-	-
10	10	20	66	61247	61248	-	-	-	-	-	-
		22	72	61249	61250	-	-	-	-	-	-
		25	72	61251	61252	61253	61254	61255	-	-	61256
		30	75	61257	-	61258	61259	61260	-	-	-
		40	88	61261	-	61262	61263	61264	-	-	-
12	12	24	73	61265	61266	-	-	-	-	-	-
		26	83	61267	61268	61269	61270	61271	61272	61273	-
		30	83	61274	-	61275	61276	61277	61278	61279	61280
		36	88	61281	-	61282	61283	61284	-	61285	-
		48	100	61286	-	61287	61288	61289	61290	61291	-
16	16	32	92	61292	-	61293	61294	61295	61296	61297	61298
		48	110	61299	-	-	61300	61301	61302	61303	-
		64	125	61304	-	-	61305	61306	61307	61308	-
20	20	40	104	61309	-	-	61310	61311	61312	61313	61314
		60	125	61315	-	-	61316	61317	61318	61319	-
		80	150	61320	-	-	61321	61322	61323	61324	-
25	25	50	125	61325	-	-	-	-	-	-	-

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ
3/8	3/8	15/16	2-1/2	61095
		1-1/2	3-1/2	61096
1/2	1/2	1	3	61097
		1-1/2	3-1/2	61098
		2	4	61099
5/8	5/8	1-7/8	4	61100
3/4	3/4	1-5/8	4	61101
		2-1/4	5	61102
		3-1/4	6	61103
1	1	2	5	61104
		3-1/4	6	61105

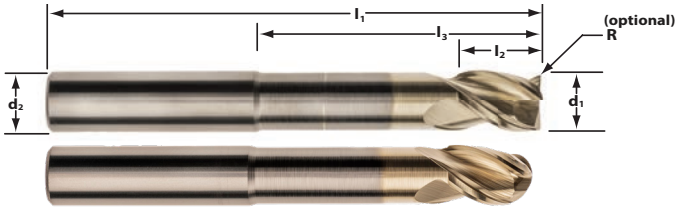
M223 w/WELDON

in: *d1: -0.0001 / -0.0004 d2: -0.0001 / -0.0004*

M223N STREAKERS



For high-performance machining in aluminum alloys. Adding a necked shank to the M223 design offers a high-performance tool that can reach into deep cavities while minimizing tool deflection. Great for work in pockets.



in: *d1: -0.0001 / -0.0004* *d2: -0.0001 / -0.0004*
mm: *d1: -0.025 / -0.0100* *d2: -0.0025 / -0.0100*

N

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Reach LBS l3	Overall Length l1	Order Code SQ	Order Code by Corner Radius .015 CR	.030 CR	.060 CR	.125 CR	Order Code BN
1/8	1/8	1/4	3/4	2-1/2	61122	61123	-	-	-	61124
			1	3	61125	61126	-	-	-	61127
3/16	3/16	1/4	3/4	2-1/2	61128	61129	-	-	-	61130
			1	3	61131	61132	-	-	-	61133
1/4	1/4	3/8	7/8	2-1/2	61134	61135	61136	-	-	61137
			1-3/8	3	61138	61139	61140	-	-	61141
			2-1/4	4	61142	61143	61144	-	-	61145
3/8	3/8	1/2	1-1/8	2-1/2	61146	61147	61148	61149	-	61150
			1-1/4	3	61151	61152	61153	61154	-	61155
			2-1/4	4	61156	61157	61158	-	-	61159
1/2	1/2	5/8	1-3/8	3	61160	61161	61162	61163	61164	61165
			2-1/4	4	61166	61167	61168	61169	61170	61171
			3-1/4	5	61172	61173	61174	61175	61176	61177
			4-1/4	6	61178	61179	61180	61181	61182	61183
5/8	5/8	3/4	1-3/4	4	61184	-	61185	-	61186	61187
			2-3/8	5	61188	-	61189	-	61190	61191
			3-3/8	6	61192	-	61193	-	61194	61195
3/4	3/4	1	1-3/4	4	61196	-	61197	61198	61199	61200
			2-3/8	5	61201	-	61202	61203	61204	61205
			3-3/8	6	61206	-	61207	61208	61209	61210
1	1	1-1/4	2-5/8	5	61211	-	61212	-	-	61213
			3-3/8	6	61214	-	61215	-	-	61216
			4-3/8	7	61217	-	61218	-	-	61219

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Reach LBS l3	Overall Length l1	Order Code SQ	Order Code by Corner Radius 0.3 CR	0.5 CR	1.0 CR	1.5 CR	2.0 CR	3.0 CR	Order Code BN
6	6	9	26	63	61342	61343	61344	61345	-	-	-	61346
			32	75	61347	61348	61349	61350	-	-	-	61351
8	8	12	34	75	61352	61353	61354	61355	-	-	-	61356
10	10	15	32	75	62010	62011	62014	62015	-	-	-	62023
			42	88	61357	61358	61359	61360	61361	-	-	61362
			52	100	61363	61364	61365	61366	61367	-	-	61368
12	12	18	38	88	61369	61370	61371	61372	61373	-	61374	61375
			50	100	61376	61377	61378	61379	61380	61381	61382	61383
			62	125	62027	62039	62045	62046	62047	62051	62052	62062
16	16	24	50	110	61384	-	61385	61386	61387	61388	61389	61390
			66	125	61391	-	61392	62099	61393	61394	61395	61396
			82	150	62100	-	62101	62102	62103	62123	62139	62143
20	20	30	62	125	61397	-	61398	62151	61399	62152	61400	61401
			82	135	62153	-	62154	62155	62156	62161	62164	62166
			102	150	61402	-	61403	62300	61404	61405	61406	61407

TOOL TIP

Coatings for Tools that Machine Aluminum

IMCO offers two types of coating on end mills designed to machine aluminum and copper alloys:

taC (photo A)
The ultimate coating for high-output machining in non-ferrous materials. This thin film coating keeps the tool cutting edges sharp for a high-shear plane. Very hard with high thermal stability and excellent wear resistance.
Find APT/C end mills with taC coating on pages 36–39.

Zirconium Nitride (ZrN) (photo B)
Adds hardness and lubricity to the cutting edge. Reduces edge build-up common in machining gummy materials, enhancing tool life and surface finish. **All new M223 and M233 end mills are coated with ZrN.**

ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	Number of Flutes	Speed (SFM)	Feed (Inch per Tooth) 1/8	3/16	1/4	3/8	1/2	5/8	3/4	1
N	Aluminum Alloys 6061, 7075, 2024	Slotting	1 x D	1 x D	3	800	.0015	.0030	.0038	.0045	.0060	.0075	.0090	.0120
		Peripheral - Rough	≤ 2 x D	.5 x D	3	1000	.0020	.0040	.0050	.0060	.0080	.0100	.0120	.0160
		Peripheral - Rough	> 2 - 3 x D	.5 x D	3	1000	.0019	.0038	.0047	.0056	.0075	.0094	.0113	.0150
		Peripheral - Rough	> 3 - 4 x D	.45 x D	3	900	.0016	.0033	.0041	.0049	.0065	.0081	.0098	.0130
		Peripheral - Rough	> 4 - 5 x D	.4 x D	3	800	.0015	.0029	.0036	.0044	.0058	.0073	.0087	.0116
		Finish	2.5 x D	.015 x D	3	1200	.0007	.0014	.0017	.0020	.0027	.0034	.0041	.0054
		*Helical Ramp Angle	3.0 deg.	1 x D	3	800	.0012	.0024	.0030	.0036	.0048	.0060	.0072	.0096
	High Silicon Aluminum A380, A390	Slotting	.75 x D	1 x D	3	500	.0011	.0023	.0028	.0034	.0045	.0056	.0068	.0090
		Peripheral - Rough	≤ 2 x D	.4 x D	3	700	.0014	.0029	.0036	.0043	.0057	.0071	.0086	.0114
		Peripheral - Rough	> 2 - 3 x D	.4 x D	3	700	.0014	.0028	.0034	.0041	.0055	.0069	.0083	.0110
		Peripheral - Rough	> 3 - 4 x D	.375 x D	3	600	.0012	.0024	.0030	.0036	.0048	.0060	.0072	.0096
		Peripheral - Rough	> 4 - 5 x D	.35 x D	3	500	.0010	.0020	.0025	.0030	.0040	.0050	.0060	.0080
		Finish	2.5 x D	.015 x D	3	900	.0006	.0013	.0016	.0019	.0025	.0031	.0038	.0050
		*Helical Ramp Angle	2.5 deg.	1 x D	3	500	.0009	.0018	.0023	.0027	.0036	.0045	.0054	.0072
	Magnesium Alloys	Slotting	1 x D	1 x D	3	800	.0015	.0030	.0038	.0045	.0060	.0075	.0090	.0120
		Peripheral - Rough	≤ 2 x D	.5 x D	3	1000	.0020	.0040	.0050	.0060	.0080	.0100	.0120	.0160
		Peripheral - Rough	> 2 - 3 x D	.5 x D	3	1000	.0019	.0038	.0047	.0056	.0075	.0094	.0113	.0150
		Peripheral - Rough	> 3 - 4 x D	.45 x D	3	900	.0016	.0033	.0041	.0049	.0065	.0081	.0098	.0130
		Peripheral - Rough	> 4 - 5 x D	.4 x D	3	800	.0015	.0029	.0036	.0044	.0058	.0073	.0087	.0116
		Finish	2.5 x D	.015 x D	3	1200	.0007	.0014	.0017	.0020	.0027	.0034	.0041	.0054
		*Helical Ramp Angle	3.0 deg.	1 x D	3	800	.0012	.0024	.0030	.0036	.0048	.0060	.0072	.0096
	Copper Alloys, Brass	Slotting	.75 x D	1 x D	3	500	.0009	.0019	.0023	.0028	.0037	.0046	.0056	.0074
		Peripheral - Rough	≤ 2 x D	.4 x D	3	600	.0012	.0023	.0029	.0035	.0046	.0058	.0069	.0092
		Peripheral - Rough	> 2 - 3 x D	.4 x D	3	600	.0011	.0023	.0028	.0034	.0045	.0056	.0068	.0090
		Peripheral - Rough	> 3 - 4 x D	.375 x D	3	500	.0010	.0020	.0024	.0029	.0039	.0049	.0059	.0078
		Peripheral - Rough	> 4 - 5 x D	.35 x D	3	450	.0008	.0017	.0021	.0025	.0033	.0041	.0050	.0066
		Finish	2.5 x D	.015 x D	3	650	.0005	.0011	.0013	.0016	.0021	.0026	.0032	.0042
		*Helical Ramp Angle	2.5 deg.	1 x D	3	500	.0007	.0015	.0019	.0022	.0030	.0037	.0044	.0059
	Bronze	Slotting	.75 x D	1 x D	3	500	.0009	.0018	.0022	.0026	.0035	.0044	.0053	.0070
		Peripheral - Rough	≤ 2 x D	.4 x D	3	600	.0011	.0022	.0028	.0033	.0044	.0055	.0066	.0088
		Peripheral - Rough	> 2 - 3 x D	.4 x D	3	600	.0011	.0021	.0026	.0032	.0042	.0053	.0063	.0084
		Peripheral - Rough	> 3 - 4 x D	.375 x D	3	500	.0009	.0018	.0022	.0026	.0035	.0044	.0053	.0070
		Peripheral - Rough	> 4 - 5 x D	.35 x D	3	450	.0007	.0015	.0018	.0022	.0029	.0036	.0044	.0058
		Finish	2.5 x D	.015 x D	3	650	.0005	.0010	.0012	.0014	.0019	.0024	.0029	.0038
		*Helical Ramp Angle	2.0 deg.	1 x D	3	500	.0007	.0014	.0018	.0021	.0028	.0035	.0042	.0056
	Composites, Plastic, Fiberglass	Slotting	.75 x D	1 x D	3	500	.0011	.0023	.0028	.0034	.0045	.0056	.0068	.0090
		Peripheral - Rough	≤ 2 x D	.4 x D	3	700	.0014	.0029	.0036	.0043	.0057	.0071	.0086	.0114
		Peripheral - Rough	> 2 - 3 x D	.4 x D	3	700	.0014	.0028	.0034	.0041	.0055	.0069	.0083	.0110
		Peripheral - Rough	> 3 - 4 x D	.375 x D	3	600	.0012	.0024	.0030	.0036	.0048	.0060	.0072	.0096
		Peripheral - Rough	> 4 - 5 x D	.35 x D	3	500	.0010	.0020	.0025	.0030	.0040	.0050	.0060	.0080
		Finish	2.5 x D	.015 x D	3	900	.0006	.0013	.0016	.0019	.0025	.0031	.0038	.0050
		*Helical Ramp Angle	3.0 deg.	1 x D	3	500	.0009	.0018	.0023	.0027	.0036	.0045	.0054	.0072

*Straight-Line Ramp Angle = Helical Ramp Angle x 5 for entry up to 1 x D.

≈ Approximately Equals
≤ Less Than or Equal To
≥ Greater Than or Equal To
× Multiply
< Less Than
> Greater Than
= Equals

Common Machining Formulas

$$RPM = \frac{SFM \times 3.82}{D}$$

$$SFM = RPM \times D \times .262$$

$$IPM = RPM \times IPT \times Z$$

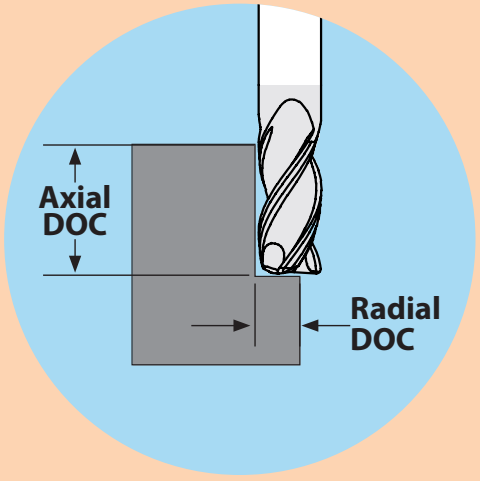
$$MRR = RDOC \times ADOC \times IPM$$

$$RPM = \frac{M/min \times 318.3}{D}$$

$$M/min = RPM \times D \times .00314$$

$$MMPM = RPM \times MMPT \times Z$$

$$MRR = RDOC \times ADOC \times MMPM$$



ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	Number of Flutes	Speed (M/min)	Feed (MM per Tooth) 3.0	4.0	5.0	6.0	8.0	10.0	12.0	16.0	20.0	25.0
N	Aluminum Alloys 6061, 7075, 2024	Slotting	1 x D	1 x D	3	244	.0360	.0479	.0600	.0720	.0960	.1195	.1440	.1915	.2390	.2995
		Peripheral - Rough	≤ 2 x D	.5 x D	3	305	.0480	.0639	.0800	.0960	.1280	.1593	.1920	.2553	.3187	.3993
		Peripheral - Rough	> 2 - 3 x D	.5 x D	3	305	.0450	.0599	.0750	.0900	.1200	.1494	.1800	.2394	.2988	.3744
		Peripheral - Rough	> 3 - 4 x D	.45 x D	3	274	.0390	.0519	.0650	.0780	.1040	.1295	.1560	.2075	.2589	.3245
		Peripheral - Rough	> 4 - 5 x D	.4 x D	3	244	.0348	.0463	.0580	.0696	.0928	.1155	.1392	.1851	.2311	.2895
		Finish	2.5 x D	.015 x D	3	366	.0162	.0216	.0270	.0324	.0432	.0538	.0648	.0862	.1076	.1348
		*Helical Ramp Angle	3.0 deg.	1 x D	3	244	.0288	.0384	.0480	.0576	.0768	.0956	.1152	.1532	.1912	.2396
	High Silicon Aluminum A380, A390	Slotting	.75 x D	1 x D	3	152	.0270	.0360	.0450	.0540	.0720	.0896	.1080	.1436	.1793	.2246
		Peripheral - Rough	≤ 2 x D	.4 x D	3	213	.0342	.0456	.0570	.0684	.0912	.1135	.1368	.1819	.2271	.2845
		Peripheral - Rough	> 2 - 3 x D	.4 x D	3	213	.0330	.0440	.0550	.0660	.0880	.1096	.1320	.1755	.2191	.2745
		Peripheral - Rough	> 3 - 4 x D	.375 x D	3	183	.0288	.0384	.0480	.0576	.0768	.0956	.1152	.1532	.1912	.2396
		Peripheral - Rough	> 4 - 5 x D	.35 x D	3	152	.0240	.0320	.0400	.0480	.0640	.0797	.0960	.1277	.1593	.1997
		Finish	2.5 x D	.015 x D	3	274	.0150	.0200	.0250	.0300	.0400	.0498	.0600	.0798	.0996	.1248
		*Helical Ramp Angle	2.5 deg.	1 x D	3	152	.0216	.0288	.0360	.0432	.0576	.0717	.0864	.1149	.1434	.1797
	Magnesium Alloys	Slotting	1 x D	1 x D	3	244	.0360	.0479	.0600	.0720	.0960	.1195	.1440	.1915	.2390	.2995
		Peripheral - Rough	≤ 2 x D	.5 x D	3	305	.0480	.0639	.0800	.0960	.1280	.1593	.1920	.2553	.3187	.3993
		Peripheral - Rough	> 2 - 3 x D	.5 x D	3	305	.0450	.0599	.0750	.0900	.1200	.1494	.1800	.2394	.2988	.3744
		Peripheral - Rough	> 3 - 4 x D	.45 x D	3	274	.0390	.0519	.0650	.0780	.1040	.1295	.1560	.2075	.2589	.3245
		Peripheral - Rough	> 4 - 5 x D	.4 x D	3	244	.0348	.0463	.0580	.0696	.0928	.1155	.1392	.1851	.2311	.2895
		Finish	2.5 x D	.015 x D	3	366	.0162	.0216	.0270	.0324	.0432	.0538	.0648	.0862	.1076	.1348
		*Helical Ramp Angle	3.0 deg.	1 x D	3	244	.0288	.0384	.0480	.0576	.0768	.0956	.1152	.1532	.1912	.2396
	Copper Alloys, Brass	Slotting	.75 x D	1 x D	3	152	.0222	.0296	.0370	.0444	.0592	.0737	.0888	.1181	.1474	.1847
		Peripheral - Rough	≤ 2 x D	.4 x D	3	183	.0276	.0368	.0460	.0552	.0736	.0916	.1104	.1468	.1832	.2296
		Peripheral - Rough	> 2 - 3 x D	.4 x D	3	183	.0270	.0360	.0450	.0540	.0720	.0896	.1080	.1436	.1793	.2246
		Peripheral - Rough	> 3 - 4 x D	.375 x D	3	152	.0234	.0312	.0390	.0468	.0624	.0777	.0936	.1245	.1554	.1947
		Peripheral - Rough	> 4 - 5 x D	.35 x D	3	137	.0198	.0264	.0330	.0396	.0528	.0657	.0792	.1053	.1315	.1647
		Finish	2.5 x D	.015 x D	3	198	.0126	.0168	.0210	.0252	.0336	.0418	.0504	.0670	.0837	.1048
		*Helical Ramp Angle	2.5 deg.	1 x D	3	152	.0178	.0237	.0296	.0355	.0474	.0590	.0710	.0945	.1179	.1478
	Bronze	Slotting	.75 x D	1 x D	3	152	.0210	.0280	.0350	.0420	.0560	.0697	.0840	.1117	.1394	.1747
		Peripheral - Rough	≤ 2 x D	.4 x D	3	183	.0264	.0352	.0440	.0528	.0704	.0876	.1056	.1404	.1753	.2196
		Peripheral - Rough	> 2 - 3 x D	.4 x D	3	183	.0252	.0336	.0420	.0504	.0672	.0837	.1008	.1341	.1673	.2096
		Peripheral - Rough	> 3 - 4 x D	.375 x D	3	152	.0210	.0280	.0350	.0420	.0560	.0697	.0840	.1117	.1394	.1747
		Peripheral - Rough	> 4 - 5 x D	.35 x D	3	137	.0174	.0232	.0290	.0348	.0464	.0578	.0696	.0926	.1155	.1448
		Finish	2.5 x D	.015 x D	3	198	.0114	.0152	.0190	.0228	.0304	.0378	.0456	.0606	.0757	.0948
		*Helical Ramp Angle	2.0 deg.	1 x D	3	152	.0168	.0224	.0280	.0336	.0448	.0558	.0672	.0894	.1115	.1398
	Composites, Plastic, Fiberglass	Slotting	.75 x D	1 x D	3	152	.0270	.0360	.0450	.0540	.0720	.0896	.1080	.1436	.1793	.2246
		Peripheral - Rough	≤ 2 x D	.4 x D	3	213	.0342	.0456	.0570	.0684	.0912	.1135	.1368	.1819	.2271	.2845
		Peripheral - Rough	> 2 - 3 x D	.4 x D	3	213	.0330	.0440	.0550	.0660	.0880	.1096	.1320	.1755	.2191	.2745
		Peripheral - Rough	> 3 - 4 x D	.375 x D	3	183	.0288	.0384	.0480	.0576	.0768	.0956	.1152	.1532	.1912	.2396
		Peripheral - Rough	> 4 - 5 x D	.35 x D	3	152	.0240	.0320	.0400	.0480	.0640	.0797	.0960	.1277	.1593	.1997
		Finish	2.5 x D	.015 x D	3	274	.0150	.0200	.0250	.0300	.0400	.0498	.0600	.0798	.0996	.1248
		*Helical Ramp Angle	3.0 deg.	1 x D	3	152	.0216	.0288	.0360	.0432	.0576	.0717	.0864	.1149	.1434	.1797

*Straight-Line Ramp Angle = Helical Ramp Angle x 5 for entry up to 1 x D.

