CLEVELAND

Application Products

High Performance Taps
Thread Mills
Carbide & PM End Mills

GREENFIELD INDUSTRIES

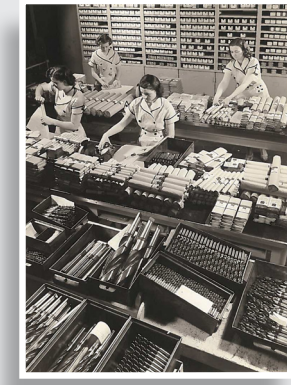
2020

CLEVELAND

We have made it our mission to invest in the resources, technology, and people that enable us to provide these qualilty application products, the Cleveland Brand.

The Cleveland® brand is well-known throughout the world for its wide selection of premium cutting tools for drilling, countersinking, reaming, threading, and milling operations.

Its roots go back to the 1870's, when Cleveland Twist Drill was established as a premier cutting tool company in the United States.



Cleveland has always been famous for the quality and reliability of its tools, and the company grew to be one of the largest high-speed steel toolmakers in the US, expanding to overseas markets.

In 1995, Cleveland Twist Drill was acquired by Greenfield Industries Inc. (GFII), a U.S. based manufacturer of precision cutting tools.

Today, Greenfield Industries is part of TDC, the world's largest manufacturer of twist drills.

Index by Style Number

Metal Cutting Safety (read this before using Cleveland® products)

Modern metal cutting operations involve high energy, high spindle or cutter speeds, and high temperatures and cutting forces. Hot, flying chips may be projected from the workpiece during metal-cutting. Although advanced cutting tool materials are designed and manufactured to withstand the high cutting forces and temperatures that normally occur in these operations, they are susceptible to fragmenting in service, particularly if they are subjected to over-stress, severe impact or otherwise abused. Therefore, precautions should be taken to adequately protect workers, observers and equipment against hot, flying chips, fragmented cutting tools, broken work pieces or other similar projectiles. Machines should be fully guarded and personal protective equipment should be used at all times.

When grinding advanced cutting tool materials, a suitable means for collection and disposal of dust, mist or sludge should be provided. Overexposure to dust or mist containing metallic particles can be hazardous to health particularly if exposure continues over an extended period of time and may cause eye, skin and mucous membrane irritation and temporary or permanent respiratory disease. Certain existing pulmonary and skin conditions may be aggravated by exposure to dust or mist. Adequate ventilation, respiratory protection and eye protection should be provided when grinding and workers should avoid breathing of and prolonged skin contact with dust or mist.

General Industry Safety and Health Regulations, Part 1910, U.S. Department of Labor, published in Title 29 of the Code of Federal Regulations should be consulted. Obtain from Cleveland® and read the applicable Material Safety Data Sheet before grinding.

Cutting tools are only one part of the worker-machine-tool system. Many variables exist in machining operations, including the metal removal rate; the workpiece size, shape, strength and rigidity; the chucking and fixturing; the load carrying capability of centers; the cutter and spindle speed and torque limitations; the holder and boring bar overhang; the available power; and the condition of the tooling and the machine. A safe metal cutting operation must take all of these variables, and others, into consideration.

Cleveland® has no control over the end use of its products or the environment into which those products are placed. Cleveland® urges that its customers adhere to the recommended standards of use of their metal cutting operations. The information included throughout this catalog under the heading "Technical Data" and other recommendations on machining practices referred to herein are only advisory in nature and do not constitute representations or warranties and are not necessarily appropriate for any particular work environment or application.

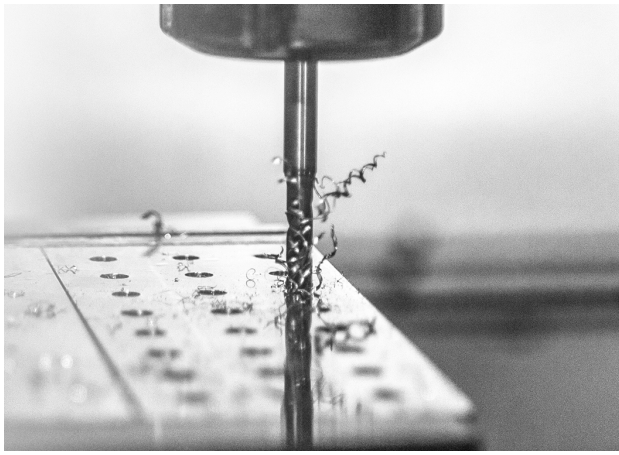
Application Products

High Performance Taps, Carbide Thread Mills and End Mills

High Performance Taps

Greenfield Industries offers an expansive line of high performance taps in the **Cleveland** brand. All taps in the **Cleveland** line are designed to machine a broad range of materials and are manufactured out of premium high speed steel.

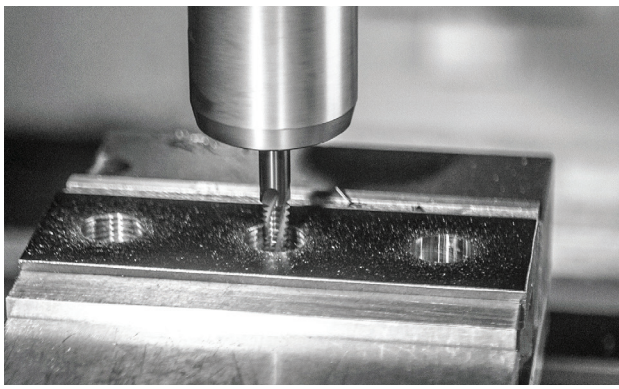
This supplement shows the range of products to be added to the Cleveland line along with machining parameters. Various surface treatments are available for our taps designed for specific applications. These taps were developed for the highest cutting performance to cope with the increasing demands placed on industrial thread cutting. By optimizing the cutting geometry, substrate material, and surface treatment the tap will achieve the best results in CNC as well as in conventional thread cutting environments.



Carbide Thread Mills

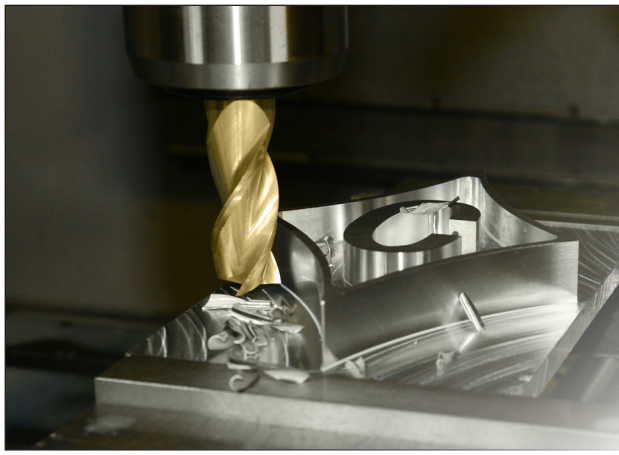
Cleveland thread mills are manufactured from premium sub-micron grain carbide and combined with an advanced PVD coating to create superior performance. The helical flutes help reduce chatter and produce a superior finish on the thread surfaces. These tools are also provided with internal coolant holes to maximize life and material removal.

With the ability to create right and left hand threads with the same tool, the **Cleveland** Thread Mill provides a cost effective way to solve your thread applications.



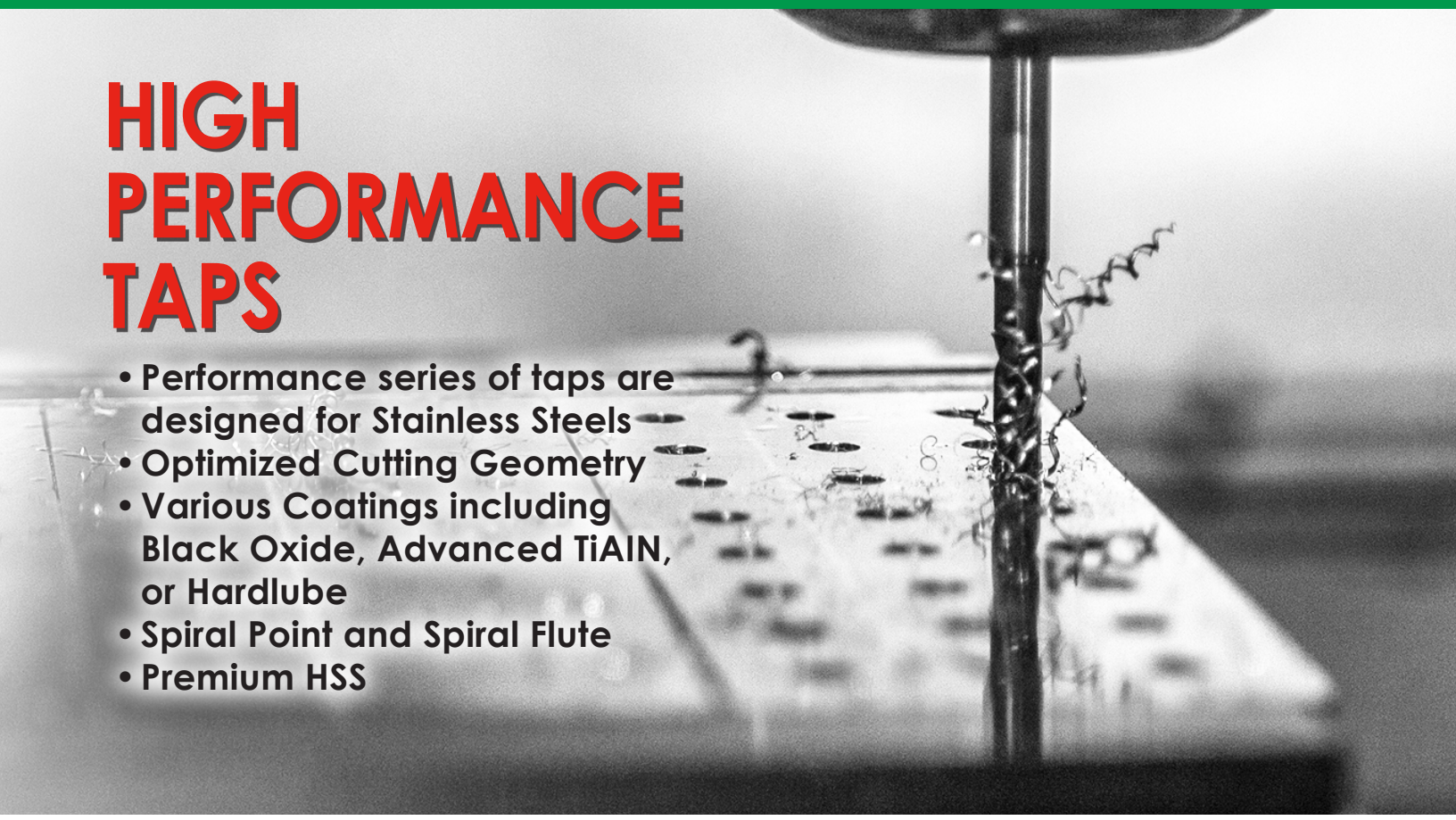
Carbide End Mills

Cleveland is proud to present to you the highest quality carbide end mills in the market today. We manufacture our end mills to serve our client's needs throughout North America and the world in our state-of-the-art facilities in Seneca, South Carolina. We have made it our mission to invest in the resources, technology and people that enable us to provide these superior end mills.