D Tool Diameter
Z Number of Flutes
RPM Revolutions per Minute
SFM Surface Feet per Minute
M/min Surface Meters per Minute
IPM Inches per Minute
MMPM Millimeters per Minute
IPT Inch per Tooth
MMPT Millimeters per Tooth
MRR Metal Removal Rate
RDOC Radial Depth of Cut
ADOC Axial Depth of Cut

Technical Resources

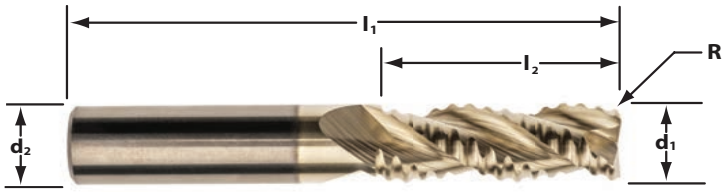
Information on tips and adjustments for the following milling operations can be found in our Technical Resources section beginning on page 129.

- HEM slotting
- Face milling
- Helical entry ramping
- Straight line ramping
- Long tool projection adjustments
- Ball nose milling adjustments
- Other helpful tips and calculations

M233 ROUGHER STREAKERS

For high-performance machining in aluminum alloys. Special cutting edge serrations reduce the horsepower needed to plow through aluminum alloys at high metal removal rates. The ZrN coating helps reduce chip packing even in heavy tool engagement cuts.

Tool Tip: M233 Rougher end mills show up to 20% power reduction from M223 in the same cut.



in: *d1: +0.0000 / -0.003* *d2: -0.0001 / -0.0004*
mm: *d1: +0.000 / -0.076* *d2: 0.0025 / -0.0100*

N

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code by Corner Radius .015 CR	.030 CR
1/4	1/4	3/4	2-1/2	61108	-
		1	3	61109	-
3/8	3/8	15/16	2-1/2	61110	-
		1-1/8	3	61111	-
		1-1/2	3-1/2	61112	-
1/2	1/2	1-1/4	3	-	61113
		1-1/2	3-1/2	-	61114
		2	4	-	61115
5/8	5/8	1-1/4	3-1/2	-	61116
		1-7/8	4	-	61117
3/4	3/4	1-5/8	4	-	61118
		2-1/4	5	-	61119
1	1	1-1/4	4	-	61120
		2	5	-	61121

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code by Corner Radius 0.5 CR	1.0 CR
6	6	13	57	61329	-
		18	63	61330	-
		24	75	61331	-
10	10	25	72	61332	-
		30	75	61333	-
		40	88	61334	-
12	12	30	83	-	61335
		36	88	-	61336
		48	100	-	61337
16	16	32	92	-	61338
		48	110	-	61339
20	20	40	104	-	61340
		60	125	-	61341

ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	Number of Flutes	Speed (SFM)	Feed (Inches per Tooth) 1/4	3/8	1/2	5/8	3/4	1
N	Aluminum Alloys 2024, 6061, 7075	Slotting	1 x D	1 x D	3	800	.0030	.0045	.0060	.0075	.0090	.0120
		Peripheral - Rough	≤ 2 x D	.5 x D	3	1000	.0040	.0060	.0080	.0100	.0120	.0160
		Peripheral - Rough	> 2 - 3 x D	.5 x D	3	1000	.0038	.0056	.0075	.0094	.0113	.0150
		Peripheral - Rough	> 3 - 4 x D	.45 x D	3	900	.0033	.0049	.0065	.0081	.0098	.0130
		*Helical Ramp Angle	3.0 deg.	1 x D	3	800	.0024	.0036	.0048	.0060	.0072	.0096
	High Silicon Aluminum A380, A390	Slotting	.75 x D	1 x D	3	500	.0023	.0034	.0045	.0056	.0068	.0090
		Peripheral - Rough	≤ 2 x D	.4 x D	3	700	.0029	.0043	.0057	.0071	.0086	.0114
		Peripheral - Rough	> 2 - 3 x D	.4 x D	3	700	.0028	.0041	.0055	.0069	.0083	.0110
		Peripheral - Rough	> 3 - 4 x D	.375 x D	3	600	.0024	.0036	.0048	.0060	.0072	.0096
		*Helical Ramp Angle	2.5 deg.	1 x D	3	500	.0018	.0027	.0036	.0045	.0054	.0072
	Magnesium Alloys	Slotting	1 x D	1 x D	3	800	.0030	.0045	.0060	.0075	.0090	.0120
		Peripheral - Rough	≤ 2 x D	.5 x D	3	1000	.0040	.0060	.0080	.0100	.0120	.0160
		Peripheral - Rough	> 2 - 3 x D	.5 x D	3	1000	.0038	.0056	.0075	.0094	.0113	.0150
		Peripheral - Rough	> 3 - 4 x D	.45 x D	3	900	.0033	.0049	.0065	.0081	.0098	.0130
		*Helical Ramp Angle	3.0 deg.	1 x D	3	800	.0024	.0036	.0048	.0060	.0072	.0096
	Copper Alloys, Brass	Slotting	.75 x D	1 x D	3	500	.0019	.0028	.0037	.0046	.0056	.0074
		Peripheral - Rough	≤ 2 x D	.4 x D	3	600	.0023	.0035	.0046	.0058	.0069	.0092
		Peripheral - Rough	> 2 - 3 x D	.4 x D	3	600	.0023	.0034	.0045	.0056	.0068	.0090
		Peripheral - Rough	> 3 - 4 x D	.375 x D	3	500	.0020	.0029	.0039	.0049	.0059	.0078
		*Helical Ramp Angle	2.5 deg.	1 x D	3	500	.0015	.0022	.0030	.0037	.0044	.0059
	Bronze	Slotting	.75 x D	1 x D	3	500	.0018	.0026	.0035	.0044	.0053	.0070
		Peripheral - Rough	≤ 2 x D	.4 x D	3	600	.0022	.0033	.0044	.0055	.0066	.0088
		Peripheral - Rough	> 2 - 3 x D	.4 x D	3	600	.0021	.0032	.0042	.0053	.0063	.0084
		Peripheral - Rough	> 3 - 4 x D	.375 x D	3	500	.0018	.0026	.0035	.0044	.0053	.0070
		*Helical Ramp Angle	2.0 deg.	1 x D	3	500	.0014	.0021	.0028	.0035	.0042	.0056
	Composites, Plastics, Fiberglass	Slotting	.75 x D	1 x D	3	500	.0023	.0034	.0045	.0056	.0068	.0090
		Peripheral - Rough	≤ 2 x D	.4 x D	3	700	.0029	.0043	.0057	.0071	.0086	.0114
		Peripheral - Rough	> 2 - 3 x D	.4 x D	3	700	.0028	.0041	.0055	.0069	.0083	.0110
		Peripheral - Rough	> 3 - 4 x D	.375 x D	3	600	.0024	.0036	.0048	.0060	.0072	.0096
		*Helical Ramp Angle	3.0 deg.	1 x D	3	500	.0018	.0027	.0036	.0045	.0054	.0072

*Straight-Line Ramp Angle = Helical ramp angle x 5 for entry up to 1 x D.

Tool Tip: M233 Rougher end mills show up to 20% power reduction from M223 in the same cut.

≈ Approximately Equals
≤ Less Than or Equal To
≥ Greater Than or Equal To
× Multiply
< Less Than
> Greater Than
= Equals

Common Machining Formulas

$$RPM = \frac{SFM \times 3.82}{D}$$

$$SFM = RPM \times D \times .262$$

$$IPM = RPM \times IPT \times Z$$

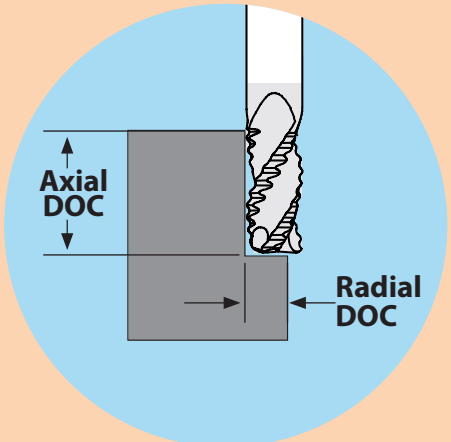
$$MRR = RDOC \times ADOC \times IPM$$

$$RPM = \frac{M/min \times 318.3}{D}$$

$$M/min = RPM \times D \times .00314$$

$$MMPM = RPM \times MMPT \times Z$$

$$MRR = RDOC \times ADOC \times MMPM$$



M233 Series Application Guide – Speed & Feed (metric)

ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	Number of Flutes	Speed (M/min)	Feed (MM per Tooth) 6.0	10.0	12.0	16.0	20.0
N	Aluminum Alloys 2024, 6061, 7075	Slotting	1 x D	1 x D	3	244	.0720	.1195	.1440	.1915	.2390
		Peripheral - Rough	≤ 2 x D	.5 x D	3	305	.0960	.1593	.1920	.2553	.3187
		Peripheral - Rough	> 2 - 3 x D	.5 x D	3	305	.0900	.1494	.1800	.2394	.2988
		Peripheral - Rough	> 3 - 4 x D	.45 x D	3	274	.0780	.1295	.1560	.2075	.2589
		*Helical Ramp Angle	3.0 deg.	1 x D	3	244	.0576	.0956	.1152	.1532	.1912
	High Silicon Aluminum A380, A390	Slotting	.75 x D	1 x D	3	152	.0540	.0896	.1080	.1436	.1793
		Peripheral - Rough	≤ 2 x D	.4 x D	3	213	.0684	.1135	.1368	.1819	.2271
		Peripheral - Rough	> 2 - 3 x D	.4 x D	3	213	.0660	.1096	.1320	.1755	.2191
		Peripheral - Rough	> 3 - 4 x D	.375 x D	3	183	.0576	.0956	.1152	.1532	.1912
		*Helical Ramp Angle	2.5 deg.	1 x D	3	152	.0432	.0717	.0864	.1149	.1434
	Magnesium Alloys	Slotting	1 x D	1 x D	3	244	.0720	.1195	.1440	.1915	.2390
		Peripheral - Rough	≤ 2 x D	.5 x D	3	305	.0960	.1593	.1920	.2553	.3187
		Peripheral - Rough	> 2 - 3 x D	.5 x D	3	305	.0900	.1494	.1800	.2394	.2988
		Peripheral - Rough	> 3 - 4 x D	.45 x D	3	274	.0780	.1295	.1560	.2075	.2589
		*Helical Ramp Angle	3.0 deg.	1 x D	3	244	.0576	.0956	.1152	.1532	.1912
	Copper Alloys, Brass	Slotting	.75 x D	1 x D	3	152	.0444	.0737	.0888	.1181	.1474
		Peripheral - Rough	≤ 2 x D	.4 x D	3	183	.0552	.0916	.1104	.1468	.1832
		Peripheral - Rough	> 2 - 3 x D	.4 x D	3	183	.0540	.0896	.1080	.1436	.1793
		Peripheral - Rough	> 3 - 4 x D	.375 x D	3	152	.0468	.0777	.0936	.1245	.1554
		*Helical Ramp Angle	2.5 deg.	1 x D	3	152	.0355	.0590	.0710	.0945	.1179
	Bronze	Slotting	.75 x D	1 x D	3	152	.0420	.0697	.0840	.1117	.1394
		Peripheral - Rough	≤ 2 x D	.4 x D	3	183	.0528	.0876	.1056	.1404	.1753
		Peripheral - Rough	> 2 - 3 x D	.4 x D	3	183	.0504	.0837	.1008	.1341	.1673
		Peripheral - Rough	> 3 - 4 x D	.375 x D	3	152	.0420	.0697	.0840	.1117	.1394
		*Helical Ramp Angle	2.0 deg.	1 x D	3	152	.0336	.0558	.0672	.0894	.1115
	Composites, Plastics, Fiberglass	Slotting	.75 x D	1 x D	3	152	.0540	.0896	.1080	.1436	.1793
		Peripheral - Rough	≤ 2 x D	.4 x D	3	213	.0684	.1135	.1368	.1819	.2271
		Peripheral - Rough	> 2 - 3 x D	.4 x D	3	213	.0660	.1096	.1320	.1755	.2191
		Peripheral - Rough	> 3 - 4 x D	.375 x D	3	183	.0576	.0956	.1152	.1532	.1912
		*Helical Ramp Angle	3.0 deg.	1 x D	3	152	.0432	.0717	.0864	.1149	.1434

*Straight-Line Ramp Angle = Helical ramp angle x 5 for entry up to 1 x D.

Tool Tip: M233 Rougher end mills show up to 20% power reduction from M223 in the same cut.

D Tool Diameter
Z Number of Flutes
RPM Revolutions per Minute
SFM Surface Feet per Minute
M/min Surface Meters per Minute
IPM Inches per Minute
MMPM Millimeters per Minute
IPT Inch per Tooth
MMPT Millimeters per Tooth
MRR Metal Removal Rate
RDOC Radial Depth of Cut
ADOC Axial Depth of Cut

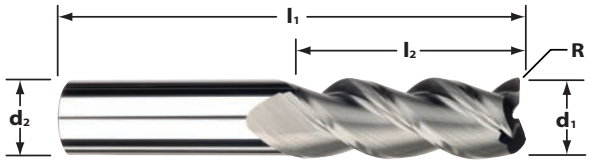
Technical Resources

Information on tips and adjustments for the following milling operations can be found in our Technical Resources section beginning on page 129.

- HEM slotting
- Face milling
- Helical entry ramping
- Straight line ramping
- Long tool projection adjustments
- Ball nose milling adjustments
- Other helpful tips and calculations

M203
STREAKERS

For high-performance machining in aluminum alloys. Unique grinds curl and evacuate gummy aluminum chips, allowing high feed rates without clogging. Excellent tool life. The 3-flute design yields a superior finish.



in: *d1: -0.0001 / -0.0004* *d2: -0.0001 / -0.0004*
mm: *d1: -0.0025 / -0.0100* *d2: -0.0025 / -0.0100*

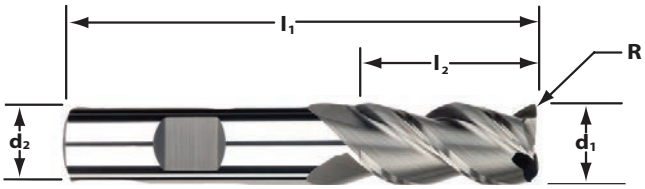
N

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius .015 CR	.030 CR	.060 CR	.125 CR
1/8	1/8	1/4	1-1/2	32520	-	-	-	-
		3/8	1-1/2	33246	34384	-	-	-
3/16	3/16	5/16	2	32521	-	-	-	-
		9/16	2	33248	34385	-	-	-
1/4	1/4	3/8	2-1/2	32986	33601	-	-	-
		3/4	2-1/2	32992	34386	34388	-	-
		1-1/4	3	33009	34435	34438	-	-
5/16	5/16	13/16	2-1/2	33250	-	-	-	-
		1-3/8	3	34454	-	-	-	-
3/8	3/8	1/2	2-1/2	32988	-	-	-	-
		1	2-1/2	32993	34458	34460	38261	-
		1-1/2	3-1/4	32998	34462	34480	38262	-
		2	4	33003	-	-	-	-
1/2	1/2	5/8	3	32989	-	33607	-	33610
		1-1/4	3	32994	34492	34522	34526	38025
		2	4	32999	34531	34534	34537	38033
		2-1/2	5	33004	-	-	-	-
		3-1/8	6	33013	-	-	-	-
5/8	5/8	1-5/8	3-1/2	32995	-	34545	-	-
		2-1/2	5	33006	-	34549	-	-
3/4	3/4	1	4	32991	-	33611	-	33614
		1-5/8	4	32996	-	34553	-	38028
		2-1/2	5	33001	-	34558	-	38036
		3-1/4	6	33007	-	34560	-	-
1	1	1-1/4	4	33137	-	-	-	-
		2	4	32997	-	-	-	-
		2-5/8	5	33002	-	-	-	-
		3-1/4	6	33008	-	-	-	-
		4-1/8	7	33012	-	-	-	-

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ
3	3	5	38	32522
4	4	11	50	33167
5	5	13	50	33169
6	6	16	57	33170
		29	75	34302
8	8	19	63	33172
		29	75	34303
10	10	22	72	33174
		40	88	34311
12	12	26	83	33175
		50	100	34305
16	16	32	92	33177
		57	125	34306
20	20	38	104	33179
		57	125	34307

M203 w/WELDON STREAKERS

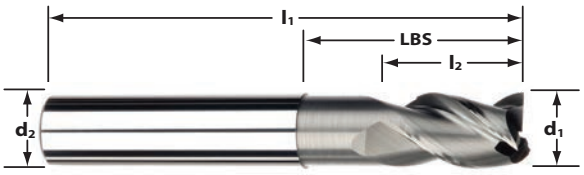
For high-performance machining in aluminum alloys. Unique grinds curl and evacuate gummy aluminum chips, allowing high feed rates without clogging. Excellent tool life. The 3-flute design yields a superior finish.



in: *d1: -0.0001 / -0.0004* *d2: -0.0001 / -0.0004*

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ
1/4	1/4	3/4	2-1/2	32634
		1-1/4	3	33011
3/8	3/8	7/8	2-1/2	32635
		1-1/2	3-1/4	32702
1/2	1/2	1-1/4	3-1/4	32637
		2	4	32703
5/8	5/8	1-1/4	3-1/2	32638
		2-1/2	5	32720
3/4	3/4	1-5/8	4	32639
		2-1/2	5	32704
1	1	2	4-1/2	32701
		2-5/8	5	32714
		3-1/4	6	32726

M203N



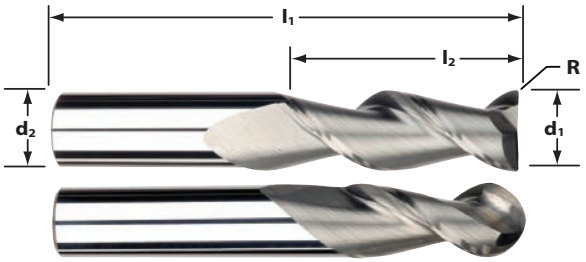
in: *d1: -0.0001 / -0.0004* *d2: -0.0001 / -0.0004*

For high-performance machining in aluminum alloys. Adding a necked shank to the M203 design offers a high-performance tool that permits clearance in deeper cavities and easier machining against tight walls. Neck relief and short flute length combine to increase end mill stability in the cut for more precise tolerances. Great for work in pockets.

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Reach LBS l3	Overall Length l1	Order Code SQ
1/4	1/4	3/8	1-1/8	2-1/2	33034
			1-5/8	3	33121
			2-1/4	4	33110
3/8	3/8	1/2	1-1/8	2-1/2	33035
			1-3/4	3	33122
			2-1/4	4	33112
1/2	1/2	5/8	1-3/8	3	33036
			2-1/4	4	33123
			2-3/8	5	33114
			3-3/8	6	33048
5/8	5/8	3/4	1-1/2	3-1/2	33038
			2-1/4	5	33124
			3-3/8	6	33116
3/4	3/4	1	1-3/4	4	33039
			2-1/4	5	33125
			3-3/8	6	33118

M202
STREAKERS

For high-performance machining in aluminum alloys. Unique grinds curl and evacuate gummy aluminum chips, allowing high feed rates without clogging. The 2-flute design increases the chip evacuation area, allowing more tool engagement. Excellent tool life.



in: *d1: -0.0001 / -0.0004* *d2: -0.0001 / -0.0004*
mm: *d1: +0.000 / -0.050* *d2: -0.0025 / -0.0100*

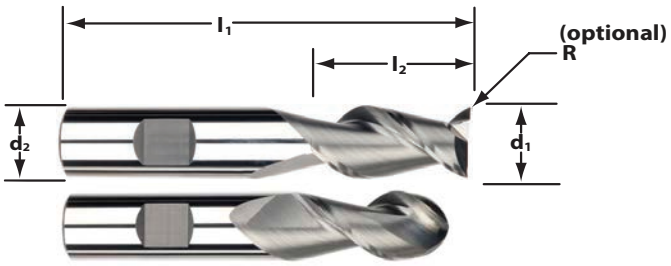
Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius .015 CR	.030 CR	.060 CR	.125 CR	Order Code BN
1/8	1/8	1/4	1-1/2	32941	-	-	-	-	-
		3/8	1-1/2	32949	33526	-	-	-	33446
3/16	3/16	5/16	2	32942	-	-	-	-	-
		9/16	2	32950	33542	-	-	-	33448
1/4	1/4	3/8	2-1/2	32943	-	-	-	-	-
		3/4	2-1/2	32951	33544	33548	-	-	32980
		1-1/4	3	32957	33552	34382	-	-	-
5/16	5/16	13/16	2-1/2	32952	-	-	-	-	32981
		1-3/8	3	32958	-	-	-	-	-
3/8	3/8	1/2	2-1/2	32945	-	-	-	-	-
		1	2-1/2	32953	33648	33689	-	-	32982
		1-1/2	3-1/4	32959	33693	33886	-	-	-
		2	4	32964	34100	34144	-	-	-
1/2	1/2	5/8	3	32946	-	-	-	-	-
		1-1/4	3	90358	34146	34161	34196	38076	32983
		2	4	32960	34198	34204	34206	38081	-
		2-1/2	5	32965	-	34235	-	-	-
5/8	5/8	1-5/8	3-1/2	32954	-	34237	38490	38494	32984
		2-1/2	5	32966	-	34243	-	-	-
		3-3/4	6	38504	-	38506	-	-	-
3/4	3/4	1-5/8	4	32955	-	34245	34262	38078	32985
		2-1/2	5	32962	-	34343	38082	38084	-
		3-1/4	6	32968	-	34345	-	38090	-

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code BN
3	3	5	38	32971	-
		8	38	-	62400
4	4	11	50	36974	62401
5	5	13	50	36976	62411
6	6	16	57	62402	62412
8	8	19	63	62403	62413
10	10	22	72	62404	62414
12	12	26	83	62406	62416
16	16	32	92	62408	62418
20	20	38	104	62410	62420

M202 w/WELDON STREAKERS

Z2 | SQ | CR | BN | 45° | NECK | NONE | WELDON

For high-performance machining in aluminum alloys. Unique grinds curl and evacuate gummy aluminum chips, allowing high feed rates without clogging. The 2-flute design increases the chip evacuation area, allowing more tool engagement. Excellent tool life.



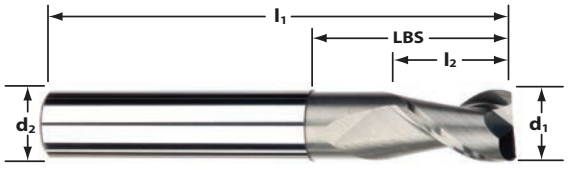
in: *d1: -0.0001 / -0.0004* *d2: -0.0001 / -0.0004*

N

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius .015 CR	.030 CR	.060 CR	Order Code BN
1/4	1/4	3/4	2-1/2	32430	33546	33550	-	32595
		1-1/4	3	32444	-	-	-	-
5/16	5/16	13/16	2-1/2	32431	-	-	-	32596
		1-3/8	3	32445	-	-	-	-
3/8	3/8	7/8	2-1/2	32432	33649	33691	33692	32597
		1-1/2	3-1/4	32446	-	-	-	-
		2	4	32510	-	-	-	-
1/2	1/2	1	3	32434	-	-	-	-
		1-1/4	3-1/4	32606	34147	34162	34197	32598
		2	4	32447	34199	34205	34207	-
		2-1/2	5	32512	-	-	-	-
5/8	5/8	1-1/4	3-1/2	32436	-	-	-	32599
		2-1/2	5	32514	-	-	-	-
3/4	3/4	1-5/8	4	32504	-	34246	-	32608
		2-1/2	5	32506	-	34344	-	-
		3-1/4	6	32516	-	-	-	-

M202N

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Reach LBS l3	Overall Length l1	Order Code SQ
1/4	1/4	3/8	1-1/8	2-1/2	32935
			1-5/8	3	33016
			2-1/4	4	33023
3/8	3/8	1/2	1-1/8	2-1/2	32936
			1-3/4	3	33018
			2-1/4	4	33024
1/2	1/2	5/8	1-3/8	3	32937
			2-1/4	4	33019
			2-3/8	5	33025
			3-3/8	6	33032
5/8	5/8	3/4	1-1/2	3-1/2	32938
			2-1/4	5	33020
			3-3/8	6	33026
3/4	3/4	1	1-3/4	4	32939
			2-1/4	5	33021
			3-3/8	6	33027



in: *d1: -0.0001 / -0.0004* *d2: -0.0001 / -0.0004*

For high-performance machining in aluminum alloys. Adding a necked shank to the M202 design offers a high-performance tool that permits clearance in deeper cavities and easier machining against tight walls. Neck relief and short flute length combine to increase end mill stability in the cut for more precise tolerances. Great for work in pockets.

ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	Number of Flutes	Speed (SFM)	Feed (Inch per Tooth) 1/8	3/16	1/4	5/16	3/8	1/2	5/8	3/4	1
N	Aluminum Alloys 2024, 6061, 7075	Slotting	1 x D	1 x D	2	800	.0015	.0023	.0030	.0038	.0045	.0060	.0075	.0090	.0120
		Peripheral - Rough	1 x D	.75 x D	2	1000	.0019	.0028	.0038	.0047	.0056	.0075	.0094	.0113	.0150
		Peripheral - Finish	1.5 x D	.01 x D	2	1200	.0024	.0035	.0047	.0059	.0071	.0094	.0118	.0141	.0188
	High Silicon Aluminum A380, A390	Slotting	.75 x D	1 x D	2	500	.0013	.0020	.0026	.0033	.0039	.0052	.0065	.0078	.0104
		Peripheral - Rough	1 x D	.5 x D	2	700	.0016	.0024	.0033	.0041	.0049	.0065	.0081	.0098	.0130
		Peripheral - Finish	1.5 x D	.01 x D	2	900	.0020	.0031	.0041	.0051	.0061	.0082	.0102	.0122	.0163
	Magnesium Alloys	Slotting	1 x D	1 x D	2	800	.0015	.0023	.0030	.0038	.0045	.0060	.0075	.0090	.0120
		Peripheral - Rough	1 x D	.75 x D	2	1000	.0019	.0028	.0038	.0047	.0056	.0075	.0094	.0113	.0150
		Peripheral - Finish	1.5 x D	.01 x D	2	1200	.0024	.0035	.0047	.0059	.0071	.0094	.0118	.0141	.0188
	Copper Alloys Brass, Bronze	Slotting	.75 x D	1 x D	2	500	.0013	.0020	.0026	.0033	.0039	.0052	.0065	.0078	.0104
		Peripheral - Rough	1 x D	.75 x D	2	575	.0016	.0024	.0033	.0041	.0049	.0065	.0081	.0098	.0130
		Peripheral - Finish	1.5 x D	.01 x D	2	650	.0020	.0031	.0041	.0051	.0061	.0082	.0102	.0122	.0163
	Composites Plastics, Fiberglass	Slotting	1 x D	1 x D	2	500	.0013	.0020	.0026	.0033	.0039	.0052	.0065	.0078	.0104
		Peripheral - Rough	1 x D	.75 x D	2	700	.0016	.0024	.0033	.0041	.0049	.0065	.0081	.0098	.0130
		Peripheral - Finish	1.5 x D	.01 x D	2	900	.0020	.0031	.0041	.0051	.0061	.0082	.0102	.0122	.0163
	Aluminum Alloys 2024, 6061, 7075	Slotting	.75 x D	1 x D	3	800	.0013	.0020	.0026	.0033	.0039	.0052	.0065	.0078	.0104
		Peripheral - Rough	1 x D	.75 x D	3	1000	.0016	.0024	.0033	.0041	.0049	.0065	.0081	.0098	.0130
		Peripheral - Finish	1.5 x D	.01 x D	3	1200	.0020	.0031	.0041	.0051	.0061	.0082	.0102	.0122	.0163
	High Silicon Aluminum A380, A390	Slotting	.5 x D	1 x D	3	500	.0011	.0017	.0022	.0028	.0033	.0044	.0055	.0066	.0088
		Peripheral - Rough	1 x D	.5 x D	3	700	.0014	.0021	.0028	.0034	.0041	.0055	.0069	.0083	.0110
		Peripheral - Finish	1.5 x D	.01 x D	3	900	.0017	.0026	.0035	.0043	.0052	.0069	.0086	.0104	.0138
	Magnesium Alloys	Slotting	.75 x D	1 x D	3	800	.0013	.0020	.0026	.0033	.0039	.0052	.0065	.0078	.0104
		Peripheral - Rough	1 x D	.75 x D	3	1000	.0016	.0024	.0033	.0041	.0049	.0065	.0081	.0098	.0130
		Peripheral - Finish	1.5 x D	.01 x D	3	1200	.0020	.0031	.0041	.0051	.0061	.0082	.0102	.0122	.0163
	Copper Alloys Brass, Bronze	Slotting	.75 x D	1 x D	3	500	.0011	.0017	.0022	.0028	.0033	.0044	.0055	.0066	.0088
		Peripheral - Rough	1 x D	.75 x D	3	575	.0014	.0021	.0028	.0034	.0041	.0055	.0069	.0083	.0110
		Peripheral - Finish	1.5 x D	.01 x D	3	650	.0017	.0026	.0035	.0043	.0052	.0069	.0086	.0104	.0138
	Composites Plastics, Fiberglass	Slotting	1 x D	1 x D	3	500	.0011	.0017	.0022	.0028	.0033	.0044	.0055	.0066	.0088
		Peripheral - Rough	1 x D	.75 x D	3	700	.0014	.0021	.0028	.0034	.0041	.0055	.0069	.0083	.0110
		Peripheral - Finish	1.5 x D	.01 x D	3	900	.0017	.0026	.0035	.0043	.0052	.0069	.0086	.0104	.0138

D = Tool Diameter

≈ Approximately Equals
≤ Less Than or Equal To
≥ Greater Than or Equal To
× Multiply
< Less Than
> Greater Than
= Equals

Common Machining Formulas

$$RPM = \frac{SFM \times 3.82}{D}$$

$$SFM = RPM \times D \times .262$$

$$IPM = RPM \times IPT \times Z$$

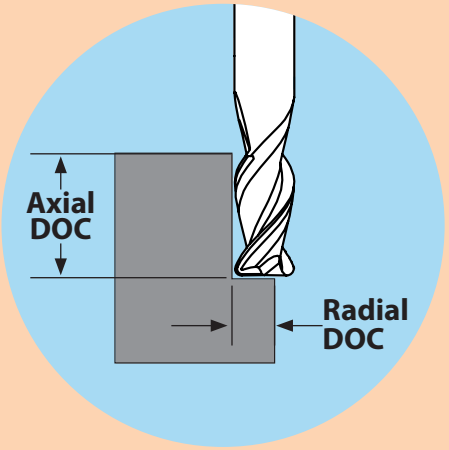
$$MRR = RDOC \times ADOC \times IPM$$

$$RPM = \frac{M/min \times 318.3}{D}$$

$$M/min = RPM \times D \times .00314$$

$$MMPM = RPM \times MMPT \times Z$$

$$MRR = RDOC \times ADOC \times MMPM$$



ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	Number of Flutes	Speed (M/Min)	Feed (MM per Tooth) 3.0	4.0	5.0	6.0	8.0	10.0	12.0	16.0	20.0
N	Aluminum Alloys 2024, 6061, 7075	Slotting	1 x D	1 x D	2	244	.0360	.0480	.0600	.0720	.0960	.1195	.1440	.1915	.2405
		Peripheral - Rough	1 x D	.75 x D	2	305	.0450	.0600	.0750	.0900	.1200	.1494	.1800	.2394	.3006
		Peripheral - Finish	1.5 x D	.01 x D	2	365	.0565	.0754	.0942	.1131	.1508	.1877	.2261	.3007	.3776
	High Silicon Aluminum A380, A390	Slotting	.75 x D	1 x D	2	153	.0312	.0416	.0520	.0624	.0832	.1036	.1248	.1660	.2084
		Peripheral - Rough	1 x D	.5 x D	2	213	.0390	.0520	.0650	.0780	.1040	.1295	.1560	.2075	.2605
		Peripheral - Finish	1.5 x D	.01 x D	2	274	.0490	.0653	.0817	.0980	.1307	.1627	.1960	.2606	.3273
	Magnesium Alloys	Slotting	1 x D	1 x D	2	244	.0360	.0480	.0600	.0720	.0960	.1195	.1440	.1915	.2405
		Peripheral - Rough	1 x D	.75 x D	2	305	.0450	.0600	.0750	.0900	.1200	.1494	.1800	.2394	.3006
		Peripheral - Finish	1.5 x D	.01 x D	2	365	.0565	.0754	.0942	.1131	.1508	.1877	.2261	.3007	.3776
	Copper Alloys Brass, Bronze	Slotting	.75 x D	1 x D	2	153	.0312	.0416	.0520	.0624	.0832	.1036	.1248	.1660	.2084
		Peripheral - Rough	1 x D	.75 x D	2	175	.0390	.0520	.0650	.0780	.1040	.1295	.1560	.2075	.2605
		Peripheral - Finish	1.5 x D	.01 x D	2	198	.0490	.0653	.0817	.0980	.1307	.1627	.1960	.2606	.3273
	Composites Plastics, Fiberglass	Slotting	1 x D	1 x D	2	153	.0312	.0416	.0520	.0624	.0832	.1036	.1248	.1660	.2084
		Peripheral - Rough	1 x D	.75 x D	2	213	.0390	.0520	.0650	.0780	.1040	.1295	.1560	.2075	.2605
		Peripheral - Finish	1.5 x D	.01 x D	2	274	.0490	.0653	.0817	.0980	.1307	.1627	.1960	.2606	.3273
	Aluminum Alloys 2024, 6061, 7075	Slotting	.75 x D	1 x D	3	244	.0312	.0416	.0520	.0624	.0832	.1036	.1248	.1660	.2084
		Peripheral - Rough	1 x D	.75 x D	3	305	.0390	.0520	.0650	.0780	.1040	.1295	.1560	.2075	.2605
		Peripheral - Finish	1.5 x D	.01 x D	3	365	.0490	.0653	.0817	.0980	.1307	.1627	.1960	.2606	.3273
	High Silicon Aluminum A380, A390	Slotting	.5 x D	1 x D	3	153	.0264	.0352	.0440	.0528	.0704	.0876	.1056	.1404	.1763
		Peripheral - Rough	1 x D	.5 x D	3	213	.0330	.0440	.0550	.0660	.0880	.1096	.1320	.1755	.2204
		Peripheral - Finish	1.5 x D	.01 x D	3	274	.0415	.0553	.0691	.0829	.1106	.1376	.1658	.2205	.2769
	Magnesium Alloys	Slotting	.75 x D	1 x D	3	244	.0312	.0416	.0520	.0624	.0832	.1036	.1248	.1660	.2084
		Peripheral - Rough	1 x D	.75 x D	3	305	.0390	.0520	.0650	.0780	.1040	.1295	.1560	.2075	.2605
		Peripheral - Finish	1.5 x D	.01 x D	3	365	.0490	.0653	.0817	.0980	.1307	.1627	.1960	.2606	.3273
	Copper Alloys Brass, Bronze	Slotting	.75 x D	1 x D	3	153	.0264	.0352	.0440	.0528	.0704	.0876	.1056	.1404	.1763
		Peripheral - Rough	1 x D	.75 x D	3	175	.0330	.0440	.0550	.0660	.0880	.1096	.1320	.1755	.2204
		Peripheral - Finish	1.5 x D	.01 x D	3	198	.0415	.0553	.0691	.0829	.1106	.1376	.1658	.2205	.2769
	Composites Plastics, Fiberglass	Slotting	1 x D	1 x D	3	153	.0264	.0352	.0440	.0528	.0704	.0876	.1056	.1404	.1763
		Peripheral - Rough	1 x D	.75 x D	3	213	.0330	.0440	.0550	.0660	.0880	.1096	.1320	.1755	.2204
		Peripheral - Finish	1.5 x D	.01 x D	3	274	.0415	.0553	.0691	.0829	.1106	.1376	.1658	.2205	.2769

D = Tool Diameter

D Tool Diameter
Z Number of Flutes
RPM Revolutions per Minute
SFM Surface Feet per Minute
M/min Surface Meters per Minute
IPM Inches per Minute
MMPM Millimeters per Minute
IPT Inch per Tooth
MMPT Millimeters per Tooth
MRR Metal Removal Rate
RDOC Radial Depth of Cut
ADOC Axial Depth of Cut

Technical Resources

Information on tips and adjustments for the following milling operations can be found in our Technical Resources section beginning on page 129.

- HEM slotting
- Face milling
- Helical entry ramping
- Straight line ramping
- Long tool projection adjustments
- Ball nose milling adjustments
- Other helpful tips and calculations

truCORE®

GENERAL PURPOSE DOES NOT MEAN "SECOND CLASS."

IMCO's truCORE series of end mills are all made from high-grade substrate and are ground to strict standards — making our base tools outstanding in their class.

truCORE Features

BETTER PRECISION, LONGER TOOL LIFE BY DESIGN.

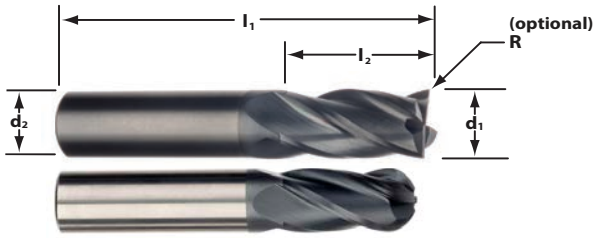
Optimized flute designs and a high-strength core give our truCORE E series end mills cutting performance you do not see with conventional general-purpose tools. TruCORE end mills are CNC ground from the highest quality material, maximizing performance and repeatability.