High Performance Taps

Universal Tool That Performs Well in a Wide Range of Materials



HIGH PERFORMANCE TAPS

- **Performance series of taps are designed for Stainless Steels**
- **Optimized Cutting Geometry**
- **Various Coatings including Black Oxide, Advanced TiAlN, or Hardlube**
- **Spiral Point and Spiral Flute**
- **Premium HSS**

Progress Series

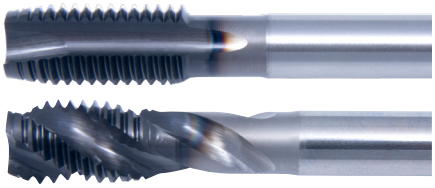
Our Progress Series Taps are designed for tapping all your hard material applications. The unique geometry and high Vanadium substrate allows the tap to freely produce high quality threads. Drive productivity by doubling tap life and doubling machine speeds.

- Black Oxide and advanced TiAlN coating

Performance Series

Our Performance Series Taps are designed for tapping all your Stainless Steel applications. The unique geometry and high Vanadium substrate allows the tap to freely produce high quality threads. Drive productivity by doubling tap life and doubling machine speeds.

- Black Oxide and advanced Hardlube coating



Tap
Product Index

CLEVELAND

				Tool Material		Blank			Champer				Application						Hole		Surface Treatment							
				HSS	HSS-E	302A	311	DIN / ANSI	Taper	Plug	Bottoming	Mod Bottoming	Steel	Stainless	Cast Iron	Non-Ferrous	High-Temp Alloy	Hardened Steel	Blind	Thru	Bright	Black Oxide	TiN	TiCN	TiAlN	AlCrN	Oxide over Nitride	Hardlube
Spiral Point Tap	Type	Style	Page																								
	Universal	**PRO-961SP**	6		•			•		•			•	•	•					•		•					
	Universal	**PRO-861SP**			•			•		•			•	•	•					•				•			
	Stainless Steel	**PER-862SP**	8		•			•		•			•	•	•					•		•					
	Stainless Steel	**PER-960SP**			•			•		•			•	•	•					•							•
Spiral Flute Tap																											
	Universal	**PRO-981SF**	10		•			•				•	•	•	•				•			•					
	Universal	**PRO-892SF**			•			•				•	•	•	•				•						•		
	Stainless Steel	**PER-893SF**	12		•			•				•	•	•	•				•			•					
	Stainless Steel	**PER-980SF**			•			•				•	•	•	•				•								•

Note

Technical Information found at the end of the ***Threading*** section

Call for additional information on our:

FastTap Catalog

Includes: Inch, National Pipe Tap,
British Standard Pipe Tap, and Metric Sizes.

Common Special Taps and Special Taps from Blanks

Average U.S. Shipping: 5 days

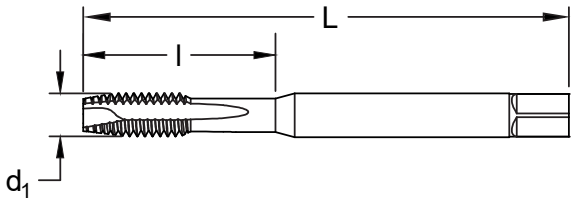
Steam Oxide, Steam Oxide over Nitride,
TiN, and TiCN coating also available.

Styles: PRO-961SP and PRO-861SP

CLEVELAND

Note
Tapping Speeds and Feeds begin on page 196.

HSS-E | DIN with ASME SHANK | Spiral Point | Straight Flute | Thru Holes | Plug 3-5 | Surface Treatment: Black Oxide, TiAlN



Feature:
Premium steel substrate, for use in a wide array of materials.

tap size and pitch d_1	thread form	decimal equiv.	no. of flutes	class of fit	shank diameter	overall length **L** (in)	thread length **l** (in)	order number Black Oxide PRO-961SP	order number TiAlN PRO-861SP
2-56	UNC	0.0860	3	2B	0.141	1.772	0.551	C96101	C86101
3-48	UNC	0.0990	3	2B	0.141	1.969	0.591	C96102	C86102
4-40	UNC	0.1120	3	2B	0.141	2.205	0.669	C96103	C86103
4-48	UNF	0.1120	3	2B	0.141	2.205	0.669	C96104	C86104
5-40	UNC	0.1250	3	2B	0.141	2.205	0.748	C96105	C86105
6-32	UNC	0.1380	3	2B	0.141	2.205	0.787	C96106	C86106
6-40	UNF	0.1380	3	2B	0.141	2.205	0.787	C96107	C86107
8-32	UNC	0.1640	3	2B	0.168	2.480	0.827	C96108	C86108
8-36	UNF	0.1640	3	2B	0.168	2.480	0.827	C96109	C86109
10-24	UNC	0.1900	3	2B	0.194	2.756	1.024	C96110	C86110
10-32	UNF	0.1900	3	2B	0.194	2.756	1.024	C96111	C86111
12-24	UNC	0.2160	3	2B	0.220	3.150	1.063	C96112	C86112
12-28	UNF	0.2160	3	2B	0.220	3.150	1.063	C96113	C86113
1/4-20	UNC	0.2500	3	2B	0.255	3.150	1.260	C96114	C86114
1/4-28	UNF	0.2500	3	2B	0.255	3.150	1.260	C96115	C86115
5/16-18	UNC	0.3125	3	2B	0.318	3.543	1.378	C96116	C86116
5/16-24	UNF	0.3125	3	2B	0.318	3.543	1.378	C96117	C86117
3/8-16	UNC	0.3750	3	2B	0.381	3.937	1.732	C96118	C86118
3/8-24	UNF	0.3750	3	2B	0.381	3.937	1.732	C96119	C86119
7/16-14	UNC	0.4375	3	2B	0.323	3.937	1.614	C96120	C86120
7/16-20	UNF	0.4375	3	2B	0.323	3.937	1.614	C96121	C86121
1/2-13	UNC	0.5000	3	2B	0.367	4.331	1.535	C96122	C86122
1/2-20	UNF	0.5000	3	2B	0.367	4.331	1.535	C96123	C86123
9/16-12	UNC	0.5625	3	2B	0.429	4.331	1.772	C96124	C86124
9/16-18	UNF	0.5625	3	2B	0.429	4.331	1.772	C96125	C86125
5/8-11	UNC	0.6250	3	2B	0.480	4.331	2.087	C96126	C86126
5/8-18	UNF	0.6250	3	2B	0.480	4.331	2.087	C96127	C86127
3/4-10	UNC	0.7500	4	2B	0.590	4.921	2.205	C96128	C86128
3/4-16	UNF	0.7500	4	2B	0.590	4.921	2.205	C96129	C86129
7/8-9	UNC	0.8750	4	2B	0.697	5.512	2.362	C96130	C86130
7/8-14	UNF	0.8750	4	2B	0.697	5.512	2.362	C96131	C86131
1-8	UNC	1.0000	4	2B	0.800	6.299	2.520	C96132	C86132
1-12	UNF	1.0000	4	2B	0.800	6.299	2.520	C96133	C86133

continued on next page

Styles: PRO-961SP and PRO-861SP (continued)

tap size and pitch d_1	thread form	decimal equiv.	no. of flutes	class of fit	shank diameter in	shank diameter mm	overall length L in	overall length L mm	thread length l in	thread length l mm	order number Black Oxide PRO-961SP	order number TiAIN PRO-861SP
M2.5x0.45	M	0.1181	3	6H	0.141	3.58	2.205	56	0.748	19	C96152	C86152
M3x0.5	M	0.1181	3	6H	0.141	3.58	2.205	56	0.748	19	C96134	C86134
M3.5x0.6	M	0.1378	3	6H	0.141	3.58	2.205	56	0.787	20	C96135	C86135
M4x0.7	M	0.1575	3	6H	0.168	4.27	2.480	63	0.827	21	C96136	C86136
M5x0.8	M	0.1969	3	6H	0.194	4.93	2.756	70	1.024	26	C96137	C86137
M6x1	M	0.2362	3	6H	0.255	6.48	3.150	80	1.260	32	C96138	C86138
M7x1	M	0.2756	3	6H	0.318	8.08	3.150	80	1.181	30	C96139	C86139
M8x1	M	0.3150	3	6H	0.318	8.08	3.543	90	1.378	35	C96140	C86140
M8x1.25	M	0.3150	3	6H	0.318	8.08	3.543	90	1.378	35	C96141	C86141
M10x1.25	M	0.3937	3	6H	0.381	9.68	3.937	100	1.575	40	C96142	C86142
M10x1.5	M	0.3937	3	6H	0.381	9.68	3.937	100	1.575	40	C96143	C86143
M12x1.25	M	0.4724	3	6H	0.367	9.32	4.331	110	1.575	40	C96144	C86144
M12x1.75	M	0.4724	3	6H	0.367	9.32	4.331	110	1.575	40	C96145	C86145
M14x1.5	M	0.5512	3	6H	0.429	10.9	4.331	110	1.772	45	C96146	C86146
M14x2	M	0.5512	3	6H	0.429	10.9	4.331	110	1.772	45	C96147	C86147
M16x1.5	M	0.6299	3	6H	0.480	12.19	4.331	110	2.087	53	C96148	C86148
M16x2	M	0.6299	3	6H	0.480	12.19	4.331	110	2.087	53	C96149	C86149
M18x1.5	M	0.7087	4	6H	0.542	13.77	4.921	125	2.165	55	C96150	C86150
M18x2.5	M	0.7087	4	6H	0.542	13.77	4.921	125	2.165	55	C96151	C86151

Spiral Point Taps

Material Reference

	Steel (HRc)				Stainless Steel			Cast Iron (HRc)		Aluminum and Non-Ferrous	Hi-Temp Alloy		Hardened Steel (HRc)
	Low Carbon		Alloy		Austenitic	Martensitic	PH	Gray	Nodular		Ni, Co, Fe Based Super Alloy	Titanium	
Hardness	13-38	>38	16-38	> 38	300 Series	400 series		18-22	22-32				>45
Black Oxide	✦		✦		✦	✦		✦	✦				
TiAIN	☆		☆		☆	☆		☆	☆				

☆ = Best Performance ✦ = Acceptable

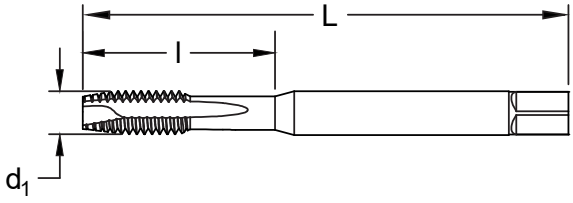
Styles: PER-862SP and PER-960SP

CLEVELAND

Note
Tapping Speeds and Feeds begin on page 196.