	E14	E14	E14	E14	E24	E13	E13	E12	M104	E520B
NUMBER OF FLUTES	Z4	Z4	Z4	Z4	Z4	Z3	Z3	Z2	Z4	Z2
END TYPES	SQ, CR, BN	SQ, BN	SQ	SQ, BN	SQ, BN	SQ, BN	SQ	SQ, BN	SQ	BN
HELIX ANGLE	30°	30°	30°	30°	30°	30°	30°	30°	30°	15°
COATING	AlTiN	TiCN	TiN	NONE	AlTiN	AlTiN	NONE	AlTiN, NONE	AlTiN	AlTiN
SHANK TYPES	PLAIN, WELDON	PLAIN, WELDON	PLAIN	PLAIN, WELDON	PLAIN	PLAIN	PLAIN	PLAIN	PLAIN	PLAIN, NECK
APPLICATIONS	ROUGH, FINISH							ROUGH	ROUGH	ROUGH, FINISH
MATERIAL(S)	K P M S N								P M	H

E14 AlTiN truCORE

Z4 | SQ | CR | BN | 30° | AlTiN | PLAIN | WELDON

For general machining in a wide range of materials. The E14 offers the most cutting edges in a general-purpose tool design. Best for roughing and finishing in a broad range of machining environments. The AlTiN coating offers superior heat resistance and hardness for increased tool life.



in: *d1: +0.000 / -0.002 d2: -0.0001 / -0.0004*

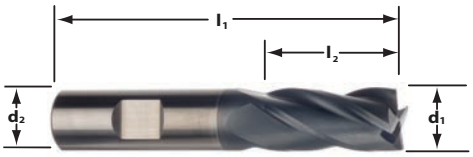
K P M S

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius .015 CR	.020 CR	.030 CR	.045 CR	.060 CR	Order Code BN
1/32	1/8	3/32	1-1/2	99345	-	-	-	-	-	30559
3/64	1/8	9/64	1-1/2	30537	-	-	-	-	-	30539
1/16	1/8	1/8	1-1/2	30529	-	-	-	-	-	30530
		3/16	1-1/2	30800	-	-	-	-	-	97852
		1/4	1-1/2	90695	-	-	-	-	-	-
5/64	1/8	1/4	1-1/2	30506	-	-	-	-	-	30482
3/32	1/8	3/16	1-1/2	31545	-	-	-	-	-	31700
		3/8	1-1/2	30531	-	-	-	-	-	30992
7/64	1/8	3/8	1-1/2	30458	-	-	-	-	-	-
1/8	1/8	1/4	1-1/2	97871	-	-	-	-	-	31747
		1/2	1-1/2	30521	97662	90523	-	-	-	30997
		5/8	2	62107	-	-	-	-	-	37897
		3/4	2-1/4	30417	-	-	-	-	-	37911
		1	3	97847	-	-	-	-	-	97842
9/64	3/16	9/16	2	30500	-	-	-	-	-	
5/32	3/16	5/16	2	39757	-	-	-	-	-	30465
		9/16	2	30501	-	-	-	-	-	30468
11/64	3/16	5/8	2	30507	-	-	-	-	-	
3/16	3/16	3/8	2	31548	-	-	-	-	-	31746
		5/8	2	30520	39694	39695	39601	-	-	30524
		3/4	2-1/2	37793	-	-	-	-	-	37915
		1	4	62110	-	-	-	-	-	37898
		1-1/8	3	34115	-	-	-	-	-	37938
13/64	1/4	5/8	2-1/2	30469	-	-	-	-	-	-
7/32	1/4	5/8	2-1/2	30546	-	-	-	-	-	31046
15/64	1/4	3/4	2-1/2	30972	-	-	-	-	-	-
1/4	1/4	1/2	2	31595	-	-	-	-	-	31745
		3/4	2-1/2	98955	30519	39513	39604	39696	-	30998
		1	4	62111	-	-	-	-	-	37899
		1-1/8	3	99336	-	-	-	-	-	37919
		1-1/2	4	98978	-	-	-	-	-	96411
		1-1/2	6	39772	-	-	-	-	-	97844
17/64	5/16	3/4	2-1/2	30976	-	-	-	-	-	-
9/32	5/16	3/4	2-1/2	96156	-	-	-	-	-	30464
19/64	5/16	13/16	2-1/2	30979	-	-	-	-	-	-
5/16	5/16	1/2	2	30534	-	-	-	-	-	31744
		13/16	2-1/2	30898	39697	39698	39700	39701	-	30525
		1-1/8	3	30461	-	-	-	-	-	34323
		1-5/8	4	34123	-	-	-	-	-	34361
21/64	3/8	1	2-1/2	31003	-	-	-	-	-	-
11/32	3/8	1	2-1/2	30463	-	-	-	-	-	30408
23/64	3/8	1	2-1/2	31004	-	-	-	-	-	-
3/8	3/8	5/8	2	31549	-	-	-	-	-	31749
		1	2-1/2	98244	37443	37444	37445	37446	37447	98262
		1-1/8	3	37727	-	-	-	-	-	37927
		1-1/2	6	97850	-	-	-	-	-	-
		1-3/4	4	34136	-	-	-	-	-	34335

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code by Corner Radius .015 CR	.020 CR	.030 CR	.045 CR	.060 CR	Order Code BN
25/64	7/16	1	2-3/4	31024	-	-	-	-	-	-
13/32	7/16	1	2-3/4	31026	-	-	-	-	-	-
27/64	7/16	1	2-3/4	31028	-	-	-	-	-	-
7/16	7/16	1	2-3/4	31040	-	-	-	-	-	31052
		2	4	37731	-	-	-	-	-	-
29/64	1/2	1	3	30475	-	-	-	-	-	-
15/32	1/2	1	3	31030	-	-	-	-	-	-
31/64	1/2	1	3	99106	-	-	-	-	-	-
1/2	1/2	5/8	2-1/2	31546	-	-	-	-	-	31743
		1	3	98245	37449	37450	37451	37452	37453	97922
		1-1/2	6	31150	-	-	-	-	-	-
		2	4	37735	-	-	-	-	-	37935
		3	6	34135	-	-	-	-	-	30473
9/16	9/16	1-1/4	3-1/2	30996	-	-	-	-	-	30409
5/8	5/8	1-1/4	3-1/2	30555	-	-	-	-	-	30991
		2-1/4	5	30561	-	-	-	-	-	-
		3	6	34143	-	-	-	-	-	-
11/16	3/4	1-1/2	4	31032	-	-	-	-	-	31050
3/4	3/4	1-1/2	4	98956	-	-	-	-	-	95757
		2-1/4	5	37751	-	-	-	-	-	-
		3	6	34151	-	-	-	-	-	-
13/16	7/8	1-1/2	4	31034	-	-	-	-	-	-
7/8	7/8	1-1/2	4	30523	-	-	-	-	-	-
15/16	1	1-1/2	4	31038	-	-	-	-	-	-
1	1	1-1/2	4	98957	-	-	-	-	-	-
		2-1/4	5	37767	-	-	-	-	-	-
		3	6	34167	-	-	-	-	-	-

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ
3/8	3/8	1	2-1/2	39790
		1-1/8	3	39168
1/2	1/2	1	3	39791
		2	4	39169
5/8	5/8	1-1/4	3-1/2	39793
		2-1/4	5	39170
		3	6	39177
3/4	3/4	1-1/2	4	39794
		2-1/4	5	39171
		3	6	39178
1	1	1-1/2	4	39796
		2-1/4	5	39172
		3	6	39365

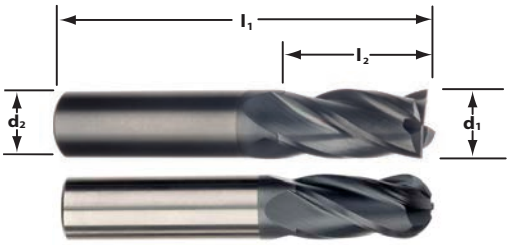
E14 w/WELDON



in: *d1: +0.000 / -0.002* *d2: -0.0001 / -0.0004*

E14 AlTiN truCORE

For general machining in a wide range of materials. The E14 offers the most cutting edges in a general-purpose tool design. Best for roughing and finishing in a broad range of machining environments. The AlTiN coating offers superior heat resistance and hardness for increased tool life.



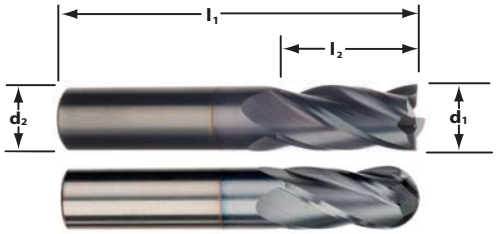
mm: *d1: +0.000 / -0.050 d2: -0.0025 / 0.0100*

K P M S

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code BN
1	3	2	38	39722	-
		3	38	32202	39835
1.5	3	4,5	38	32204	39836
		6	38	30252	62570
2	3	6,3	38	32208	39838
		9	38	30253	62571
2.5	3	5	38	39725	-
		9,5	38	32212	39839
3	3	9	38	99284	-
		12	38	32214	39841
		19	57	39804	-
		25	75	32301	39892
3.5	4	14	50	32216	-
4	4	14	50	32218	39843
		19	63	39805	-
		31	75	32302	39893
5	5	16	50	32224	39847
		19	63	39806	-
		31	75	32305	-
6	6	13	57	36587	-
		19	63	32226	39848
		29	75	39807	39883
		38	100	32306	39895
8	8	20	63	32228	39850
		29	75	39808	-
		41	100	32308	39896
10	10	25	72	32230	39852
		40	88	36838	-
		45	100	32310	39897
12	12	25	75	32231	39853
		26	83	36593	37344
		50	100	39810	39886
		75	150	32312	-
16	16	32	92	36595	39865
		57	125	39812	39888
		75	150	32318	-
20	20	38	104	36597	32672
		57	125	39814	39890
		75	150	32324	-
25	25	45	120	36899	-
		75	150	32325	-

E14 TiCN truCORE

For general machining in a wide range of materials. The E14 offers the most cutting edges in a general-purpose tool design. Best for roughing and finishing in a broad range of machining environments. The TiCN coating protects the cutting edge and increases tool life over uncoated end mills.



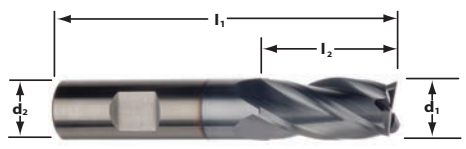
in: *d1: +0.000 / -0.002* *d2: -0.0001 / -0.0004*

K P M S

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code BN
1/32	1/8	3/32	1-1/2	34402	-
3/64	1/8	9/64	1-1/2	34403	-
1/16	1/8	3/16	1-1/2	34404	34504
3/32	1/8	3/8	1-1/2	34406	34506
1/8	1/8	1/4	1-1/2	31532	-
		1/2	1-1/2	34408	34508
		3/4	2-1/4	37710	-
		1	3	34110	-
5/32	3/16	9/16	2	34410	-
3/16	3/16	3/8	2	31534	-
		5/8	2	34412	34512
		1-1/8	3	34114	-
1/4	1/4	1/2	2	31536	-
		3/4	2-1/2	34416	34516
		1-1/8	3	37718	-
		1-1/2	4	34118	-
5/16	5/16	13/16	2-1/2	34420	-
3/8	3/8	1	2-1/2	34424	34524
		1-1/8	3	37726	-
		1-3/4	4	34126	-
7/16	7/16	1	2-3/4	34430	-
1/2	1/2	1	3	34432	34532
		2	4	37734	-
		3	6	34134	-
5/8	5/8	1-1/4	3-1/2	34440	34540
		2-1/4	5	37742	-
		3	6	34142	-
3/4	3/4	1-1/2	4	34448	34548
		2-1/4	5	37750	-
		3	6	34150	-
1	1	1-1/2	4	34464	-
		2-1/4	5	37766	-
		3	6	34166	-

E14 w/WELDON

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ
3/8	3/8	1	2-1/2	39781
1/2	1/2	1	3	39782
5/8	5/8	1-1/4	3-1/2	39784
3/4	3/4	1-1/2	4	39785



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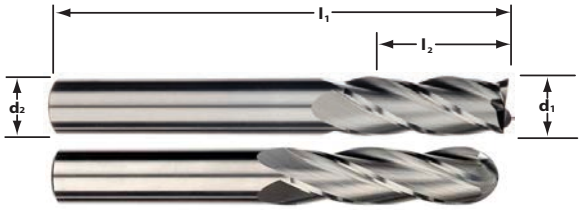
E14 UNCOATED truCORE

For general machining in a wide range of materials. The E14 offers the most cutting edges in a general-purpose tool design. Best for roughing and finishing in a broad range of machining environments.



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mm: *d1: +0.000 / -0.050 d2: -0.0025 / -0.0100*

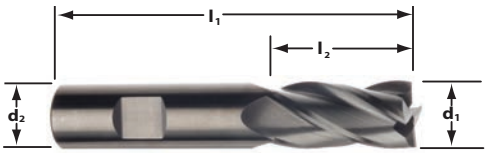
K P M S

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code BN
1/32	1/8	3/32	1-1/2	30701	30901
3/64	1/8	9/64	1-1/2	30703	-
1/16	1/8	3/16	1-1/2	30705	30905
5/64	1/8	1/4	1-1/2	30707	-
3/32	1/8	3/8	1-1/2	30709	30909
7/64	1/8	3/8	1-1/2	30711	-
1/8	1/8	1/4	1-1/2	31507	-
		1/2	1-1/2	30713	30913
		3/4	2-1/4	37708	-
		1	3	34108	-
5/32	3/16	9/16	2	30717	-
3/16	3/16	3/8	2	31511	-
		5/8	2	30721	30921
		3/4	2-1/2	37712	-
		1-1/8	3	34112	-
7/32	1/4	5/8	2-1/2	30725	-
1/4	1/4	1/2	2	31515	-
		3/4	2-1/2	30729	30929
		1-1/8	3	37716	-
		1-1/2	4	34116	-
5/16	5/16	13/16	2-1/2	30737	-
		1-1/8	3	37720	-
		1-5/8	4	34120	-
3/8	3/8	5/8	2	31519	-
		1	2-1/2	30745	30945
		1-1/8	3	37724	-
		1-3/4	4	34124	-
7/16	7/16	1	2-3/4	30772	-
1/2	1/2	5/8	2-1/2	31523	-
		1	3	30761	30961
		2	4	37732	-
		3	6	34132	-
5/8	5/8	1-1/4	3-1/2	30765	30965
		2-1/4	5	37740	-
		3	6	34140	-
3/4	3/4	1-1/2	4	30769	30969
		2-1/4	5	37748	-
		3	6	34148	-
1	1	1-1/2	4	30777	-
		2-1/4	5	37764	-
		3	6	34164	-

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ
1	3	3	38	31471
1.5	3	6	38	38607
2	3	6,3	38	31473
		9	38	38608
2.5	3	9,5	38	31474
3	3	12	38	31475
		19	57	30125
		25	75	30040
4	4	14	50	31477
		19	63	30126
		31	75	30043
5	5	16	50	31479
		19	63	30127
		31	100	30135
6	6	19	63	31480
		29	75	30049
		38	100	30137
8	8	20	63	31482
		29	75	30052
		41	100	30138
10	10	25	72	31484
		40	88	30079
		45	100	30055
12	12	25	75	31485
		50	100	30058
		75	150	30061
16	16	32	92	36579
		57	125	30131
		75	150	30067
20	20	38	104	36581
		57	125	30133
		75	150	30073

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ
3/8	3/8	1	2-1/2	39745
1/2	1/2	1	3	39761
5/8	5/8	1-1/4	3-1/2	39765
3/4	3/4	1-1/2	4	39769

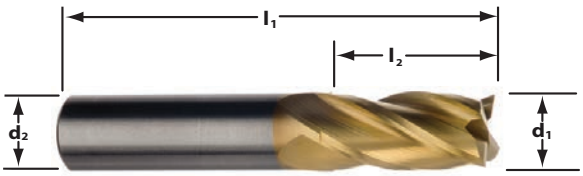
E14 w/WELDON



in: *d1: +0.000 / -0.002 d2: -0.0001 / -0.0004*

E14 TiN truCORE

For general machining in a wide range of materials. The E14 offers the most cutting edges in a general tool design. Best for roughing and finishing in a broad range of machining environments. The TiN coating protects the cutting edge and increases tool life over uncoated end mills.



in: *d1: +0.000 / -0.002 d2: -0.0001 / -0.0004*

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ
1/16	1/8	3/16	1-1/2	30706
3/32	1/8	3/8	1-1/2	30710
1/8	1/8	1/2	1-1/2	30714
3/16	3/16	5/8	2	30722
1/4	1/4	3/4	2-1/2	30730
5/16	5/16	13/16	2-1/2	30738
3/8	3/8	1	2-1/2	30746
1/2	1/2	1	3	30762
5/8	5/8	1-1/4	3-1/2	30766
3/4	3/4	1-1/2	4	30770

TOOL TIP

Driving Performance to the Edge.

What makes IMCO end mills the best choice for your everyday applications?

Strength: All IMCO truCORE end mills are made using submicron grain carbide with a 10% cobalt binder, increasing the transverse rupture strength for longer durability and even edge wear.

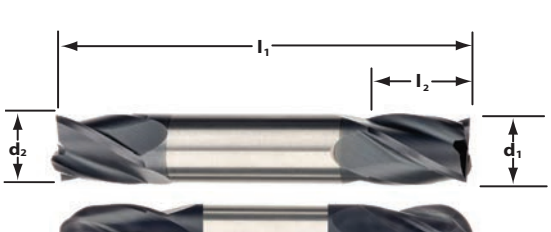
Consistency: IMCO end mills are manufactured on high-precision CNC grinders to exacting standards, ensuring repeatability from tool to tool.

Variety: Many length and dimension options are available in tools with 2-, 3- or 4-flutes—many with high-performance coatings. Weldon flats are available on common sizes.

With all of this, it's easy to see how IMCO tooling can give you maximum performance when working in a wide range of materials.

E24 AlTiN truCORE

For general machining in a wide range of materials. The E24 offers the reliability of our general-purpose tool design in a double-ended form. Best for roughing and finishing in a broad range of machining environments. The AlTiN coating offers superior heat resistance and hardness for increased tool life.



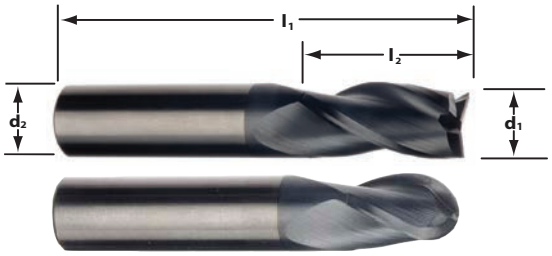
in: *d1: +0.000 / -0.002* *d2: -0.0001 / -0.0004*

K P M S

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code BN
1/32	1/8	1/16	1-1/2	30410	32083
3/64	1/8	3/32	1-1/2	31900	32182
1/16	1/8	1/8	1-1/2	31985	32181
5/64	1/8	1/8	1-1/2	31949	32085
3/32	1/8	3/16	1-1/2	31927	32086
7/64	1/8	3/16	1-1/2	31957	-
1/8	1/8	1/4	1-1/2	99125	32139
9/64	3/16	5/16	2	31926	-
5/32	3/16	5/16	2	31995	32090
11/64	3/16	5/16	2	31958	-
3/16	3/16	3/8	2	99331	32138
7/32	1/4	1/2	2-1/2	31959	-
1/4	1/4	1/2	2-1/2	31990	32137
5/16	5/16	1/2	2-1/2	31991	32140
3/8	3/8	9/16	2-1/2	31929	32200
1/2	1/2	5/8	3	31998	32201

E13 AlTiN truCORE

For general machining in a wide range of materials. The E13 offers a combination of strong cutting edges with increased flute spacing in a general-purpose tool design. Best for roughing and finishing in slots and pockets and in gummy materials. The AlTiN coating offers superior heat resistance and hardness for increased tool life.



in: *d1: +0.000 / -0.002* *d2: -0.0001 / -0.0004*
mm: *d1: +0.000 / -0.050* *d2: -0.0025 / -0.0100*

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code BN
1/32	1/8	3/32	1-1/2	33801	-
3/64	1/8	9/64	1-1/2	33819	-
1/16	1/8	1/8	1-1/2	34057	62063
		3/16	1-1/2	33826	62055
3/32	1/8	3/16	1-1/2	34011	62064
		3/8	1-1/2	33827	62056
1/8	1/8	1/4	1-1/2	33800	62065
		1/2	1-1/2	33810	62057
		3/4	2-1/4	33911	62070
		1	3	34046	-
5/32	3/16	9/16	2	33814	-
3/16	3/16	3/8	2	34058	62066
		5/8	2	33850	62058
		3/4	2-1/2	33913	62071
		1-1/8	3	34047	-
1/4	1/4	1/2	2	34059	62067
		3/4	2-1/2	33852	62059
		1-1/8	3	33929	62072
		1-1/2	4	34051	62081
5/16	5/16	13/16	2-1/2	33853	-
3/8	3/8	1	2-1/2	33854	99776
		1-1/8	3	33931	62074
1/2	1/2	1	3	90089	62060
		2	4	33955	62075
5/8	5/8	1-1/4	3-1/2	33855	-
3/4	3/4	1-1/2	4	33856	-
		2-1/4	5	34069	-

TOOL TIP

Aim For a Chip-Free Cutting Zone.

The proper location and volume of flood coolant are essential for a successful cut. Coolant plays a very important part in chip evacuation, especially when machining in a pocket or closed area. But simply blasting a large amount of coolant at the end mill isn't the most effective way to flush chips from the cutting zone. In fact, failure to direct the coolant properly increases the risk of re-cutting chips, causing tool damage and premature wear.

As this series of photos demonstrates, the most productive way to flush chips out of a pocket is to direct the coolant to the bottom of the cut. This allows the coolant to rebound off the tool and part floor, lifting the chips out and away from the tool's cutting edges

Coolant flow is perpendicular to the end mill, flowing past the end mill without hitting it directly. This will not evacuate the chips from the flutes sufficiently or provide proper cooling to the cutting edges.

Coolant flow is hitting the end mill nicely, but it is perpendicular to it. This will cool the end mill but will not lift and flush the chips out of the cutting zone.