HSS-E | DIN with ASME SHANK | Spiral Point | Straight Flute | Thru Holes | Plug 3-5

Surface Treatment: Black Oxide | Hardlube



Feature:
Premium steel substrate, for use in a wide array of materials.

tap size and pitch d_1	thread form	decimal equiv.	no. of flutes	class of fit	shank diameter	overall length **L** (in)	thread length **l** (in)	order number Black Oxide PER-862SP	order number Hardlube PER-960SP
2-56	UNC	0.0860	3	2B	0.141	1.772	0.551	C86201	C96001
3-48	UNC	0.0990	3	2B	0.141	1.969	0.591	C86202	C96002
4-40	UNC	0.1120	3	2B	0.141	2.205	0.669	C86203	C96003
4-48	UNF	0.1120	3	2B	0.141	2.205	0.669	C86204	C96004
5-40	UNC	0.1250	3	2B	0.141	2.205	0.748	C86205	C96005
6-32	UNC	0.1380	3	2B	0.141	2.205	0.787	C86206	C96006
6-40	UNF	0.1380	3	2B	0.141	2.205	0.787	C86207	C96007
8-32	UNC	0.1640	3	2B	0.168	2.480	0.827	C86208	C96008
8-36	UNF	0.1640	3	2B	0.168	2.480	0.827	C86209	C96009
10-24	UNC	0.1900	3	2B	0.194	2.756	1.024	C86210	C96010
10-32	UNF	0.1900	3	2B	0.194	2.756	1.024	C86211	C96011
12-24	UNC	0.2160	3	2B	0.220	3.150	1.063	C86212	C96012
12-28	UNF	0.2160	3	2B	0.220	3.150	1.063	C86213	C96013
1/4-20	UNC	0.2500	3	2B	0.255	3.150	1.260	C86214	C96014
1/4-28	UNF	0.2500	3	2B	0.255	3.150	1.260	C86215	C96015
5/16-18	UNC	0.3125	3	2B	0.318	3.543	1.378	C86216	C96016
5/16-24	UNF	0.3125	3	2B	0.318	3.543	1.378	C86217	C96017
3/8-16	UNC	0.3750	3	2B	0.381	3.937	1.732	C86218	C96018
3/8-24	UNF	0.3750	3	2B	0.381	3.937	1.732	C86219	C96019
7/16-14	UNC	0.4375	3	2B	0.323	3.937	1.614	C86220	C96020
7/16-20	UNF	0.4375	3	2B	0.323	3.937	1.614	C86221	C96021
1/2-13	UNC	0.5000	3	2B	0.367	4.331	1.535	C86222	C96022
1/2-20	UNF	0.5000	3	2B	0.367	4.331	1.535	C86223	C96023
9/16-12	UNC	0.5625	3	2B	0.429	4.331	1.772	C86224	C96024
9/16-18	UNF	0.5625	3	2B	0.429	4.331	1.772	C86225	C96025
5/8-11	UNC	0.6250	3	2B	0.480	4.331	2.087	C86226	C96026
5/8-18	UNF	0.6250	3	2B	0.480	4.331	2.087	C86227	C96027
3/4-10	UNC	0.7500	4	2B	0.590	4.921	2.205	C86228	C96028
3/4-16	UNF	0.7500	4	2B	0.590	4.921	2.205	C86229	C96029
7/8-9	UNC	0.8750	4	2B	0.697	5.512	2.362	C86230	C96030
7/8-14	UNF	0.8750	4	2B	0.697	5.512	2.362	C86231	C96031
1-8	UNC	1.0000	4	2B	0.800	6.299	2.520	C86232	C96032
1-12	UNF	1.0000	4	2B	0.800	6.299	2.520	C86233	C96033

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Styles: PER-862SP and PER-960SP (continued)

tap size and pitch d_1	thread form	decimal equiv.	no. of flutes	class of fit	shank diameter in	shank diameter mm	overall length L in	overall length L mm	thread length l in	thread length l mm	order number Black Oxide PER-862SP	order number Hardlube PER-960SP
M2.5x0.45	M	0.1181	3	6H	0.141	3.58	2.205	56	0.748	19	C86252	C96052
M3x0.5	M	0.1181	3	6H	0.141	3.58	2.205	56	0.748	19	C86234	C96034
M3.5x0.6	M	0.1378	3	6H	0.141	3.58	2.205	56	0.787	20	C86235	C96035
M4x0.7	M	0.1575	3	6H	0.168	4.27	2.480	63	0.827	21	C86236	C96036
M5x0.8	M	0.1969	3	6H	0.194	4.93	2.756	70	1.024	26	C86237	C96037
M6x1	M	0.2362	3	6H	0.255	6.48	3.150	80	1.260	32	C86238	C96038
M7x1	M	0.2756	3	6H	0.318	8.08	3.150	80	1.181	30	C86239	C96039
M8x1	M	0.3150	3	6H	0.318	8.08	3.543	90	1.378	35	C86240	C96040
M8x1.25	M	0.3150	3	6H	0.318	8.08	3.543	90	1.378	35	C86241	C96041
M10x1.25	M	0.3937	3	6H	0.381	9.68	3.937	100	1.575	40	C86242	C96042
M10x1.5	M	0.3937	3	6H	0.381	9.68	3.937	100	1.575	40	C86243	C96043
M12x1.25	M	0.4724	3	6H	0.367	9.32	4.331	110	1.575	40	C86244	C96044
M12x1.75	M	0.4724	3	6H	0.367	9.32	4.331	110	1.575	40	C86245	C96045
M14x1.5	M	0.5512	3	6H	0.429	10.9	4.331	110	1.772	45	C86246	C96046
M14x2	M	0.5512	3	6H	0.429	10.9	4.331	110	1.772	45	C86247	C96047
M16x1.5	M	0.6299	3	6H	0.480	12.19	4.331	110	2.087	53	C86248	C96048
M16x2	M	0.6299	3	6H	0.480	12.19	4.331	110	2.087	53	C86249	C96049
M18x1.5	M	0.7087	4	6H	0.542	13.77	4.921	125	2.165	55	C86250	C96050
M18x2.5	M	0.7087	4	6H	0.542	13.77	4.921	125	2.165	55	C86251	C96051

Spiral Point Taps

Material Reference

	Steel (HRc)				Stainless Steel			Cast Iron (HRc)		Aluminum and Non-Ferrous	Hi-Temp Alloy		Hardened Steel (HRc)
	Low Carbon		Alloy		Austenitic	Martensitic	PH	Gray	Nodular		Ni, Co, Fe Based Super Alloy	Titanium	
Hardness	13-38	>38	16-38	> 38	300 Series	400 series		18-22	22-32				>45
Black Oxide	✦		✦		✦	✦		✦	✦				
Hardlube	☆	✦	☆	✦	☆	☆	☆	☆	☆				

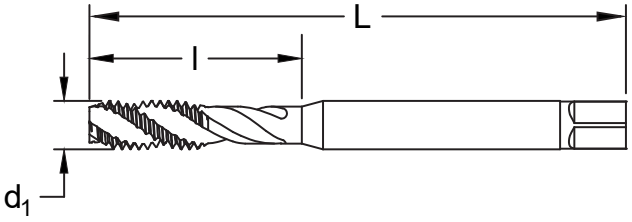
☆ = Best Performance ✦ = Acceptable

Styles: PRO-981SF and PRO-892SF

CLEVELAND

Note
Tapping Speeds and Feeds begin on page 196.

HSS-E | DIN with ASME SHANK | 38° Spiral Flute | Blind Holes | Modified Bottom 2-3 | Surface Treatment: Black Oxide, TiAlN



Spiral Flute Taps

tap size and pitch d_1 (in)	thread form	decimal equiv.	no. of flutes	class of fit	shank diameter	overall length L (in)	thread length l (in)	order number Black Oxide PRO-981SF	order number TiAlN PRO-892SF
2-56	UNC	0.0860	3	2B	0.141	1.772	0.551	C98101	C89201
3-48	UNC	0.0990	3	2B	0.141	1.969	0.591	C98102	C89202
4-40	UNC	0.1120	3	2B	0.141	2.205	0.669	C98103	C89203
4-48	UNF	0.1120	3	2B	0.141	2.205	0.669	C98104	C89204
5-40	UNC	0.1250	3	2B	0.141	2.205	0.748	C98105	C89205
6-32	UNC	0.1380	3	2B	0.141	2.205	0.787	C98106	C89206
6-40	UNF	0.1380	3	2B	0.141	2.205	0.787	C98107	C89207
8-32	UNC	0.1640	3	2B	0.168	2.480	0.827	C98108	C89208
8-36	UNF	0.1640	3	2B	0.168	2.480	0.827	C98109	C89209
10-24	UNC	0.1900	3	2B	0.194	2.756	1.024	C98110	C89210
10-32	UNF	0.1900	3	2B	0.194	2.756	1.024	C98111	C89211
12-24	UNC	0.2160	3	2B	0.220	3.150	1.063	C98112	C89212
12-28	UNF	0.2160	3	2B	0.220	3.150	1.063	C98113	C89213
1/4-20	UNC	0.2500	3	2B	0.255	3.150	1.260	C98114	C89214
1/4-28	UNF	0.2500	3	2B	0.255	3.150	1.260	C98115	C89215
5/16-18	UNC	0.3125	3	2B	0.318	3.543	1.378	C98116	C89216
5/16-24	UNF	0.3125	3	2B	0.318	3.543	1.378	C98117	C89217
3/8-16	UNC	0.3750	3	2B	0.381	3.937	1.732	C98118	C89218
3/8-24	UNF	0.3750	3	2B	0.381	3.937	1.732	C98119	C89219
7/16-14	UNC	0.4375	3	2B	0.323	3.937	1.614	C98120	C89220
7/16-20	UNF	0.4375	3	2B	0.323	3.937	1.614	C98121	C89221
1/2-13	UNC	0.5000	3	2B	0.367	4.331	1.535	C98122	C89222
1/2-20	UNF	0.5000	3	2B	0.367	4.331	1.535	C98123	C89223
9/16-12	UNC	0.5625	4	2B	0.429	4.331	1.772	C98124	C89224
9/16-18	UNF	0.5625	4	2B	0.429	4.331	1.772	C98125	C89225
5/8-11	UNC	0.6250	4	2B	0.480	4.331	2.087	C98126	C89226
5/8-18	UNF	0.6250	4	2B	0.480	4.331	2.087	C98127	C89227
3/4-10	UNC	0.7500	4	2B	0.590	4.921	2.205	C98128	C89228
3/4-16	UNF	0.7500	4	2B	0.590	4.921	2.205	C98129	C89229
7/8-9	UNC	0.8750	4	2B	0.697	5.512	2.362	C98130	C89230
7/8-14	UNF	0.8750	4	2B	0.697	5.512	2.362	C98131	C89231
1-8	UNC	1.0000	4	2B	0.800	6.299	2.520	C98132	C89232
1-12	UNF	1.0000	4	2B	0.800	6.299	2.520	C98133	C89233

continued on next page

Styles: PRO-981SF and PRO-892SF (continued)

tap size and pitch d_1	thread form	decimal equiv.	no. of flutes	class of fit	shank diameter in	shank diameter mm	overall length L in	overall length L mm	thread length l in	thread length l mm	order number Black Oxide PRO-981SF	order number TiAlN PRO-892SF
M3x0.5	M	0.1181	3	6H	0.141	3.58	2.205	56	0.748	19	C98134	C89234
M3.5x0.6	M	0.1378	3	6H	0.141	3.58	2.205	56	0.787	20	C98135	C89235
M4x0.7	M	0.1575	3	6H	0.168	4.27	2.480	63	0.827	21	C98136	C89236
M5x0.8	M	0.1969	3	6H	0.194	4.93	2.756	70	1.024	26	C98137	C89237
M6x1	M	0.2362	3	6H	0.255	6.48	3.150	80	1.260	32	C98138	C89238
M7x1	M	0.2756	3	6H	0.318	8.08	3.150	80	1.181	30	C98139	C89239
M8x1	M	0.3150	3	6H	0.318	8.08	3.543	90	1.378	35	C98140	C89240
M8x1.25	M	0.3150	3	6H	0.318	8.08	3.543	90	1.378	35	C98141	C89241
M10x1.25	M	0.3937	3	6H	0.381	9.68	3.937	100	1.575	40	C98142	C89242
M10x1.5	M	0.3937	3	6H	0.381	9.68	3.937	100	1.575	40	C98143	C89243
M12x1.25	M	0.4724	3	6H	0.367	9.32	4.331	110	1.575	40	C98144	C89244
M12x1.75	M	0.4724	3	6H	0.367	9.32	4.331	110	1.575	40	C98145	C89245
M14x1.5	M	0.5512	3	6H	0.429	10.9	4.331	110	1.772	45	C98146	C89246
M14x2	M	0.5512	3	6H	0.429	10.9	4.331	110	1.772	45	C98147	C89247
M16x1.5	M	0.6299	4	6H	0.480	12.19	4.331	110	2.087	53	C98148	C89248
M16x2	M	0.6299	4	6H	0.480	12.19	4.331	110	2.087	53	C98149	C89249
M18x1.5	M	0.7087	4	6H	0.542	13.77	4.921	125	2.165	55	C98150	C89250
M18x2.5	M	0.7087	4	6H	0.542	13.77	4.921	125	2.165	55	C98151	C89251
M20x2.5	M	0.7874	4	6H	0.650	16.51	5.512	140	2.480	63	C98152	C89252
M22x2.5	M	0.8661	4	6H	0.697	17.70	5.512	140	2.362	60	C98153	C89253
M24x3.0	M	0.9449	4	6H	0.760	19.30	6.299	160	2.598	66	C98154	C89254

Spiral Flute Taps

Material Reference

	Steel (HRc)				Stainless Steel			Cast Iron (HRc)		Aluminum and Non-Ferrous	Hi-Temp Alloy		Hardened Steel (HRc)
	Low Carbon		Alloy		Austenitic	Martensitic	PH	Gray	Nodular		Ni, Co, Fe Based Super Alloy	Titanium	
Hardness	13-38	>38	16-38	> 38	300 Series	400 series		18-22	22-32				>45
Black Oxide	✦		✦		✦	✦		✦	✦				
TiAlN	☆		☆		☆	☆		☆	☆				

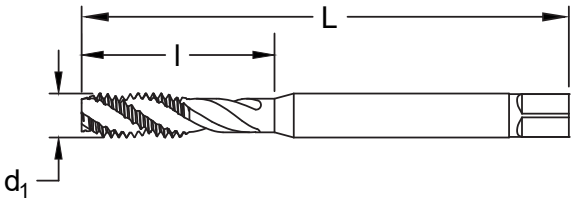
☆ = Best Performance ✦ = Acceptable

Styles: PER-893SF and PER-980SF

CLEVELAND

Note
Tapping Speeds and Feeds begin on page 196.

HSS-E | DIN with ASME SHANK | 38° Spiral Flute | Blind Holes | Modified Bottom 2-3 | Surface Treatment: Black Oxide, Hardlube



tap size and pitch d_1 (in)	thread form	decimal equiv.	no. of flutes	class of fit	shank diameter	overall length L (in)	thread length l (in)	order number Black Oxide PER-893SF	order number Hardlube PER-980SF
2-56	UNC	0.0860	3	2B	0.141	1.772	0.551	C89301	C98001
3-48	UNC	0.0990	3	2B	0.141	1.969	0.591	C89302	C98002
4-40	UNC	0.1120	3	2B	0.141	2.205	0.669	C89303	C98003
4-48	UNF	0.1120	3	2B	0.141	2.205	0.669	C89304	C98004
5-40	UNC	0.1250	3	2B	0.141	2.205	0.748	C89305	C98005
6-32	UNC	0.1380	3	2B	0.141	2.205	0.787	C89306	C98006
6-40	UNF	0.1380	3	2B	0.141	2.205	0.787	C89307	C98007
8-32	UNC	0.1640	3	2B	0.168	2.480	0.827	C89308	C98008
8-36	UNF	0.1640	3	2B	0.168	2.480	0.827	C89309	C98009
10-24	UNC	0.1900	3	2B	0.194	2.756	1.024	C89310	C98010
10-32	UNF	0.1900	3	2B	0.194	2.756	1.024	C89311	C98011
12-24	UNC	0.2160	3	2B	0.220	3.150	1.063	C89312	C98012
12-28	UNF	0.2160	3	2B	0.220	3.150	1.063	C89313	C98013
1/4-20	UNC	0.2500	3	2B	0.255	3.150	1.260	C89314	C98014
1/4-28	UNF	0.2500	3	2B	0.255	3.150	1.260	C89315	C98015
5/16-18	UNC	0.3125	3	2B	0.318	3.543	1.378	C89316	C98016
5/16-24	UNF	0.3125	3	2B	0.318	3.543	1.378	C89317	C98017
3/8-16	UNC	0.3750	3	2B	0.381	3.937	1.732	C89318	C98018
3/8-24	UNF	0.3750	3	2B	0.381	3.937	1.732	C89319	C98019
7/16-14	UNC	0.4375	3	2B	0.323	3.937	1.614	C89320	C98020
7/16-20	UNF	0.4375	3	2B	0.323	3.937	1.614	C89321	C98021
1/2-13	UNC	0.5000	3	2B	0.367	4.331	1.535	C89322	C98022
1/2-20	UNF	0.5000	3	2B	0.367	4.331	1.535	C89323	C98023
9/16-12	UNC	0.5625	4	2B	0.429	4.331	1.772	C89324	C98024
9/16-18	UNF	0.5625	4	2B	0.429	4.331	1.772	C89325	C98025
5/8-11	UNC	0.6250	4	2B	0.480	4.331	2.087	C89326	C98026
5/8-18	UNF	0.6250	4	2B	0.480	4.331	2.087	C89327	C98027
3/4-10	UNC	0.7500	4	2B	0.590	4.921	2.205	C89328	C98028
3/4-16	UNF	0.7500	4	2B	0.590	4.921	2.205	C89329	C98029
7/8-9	UNC	0.8750	4	2B	0.697	5.512	2.362	C89330	C98030
7/8-14	UNF	0.8750	4	2B	0.697	5.512	2.362	C89331	C98031
1-8	UNC	1.0000	4	2B	0.800	6.299	2.520	C89332	C98032
1-12	UNF	1.0000	4	2B	0.800	6.299	2.520	C89333	C98033

continued on next page

Styles: PER-893SF and PER-980SF (continued)

tap size and pitch d_1	thread form	decimal equiv.	no. of flutes	class of fit	shank diameter in	shank diameter mm	overall length L in	overall length L mm	thread length l in	thread length l mm	order number Black Oxide PER-893SF	order number Hardlube PER-980SF
M3x0.5	M	0.1181	3	6H	0.141	3.58	2.205	56	0.748	19	C89334	C98034
M3.5x0.6	M	0.1378	3	6H	0.141	3.58	2.205	56	0.787	20	C89335	C98035
M4x0.7	M	0.1575	3	6H	0.168	4.27	2.480	63	0.827	21	C89336	C98036
M5x0.8	M	0.1969	3	6H	0.194	4.93	2.756	70	1.024	26	C89337	C98037
M6x1	M	0.2362	3	6H	0.255	6.48	3.150	80	1.260	32	C89338	C98038
M7x1	M	0.2756	3	6H	0.318	8.08	3.150	80	1.181	30	C89339	C98039
M8x1	M	0.3150	3	6H	0.318	8.08	3.543	90	1.378	35	C89340	C98040
M8x1.25	M	0.3150	3	6H	0.318	8.08	3.543	90	1.378	35	C89341	C98041
M10x1.25	M	0.3937	3	6H	0.381	9.68	3.937	100	1.575	40	C89342	C98042
M10x1.5	M	0.3937	3	6H	0.381	9.68	3.937	100	1.575	40	C89343	C98043
M12x1.25	M	0.4724	3	6H	0.367	9.32	4.331	110	1.575	40	C89344	C98044
M12x1.75	M	0.4724	3	6H	0.367	9.32	4.331	110	1.575	40	C89345	C98045
M14x1.5	M	0.5512	3	6H	0.429	10.9	4.331	110	1.772	45	C89346	C98046
M14x2	M	0.5512	3	6H	0.429	10.9	4.331	110	1.772	45	C89347	C98047
M16x1.5	M	0.6299	4	6H	0.480	12.19	4.331	110	2.087	53	C89348	C98048
M16x2	M	0.6299	4	6H	0.480	12.19	4.331	110	2.087	53	C89349	C98049
M18x1.5	M	0.7087	4	6H	0.542	13.77	4.921	125	2.165	55	C89350	C98050
M18x2.5	M	0.7087	4	6H	0.542	13.77	4.921	125	2.165	55	C89351	C98051
M20x2.5	M	0.7874	4	6H	0.650	16.51	5.512	140	2.480	63	C89352	C98052
M22x2.5	M	0.8661	4	6H	0.697	17.70	5.512	140	2.362	60	C89353	C98053
M24x3.0	M	0.9449	4	6H	0.760	19.30	6.299	160	2.598	66	C89354	C98054

Spiral Flute Taps

Material Reference

	Steel (HRc)				Stainless Steel			Cast Iron (HRc)		Aluminum and Non-Ferrous	Hi-Temp Alloy		Hardened Steel (HRc)
	Low Carbon		Alloy		Austenitic	Martensitic	PH	Gray	Nodular		Ni, Co, Fe Based Super Alloy	Titanium	
Hardness	13-38	>38	16-38	> 38	300 Series	400 series		18-22	22-32				>45
Black Oxide	✦		✦		✦	✦		✦	✦				
Hardlube	☆	✦	☆	✦	☆	☆	☆	☆	☆				

☆ = Best Performance ✦ = Acceptable

These taps were developed for the highest cutting performance to cope with the increasing demands placed on industrial thread cutting. By optimizing the cutting geometry, substrate material, and surface treatment the tap will achieve the best results in CNC as well as in conventional thread cutting environments.