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code BN
1	3	2	38	30897	-
		3	38	62456	-
1.5	3	4,5	38	62457	-
		6	38	37012	-
2	3	6,3	38	62458	-
		9	38	37014	-
2.5	3	9,5	38	37016	-
3	3	12	38	30247	62604
		19	57	62260	-
		25	75	62170	-
4	4	14	50	37020	62606
		19	63	62261	-
		31	75	62171	-
5	5	16	50	37024	62608
		19	63	62262	-
		31	75	37033	-
6	6	13	57	36773	-
		19	63	37026	32591
		29	75	62263	-
8	8	20	63	37028	32592
		29	75	62264	-
		41	100	62174	-
10	10	25	72	37031	32593
		40	88	37166	-
		45	100	62175	-
12	12	25	75	37034	-
		26	83	36779	37380
		50	100	62266	-
		75	150	62176	-
16	16	32	92	36781	-
		57	125	62268	-
		75	150	62178	-
20	20	38	104	36783	-
		57	125	62270	-
		75	150	62180	-

Coolant volume is weak and too high. The coolant is not aimed into the cutting zone, which limits its effectiveness in flushing the chips, lubricating and cooling at the point of cut.

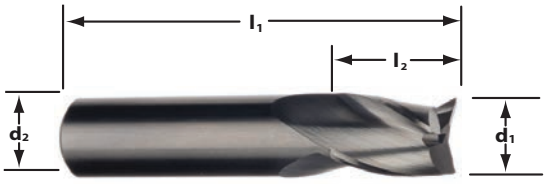
This example of coolant placement shows plenty of flush at the end mill. The three spray nozzles are pointing down at the end mill, forcing the chips up and out of the cutting zone.

There is not enough coolant volume to adequately flush chips out of the cutting zone. This condition will result in re-cutting of chips and premature tool wear.

The best coolant flush for evacuating chips from a pocket uses a coolant flush-type collet and through-spindle coolant (if your machine is equipped with it). Coolant is forced all around the end mill – 360° – at high pressure. High-pressure coolant hits the bottom of the cut and lifts the chips out and away from the cutting zone quickly and efficiently.

E13 UNCOATED truCORE

For general machining in a wide range of materials. The E13 offers a combination of strong cutting edges with increased flute spacing in a general-purpose tool design. Best for roughing and finishing in slots and pockets and in gummy materials.



in: *d1: +0.000 / -0.002* *d2: -0.0001 / -0.0004*

P M N

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ
1/8	1/8	1/4	1-1/2	33775
		1/2	1-1/2	33808
		3/4	2-1/4	33782
		1	3	33791
3/16	3/16	3/8	2	33776
		5/8	2	33812
		3/4	2-1/2	33783
		1-1/8	3	33792
1/4	1/4	1/2	2	33777
		3/4	2-1/2	33816
		1-1/8	3	33784
5/16	5/16	13/16	2-1/2	33820
3/8	3/8	1	2-1/2	33824
		1-1/8	3	33786
1/2	1/2	1	3	33832
		2	4	33787
5/8	5/8	1-1/4	3-1/2	33840
3/4	3/4	1-1/2	4	33848
		2-1/4	5	33789

TOOL TIP

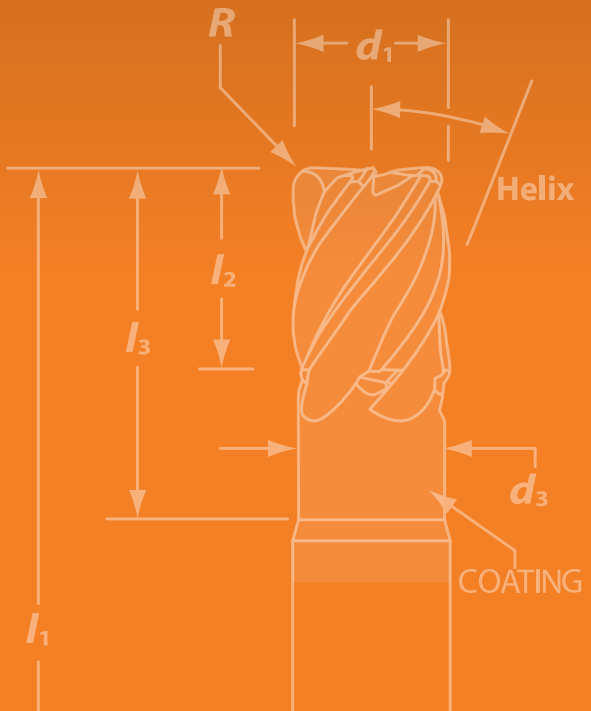
Tool Modifications.

Special tooling requirements can often be met through one or more of these simple modifications of standard, off-the-shelf products.

- Add corner radius or chamfer (Note that corners on some series cannot be modified)
- Add a Weldon flat to tool shank
- Add a neck relief
- Shorten flute length
- Add a drill point to an end mill

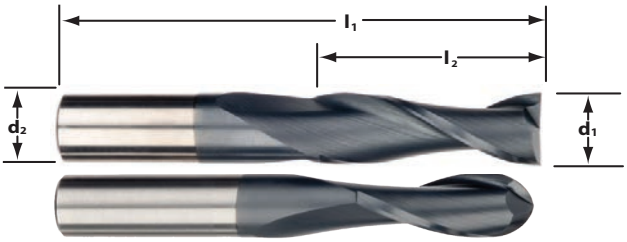
These coatings can also be added to existing uncoated products.

AlTiNX	TiN
AlTiN	ZrN
AlCrNX	taC
TiCN	DLC (Diamond-Like Coating)



E12 AlTiN truCORE

For general machining in a wide range of materials. The E12 offers the maximum flute spacing in a general-purpose tool design. Best for roughing, slotting and pocketing in materials and in applications in which chip evacuation is a challenge. The AlTiN coating offers superior heat resistance and hardness for increased tool life.



in: *d1: +0.000 / -0.002 d2: -0.0001 / -0.0004*
mm: *d1: +0.000 / -0.050 d2: -0.0025 / -0.0100*

P M N

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code BN
1/32	1/8	1/16	1-1/2	38923	30372
		3/32	1-1/2	30509	30303
3/64	1/8	3/32	1-1/2	39093	30373
		9/64	1-1/2	35603	30302
1/16	1/8	1/8	1-1/2	39104	30374
		3/16	1-1/2	30336	30433
5/64	1/8	1/4	1-1/2	30337	30349
3/32	1/8	3/16	1-1/2	39105	30375
		3/8	1-1/2	30338	30350
7/64	1/8	3/8	1-1/2	30339	-
1/8	1/8	1/4	1-1/2	90088	31956
		1/2	1-1/2	96342	30993
		3/4	2-1/4	36610	30385
		1	3	34015	31291
9/64	3/16	9/16	2	30344	-
5/32	3/16	9/16	2	30503	30354
11/64	3/16	5/8	2	30345	-
3/16	3/16	3/8	2	39131	30378
		5/8	2	30554	90087
		3/4	2-1/2	36619	30386
		1-1/8	3	34023	90081
13/64	1/4	5/8	2-1/2	97907	-
7/32	1/4	5/8	2-1/2	30348	30355
15/64	1/4	3/4	2-1/2	30510	-
1/4	1/4	1/2	2	39154	30563
		3/4	2-1/2	30553	30994
		1-1/8	3	36645	30387
		1-1/2	4	34035	90082
5/16	5/16	13/16	2-1/2	30557	30562
		1-1/8	3	36640	20561
		1-5/8	4	34036	-
3/8	3/8	1	2-1/2	30556	30995
		1-1/8	3	36646	30390
		1-3/4	4	34037	31293
1/2	1/2	1	3	30552	97921
		2	4	36647	30392
		3	6	34039	-
5/8	5/8	1-1/4	3-1/2	30532	-
		2-1/4	5	36648	-
3/4	3/4	1-1/2	4	30700	-
		2-1/4	5	36649	-

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code BN
1	3	2	38	62288	-
		3	38	99079	99080
1.5	3	4,5	38	62455	62459
		6	38	37980	62579
2	3	6,3	38	99081	99082
		9	38	37981	62580
2.5	3	9,5	38	37982	-
3	3	12	38	32601	32600
		19	57	62194	62625
		25	75	62182	62649
4	4	14	50	99357	32602
		19	63	62195	62626
		31	75	62183	62650
5	5	16	50	32604	99083
		19	63	62196	62627
		31	75	32610	-
6	6	13	57	36758	-
		19	63	37984	62584
		29	75	62197	62628
		38	100	62185	62652
8	8	20	63	31492	99085
		29	75	62198	62629
		41	100	62186	-
10	10	25	72	99358	62587
		40	88	37174	37504
		45	100	62187	-
12	12	25	75	99359	99356
		26	83	36764	-
		50	100	62200	62631
		75	150	62188	-

TOOL RENEWAL SERVICES

Resharpen. Restore. Recharge.

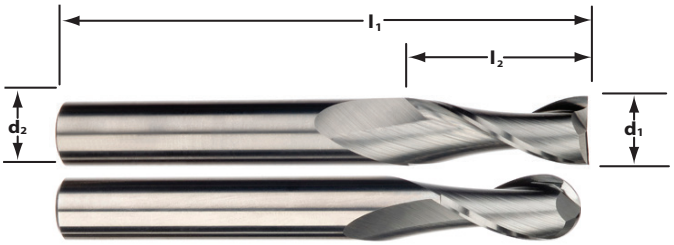
Get the most out of your tooling investment by utilizing IMCO's reconditioning services. Reconditioning is a cost-effective way to increase the life span and value of your IMCO end mills.

- No quantity limit
- 2- to 3-week turnaround upon order confirmation (coating included) on most tools
- Original coating put back on all IMCO end mills

Contact us with questions or for a quote for our resharpening services at regrinds@imcousa.com. You can also find our order form on our website at imcousa.com/resources/catalog.

E12 UNCOATED truCORE

For general machining in a wide range of materials. The E12 offers the maximum flute spacing in a general-purpose tool design. Best for roughing, slotting, and pocketing in materials and in applications in which chip evacuation is a challenge.



in: *d1: +0.000 / -0.002 d2: -0.0001 / -0.0004*
mm: *d1: +0.000 / -0.050 d2: -0.0025 / -0.0100*

P M N

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code BN
1/32	1/8	3/32	1-1/2	30601	30801
3/64	1/8	9/64	1-1/2	30603	30803
1/16	1/8	3/16	1-1/2	30605	30805
5/64	1/8	1/4	1-1/2	30607	30807
3/32	1/8	3/8	1-1/2	30609	30809
7/64	1/8	3/8	1-1/2	30611	30811
1/8	1/8	1/4	1-1/2	31407	31607
		1/2	1-1/2	30613	30813
		3/4	2-1/4	37608	37808
		1	3	34008	34208
5/32	3/16	9/16	2	30617	30817
3/16	3/16	3/8	2	31411	-
		5/8	2	30621	30821
		3/4	2-1/2	37612	37812
		1-1/8	3	34012	34212
1/4	1/4	1/2	2	31415	-
		3/4	2-1/2	30629	30829
		1-1/8	3	37616	37816
		1-1/2	4	34016	34216
		1-1/2	6	31063	31263
5/16	5/16	1/2	2	31417	-
		13/16	2-1/2	30637	30837
		1-1/8	3	37620	37820
		1-5/8	4	34020	-
3/8	3/8	1	2-1/2	30645	30845
		1-1/8	3	37624	37824
		1-1/2	6	31035	31235
		1-3/4	4	34024	34224
1/2	1/2	1	3	30661	30861
		1-1/2	6	31047	31247
		2	4	37632	37832
		3	6	34032	-
5/8	5/8	1-1/4	3-1/2	30665	-
		2-1/4	5	37640	-
3/4	3/4	1-1/2	4	30669	-
		2-1/4	5	37648	-

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ	Order Code BN
1	3	3	38	31431	32551
1.5	3	6	38	38602	38611
2	3	9	38	38603	38612
2.5	3	9,5	38	31434	-
3	3	12	38	31435	32555
		19	57	30153	39114
		25	75	30001	32365
4	4	14	50	31437	32557
		19	63	30155	39115
		31	75	30004	32368
5	5	16	50	31439	32559
		19	63	30156	39116
		31	100	30231	39123
6	6	19	63	31440	32560
		29	75	30010	32374
		38	100	30234	39125
8	8	20	63	31442	32562
		29	75	30013	32377
		41	100	30235	-
10	10	25	72	31444	32564
		40	88	30223	39469
		45	100	30016	-
12	12	25	75	31445	32565
		50	100	30019	32383
		75	150	30022	-

TOOL TIP

Tip for Small-Diameter End Mills.

When using small-diameter end mills, it is not uncommon to have less spindle speed on a machine than what is suggested in the speed and feed chart. When dealing with this condition, it is important to remember to maintain the suggested "load" on the tool – don't decrease the chip load shown in the chart to equal the lower spindle speed.

- Run the maximum RPM that the machine will safely allow.
- Use the suggested chip load from the speed and feed chart.
- Maintain the suggested axial and radial tool engagements.

This combination will ensure the best tool life and proper finish.

E Series Application Guide – Speed & Feed (inch)

ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	Number of Flutes	Speed (SFM)			Feed (Inches Per Tooth)									
						Uncoated	TiCN	AlTiN	1/16	1/8	3/16	1/4	5/16	3/8	1/2	5/8	3/4	1
K	Cast Iron - Gray	Slotting	.5 x D	1 x D	4	--	350	350	.00032	.0006	.0010	.0013	.0016	.0019	.0026	.0032	.0038	.0051
		Peripheral - Rough	1 x D	.5 x D	4	--	400	400	.00040	.0008	.0012	.0016	.0020	.0024	.0032	.0040	.0048	.0064
		Peripheral - Finish	1.5 x D	.01 x D	4	--	450	450	.00046	.0009	.0014	.0018	.0023	.0027	.0036	.0046	.0055	.0073
	Cast Iron - Ductile	Slotting	.5 x D	1 x D	4	--	250	250	.00030	.0006	.0009	.0012	.0015	.0018	.0024	.0030	.0036	.0048
		Peripheral - Rough	1 x D	.5 x D	4	--	275	275	.00038	.0008	.0011	.0015	.0019	.0023	.0030	.0038	.0045	.0060
		Peripheral - Finish	1.5 x D	.01 x D	4	--	325	325	.00042	.0008	.0013	.0017	.0021	.0025	.0034	.0042	.0051	.0068
P	Low Carbon Steels 1018, 12L14, 8620	Slotting	.5 x D	1 x D	4	250	275	300	.00030	.0006	.0009	.0012	.0015	.0018	.0024	.0030	.0036	.0048
		Slotting	.5 x D	1 x D	3	250	275	300	.00030	.0006	.0009	.0012	.0015	.0018	.0024	.0030	.0036	.0048
		Peripheral - Rough	1 x D	.5 x D	4	275	300	325	.00038	.0008	.0011	.0015	.0019	.0023	.0030	.0038	.0045	.0060
		Peripheral - Rough	1 x D	.5 x D	3	275	300	325	.00038	.0008	.0011	.0015	.0019	.0023	.0030	.0038	.0045	.0060
		Finish	1.5 x D	.01 x D	4	300	325	350	.00047	.0009	.0014	.0019	.0024	.0028	.0038	.0047	.0057	.0075
	Medium Carbon Steels 4140, 4340	Slotting	.5 x D	1 x D	4	225	250	275	.00027	.0005	.0008	.0011	.0014	.0016	.0022	.0027	.0032	.0043
		Peripheral - Rough	1 x D	.5 x D	4	250	275	300	.00034	.0007	.0010	.0014	.0017	.0020	.0027	.0034	.0041	.0054
		Finish	1.5 x D	.01 x D	4	275	300	325	.00042	.0008	.0013	.0017	.0021	.0025	.0034	.0042	.0051	.0068
	Tool & Die Steels ≤ 48 HRC A2, D2, H13, P20	Slotting	.5 x D	1 x D	4	225	250	275	.00025	.0005	.0008	.0010	.0013	.0015	.0020	.0025	.0030	.0040
		Peripheral - Rough	1 x D	.5 x D	4	250	275	300	.00031	.0006	.0009	.0013	.0016	.0019	.0025	.0031	.0038	.0050
		Finish	1.5 x D	.01 x D	4	275	300	325	.00039	.0008	.0012	.0016	.0020	.0024	.0031	.0039	.0047	.0063
H	Hardened Steels 49 HRC to 58 HRC	Slotting	.25 x D	1 x D	4	60	75	225	.00014	.0003	.0004	.0006	.0007	.0008	.0011	.0014	.0017	.0022
		Peripheral - Rough	1 x D	.25 x D	4	80	100	250	.00017	.0003	.0005	.0007	.0009	.0010	.0014	.0017	.0021	.0028
		Finish	1.5 x D	.01 x D	4	100	125	275	.00019	.0004	.0006	.0008	.0009	.0011	.0015	.0019	.0023	.0030
M	Martensitic Stainless Steels 416, 410, 440C	Slotting	.5 x D	1 x D	4	--	250	250	.00020	.0004	.0006	.0008	.0010	.0012	.0016	.0020	.0024	.0032
		Peripheral - Rough	1 x D	.5 x D	4	--	275	275	.00025	.0005	.0008	.0010	.0013	.0015	.0020	.0025	.0030	.0040
		Finish	1.5 x D	.01 x D	4	--	325	325	.00031	.0006	.0009	.0013	.0016	.0019	.0025	.0031	.0038	.0050
	Austenitic Stainless Steels 303, 304, 316	Slotting	.5 x D	1 x D	4	200	225	250	.00020	.0004	.0006	.0008	.0010	.0012	.0016	.0020	.0024	.0032
		Slotting	.5 x D	1 x D	3	200	225	250	.00020	.0004	.0006	.0008	.0010	.0012	.0016	.0020	.0024	.0032
		Peripheral - Rough	1 x D	.5 x D	4	250	275	300	.00025	.0005	.0008	.0010	.0013	.0015	.0020	.0025	.0030	.0040
		Peripheral - Rough	1 x D	.5 x D	3	250	275	300	.00025	.0005	.0008	.0010	.0013	.0015	.0020	.0025	.0030	.0040
		Finish	1.5 x D	.01 x D	4	300	325	350	.00031	.0006	.0009	.0013	.0016	.0019	.0025	.0031	.0038	.0050
	Precipition Hardening Stainless Steels 17-4 PH, 15-5 PH	Slotting	.25 x D	1 x D	4	175	200	225	.00020	.0004	.0006	.0008	.0010	.0012	.0016	.0020	.0024	.0031
		Peripheral - Rough	1 x D	.25 x D	4	200	225	250	.00025	.0005	.0007	.0010	.0012	.0015	.0020	.0025	.0029	.0039
		Finish	1.5 x D	.01 x D	4	225	250	275	.00027	.0005	.0008	.0011	.0013	.0016	.0021	.0027	.0032	.0043
S	Titanium Alloys	Slotting	.25 x D	1 x D	4	175	200	225	.00020	.0004	.0006	.0008	.0010	.0012	.0016	.0020	.0024	.0031
		Peripheral - Rough	1 x D	.25 x D	4	200	225	250	.00025	.0005	.0007	.0010	.0012	.0015	.0020	.0025	.0029	.0039
		Finish	1.5 x D	.01 x D	4	225	250	275	.00027	.0005	.0008	.0011	.0013	.0016	.0021	.0027	.0032	.0043
	High Temperature Alloys Inconel, Haynes, Stellite, Hastalloy	Slotting	.25 x D	1 x D	4	35	40	45	.00017	.0003	.0005	.0007	.0009	.0010	.0014	.0017	.0021	.0028
		Peripheral - Rough	1 x D	.25 x D	4	45	50	60	.00022	.0004	.0006	.0009	.0011	.0013	.0017	.0022	.0026	.0035
		Finish	1.5 x D	.01 x D	4	55	55	65	.00024	.0005	.0007	.0009	.0012	.0014	.0019	.0024	.0028	.0038
N	Aluminum Alloys 2024, 6061, 7075	Slotting	.5 x D	1 x D	2	350	550	--	.00038	.0008	.0011	.0015	.0019	.0023	.0030	.0038	.0046	.0061
		Peripheral - Rough	1 x D	.5 x D	2	450	650	--	.00048	.0010	.0014	.0019	.0024	.0029	.0038	.0048	.0057	.0076
		Peripheral - Finish	1.5 x D	.01 x D	3	550	--	--	.00053	.0011	.0016	.0021	.0027	.0032	.0043	.0053	.0064	.0085
	Copper Alloys Brass & Bronze	Slotting	.5 x D	1 x D	2	275	350	350	.00040	.0008	.0012	.0016	.0020	.0024	.0032	.0040	.0048	.0064
		Peripheral - Rough	1 x D	.5 x D	2	300	400	400	.00050	.0010	.0015	.0020	.0025	.0030	.0040	.0050	.0060	.0080
		Peripheral - Rough	1 x D	.5 x D	3	300	--	400	.00045	.0009	.0014	.0018	.0023	.0027	.0036	.0045	.0054	.0072
		Peripheral - Finish	1.5 x D	.01 x D	2	350	450	450	.00063	.0013	.0019	.0025	.0031	.0038	.0050	.0063	.0075	.0101
		Peripheral - Finish	1.5 x D	.01 x D	3	350	--	450	.00057	.0011	.0017	.0023	.0028	.0034	.0045	.0057	.0068	.0090
	Composites, Plastics	Slotting	.5 x D	1 x D	4	300	350	350	.00040	.0008	.0012	.0016	.0020	.0024	.0032	.0040	.0048	.0064
		Peripheral - Rough	1 x D	.5 x D	4	375	450	450	.00050	.0010	.0015	.0020	.0025	.0030	.0040	.0050	.0060	.0080
		Peripheral - Finish	1.5 x D	.01 x D	4	450	650	650	.00057	.0011	.0017	.0023	.0028	.0034	.0045	.0057	.0068	.0090
	Magnesium Alloys	Slotting	.5 x D	1 x D	2	350	550	550	.00040	.0008	.0012	.0016	.0020	.0024	.0032	.0040	.0048	.0064
		Peripheral - Rough	1 x D	.5 x D	2	450	650	650	.00050	.0010	.0015	.0020	.0025	.0030	.0040	.0050	.0060	.0080
		Peripheral - Finish	1.5 x D	.01 x D	2	550	750	750	.00057	.0011	.0017	.0023	.0028	.0034	.0045	.0057	.0068	.0090
	Graphite	Slotting	.5 x D	1 x D	4	350	400	450	.00045	.0009	.0014	.0018	.0023	.0027	.0036	.0045	.0054	.0072
		Peripheral - Rough	1 x D	.5 x D	4	425	475	525	.00056	.0011	.0017	.0023	.0028	.0034	.0045	.0056	.0068	.0090
		Peripheral - Finish	1.5 x D	.01 x D	4	500	550	600	.00063	.0013	.0019	.0025	.0031	.0038	.0050	.0063	.0075	.0101

D = Tool Diameter

Information on tips and adjustments can be found in our Technical Resources section beginning on page 129.

ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	Number of Flutes	Speed (M/min) Uncoated	TiCN	AlTiN	Feed (MM per Tooth) 3.0	4.0	5.0	6.0	8.0	10.0	12.0	14.0	16.0	20.0
K	Cast Iron - Gray	Slotting	.5 x D	1 x D	4	--	107	107	.0154	.0205	.0256	.0307	.0410	.0512	.0614	.0717	.0768	.1026
		Peripheral - Rough	1 x D	.5 x D	4	--	122	122	.0192	.0256	.0320	.0384	.0512	.0640	.0768	.0896	.0960	.1282
		Peripheral - Finish	1.5 x D	.01 x D	4	--	137	137	.0219	.0291	.0364	.0437	.0583	.0729	.0874	.1020	.1093	.1460
	Cast Iron - Ductile	Slotting	.5 x D	1 x D	4	--	76	76	.0144	.0192	.0240	.0288	.0384	.0480	.0576	.0672	.0720	.0962
		Peripheral - Rough	1 x D	.5 x D	4	--	84	84	.0180	.0240	.0300	.0360	.0480	.0600	.0720	.0840	.0900	.1202
		Peripheral - Finish	1.5 x D	.01 x D	4	--	99	99	.0204	.0271	.0339	.0407	.0543	.0678	.0814	.0950	.1018	.1359
P	Low Carbon Steels 1018, 12L14, 8620	Slotting	.5 x D	1 x D	4	76	84	91	.0144	.0192	.0240	.0288	.0384	.0480	.0576	.0672	.0720	.0962
		Slotting	.5 x D	1 x D	3	76	84	91	.0144	.0192	.0240	.0288	.0384	.0480	.0576	.0672	.0720	.0962
		Peripheral - Rough	1 x D	.5 x D	4	84	91	99	.0180	.0240	.0300	.0360	.0480	.0600	.0720	.0840	.0900	.1202
		Peripheral - Rough	1 x D	.5 x D	3	84	91	99	.0180	.0240	.0300	.0360	.0480	.0600	.0720	.0840	.0900	.1202
		Finish	1.5 x D	.01 x D	4	91	99	107	.0226	.0301	.0377	.0452	.0603	.0754	.0904	.1055	.1131	.1510
	Medium Carbon Steels 4140, 4340	Slotting	.5 x D	1 x D	4	69	76	84	.0130	.0173	.0216	.0259	.0346	.0432	.0518	.0605	.0648	.0866
		Peripheral - Rough	1 x D	.5 x D	4	76	84	91	.0162	.0216	.0270	.0324	.0432	.0540	.0648	.0756	.0810	.1082
		Finish	1.5 x D	.01 x D	4	84	91	99	.0204	.0271	.0339	.0407	.0543	.0678	.0814	.0950	.1018	.1359
	Tool & Die Steels ≤ 48 HRC A2, D2, H13, P20	Slotting	.5 x D	1 x D	4	69	76	84	.0120	.0160	.0200	.0240	.0320	.0400	.0480	.0560	.0600	.0802
		Peripheral - Rough	1 x D	.5 x D	4	76	84	91	.0150	.0200	.0250	.0300	.0400	.0500	.0600	.0700	.0750	.1002
		Finish	1.5 x D	.01 x D	4	84	91	99	.0188	.0251	.0314	.0377	.0503	.0628	.0754	.0879	.0942	.1259
H	Hardened Steels 49 HRC to 58 HRC	Slotting	.25 x D	1 x D	4	18	23	69	.0067	.0089	.0111	.0133	.0177	.0222	.0266	.0310	.0333	.0444
		Peripheral - Rough	1 x D	.25 x D	4	24	30	76	.0083	.0111	.0139	.0166	.0222	.0277	.0333	.0388	.0416	.0555
		Finish	1.5 x D	.01 x D	4	30	38	84	.0090	.0121	.0151	.0181	.0241	.0301	.0362	.0422	.0452	.0604
M	Martensitic Stainless Steels 416, 410, 440C	Slotting	.5 x D	1 x D	4	--	76	76	.0096	.0128	.0160	.0192	.0256	.0320	.0384	.0448	.0480	.0641
		Peripheral - Rough	1 x D	.5 x D	4	--	84	84	.0120	.0160	.0200	.0240	.0320	.0400	.0480	.0560	.0600	.0802
		Finish	1.5 x D	.01 x D	4	--	99	99	.0151	.0201	.0251	.0301	.0402	.0502	.0603	.0703	.0754	.1007
	Austenitic Stainless Steels 303, 304, 316	Slotting	.5 x D	1 x D	4	61	69	76	.0096	.0128	.0160	.0192	.0256	.0320	.0384	.0448	.0480	.0641
		Slotting	.5 x D	1 x D	3	61	69	76	.0096	.0128	.0160	.0192	.0256	.0320	.0384	.0448	.0480	.0641
		Peripheral - Rough	1 x D	.5 x D	4	76	84	91	.0120	.0160	.0200	.0240	.0320	.0400	.0480	.0560	.0600	.0802
		Peripheral - Rough	1 x D	.5 x D	3	76	84	91	.0120	.0160	.0200	.0240	.0320	.0400	.0480	.0560	.0600	.0802
		Finish	1.5 x D	.01 x D	4	91	99	107	.0151	.0201	.0251	.0301	.0402	.0502	.0603	.0703	.0754	.1007
	Precipition Hardening Stainless Steels 17-4 PH, 15-5 PH	Slotting	.25 x D	1 x D	4	53	61	69	.0094	.0126	.0157	.0188	.0251	.0314	.0377	.0440	.0471	.0629
		Peripheral - Rough	1 x D	.25 x D	4	61	69	76	.0118	.0157	.0196	.0236	.0314	.0393	.0471	.0550	.0589	.0787
		Finish	1.5 x D	.01 x D	4	69	76	84	.0128	.0171	.0214	.0256	.0342	.0427	.0513	.0598	.0641	.0856
S	Titanium Alloys	Slotting	.25 x D	1 x D	4	53	61	69	.0094	.0126	.0157	.0188	.0251	.0314	.0377	.0440	.0471	.0629
		Peripheral - Rough	1 x D	.25 x D	4	61	69	76	.0118	.0157	.0196	.0236	.0314	.0393	.0471	.0550	.0589	.0787
		Finish	1.5 x D	.01 x D	4	69	76	84	.0128	.0171	.0214	.0256	.0342	.0427	.0513	.0598	.0641	.0856
	High Temperature Alloys Inconel, Haynes, Stellite, Hastalloy	Slotting	.25 x D	1 x D	4	11	12	14	.0083	.0111	.0139	.0166	.0222	.0277	.0333	.0388	.0416	.0555
		Peripheral - Rough	1 x D	.25 x D	4	14	15	18	.0104	.0139	.0173	.0208	.0277	.0346	.0416	.0485	.0520	.0694
		Finish	1.5 x D	.01 x D	4	17	17	20	.0113	.0151	.0188	.0226	.0302	.0377	.0452	.0528	.0565	.0755
N	Aluminum Alloys 2024, 6061, 7075	Slotting	.5 x D	1 x D	2	107	168	--	.0182	.0243	.0304	.0365	.0486	.0608	.0730	.0851	.0912	.1218
		Peripheral - Rough	1 x D	.5 x D	2	137	198	--	.0228	.0304	.0380	.0456	.0608	.0760	.0912	.1064	.1140	.1523
		Peripheral - Finish	1.5 x D	.01 x D	3	168	--	--	.0256	.0342	.0427	.0513	.0683	.0854	.1025	.1196	.1281	.1712
	Copper Alloys Brass & Bronze	Slotting	.5 x D	1 x D	2	84	107	107	.0192	.0256	.0320	.0384	.0512	.0640	.0768	.0896	.0960	.1282
		Peripheral - Rough	1 x D	.5 x D	2	91	122	122	.0240	.0320	.0400	.0480	.0640	.0800	.0960	.1120	.1200	.1603
		Peripheral - Rough	1 x D	.5 x D	3	91	--	122	.0216	.0288	.0360	.0432	.0576	.0720	.0864	.1008	.1080	.1443
		Peripheral - Finish	1.5 x D	.01 x D	2	107	137	137	.0301	.0402	.0502	.0603	.0804	.1005	.1206	.1407	.1507	.2014
		Peripheral - Finish	1.5 x D	.01 x D	3	107	--	137	.0271	.0362	.0452	.0543	.0724	.0904	.1085	.1266	.1357	.1813
	Composites, Plastics	Slotting	.5 x D	1 x D	4	91	107	107	.0192	.0256	.0320	.0384	.0512	.0640	.0768	.0896	.0960	.1282
		Peripheral - Rough	1 x D	.5 x D	4	114	137	137	.0240	.0320	.0400	.0480	.0640	.0800	.0960	.1120	.1200	.1603
		Peripheral - Finish	1.5 x D	.01 x D	4	137	198	198	.0271	.0362	.0452	.0543	.0724	.0904	.1085	.1266	.1357	.1813
	Magnesium Alloys	Slotting	.5 x D	1 x D	2	107	168	168	.0192	.0256	.0320	.0384	.0512	.0640	.0768	.0896	.0960	.1282
		Peripheral - Rough	1 x D	.5 x D	2	137	198	198	.0240	.0320	.0400	.0480	.0640	.0800	.0960	.1120	.1200	.1603
		Peripheral - Finish	1.5 x D	.01 x D	2	168	229	229	.0271	.0362	.0452	.0543	.0724	.0904	.1085	.1266	.1357	.1813
	Graphite	Slotting	.5 x D	1 x D	4	107	122	137	.0216	.0288	.0360	.0432	.0576	.0720	.0864	.1008	.1080	.1443
		Peripheral - Rough	1 x D	.5 x D	4	130	145	160	.0270	.0360	.0450	.0540	.0720	.0900	.1080	.1260	.1350	.1803
		Peripheral - Finish	1.5 x D	.01 x D	4	152	168	183	.0301	.0402	.0502	.0603	.0804	.1005	.1206	.1407	.1507	.2014

D = Tool Diameter

Information on tips and adjustments can be found in our Technical Resources section beginning on page 129.

M104 truCORE

For machining low carbon and tool steels under 40 HRC. The M104 Rougher/Finisher has a unique chipbreaker geometry that allows for high feed rates, excellent chip control and finishes superior to most 4-flute roughing end mills. The AlTiN coating offers superior heat resistance and hardness for increased tool life.

in: *d1: +0.000 / -0.002 d2: -0.0001 / -0.0004*

P M

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Order Code SQ
1/8	1/8	1/4	1-1/2	33290
		1/2	1-1/2	30423
3/16	3/16	3/8	2	33296
		5/8	2	30462
1/4	1/4	1/2	2	91779
		3/4	2-1/2	98991
		1-1/8	3	33299
5/16	5/16	1/2	2	33163
		13/16	2-1/2	30551
3/8	3/8	5/8	2	33103
		1	2-1/2	33153
		1-1/8	3	33300
1/2	1/2	5/8	2-1/2	33181
		1	3	98961
		2	4	30434
5/8	5/8	1-1/4	3-1/2	33157
		2-1/4	5	97343
3/4	3/4	1	3	33297
		1-1/2	4	33159
		2-1/4	5	33301
1	1	1-1/2	4	33161
		2-1/4	5	33302

M104 Application Guide – Speed & Feed (inch)

ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	Number of Flutes	Speed (SFM)	Feed (Inch per Tooth) 1/8	3/16	1/4	5/16	3/8	1/2	5/8	3/4	1
P	Low Carbon Steels 1018, 12L14, 8620	Slotting	1 x D	1 x D	4	350	.0015	.0009	.0012	.0015	.0018	.0024	.0030	.0036	.0048
		Peripheral -Rough	≤ 2 x D	.4 x D	4	425	.0008	.0011	.0015	.0019	.0023	.0030	.0038	.0045	.0060
		Peripheral -Rough	> 2 - 3 x D	.4 x D	4	400	.0007	.0011	.0014	.0018	.0021	.0028	.0035	.0042	.0056
		Peripheral -Rough	> 3 - 4 x D	.35 x D	4	385	.0007	.0010	.0013	.0016	.0020	.0026	.0033	.0039	.0052
		*Helical Ramp Angle	1 - 2 deg.	1 x D	4	350	.0005	.0007	.0010	.0012	.0014	.0019	.0024	.0029	.0038
	Medium Carbon Steels <38 HRc 4140, 4340	Slotting	.75 x D	1 x D	4	275	.0011	.0009	.0012	.0014	.0017	.0023	.0029	.0035	.0046
		Peripheral -Rough	≤ 2 x D	.4 x D	4	350	.0007	.0011	.0015	.0018	.0022	.0029	.0036	.0044	.0058
		Peripheral -Rough	> 2 - 3 x D	.4 x D	4	335	.0007	.0010	.0014	.0017	.0020	.0027	.0034	.0041	.0054
		Peripheral -Rough	> 3 - 4 x D	.35 x D	4	315	.0006	.0009	.0013	.0016	.0019	.0025	.0031	.0038	.0050
		*Helical Ramp Angle	1 - 2 deg.	1 x D	4	275	.0005	.0007	.0009	.0012	.0014	.0018	.0023	.0028	.0037
	Tool & Die Steels < 38 HRc A2, D2, H13, P20	Slotting	1 x D	1 x D	4	275	.0006	.0009	.0012	.0015	.0018	.0024	.0030	.0036	.0048
		Peripheral -Rough	≤ 2 x D	.3 x D	4	350	.0007	.0011	.0015	.0018	.0022	.0029	.0036	.0044	.0058
		Peripheral -Rough	> 2 - 3 x D	.3 x D	4	335	.0007	.0010	.0014	.0017	.0020	.0027	.0034	.0041	.0054
		Peripheral -Rough	> 3 - 4 x D	.25 x D	4	315	.0006	.0009	.0013	.0016	.0019	.0025	.0031	.0038	.0050
		*Helical Ramp Angle	1 - 2 deg.	1 x D	4	275	.0005	.0007	.0010	.0012	.0014	.0019	.0024	.0029	.0038
M	Martensitic Stainless Steels 416, 410, 440C	Slotting	.75 x D	1 x D	4	250	.0005	.0008	.0011	.0013	.0016	.0021	.0026	.0032	.0042
		Peripheral -Rough	≤ 2 x D	.3 x D	4	300	.0007	.0010	.0013	.0016	.0020	.0026	.0033	.0039	.0052
		Peripheral -Rough	> 2 - 3 x D	.3 x D	4	285	.0006	.0009	.0013	.0016	.0019	.0025	.0031	.0038	.0050
		Peripheral -Rough	> 3 - 4 x D	.25 x D	4	270	.0006	.0009	.0012	.0014	.0017	.0023	.0029	.0035	.0046
		*Helical Ramp Angle	1 - 2 deg.	1 x D	4	250	.0004	.0006	.0008	.0011	.0013	.0017	.0021	.0025	.0034

≈ Approximately Equals × Multiply > Greater Than
≤ Less Than or Equal To < Less Than = Equals
≥ Greater Than or Equal To

E520B truCORE

For contouring in carbon and tool steels. The E520B is designed for contouring applications in pre-hard and hardened steels. Added length and necked shank provide for stability when machining in deeper cavities. The AlTiN coating offers superior heat resistance and hardness for increased tool life.

in: *d1: +0.000 / -0.002 d2: -0.0001 / -0.0004*

P H

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Reach LBS l3	Overall Length l1	Order Code BN
1/8	1/4	1/8	3/8	3	34288
3/16	1/4	3/16	9/16	3	34289
1/4	1/4	1/4	1-5/8	3	34290
3/8	3/8	3/8	2-1/4	4	34292
1/2	1/2	1/2	2-1/4	4	34293

E520B Application Guide – Speed & Feed (inch)

ISO Code	Work Material Hardness	Type of Cut	Axial DOC	Radial DOC	No. of Flutes	Speed (SFM)	Feed (Inches per Tooth) 1/8	1/4	3/8	1/2
P	≤ 48 HRC	Rough	.2 x D	.2 x D	2	400	.0013	.0025	.0038	.0050
		Finish	.02 x D	.02 x D	2	275	.0015	.0030	.0045	.0060
H	49 to 57 HRC	Rough	.2 x D	.2 x D	2	375	.0008	.0017	.0025	.0033
		Finish	.02 x D	.02 x D	2	250	.0010	.0020	.0030	.0040
	58 to 62 HRC	Rough	.1 x D	.1 x D	2	250	.0007	.0014	.0021	.0028
		Finish	.01 x D	.01 x D	2	150	.0005	.0011	.0016	.0021

≈ Approximately Equals
≤ Less Than or Equal To
≥ Greater Than or Equal To
× Multiply
< Less Than
> Greater Than
= Equals

Common Machining Formulas

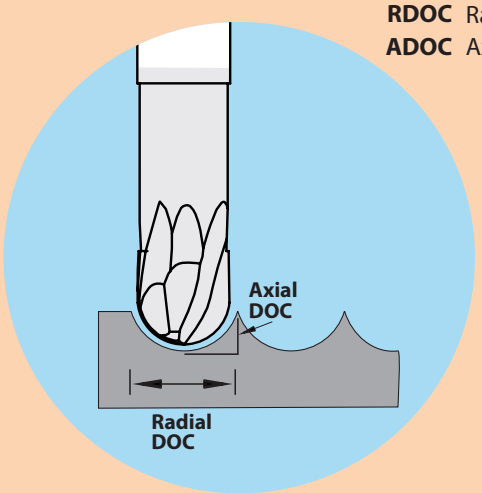
$$RPM = \frac{SFM \times 3.82}{D}$$

SFM = RPM x D x .262

IPM = RPM x IPT x Z

MRR = RDOC x ADOC x IPM

D Tool Cutting Diameter
Z Number of Flutes
RPM Revolutions per Minute
SFM Surface Feet per Minute
IPM Inches per Minute
MRR Metal Removal Rate
RDOC Radial Depth of Cut
ADOC Axial Depth of Cut



Technical Resources

Information on tips and adjustments for the following milling operations can be found in our Technical Resources section beginning on page 129.

- HEM slotting
- Face milling
- Helical entry ramping
- Straight line ramping
- Long tool projection adjustments
- Ball nose milling adjustments
- Other helpful tips and calculations

TECH SUPPORT

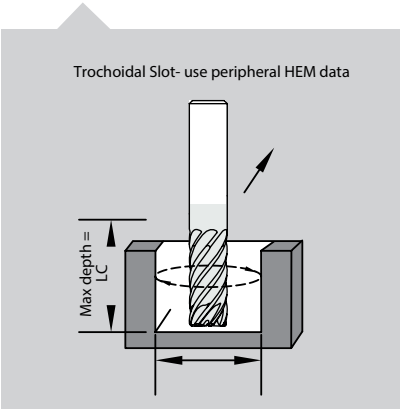
Use the guidelines shown in this section when machining a variety of tool paths. When necessary, adjustments refer back to the specific end mill speed and feed charts as listed throughout the catalog and can be found on the following pages:

HEM SLOTTING GUIDES

The width of the desired slot will determine the number of flutes and end mill diameter that should be selected. The following guide shows the minimum slot width for each series of end mill.