Our **Progress series** taps are designed to be a "Universal" tool that performs well in a wide range of Steel Alloys as well as Stainless Steels and Ductile Irons.

Our **Performance series** taps are designed for those difficult jobs using Stainless Steel as well as Steel Alloys and Ductile Irons.

Material		Application *1 = First Choice, 2 = Second Choice, (3) = Also Suitable* Black Oxide	TiAlN	Hardlube	Tapping Speed (SFM) Vc = SFM RPM = (SFM/Diameter) x 3.82 Black Oxide	TiAlN	Hardlube
Structural steels < 1000 N/mm^2	G01		1		40	73	77
Structural steels > 1000 N/mm^2	G02		(3)	1	27	40	42
Case hardening steels < 1000 N/mm^2	G03		2	1	33	66	70
Case hardening steels > 1000 N/mm^2	G04		(3)	1	20	33	35
Heat treatable steels < 1000 N/mm^2	G05		2	1	20	46	49
Heat treatable steels > 1000 N/mm^2	G06		(3)	1	14	27	29
Nitriding steels	G07	(3)	2	1	14	27	29
Carbon tool steels	G08		1	2	20	30	32
Heat Resisting Steels < 1400 N/mm^2	G09	(3)	(3)	1	14	23	25
Cr Stainless Steels, Sulphured	G10	(3)	(3)	1	20	33	35
Cr Stainless Steels, Ferric & Martensitic	G11	(3)	(3)	1	20	33	35
Cr-Ni Stainless Steels, Austenitic	G12	(3)	(3)	1	17	27	29
Free Cutting Steels	G13		1		46	79	83
Cast Steels < 1000 N/mm^2	G14		1		33	53	56
Cast Steels > 900 N/mm^2	G15		2	1	20	27	29
Malleable Cast Iron	G16		(3)		33	53	56
Nodular Graphite Cast Iron	G17		(3)		40	53	56
Lamellar Graphite Cast Iron (Grey Cast Iron)	G18		(3)		33	46	49
Vermicular Graphite Cast Iron	G19		(3)		40	53	56
Copper	G20		(3)		33	53	56
Hard Brass -- Short Chipping	G21		(3)		66	115	121
Soft Brass -- Long Chipping	G22		(3)		60	109	115
Red Brass	G23		(3)		33	60	63
Phosphor Bronze	G24		(3)		40	69	73
Aluminum Alloy - Wrought	G25		(3)		50	79	83
Aluminum Alloy - Cast (0.5% to 5% Silicon)	G26		(3)		66	86	91
Aluminum Alloy - Cast (5% to 10% Silicon)	G27		(3)		66	86	91
Aluminum Alloy - Cast (> 10% Silicon)	G28		(3)		66	86	91
Magnesium Alloy - Wrought	G29		(3)		50	79	83
Magnesium Alloy - Cast	G30		(3)		66	86	91
Nickel Alloy	G31		(3)		14	20	21
Titanium Alloy	G32		(3)		14	20	21
Ferro - TIC	G33		(3)		14	20	21
Thermoplastic Compounds/Synthetics	G34		(3)		66	66	70
High Strength Structural Steels - Fine Grained	G35		(3)		20	33	35

Carbide Thread Mills

The perfect solution for your most demanding jobs

CLEVELAND

Mini Thread Mills

- Solid carbide
- AlCrN coating
- Available in 2x, 3x the diameter of the tool

Thread Mills

- Helical flute design reduces thread chatter
- Ideal for internal and external threads
- Advanced TiAlN coating
- Available in solid and coolant-thru styles

Thread Mill Product Index

Thread Mills

	Type	Style	Page	Tool Material: HSS	Tool Material: Cobalt	Tool Material: Carbide	Thread: UNC	Thread: UNF	Thread: NPT	Thread: NPTF	Thread: Metric Coarse	Thread: Metric Fine	Thread: BSPP	Thread: BSPT	Thread: DIN	Application: Steel	Application: Stainless	Application: Cast Iron	Application: Non-Ferrous	Application: Special Alloy	Application: Hardened Steel	Coolant: Non	Coolant: Thru	Surface Treatment: TiAlN	Surface Treatment: AlCrN	Surface Treatment: Hardlube
	**Mini**	**CMTM2, CMTMM2**	17			•	•	•			•	•				•	•	•	•	•	•	•			•	
	Mini	**CMTM3, CMTMM3**	18			•	•	•			•	•				•	•	•	•	•	•	•			•	
	General Purpose - Inch	**CTM, CTMC**	19			•	•	•								•	•	•		•	•	•	•	•		
	General Purpose - Metric	**CTMM, CTMMC**	20			•									•	•	•	•		•	•	•	•	•		
	National Pipe Tapered	**CTMNP, CTMNPC**	20			•			•	•						•	•	•		•	•	•	•	•		
	British Pipe Tapered	**CTMBPP, CTMBPPC**	21			•							•			•	•	•		•	•	•	•	•		
	British Pipe Parallel	**CTMBPT, CTMBPTC**	21			•								•		•	•	•		•	•	•	•	•		

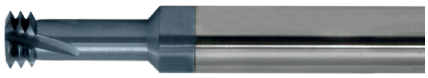
Note

Technical Information found at the end of the ***Threading*** section

Mini Thread Mills

Designed for your most demanding jobs.

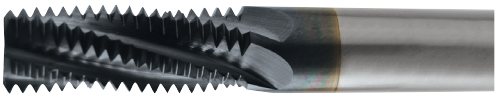
- 2x Dia. Sizes: 1-64 to 1/2-13, M1.6x0.35 to M12x1.75
  1-72 to 7/16-20, M3.5-M16x0.5 to M12-M48x1.50
- 3x Dia. Sizes: 2/56 to 5/16x18, M1.6x.035 to M8x1.25
  1-72 to 5/16x24, M3.5-M16x0.5 to M8-M40x1.0



Thread Mills

Provides a stronger, cleaner thread

- Sizes: 6-32 to 1-12, M4x0.70 to M20x3.00
  1/16-27 to 1-11.5 (NP)



Style: CMTM2

Note

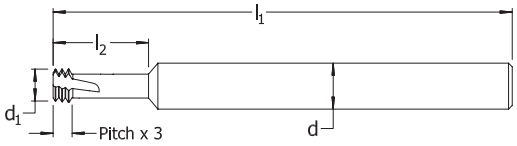
Formula: $2 \times d_1$ ($l_2 \leq 2 \times$ Thread Diameter)

* Bore diameter applies to the smallest thread diameter.

For Internal & External Threads

Carbide

Surface Treatment: AlCrN



Feature:

Excel in internal deep threads in hard to cut materials.

American UN UNC	American UN UNF	thread TPI	thread pitch	shank diameter d	cutting diameter d_1	overall length l_1	cut depth l_2	pitch x 3 thread length	no. of flutes	no. of teeth	*bore dia.	order number CMTM2
	1-72	72	0.014	1/4	.057	2.5	.154	0.042	3	3	.060	C95102
1-64	2-64	64	0.016	1/4	.057	2.5	.165	0.047	3	3	.060	C95103
2-56	3-56	56	0.018	1/4	.065	2.5	.197	0.054	3	3	.069	C95104
3-48	4-48	48	0.021	1/4	.075	2.5	.236	0.063	3	3	.080	C95105
4, 5-40	6-40	40	0.025	1/4	.085	2.5	.236	0.075	3	3	.090	C95106
	8-36	36	0.028	1/4	.115	2.5	.343	0.083	3	3	.125	C95107
6, 8-32	10-32	32	0.031	1/4	.100	2.5	.292	0.094	3	3	.110	C95108
8-32	10-32	32	0.031	1/4	.120	2.5	.394	0.094	3	3	.130	C95109
	1/4"x28	28	0.036	1/4	.180	2.5	.520	0.107	3	3	.190	C95110
10-24	5/16"x24	24	0.042	1/4	.130	2.5	.400	0.125	3	3	.140	C95111
	5/16"x24	24	0.042	1/4	.240	2.5	.650	0.125	3	3	.255	C95112
1/4"x20	7/16"x20	20	0.05	1/4	.185	2.5	.530	0.150	3	3	.200	C95113
	7/16"x20	20	0.05	3/8	.340	3	.900	0.150	4	3	.355	C95114
3/8"x16		16	0.063	3/8	.290	3	.750	0.188	4	3	.307	C95115
7/16"x14		14	0.071	3/8	.340	3	.900	0.214	4	3	.355	C95116
1/2-13		13	0.077	3/8	.350	3	1.10	0.231	4	3	.415	C95117

Style: CMTMM2

Mini - Metric
2x Diameter

Note

Formula: $2 \times d_1$ ($l_2 \leq 2 \times$ Thread Diameter)

* Bore diameter applies to the smallest thread diameter.

For Internal & External Threads

Carbide

Surface Treatment: AlCrN

ISO metric M coarse	ISO metric M fine	pitch mm	pitch inch	shank diameter d mm	cutting diameter d_1 mm	overall length l_1 mm	cut depth l_2 mm	pitch x 3 thread length mm	no. of flutes	no. of teeth	*bore dia.	order number CMTMM2
M1.6x0.35		0.35	0.014	3.175	1.193	63.5	3.56	1.07	3	3	.050	C95127
M2x0.4		0.40	0.016	6.350	1.524	63.5	4.19	1.22	3	3	.065	C95128
M2.2x0.45		0.45	0.018	6.350	1.651	63.5	4.57	1.37	3	3	.070	C95129
M2.5x0.45		0.45	0.018	6.350	1.905	63.5	5.08	1.37	3	3	.080	C95130
M3x0.5	M3.5-M16x0.5	0.50	0.020	6.350	2.286	63.5	6.22	1.52	3	3	.095	C95131
M3.5x0.6		0.60	0.024	6.350	2.667	63.5	7.24	1.83	3	3	.111	C95132
M4x0.7		0.70	0.028	6.350	3.048	63.5	8.26	2.13	3	3	.126	C95133
M5x0.8		0.80	0.031	6.350	3.937	63.5	10.16	2.36	3	3	.161	C95134
M6x1.0	M8-M40x1.0	1.00	0.039	6.350	4.699	63.5	12.70	2.97	3	3	.193	C95135
M8x1.25		1.25	0.049	6.350	6.223	63.5	16.51	3.73	3	3	.257	C95136
M10x1.5	M12-M48x1.50	1.50	0.059	9.525	8.382	76.2	20.32	4.49	3	3	.343	C95137
M12x1.75		1.75	0.069	9.525	9.144	76.2	25.40	5.26	4	3	.395	C95138

Material Reference

	Steel (HRc)				Stainless Steel			Cast Iron (HRc)		Aluminum and Non-Ferrous	Hi-Temp Alloy		Hardened Steel (HRc)
	Low Carbon		Alloy		Austenitic	Martensitic	PH	Gray	Nodular		Ni, Co, Fe Based Super Alloy	Titanium	
Hardness	13-38	>38	16-38	> 38	300 Series	400 series		18-22	22-32				>45
AlCrN	✦	☆	✦	☆	☆	☆	☆	✦	✦	✦	☆	☆	☆

☆ = Best Performance ✦ = Acceptable

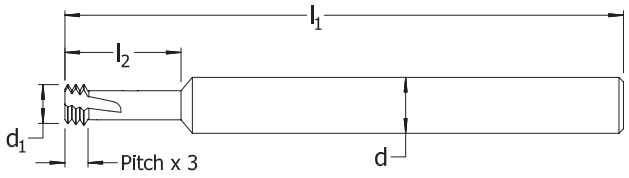
Mini Thread Mills

Mini - Inch
3x Diameter

Style: CMTM3

Note
Formula: *3 x d_1 ($l_2 \leq$ 3 x Thread Diameter)*
** Bore diameter applies to the smallest thread diameter.*
For Internal & External Threads

Carbide | Surface Treatment: AlCrN



American UN UNC	American UN UNF	thread TPI	thread pitch	shank diameter d	cutting diameter d_1	overall length l_1	cut depth l_2	pitch x 3 thread length	no. of flutes	no. of teeth	*bore dia.	order number CMTM3
	1-72	72	0.014	1/4	.057	2.5	.240	0.042	3	3	.060	C95118
2-56	3-56	56	0.018	1/4	.065	2.5	.260	0.054	3	3	.069	C95119
4, 5-40	6-40	40	0.025	1/4	.085	2.5	.310	0.075	3	3	.090	C95120
5-40	6-40	40	0.025	1/4	.100	2.5	.400	0.075	3	3	.110	C95121
8-32	10-32	32	0.031	1/4	.120	2.5	.500	0.094	3	3	.130	C95122
	1/4"x28	28	0.036	1/4	.180	2.5	.750	0.107	3	3	.190	C95123
1/4"x20	7/16"x20	20	0.05	1/4	.185	2.5	.750	0.150	3	3	.200	C95124
	5/16"x24	24	0.042	1/4	.240	2.5	.940	0.125	3	3	.255	C95125
5/16"x18		18	0.056	1/4	.240	2.5	.900	0.167	3	3	.255	C95126

Mini - Metric
3x Diameter

Style: CMTMM3

Note
Formula: *3 x d_1 ($l_2 \leq$ 3 x Thread Diameter)*
** Bore diameter applies to the smallest thread diameter.*
For Internal & External Threads

Carbide | Surface Treatment: AlCrN

ISO metric M coarse	ISO metric M fine	pitch mm	pitch inch	shank diameter d mm	cutting diameter d_1 mm	overall length l_1 mm	cut depth l_2 mm	pitch x 3 thread length mm	no. of flutes	no. of teeth	*bore dia.	order number CMTMM3
M1.6x0.35		0.35	0.014	3.175	1.938	63.5	5.00	1.07	3	3	.050	C95139
M2x0.4		0.40	0.016	6.350	1.524	63.5	6.22	1.22	3	3	.065	C95140
M2.5x0.45		0.45	0.018	6.350	1.905	63.5	6.99	1.37	3	3	.080	C95141
M3x0.5	M3.5-M16x0.5	0.50	0.020	6.350	2.286	63.5	9.149	1.52	3	3	.095	C95142
M4x0.7		0.70	0.028	6.350	3.048	63.5	12.45	2.13	3	3	.126	C95143
M5x0.8		0.80	0.031	6.350	3.937	63.5	15.49	2.36	3	3	.161	C95144
M6x1.0	M8-M40x1.0	1.00	0.039	6.350	4.699	63.5	18.42	2.97	3	3	.193	C95145
M8x1.25		1.25	0.049	6.350	6.223	63.5	21.64	3.73	3	3	.257	C95146

Material Reference

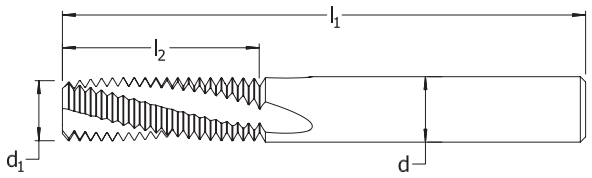
	Steel (HRc)				Stainless Steel			Cast Iron (HRc)		Aluminum and Non-Ferrous	Hi-Temp Alloy		Hardened Steel (HRc)
	Low Carbon		Alloy		Austenitic	Martensitic	PH	Gray	Nodular		Ni, Co, Fe Based Super Alloy	Titanium	
Hardness	13-38	>38	16-38	> 38	300 Series	400 series		18-22	22-32				>45
AlCrN	✦	☆	✦	☆	☆	☆	☆	✦	✦	✦	☆	☆	☆

☆ = Best Performance ✦ = Acceptable

Styles: CTM Solid and CTMC Coolant-Thru

Note
For Internal & External Threads

UNC UNF | Carbide | Surface Treatment: TiAlN



Feature:
Capable of producing right or left hand threads.

thread size	shank diameter d	cutting diameter d_1	overall length l_1	length of cut l_2	number of flutes	order number CTM non-coolant	order number CTMC coolant-thru
6-32	1/8	.095	2	.218	3	C95000	—
8-32	1/8	.115	2	.250	3	C95001	—
8-36	1/8	.115	2	.250	3	C95002	—
10-24	3/16	.120	2	.312	3	C95003	—
10-32	3/16	.120	2	.312	3	C95004	—
1/4-20	3/16	.180	2-1/2	.500	3	C95005	C95026
1/4-28	3/16	.180	2-1/2	.500	3	C95006	C95027
5/16-18	1/4	.240	2-1/2	.625	3	C95007	C95028
5/16-24	1/4	.240	2-1/2	.625	3	C95008	C95029
3/8-16	5/16	.290	3	.750	4	C95009	C95030
3/8-24	5/16	.290	3	.750	4	C95010	C95031
7/16-14	3/8	.340	3	.875	4	C95011	C95032
7/16-20	3/8	.340	3	.875	4	C95012	C95033
1/2-13	3/8	.350	3-1/2	.875	4	C95013	C95034
1/2-20	3/8	.350	3-1/2	.875	4	C95014	—
9/16-12	1/2	.370	3-1/2	.875	4	C95015	C95035
9/16-18	1/2	.370	3-1/2	.875	4	C95016	C95036
5/8-11	1/2	.470	3-1/2	1.250	5	C95017	C95037
5/8-18	1/2	.470	3-1/2	1.250	5	C95018	C95038
3/4-10	1/2	.495	3-1/2	1.250	5	C95019	C95039
3/4-12	1/2	.495	3-1/2	1.250	5	C95020	C95040
3/4-16	1/2	.495	3-1/2	1.250	5	C95021	C95041
7/8-9	1/2	.495	3-1/2	1.250	5	C95022	C95042
7/8-14	1/2	.495	3-1/2	1.250	5	C95023	C95043
1-8	3/4	.620	4	1.375	5	C95024	C95044
1-12	3/4	.620	4	1.375	5	C95025	C95045

Material Reference

	Steel (HRc)				Stainless Steel			Cast Iron (HRc)		Aluminum and Non-Ferrous	Hi-Temp Alloy		Hardened Steel (HRc)
	Low Carbon		Alloy		Austenitic	Martensitic	PH	Gray	Nodular		Ni, Co, Fe Based Super Alloy	Titanium	
Hardness	13-38	>38	16-38	> 38	300 Series	400 series		18-22	22-32				>45
TiAlN	☆	✦	☆	✦	☆	☆	☆	✦	✦		✦	✦	✦

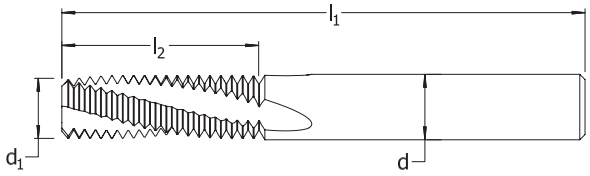
☆ = Best Performance ✦ = Acceptable

General Purpose
Metric - Helical Thread Mills

Styles: CTMM Solid and CTMMC Coolant-Thru

Note
For Internal & External Threads

DIN | Carbide | Surface Treatment: TiAlN



Feature:
Excellent option in difficult materials.