Tool	Minimum Slot Width	Maximum Slot Depth
IPT/C 7	2 x end mill diameter	Full length of cut
IPT/C 9	2 x end mill diameter	Full length of cut
IPT/C 11	2.25 x end mill diameter	Full length of cut
IPT/C 13	2.5 x end mill diameter	Full length of cut
APT/C 5	1.75 x end mill diameter	Full length of cut
M525/C	1.75 x end mill diameter	.8 x length of cut
M527/C	2 x end mill diameter	.8 x length of cut

Speed and feed parameters for HEM slotting can be found marked as "Peripheral-HEM" for POW•R•PATH and as "HEM" for enDURO tools in the speed and feed charts for those series.

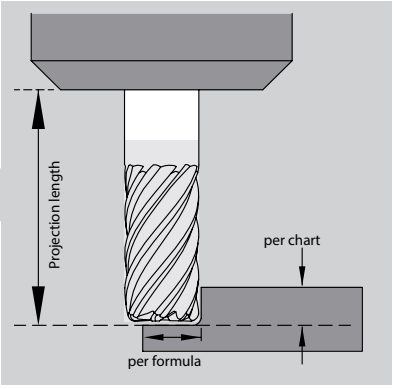


FACING

When facing, an end mill with a corner radius is suggested for the best finish. Apply the adjustments below to the Peripheral Rough values from the application guide for the end mill being used.

RDOC Formula

Step-over = (D - (2 x corner radius)) x .75



	Non-IP End Mills					
	Rough Facing			Finish Facing		
Projection Length	SFM or M/min	IPT or mm/tooth	ADOC	SFM or M/min	IPT or mm/tooth	ADOC
0 to 3 x D	1.2 x chart value	.85 x chart value	.25 x D Maximum	1.2 x chart value	.75 x chart value	.07 x D Maximum
> 3 to 4 x D	1.1 x chart value	.75 x chart value	.25 x D Maximum	1.1 x chart value	.65 x chart value	.07 x D Maximum
> 4 to 5 x D	1.0 x chart value	.65 x chart value	.25 x D Maximum	1.0 x chart value	.55 x chart value	.06 x D Maximum
> 5 to 6 x D	.9 x chart value	.55 x chart value	.25 x D Maximum	.9 x chart value	.45 x chart value	.05 x D Maximum

	IP End Mills					
	Rough Facing			Finish Facing		
Projection Length	SFM or M/min	IPT or mm/tooth	ADOC	SFM or M/min	IPT or mm/tooth	ADOC
0 to 3 x D	1.0 x chart value	.40 x chart value	.25 x D Maximum	1.0 x chart value	.70 x chart value	.07 x D Maximum
> 3 to 4 x D	1.0 x chart value	.40 x chart value	.25 x D Maximum	1.0 x chart value	.70 x chart value	.07 x D Maximum
> 4 to 5 x D	1.0 x chart value	.40 x chart value	.20 x D Maximum	1.0 x chart value	.70 x chart value	.05 x D Maximum
> 5 to 6 x D	1.0 x chart value	.40 x chart value	.20 x D Maximum	1.0 x chart value	.70 x chart value	.05 x D Maximum

D = Tool Diameter

HELICAL RAMP TO CREATE AN ENTRY HOLE

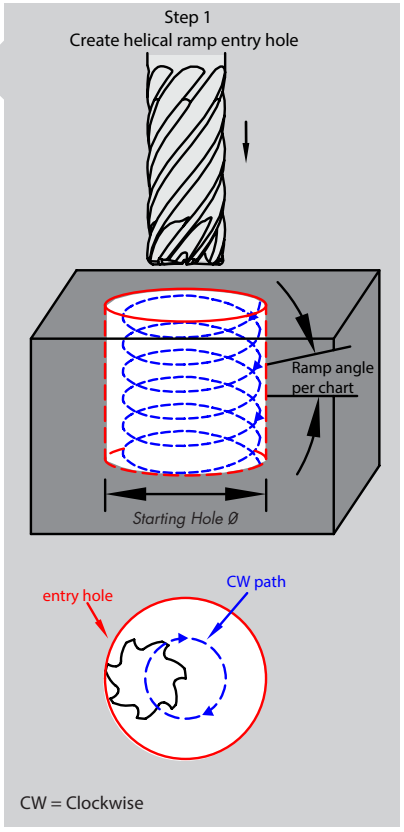
Using a helical ramp move to generate an entry hole is a preferred method to enter the middle of a part. The creation of the entry hole can be either a one-step or a two-step process depending on the number of flutes on the end mill. Tools with seven or fewer flutes only require one step; tools with more than seven flutes require two steps.

Step 1: Create helical ramp entry hole

The diameter of the starting hole will be: *(tool diameter x 2) - (corner radius x 2)*

Use the following guide for speed, feed and ramp angle parameters. Note that the terms "Same as chart," "Slotting speed in chart," "Slotting feed in chart," and IPT and MMPT reference the data that is shown in the speed and feed charts located in each tool series section.

Tool	Speed	Feed Adjustment – with high-pressure coolant	Feed Adjustment – with standard flood coolant	Ramp Angle
IPT/C 7	Same as chart	IPT or MMPT x 1.6	IPT or MMPT x 1.25	0.5°
IPT/C 9	Same as chart	IPT or MMPT x 1.6	IPT or MMPT x 1.25	0.5°
IPT/C 11	Same as chart	IPT or MMPT x 1.6	IPT or MMPT x 1.25	0.5°
IPT/C 13	Same as chart	IPT or MMPT x 1.6	IPT or MMPT x 1.25	0.5°
APT/C 5	Same as chart	IPT or MMPT x 1.6	IPT or MMPT x 1.25	3°
M525	Slotting speed in chart	Slotting feed in chart	Slotting feed in chart	1° - 2.5°
M527	Slotting speed in chart	Slotting feed in chart	Slotting feed in chart	1° - 2.5°
M503	Slotting speed in chart	Slotting feed in chart	Slotting feed in chart	1° - 2.5°
M726	Slotting speed in chart	Slotting feed in chart	Slotting feed in chart	1° - 2.5°
M706	Slotting speed in chart	Slotting feed in chart	Slotting feed in chart	1° - 2.5°
M806	Slotting speed in chart	Slotting feed in chart	Slotting feed in chart	1° - 2.5°
M924	Slotting speed in chart	Slotting feed in chart	Slotting feed in chart	1° - 2.5°
M904	Slotting speed in chart	Slotting feed in chart	Slotting feed in chart	1° - 2.5°
M905	Slotting speed in chart	Slotting feed in chart	Slotting feed in chart	1° - 2.5°
M223	Slotting speed in chart	Slotting feed in chart	Slotting feed in chart	3° - 5°
M233	Slotting speed in chart	Slotting feed in chart	Slotting feed in chart	3° - 5°
M203	Slotting speed in chart	Slotting feed in chart	Slotting feed in chart	3° - 5°
M202	Slotting speed in chart	Slotting feed in chart	Slotting feed in chart	3° - 5°
E14	Slotting speed in chart	Slotting feed in chart	Slotting feed in chart	1° - 2.5°
E13	Slotting speed in chart	Slotting feed in chart	Slotting feed in chart	1° - 2.5°
E12	Slotting speed in chart	Slotting feed in chart	Slotting feed in chart	1° - 2.5°
M104	Slotting speed in chart	Slotting feed in chart	Slotting feed in chart	1° - 2.5°



IPT = Inch per tooth from the speed and feed charts
MMPT = Millimeter per tooth from the speed and feed charts
Speed = Surface feet per minute (SFM) or meters per min (M/Min)

Step 2: There are two common methods to open up the starter hole.

METHOD A – Expand the entry hole from inside out.

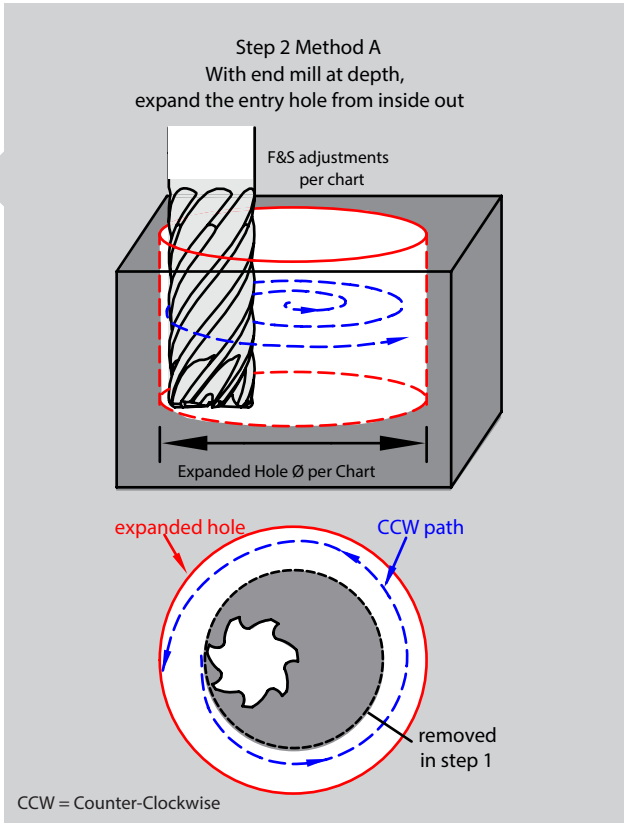
7-, 9-, 11- and 13-flute tools

After reaching the desired entry hole depth in Step 1, and with the end mill still at depth, expand the hole outwards using the feed rate adjustment found in the chart below. Continue until the entry hole is enlarged to the expanded diameter shown below.

Tool	Expanded Hole Ø	Feed Rate Adjustment	Step-Over Adjustment
IPT/C 7,9	3 x D	IPT or MMPT x .75	RDOC x .5
IPT/C 11	3.75 x D	IPT or MMPT x .75	RDOC x .5
IPT/C 13	3.75 x D	IPT or MMPT x .75	RDOC x .5

D = Tool Diameter

Once the expanded entry hole diameter is achieved, climb cut machining can begin at 100% of the Peripheral-HEM values in the feed and speed chart for the tool series you're using.



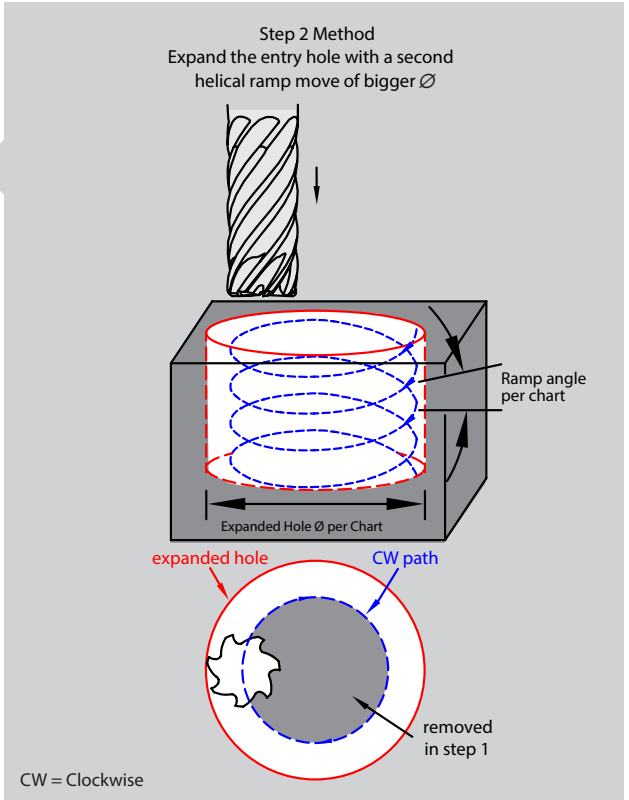
METHOD B – Expand the entry hole with a second helical ramp move.

Method B will expand the entry hole by doing a second helical ramp entry hole of a larger diameter than in Step 1. After completing Step 1, retract the end from the hole, and machine the second helical ramp entry hole using the same speed, feed and location as the first hole.

Tool	Expanded Hole Ø	Feed Rate Adjustment	Ramp Angle
IPT/C 9	3 x D	IPT or MMPT x 1.6	0.5°
IPT/C 11	3.75 x D	IPT or MMPT x 1.6	0.5°
IPT/C 13	3.75 x D	IPT or MMPT x 1.6	0.5°

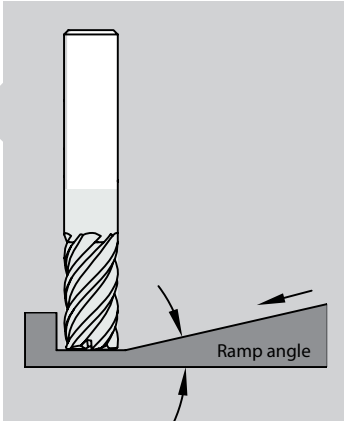
D = Tool Diameter

Once the expanded entry hole diameter is achieved, climb cut machining can begin at 100% of the Peripheral-HEM values in the feed and speed chart for the tool series you're using.



STRAIGHT-LINE RAMP ADJUSTMENTS

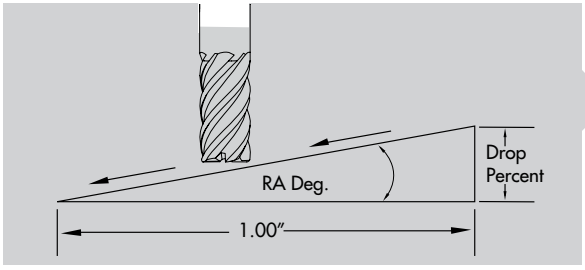
Straight-line ramp moves are an alternative method to enter the middle of a part. The following guide shows speed, feed and ramp angle data for different IMCO end mills.



Use the following guide for speed, feed and ramp angle parameters. Note that the terms "Same as chart," "Slotting speed in chart," and "Slotting IPT/MMPT," and "Helical ramp" (M223 and M233) reference the data shown in the speed and feed charts located in each tool series section. Not all tools are designed to allow the chip clearance required for straight-line ramping, as indicated in the guide.

Tool	Max Ramp Angle	SFM / MMPM	Feed	Max Ramp Depth	Max Ramp Length
IPT/C 7	Not recommended	-	-	-	-
IPT/C 9	Not recommended	-	-	-	-
IPT/C 11	Not recommended	-	-	-	-
IPT/C 13	Not recommended	-	-	-	-
APT/C 5	10°	Slotting speed	Slotting IPT or MMPT x .65	75% of D	(.75 x D) / drop per inch or mm
M525	2.5°	Slotting speed	Slotting IPT or MMPT x .75	50% of D	(.5 x D) / drop per inch or mm
M527	2.5°	Slotting speed	Slotting IPT or MMPT x .75	50% of D	(.5 x D) / drop per inch or mm
M503	2.5°	Slotting speed	Slotting IPT x .75	50% of D	(.5 xD) / drop per inch
M726	Not recommended	-	-	-	-
M706	Not recommended	-	-	-	-
M806	Not recommended	-	-	-	-
M924	2.5°	Slotting speed	Slotting IPT or MMPT x .75	50% of D	(.5 x D) / drop per inch or mm
M904	2.5°	Slotting speed	Slotting IPT x .75	50% of D	(.5 xD) / drop per inch
M905	2.5°	Slotting speed	Slotting IPT x .75	50% of D	(.5 x D) / drop per inch
M223	Helical ramp x 5	Same as chart	Same as chart	100% of D	(.75 x D) / drop per inch or mm
M233	Helical ramp x 5	Same as chart	Same as chart	100% of D	(.75 x D) / drop per inch or mm
M203	15°	Slotting speed	Slotting IPT or MMPT x .70	50% of D	(.5 x D) / drop per inch or mm
M202	15°	Slotting speed	Slotting IPT or MMPT x .70	50% of D	(.5 x D) / drop per inch or mm
E14	2.5°	Slotting speed	Slotting IPT or MMPT x .75	50% of D	(.5 x D) / drop per inch or mm
E13	2.5°	Slotting speed	Slotting IPT or MMPTx .75	50% of D	(.5 x D) / drop per inch or mm
E12	2.5°	Slotting speed	Slotting IPT or MMPT x .75	50% of D	(.5 x D) / drop per inch or mm
M104	2.5°	Slotting speed	Slotting IPT x .75	50% of D	(.5 x D) / drop per inch

D = Tool Diameter



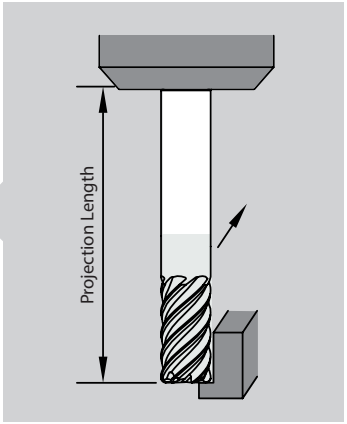
Use this guide ▶ to determine the maximum ramp length.

Ramp Angle	Drop (per inch)	Drop (per mm)
0.5°	0.0088	0.224
1°	0.0175	0.445
2°	0.0375	0.953
2.5°	0.0438	1.113
3°	0.0525	1.334
5°	0.0875	2.223
10°	0.1750	4.445
15°	0.2625	6.668

ADJUSTMENTS FOR LONG REACH APPLICATIONS

Using long-length tools increases the amount of tool projection from the tool holder and the spindle. As the tool projection increases so does the amount of tool deflection. Tool deflection causes chatter, resulting in poor surface finish and reduced tool life. Tool options that help minimize tool deflection in long projection applications are:

- Use a larger diameter tool for the operation. Larger tools have larger cores, which reduces deflection.
- Use a tool with a necked shank, which shortens the flute length and increases the core strength of the end mill.



Speed and feed adjustments for long tool projections:

Adjustments must be made to reduce chatter and maximize tool life when using long length tools. The adjustments below are based on the total amount of tool projection and use the speed and feed data found in the application charts for each tool series.

Projection	SFM / MMPM	Feed
> 1.25 to 3 x D	SFM or M/min x .95	IPT or MMPT x .95
> 3 to 4 x D	SFM or M/min x .90	IPT or MMPT x .90
> 4 to 5 x D	SFM or MMPM x .80	IPT or MMPT x .80
> 5 to 6 x D	SFM or MMPM x .70	IPT or MMPT x .70

D = Tool diameter
IPT = Inch per tooth
MMPT = Millimeter per tooth
SFM = Surface feet per minute
MPM = Millimeters per minute

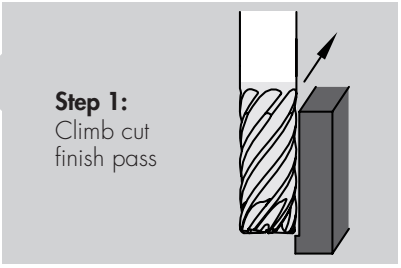
IMPORTANT NOTES: No adjustments are necessary when using the speed and feed data for HEM tool paths found in the charts for any of the POW•R•PATH and enDURO end mills. Use the data directly from the charts. This applies only when using HEM tool paths.

The M223 and M233 have the long projections adjustments already incorporated into the speed and feed charts for those series. Use the data directly from the charts with no adjustments for long projections.

Tool Tip: Eliminate Wall Taper When Finishing.

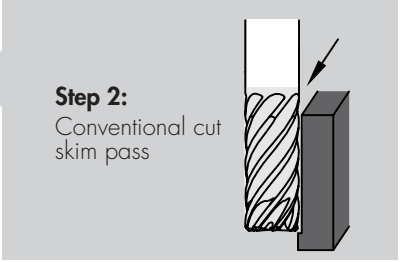
STEP 1:

Run a climb cut finish pass using speed, feed and step-over values (RDOC) from the speed and feed charts. Adjust for tool projection if needed.



STEP 2:

Re-run the path using the same speeds and feeds but in a conventional cut direction. Simply retrace the prior finish pass; do not program to remove more stock. This skim pass, traveling in the opposite direction of the first pass, will help eliminate wall taper caused by tool deflection during the first pass.



ADJUSTMENTS FOR BALL NOSE END MILLS

The speeds and feeds of ball nose end mills must be adjusted to ensure proper tool life. Adjustments are based on the amount of tool engagement.