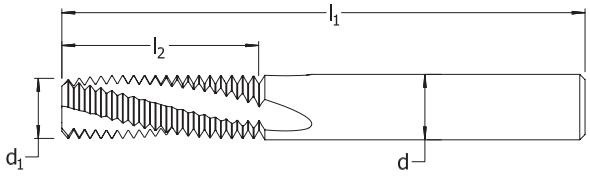
thread size	shank diameter d	cutting diameter d_1	overall length l_1	length of cut l_2	number of flutes	order number CTMM non-coolant	order number CTMMC coolant-thru
M4 X 0.70	1/8	.120	2	.250	2	C95072	—
M4.5 X 0.75	1/8	.120	2	.250	3	C95073	—
M5 X 0.80	3/16	.120	2	.312	3	C95074	C95088
M6 X 1.00	3/16	.170	2-1/2	.500	3	C95075	C95089
M8 X 0.75	1/4	.235	2-1/2	.625	3	C95076	C95090
M8 X 1.00	1/4	.235	2-1/2	.625	3	C95077	C95091
M8 X 1.25	1/4	.235	2-1/2	.625	3	C95078	C95092
M10 X 1.25	516	.300	3	.750	4	C95079	C95093
M10 X 1.50	5/16	.300	3	.750	4	C95080	C95094
M12 X 1.00	3/8	.360	3-1/2	.875	4	C95081	C95095
M12 X 1.25	3/8	.360	3-1/2	.875	4	C95082	C95096
M12 X 1.75	3/8	.360	3-1/2	.875	4	C95083	C95097
M14 X 1.50	3/8	.360	3-1/2	.875	4	C95084	C95098
M16 X 2.00	1/2	.470	3-1/2	1.250	5	C95085	C95099
M18 X 2.50	1/2	.470	3-1/2	1.250	5	C95086	C95100
M20 X 3.00	1/2	.470	3-1/2	1.250	5	C95087	C95101

National Pipe Tapered
Inch - Helical Thread Mills

Styles: CTMNP Solid and CTMNPC Coolant-Thru

Note
For Internal & External Threads

NPT NPTF | Carbide | Surface Treatment: TiAlN



Feature:
Designed to cut internal and external threads.

thread size	shank diameter d	cutting diameter d_1	overall length l_1	length of cut l_2	number of flutes	order number CTMNP non-coolant	order number CTMNPC coolant-thru
1/16-27	1/4	.245	2-1/2	.437	3	C95046	C95051
1/8-27	5/16	.310	2-1/2	.437	4	C95047	C95052
1/4, 3/8-18	3/8	.305	3	.625	4	C95048	C95053
1/2, 3/4-14	1/2	.495	3-1/2	.875	4	C95049	C95054
1-11.5	3/4	.620	4	1.125	5	C95050	C95055

Material Reference

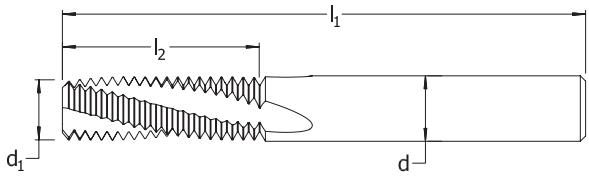
	Steel (HRc)				Stainless Steel			Cast Iron (HRc)		Aluminum and Non-Ferrous	Hi-Temp Alloy		Hardened Steel (HRc)
	Low Carbon		Alloy		Austenitic	Martensitic	PH	Gray	Nodular		Ni, Co, Fe Based Super Alloy	Titanium	
Hardness	13-38	>38	16-38	> 38	300 Series	400 series		18-22	22-32				>45
TiAlN	☆	✦	☆	✦	☆	☆	☆	✦	✦		✦	✦	✦

☆ = Best Performance ✦ = Acceptable

Styles: CTMBPP Solid and CTMBPPC Coolant-Thru

Note
For Internal & External Threads

BSPP | Carbide | Surface Treatment: TiAlN



Feature:
55 degree thread profile.

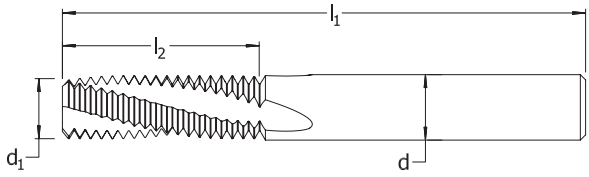
thread size	shank diameter d	cutting diameter d_1	overall length l_1	length of cut l_2	number of flutes	order number CTMBPP non-coolant	order number CTMBPPC coolant-thru
1/16, 1/8-28	1/4	.240	2-1/2	.572	3	C95056	C95060
1/4-19	5/16	.312	3	.737	4	C95057	C95061
1/2-14	1/2	.470	3-1/2	1.143	4	C95058	C95062
1-11	5/8	.620	4	1.546	5	C95059	C95063

Styles: CTMBPT Solid and CTMBPTC Coolant-Thru

British Pipe Parallel
Inch - Helical Thread Mills

Note
For Internal & External Threads

BSPT | Carbide | Surface Treatment: TiAlN



Feature:
55 degree thread profile.

thread size	shank diameter d	cutting diameter d_1	overall length l_1	length of cut l_2	number of flutes	order number CTMBPT non-coolant	order number CTMBPTC coolant-thru
1/16, 1/8-28	1/4	.240	2-1/2	.401	3	C95064	C95068
1/4-19	5/16	.312	3	.578	4	C95065	C95069
1/2-14	1/2	.470	3-1/2	.785	4	C95066	C95070
1-11	5/8	.620	4	1.546	5	C95067	C95071

Material Reference

	Steel (HRc)				Stainless Steel			Cast Iron (HRc)		Aluminum and Non-Ferrous	Hi-Temp Alloy		Hardened Steel (HRc)
	Low Carbon		Alloy		Austenitic	Martensitic	PH	Gray	Nodular		Ni, Co, Fe Based Super Alloy	Titanium	
Hardness	13-38	>38	16-38	> 38	300 Series	400 series		18-22	22-32				>45
TiAlN	☆	✦	☆	✦	☆	☆	☆	✦	✦		✦	✦	✦

☆ = Best Performance ✦ = Acceptable

Material	Class	Typical Grades	SFPM & Feed Inches per Tooth Tool Shank Diameter (Number of Flutes) 1/8" (3)	3/16" (3)	1/4" (3)	5/16" (4)	3/8" (4)	1/2" (5)	3/4" (5)
Steel	Plain & Low Carbon to 22Rc	1005,1020,1108-1119, 1213-1215, 1513-1518, 4012, 5015, 9310	600 .003	600 .003	600 .004	600 .005	600 .005	600 .006	600 .006
Medium Carbon & Alloy Steels	Carbon & Alloys 22 Rc to 32 RC	1025, 1130-1151, 1330-1345, 1520-1572, 4023-4063, 4120-4161, 4320-4340, 4620-4640, 8620-8660, 8720-8750, 6150, 51000, 52100	575 .001	575 .003	575 .002	575 .003	575 .003	575 .004	575 .004
Medium Carbon & Alloy Steels	Carbon & Alloys 32 Rc to 42 RC	1040-1095, 1140-1151, 1330-1345, 1520-1572, 4023-4063, 4120-4161, 4330-4340, 4620-4660, 8620-8660, 8740-8750, 6150, 51000, 52100	525 .0003	525 .0003	525 .0005	525 .0006	525 .0007	525 .001	525 .0015
Stainless Steels	Austenitic	301-304, 310, 316, 321, 347	525 .001	525 .001	525 .0015	525 .0015	525 .002	525 .003	525 .004
Stainless Steels	Martensitic	403, 410, 416, 420, 430, 431, 440C	550 .001	550 .001	550 .0015	550 .0015	550 .002	550 .003	550 .004
Stainless Steels	Precipitation Hardening	15-5PH, 17-4PH, AM350, AM355, AM363, PH13-8Mo, PH14-8Mo	300 .001	300 .001	300 .001	300 .0015	300 .0015	300 .002	300 .002
Nickel	Nickel Base Alloys	Inco 700, 713C, 718, Inconel X, Monel 400, 401, 404 & K401 Rene 41 Rene 95 Waspoloy, Udimet 500 & 700	120 .0005	120 .0005	120 .001	120 .001	120 .0015	120 .002	120 .001
Titanium	Titanium and Titanium Alloys	Pure Ti, Ti-6AL-4V, Ti-8Al-1Mo, Ti-&Al-4Mo	100 .0005	100 .0005	100 .001	100 .001	100 .0015	100 .002	100 .002
Cast Iron	Gray, Malleable & Ductile	A48, A220, A436, A319, A536, A602, J158, J434	600 .001	600 .0015	600 .0015	600 .002	600 .003	600 .004	600 .004
Non-Ferrous	Low Si & Cast Aluminum	6061, Free Machining Brass	1700 .002	1700 .002	1700 .003	1700 .003	1700 .004	1700 .005	1700 .005

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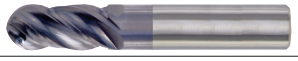
Cutting Diameter: 1/32" through 1": +0.000 – 0.002
Shank Diameter: h6

	Type	Style	Page	No. of Flutes	End Work: Square	Ball	Chamfer	Radius	Application: Steel	Stainless	Cast Iron	Non-Ferrous	High-Temp Alloy	Hardened Steel	Machining: Slot	Profile	Plunging	Ramping	Drilling	Chamfer	Slot w/ Radius	Surface Treatment: Bright	TiCN	TiAlN	AlCrN	ZrN	AP/MAX
Variable Index																											
	Variable Index Ferrous Material	CEM-V-4R	26	4	•			•	•	•			•	•	•	•	•	•			•	•						•
	Variable Index Ferrous Material	CEM-V-4B	29	4		•			•	•			•	•	•	•	•	•			•	•						•
	Variable Index Ferrous Material	CEM-V2-5R	30	5	•			•	•	•			•	•	•	•	•	•			•	•						•
	Variable Index Ferrous Material	CEM-V3-7R	32	7	•			•	•	•	•		•	•	•	•		•			•							•
	Variable Index Ferrous Material	CEM-V3-7RCB	34	7	•			•	•	•	•		•	•	•	•		•			•							•
Aluminum																											
	Aluminum Material	CEM-AM2	37	2	•							•			•		•	•	•			•				•		
	Aluminum Material	CEM-AM3	38	3	•							•			•	•	•	•				•				•		
PM Plus™																											
	Finisher High Helix	PM-539R	40	3	•			•				•			•	•		•			•	•	•					
	Finisher - Left - High Helix/Cut	PM-539L	41	3	•							•			•	•		•				•	•					
	Rougher Coarse Profile	PM-538R	42	3	•			•				•			•	•		•			•	•	•					
	Rougher - Left Low Helix/Cut	PM-538L	43	3	•			•				•			•	•		•			•	•						

Variable Index Carbide

End Mills are designed for hard to machine or difficult materials including stainless steel. These tools have an uneven indexing in the flutes which eliminates chatter. They are available with various corner radius's and surface treatments. This results in an improved finish on the part being machined and an extended tool life of 2-3 times longer than a conventional carbide end mill.

Aluminum

Delivers superior performance, providing increased tool life and improved part finish. The concentric margins stabilize the tool in the cut and reduce chatter at elevated speeds. Provide greater resistance to chipping with increased feed and speed rates over conventional carbide tools. The design incorporates rake enhancements in the flutes for improved chip flow and higher feed rates at high and low spindle speeds. Tool design eliminates excess pressure that causes chip packing. 3-flute square end gives superior surface finishes without sacrificing metal removal rates in high-speed slotting, profiling, and ramping applications.

PM Plus Finisher

3-flute design provides a superior surface finish in Aluminum Alloys. Powered Metal substrate improves edge strength and enhances tool life. Designed to be used in conjunction with the PM-538 rougher as a finishing tool.

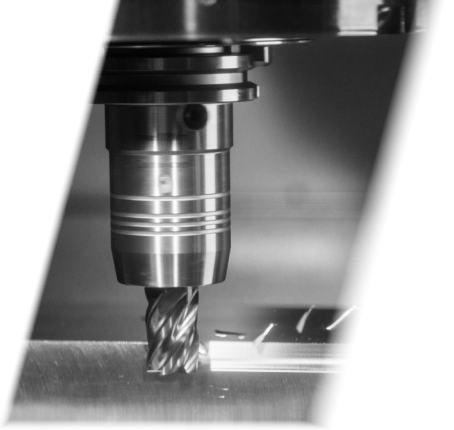
PM Plus Rougher

3-flute geometry designed specifically for machining Aluminum Alloys. Powered Metal substrate improves edge strength and enhances tool life. The unique combination of geometry and substrate provides performances that match carbide tooling.