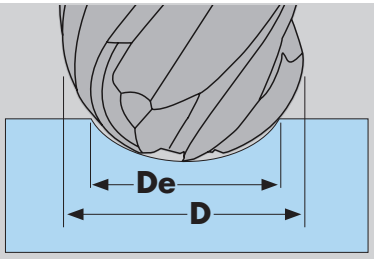
If the depth of cut (ADOC) is <50% of the tool diameter:

Adjustments must be made to determine the effective cutting diameter and to adjust for axial chip thinning. Follow these steps:

STEP 1: Use speed and feed values for slot cuts from the speed and feed charts for the appropriate material and tool diameter.
Note: Make an additional adjustment using the chart to the right if the tool projection exceeds 2.5 x the tool diameter.

Projection	Speed Adj	Feed Adj
> 2.5 to 3 x D	SFM or MMPM x .95	IPT or MMPT x .95
> 3 to 4 x D	SFM or MMPM x .90	IPT or MMPT x .90
> 4 to 5 x D	SFM or MMPM x .80	IPT or MMPT x .80
> 5 to 6 x D	SFM or MMPM x .70	IPT or MMPT x .70

STEP 2: Determine the effective cutting diameter (De) of the end mill based on the axial depth of cut. The effective cutting diameter will be used to make both speed and feed adjustments.



Use D when making shallow cuts with full radius

Ball Nose "Effective Diameter"

$$D = 2x \sqrt{R^2 - (R - ADOC)^2}$$

For easy reference, use the charts below.

Fractional:

Depth of Cut (ADOC)	1/8		1/4		3/8		1/2		3/4		1	
	Depth	De	Depth	De	Depth	De	Depth	De	Depth	De	Depth	De
10% of tool diameter	.013	.075	.025	.150	.038	.225	.050	.300	.075	.450	.100	.600
20% of tool diameter	.025	.100	.050	.200	.075	.300	.100	.400	.150	.600	.200	.800
30% of tool diameter	.038	.115	.075	.229	.113	.344	.150	.458	.225	.687	.300	.917
40% of tool diameter	.050	.123	.100	.245	.150	.367	.200	.490	.300	.73	.400	.980
50% of tool diameter	.063	.125	.125	.250	.186	.375	.250	.500	.375	.7500	.500	1.000

Metric:

Depth of Cut (ADOC)	3.0		6.0		10.0		12.0		20.0		25.0	
	Depth	De	Depth	De	Depth	De	Depth	De	Depth	De	Depth	De
10% of tool diameter	.300	1.800	.600	3.600	1.000	6.000	1.200	7.200	2.000	12.000	2.500	15.000
20% of tool diameter	.600	2.400	1.200	4.800	2.000	8.000	2.400	9.600	4.000	16.000	5.00	20.000
30% of tool diameter	.900	2.750	1.800	5.500	3.000	9.165	3.600	10.998	6.000	18.330	7.500	22.913
40% of tool diameter	1.200	2.940	2.400	5.880	4.000	9.800	4.800	11.760	8.000	19.600	10.000	24.500
50% of tool diameter	1.500	3.000	3.000	6.000	5.000	10.000	6.000	12.000	10.000	20.000	12.500	25.000

STEP 3: Calculate speed based on using the effective cutting diameter. Use the standard SFM or M/min to RPM conversion formula. Substitute the effective cutting diameter (De) for the actual tool diameter (D).

Fractional: ***RPM = (SFM x 3.82) / De***
Metric: ***RPM = (M/min x 318.3) / De***

D = Actual tool diameter
IPT = Feed rate from chart for slot milling
De = Effective cutting diameter
MMPT = Feed rate from chart for slot milling

STEP 4: Calculate the adjusted feed rate based on the effective cutting diameter and the axial chip thinning formula.

Fractional: ***IPTadj = (D x IPT) / De***
Metric: ***MMPTadj = (D x MMPT) / De***

The new feed rate is calculated:

Fractional: ***IPM = RPM x (Z x IPT adj)***
Metric: ***MMPM = RPM x (Z x MMPTadj)***

IPM = Inches per minute
Z = # of flutes
IPT adj = Adjusted chip load per tooth fractional
MMPT adj = Adjusted chip load per tooth metric
MMPM = Millimeters per minute

If the axial depth of cut (ADOC) is ≥50% of the tool diameter:

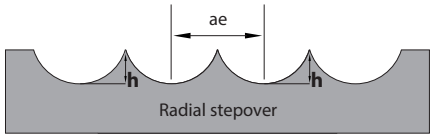
- Use the speed and feed values shown for the slotting operation in the speed and feed charts for the series of end mill being used.
- If the tool projection exceeds 2.5 x the tool diameter, adjust the slotting speeds and feeds by the chart for long reach tool adjustments. This can be found on page 133.

SURFACE FINISH

Radial depth of cut (RDOC), or step-over, is based on the desired finish. The lighter the step-over, the lower the scallop height (material left uncut by the radius of the tool), and the better the finish. These charts calculate approximate scallop height using the following formula:

h ~ (ae²) / (8R)

h = Scallop height
ae = Radial step-over
R = Radius of end mill
(tool diameter x .5)



Fractional

Tool Diameter	Step-over % of OD	Step-over Actual	Approx Scallop Height
1/8	10%	.013	.0003
	20%	.025	.0013
	30%	.038	.0028
1/4	10%	.025	.0006
	20%	.050	.0025
	30%	.075	.0056
3/8	10%	.038	.0009
	20%	.075	.0038
	.30%	.113	.0084
1/2	10%	.050	.0013
	20%	.100	.0050
	30%	.150	.0113
3/4	10%	.075	.0019
	20%	.150	.0075
	30%	.225	.0169
1	10%	.100	.0025
	20%	.200	.0100
	30%	.300	.0225

Metric

Tool Diameter	Step-over % of OD	Step-over Actual	Approx Scallop Height
3.0 mm	10%	.300	.0075
	20%	.600	.0300
	30%	.900	.0675
6.0 mm	10%	.600	.0150
	20%	1.200	.0600
	30%	1.800	.1350
10.0 mm	10%	1.000	.0250
	20%	2.000	.1000
	.30%	3.000	.2250
12.0 mm	10%	1.200	.0300
	20%	2.400	.1200
	30%	3.600	.2700
20.0 mm	10%	2.000	.0500
	20%	4.000	.2000
	30%	6.000	.4500
25.0 mm	10%	2.500	.0625
	20%	5.000	.2500
	30%	7.500	.5625

Tool Holder Recommendations When Using HEM

HEM tool paths reduce the amount of radial cutting forces exerted on the end mill, allowing more aggresive speeds and feeds and higher metal removal rates (MRR). Along with higher MRRs come higher axial cutting forces, which work to pull the end mill out of the holder and into the part. Using a holder with gripping power high enough to overcome these increased axial forces is critical for successful machining in HEM tool paths. For better tool life, it is also important to choose a holder that minimizes the run-out of the tool assembly.

Holder Type	Use in HEM Programming?
Press fit	Recommended
Shrink fit	Recommended
Mechanical chuck	Recommended
Hydraulic chuck	Only if ADOC < 3 x D
Advanced ER collet	Only if ADOC < 3 x D
Standard ER collet	Not recommended
Side lock holder	MUST keep run-out minimized

Determining Power Requirements

It can be helpful to understand the power requirements for an application. The following formulas calculate spindle and motor horsepower and spindle torque.

Step 1: Metal Removal Rate (MRR) = (Tool Feed Rate) x Radial DOC x Axial DOC

Step 2: Spindle HP = Metal Removal Rate x UHP

Step 3: Motor HP = Spindle HP / Efficiency

Step 4: Spindle Torque (ft. lbs.) = (Spindle HP x 63,030) / RPM

UHP Factors Ratings

Material	Factor
Aluminum	0.3
Cast iron	0.8
Carbon steel	1
Alloy steel	1.1
Mold steel	1.2
Tool steel	1.2
Stainless steel	1.5
Titanium	1.8
Hi-temp alloys	2

Efficiency Ratings

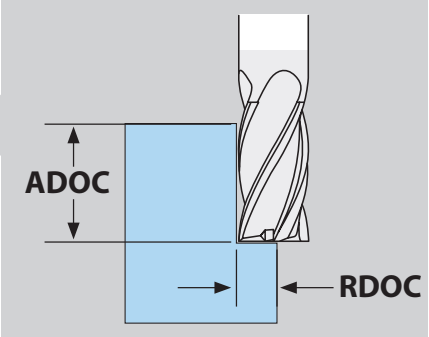
Spindle Type	%
Direct drive	90%
Gear drive	85%
2 Belt	70%
1 Belt	50%
Average	80%

Chip Thinning & Light Cuts

When using a light radial stepover, the chip that is created is thinner than what is entered into the program. This thinning occurs when the radial stepover is less than 50% of the tool diameter.

When the chips are too thin, the cutting edges tend to "rub" the part and begin to wear too quickly. To avoid this problem, use the radial chip-thinning formula at right to calculate an adjusted feed per tooth necessary to maintain optimal chip thickness.

Radial Chip Thinning Adjustment $IPT_{adj} = \frac{IPT \times (D/2)}{\sqrt{(D \times RDOC) - RDOC^2}}$

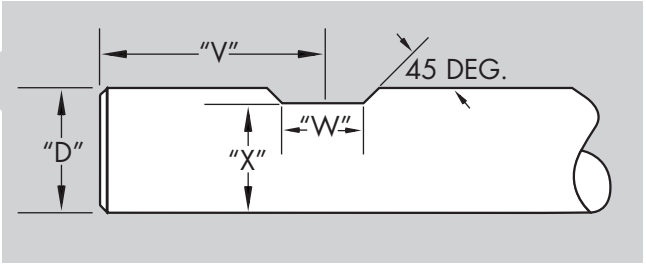


Apply chip thinning adjustment when RDOC < D

*This adjustment has been applied in the Speed and Feed charts in this catalog.

Adding a Weldon Flat

IMCO uses the location and dimensions specified in the ANSI B94.19-1985 standard when adding a Weldon flat to an end mill. All requests for locations and dimensions not matching the ANSI standard must be communicated in writing to IMCO.



Fractional

"D"	"W"	"X"	"V"
Shank Diameter	+.015 -0	'+0 -.010	+.015 -015
.375	.281	.325	.781
.5	.330	.440	.890
.625	.406	.560	.953
.75	.455	.675	1.016
1	.516	.925	1.140
1.25	.516	1.156	1.140

Metric

"D"	"W"	"X"	"V"
Shank Diameter	+.015 -0	'+0 -.010	+.015 -015
10 mm (.3937)	.276	.335	.787
12 mm (.4724)	.315	.409	.886
16 mm (.6299)	.394	.559	.945
20 mm (.7874)	.433	.716	.984
25 mm (.9843)	.472	.905	1.260
1.25	.516	1.156	1.140

Note: All dimensions are shown in fractional decimal equivalents.

Conversions for Fractional and Metric Units

Multiply	By	To Get
Millimeters	0.03937	Inches
Centimeters	0.3937	Inches
Meters	3.2808	Feet
Millimeters Per Minute (MM/min)	0.03937	Inches Per Minute (IPM)
Cubic Centimeters Per Minute (cm^3)	0.061	Cubic Inches Per Minute (in^3)
Meters Per Minute (M/min)	3.2808	Surface Feet Per Minute (SFM)
Inches	25.4	Millimeters
Inches	2.54	Centimeters
Feet	0.3048	Meters
Inches Per Minute (IPM)	25.4	Millimeters Per Minute (MM/min)
Cubic Inches Per Minute (in^3)	16.387	Cubic Centimeters Per Minute (cm^3)
Surface Feet Per Minute (SFM)	0.3048	Meters Per Minute (M/min)

Decimal Equivalent Chart

Tool Size	Decimal Equiv.
#80	.0135
0.35	.0138
#79	.0145
1/64	.0156
0.40	.0158
#78	.0160
0.45	.0177
#77	.0180
0.50	.0197
#76	.0200
#75	.0210
0.55	.0217
#74	.0225
0.60	.0236
#73	.0240
#72	.0250
0.65	.0256
#71	.0260
0.70	.0276
#70	.0280
#69	.0292
0.75	.0295
#68	.0310
1/32	.0312
0.80	.0315
#67	.0320
#66	.0330
0.85	.0335
#65	.0350
0.90	.0354
#64	.0360
#63	.0370
0.95	.0374
#62	.0380
#61	.0390
1.00	.0394
#60	.0400
#59	.0410
1.05	.0413
#58	.0420
#57	.0430
1.10	.0433
1.15	.0453
#56	.0465
3/64	.0469
1.20	.0472
1.25	.0492
1.30	.0512
#55	.0520
1.35	.0531
#54	.0550
1.40	.0551
1.45	.0571
1.50	.0591
#53	.0595
1.55	.0610

Tool Size	Decimal Equiv.
1/16	.0625
1.60	.0630
#52	.0635
1.65	.0650
1.70	.0669
#51	.0670
1.75	.0689
#50	.0700
1.80	.0709
1.85	.0728
#49	.0730
1.90	.0748
#48	.0760
1.95	.0768
5/64	.0781
#47	.0785
2.00	.0787
2.05	.0807
#46	.0810
#45	.0820
2.10	.0827
2.15	.0846
#44	.0860
2.20	.0866
2.25	.0886
#43	.0890
2.30	.0906
2.35	.0925
#42	.0935
3/32	.0938
2.40	.0945
#41	.0960
2.45	.0965
#40	.0980
2.50	.0984
#39	.0995
#38	.1015
2.60	.1024
#37	.1040
2.70	.1063
#36	.1065
2.75	.1083
7/64	.1094
#35	.1100
2.80	.1102
#34	.1110
#33	.1130
2.90	.1142
#32	.1160
3.00	.1181
#31	.1200
3.10	.1220
1/8	.1250
3.20	.1260
3.25	.1280
#30	.1285

Tool Size	Decimal Equiv.
3.30	.1299
3.40	.1339
#29	.1360
3.50	.1378
#28	.1405
9/64	.1406
3.60	.1417
#27	.1440
3.70	.1457
#26	.1470
3.75	.1476
#25	.1495
3.80	.1496
#24	.1520
3.90	.1535
#23	.1540
5/32	.1562
#22	.1570
4.00	.1575
#21	.1590
#20	.1610
4.10	.1614
4.20	.1654
#19	.1660
4.25	.1673
4.30	.1693
#18	.1695
11/64	.1719
#17	.1730
4.40	.1732
#16	.1770
4.50	.1772
#15	.1800
4.60	.1811
#14	.1820
#13	.1850
4.70	.1850
4.75	.1870
3/16	.1875
4.80	.1890
#12	.1890
#11	.1910
4.90	.1929
#10	.1935
#9	.1960
5.00	.1969
#8	.1990
5.10	.2008
#7	.2010
13/64	.2031
#6	.2040
5.20	.2047
#5	.2055
5.25	.2067
5.30	.2087
#4	.2090

Tool Size	Decimal Equiv.
5.40	.2126
#3	.2130
5.50	.2165
7/32	.2188
5.60	.2205
#2	.2210
5.70	.2244
5.75	.2264
#1	.2280
5.80	.2283
5.90	.2323
A	.2340
15/64	.2344
6.00	.2362
B	.2380
6.10	.2402
C	.2420
6.20	.2441
D	.2460
6.25	.2461
6.30	.2480
1/4	.2500
E	.2500
6.40	.2520
6.50	.2559
F	.2570
6.60	.2598
G	.2610
6.70	.2638
17/64	.2656
6.75	.2657
H	.2660
6.80	.2677
6.90	.2717
I	.2720
7.00	.2756
J	.2770
7.10	.2795
K	.2810
9/32	.2812
7.20	.2835
7.25	.2854
7.30	.2874
L	.2900
7.40	.2913
M	.2950
7.50	.2953
19/64	.2969
7.60	.2992
N	.3020
7.70	.3031
7.75	.3051
7.80	.3071
7.90	.3110
5/16	.3125
8.00	.3150

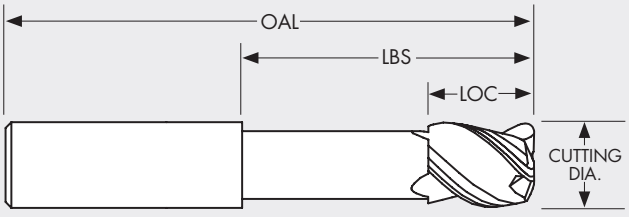
Tool Size	Decimal Equiv.
O	.3160
8.10	.3189
8.20	.3228
P	.3230
8.25	.3248
8.30	.3268
21/64	.3281
8.40	.3307
Q	.3320
8.50	.3346
8.60	.3386
R	.3390
8.70	.3425
11/32	.3438
8.75	.3445
8.80	.3465
S	.3480
8.90	.3504
9.00	.3543
T	.3580
9.10	.3583
23/64	.3594
9.20	.3622
9.25	.3642
9.30	.3661
U	.3680
9.40	.3701
9.50	.3740
3/8	.3750
V	.3770
9.60	.3780
9.70	.3819
9.75	.3839
9.80	.3858
W	.3860
9.90	.3898
25/64	.3906
10.00	.3937
X	.3970
Y	.4040
13/32	.4062
Z	.4130
10.50	.4134
27/64	.4219
11.00	.4331
7/16	.4375
11.50	.4528
29/64	.4531
15/32	.4688
12.00	.4724
31/64	.4844
12.50	.4921
1/2	.5000
13.00	.5118
33/64	.5156

Tool Size	Decimal Equiv.
17/32	.5312
13.50	.5315
35/64	.5469
14.00	.5512
9/16	.5625
14.50	.5709
37/64	.5781
15.00	.5906
19/32	.5938
39/64	.6094
15.50	.6102
5/8	.6250
16.00	.6299
41/64	.6406
16.50	.6496
21/32	.6562
17.00	.6693
43/64	.6719
11/16	.6875
17.50	.6890
45/64	.7031
18.00	.7087
23/32	.7188
18.50	.7283
47/64	.7344
19.00	.7480
3/4	.7500
49/64	.7656
19.50	.7677
25/32	.7812
20.00	.7874
51/64	.7969
20.50	.8071
13/16	.8125
21.00	.8268
53/64	.8281
27/32	.8438
21.50	.8465
55/64	.8594
22.00	.8661
7/8	.8750
22.50	.8858
57/64	.8906
23.00	.9055
29/32	.9062
59/64	.9219
23.50	.9252
15/16	.9375
24.00	.9449
61/64	.9531
24.50	.9646
31/32	.9688
25.00	.9843
63/64	.9844
1	1.000

EZ-QUOTE GUIDE

IMCO's smart coding system simplifies the way to communicate all of the features needed for a made-to-order tool. Just use the specifics of the tool you need quoted, "plug" them into the coding system, and you're there!

Each EZ-Quote part number describes the tool itself. It starts with general information (type of tool and tool family) and gets more specific as you go.



Building the EZ-Quote code, step by step.

Insert the numbers in the segments as indicated here. If a certain segment doesn't apply (neck dimension, taper or special shank), just skip it. Separate the segments with hyphens.

1 **Enter the model number.**
For example, the model number for a 5-Flute enDURO end mill would be M525.

2 Enter the **tool diameter** (always to three decimal places). Include the leading zero for diameters less than 1 in. or 10 mm.

3 Enter the **length of cut (LOC).** Include the leading zero for an LOC less than 1 in. or 10mm.

4 Enter the **length below shank (LBS) or reach**. Include the leading zero for an LBS less than 1 in. or 100mm. Indicate that this is a neck dimension by placing an N before the number. (If the tool has no neck, you can skip this segment altogether.)

5 Enter the **end/corner** type or size. Include the leading zero for corner radii less than 1 in. or 1 mm. For any other end/corner type, just indicate the type: SQ = square end, BN = ball nose, CC = corner chamfer.

6 If the **overall length** you need is not the standard length for the combination of tool diameter, LOC and LBS, then enter the overall length **(OAL)** here. Indicate that this is an overall length by placing an L before the number. If you do not specify an overall length, we will assume it is standard length.

7 Enter the code for the **type of shank** you need (W = Weldon flat, WN = whistle notch, P = plain). If you do not specify a shank style, we will assume it is a plain shank.

8 Enter the coating ONLY if it is different than the standard coating for that model.

	1 MODEL	2 TOOL DIAMETER	3 LENGTH OF CUT (LOC)	4 LENGTH BELOW SHANK (LBS)	5 END	6 OVERALL LENGTH	7 SHANK	8 COATING
INCH	M525 –	0375 –	0750 –	N2375 –	045 –	L4 –	W –	AlCrNX
METRIC	E14 –	060 –	008 –	N020 –	050 –	L075 –	P –	NONE

Segments highlighted in white may be omitted.

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