Your Source for Fast Delivery Carbide End Mills

CLEVELAND

FAST MILL



High Quality Quick - *Fast* Delivery of Solid Carbide End Mills.

Specifications are industry standard unless specified on reverse side.

Quotes provided within **24-48 hours.**

Deliveries in the U.S., ship within **15 working days.**

Cleveland tools are made out of premium micro grain carbide material to give you the results you expect from the Cleveland brand.

The ***Fast Mill*** program is designed to provide Carbide End Mill specials for your demanding applications. **Most specials ship within 15 working days.** Call our knowledgeable sales team to assist in identifying the correct tool for your specific requirements.

Parameters

- Shank diameters (h6): .125" to 1.250"
- Cutting diameter to be smaller than shank diameter.
- Overall maximum length: 12.0"
- Maximum length of cut: 8.0"
- 2 to 10 flute with any helix or geometry.
- Diameters and radii of most sizes and tolerances.
- Minimum of 5 pieces.
- 2nd Day Air delivery anywhere within the United States.

Contact Name:

Quantity: (5 piece minimum)

End Design (Square, Ball)

Surface Finish (Specify Coating or *Best Available):

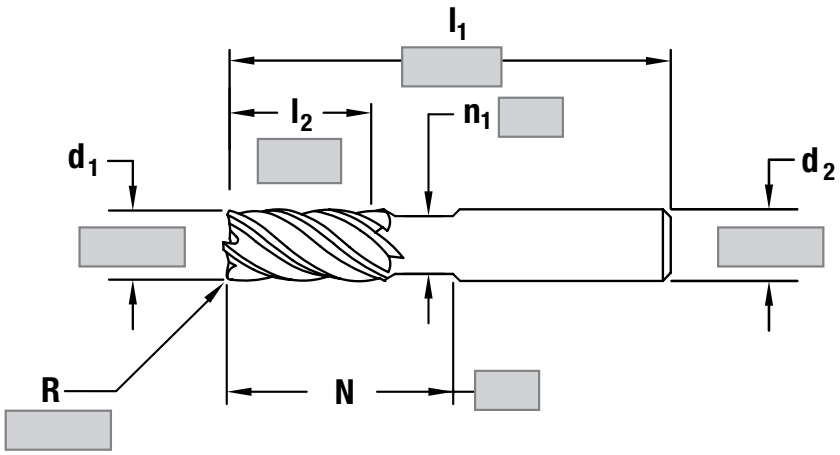
*Best available coating is based on workpiece material

Shank (Plain, Weldon):

Number of Flutes:

Workpiece Material: (Hardness)

Application / Additional Features:



For a **quote** reference *FastMill* and send to: standard.distributors@gfii.com

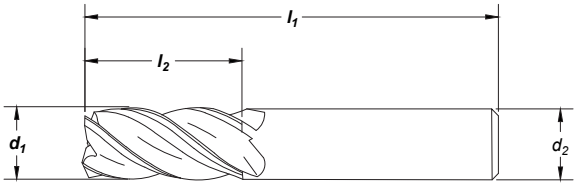
Greenfield Industries will help you save time and increase productivity in your toughest applications.

Style: CEM-V-4R

CLEVELAND

Note
**Weldon flats available 1/2" and larger.*

Solid Carbide | 4 Flute CC | Helix 38° | Radius End | Square End | Surface Treatment: Bright, AP/MAX



cutting diameter d_1 fractional	cutting diameter d_1 decimal	shank diameter d_2	length of cut l_2 (in)	overall length l_1 (in)	no. of flutes	corner radius	order number CEM-V-4R bright	order number CEM-V-4R AP/MAX
1/8	.1250	1/8	1/4	1-1/2	4	0.000	C60001	C80001
1/8	.1250	1/8	1/4	1-1/2	4	0.010	C60002	C80002
1/8	.1250	1/8	3/8	1-1/2	4	0.000	C60003	C80003
1/8	.1250	1/8	3/8	1-1/2	4	0.010	C60004	C80004
1/8	.1250	1/8	1/2	1-1/2	4	0.000	C60005	C80005
1/8	.1250	1/8	1/2	1-1/2	4	0.010	C60006	C80006
3/16	.1875	3/16	3/8	2	4	0.000	C60007	C80007
3/16	.1875	3/16	3/8	2	4	0.010	C60008	C80008
3/16	.1875	3/16	7/16	2	4	0.000	C60009	C80009
3/16	.1875	3/16	7/16	2	4	0.010	C60010	C80010
3/16	.1875	3/16	3/4	2-1/2	4	0.000	C60011	C80011
3/16	.1875	3/16	3/4	2-1/2	4	0.010	C60012	C80012
1/4	.2500	1/4	1/2	2	4	0.000	C60013	C80013
1/4	.2500	1/4	1/2	2	4	0.020	C60014	C80014
1/4	.2500	1/4	3/4	2-1/2	4	0.000	C60015	C80015
1/4	.2500	1/4	3/4	2-1/2	4	0.020	C60016	C80016
1/4	.2500	1/4	3/4	2-1/2	4	0.045	C60017	C80017
1/4	.2500	1/4	1-1/8	3	4	0.000	C60018	C80018
1/4	.2500	1/4	1-1/8	3	4	0.020	C60019	C80019
1/4	.2500	1/4	1-1/4	3	4	0.000	C60020	C80020
5/16	.3125	5/16	1/2	2	4	0.000	C60021	C80021
5/16	.3125	5/16	1/2	2	4	0.020	C60022	C80022
5/16	.3125	5/16	13/16	2-1/2	4	0.000	C60023	C80023
5/16	.3125	5/16	13/16	2-1/2	4	0.020	C60024	C80024
5/16	.3125	5/16	1-1/4	3	4	0.000	C60025	C80025
5/16	.3125	5/16	1-1/4	3	4	0.020	C60026	C80026
3/8	.3750	3/8	5/8	2	4	0.000	C60027	C80027
3/8	.3750	3/8	5/8	2	4	0.020	C60028	C80028
3/8	.3750	3/8	7/8	2-1/2	4	0.000	C60029	C80029
3/8	.3750	3/8	7/8	2-1/2	4	0.020	C60030	C80030
3/8	.3750	3/8	1-1/8	3	4	0.000	C60031	C80031
3/8	.3750	3/8	1-1/8	3	4	0.020	C60032	C80032
3/8	.3750	3/8	2	4	4	0.000	C60033	C80033
3/8	.3750	3/8	2	4	4	0.020	C60034	C80034

continued on next page

Style: CEM-V-4R (continued)

cutting diameter d_1 fractional	cutting diameter d_1 decimal	shank diameter d_2	length of cut l_2 (in)	overall length l_1 (in)	no. of flutes	corner radius	order number CEM-V-4R bright	order number CEM-V-4R AP/MAX
7/16	.4375	7/16	5/8	2-1/2	4	0.000	C60035	C80035
7/16	.4375	7/16	5/8	2-1/2	4	0.020	C60036	C80036
7/16	.4375	7/16	1	3	4	0.000	C60037	C80037
7/16	.4375	7/16	1	3	4	0.020	C60038	C80038
7/16	.4375	7/16	2	4	4	0.000	C60039	C80039
1/2*	.5000	1/2	5/8	2-1/2	4	0.000	C60040	C80040
1/2*	.5000	1/2	5/8	2-1/2	4	0.020	C60041	C80041
1/2*	.5000	1/2	5/8	2-1/2	4	0.030	C60042	C80042
1/2*	.5000	1/2	1	3	4	0.000	C60043	C80043
1/2*	.5000	1/2	1	3	4	0.030	C60044	C80044
1/2*	.5000	1/2	1	3	4	0.060	C60045	C80045
1/2*	.5000	1/2	1	3	4	0.090	C60046	C80046
1/2*	.5000	1/2	1	3	4	0.125	C60047	C80047
1/2*	.5000	1/2	1-1/4	3	4	0.000	C60048	C80048
1/2*	.5000	1/2	1-1/4	3	4	0.020	C60049	C80049
1/2*	.5000	1/2	1-1/4	3	4	0.030	C60050	C80050
1/2*	.5000	1/2	1-1/4	3	4	0.060	C60051	C80051
1/2*	.5000	1/2	1-1/4	3	4	0.090	C60052	C80052
1/2*	.5000	1/2	1-1/4	3	4	0.125	C60053	C80053
1/2*	.5000	1/2	2	4	4	0.000	C60054	C80054
1/2*	.5000	1/2	2	4	4	0.030	C60055	C80055
1/2*	.5000	1/2	2	4	4	0.060	C60056	C80056
1/2*	.5000	1/2	2	4	4	0.090	C60057	C80057
1/2*	.5000	1/2	2	4	4	0.125	C60058	C80058
5/8*	.6250	5/8	3/4	3	4	0.000	C60059	C80059
5/8*	.6250	5/8	3/4	3	4	0.030	C60060	C80060
5/8*	.6250	5/8	1-1/4	3-1/2	4	0.000	C60061	C80061
5/8*	.6250	5/8	1-1/4	3-1/2	4	0.030	C60062	C80062
5/8*	.6250	5/8	1-1/4	3-1/2	4	0.060	C60063	C80063
5/8*	.6250	5/8	1-1/4	3-1/2	4	0.090	C60064	C80064
5/8*	.6250	5/8	1-1/4	3-1/2	4	0.125	C60065	C80065
5/8*	.6250	5/8	2-1/4	5	4	0.000	C60066	C80066
5/8*	.6250	5/8	2-1/4	5	4	0.030	C60067	C80067
5/8*	.6250	5/8	2-1/4	5	4	0.060	C60068	C80068
5/8*	.6250	5/8	2-1/4	5	4	0.090	C60069	C80069
5/8*	.6250	5/8	2-1/4	5	4	0.125	C60070	C80070

** Weldon flats available on 1/2" and over, please specify when ordering and call customer service for pricing.*

continued on next page

Material Reference

	Steel (HRc)				Stainless Steel			Cast Iron (HRc)		Aluminum and Non-Ferrous	Hi-Temp Alloy		Hardened Steel (HRc)
	Low Carbon		Alloy		Austenitic	Martensitic	PH	Gray	Nodular		Ni, Co, Fe Based Super Alloy	Titanium	
Hardness	13-38	>38	16-38	> 38	300 Series	400 series		18-22	22-32				>45
AP/MAX	☆	✦	☆	✦	☆	☆	✦				☆	☆	✦

☆ = Best Performance ✦ = Acceptable

Style: CEM-V-4R (continued)

cutting diameter d_1 fractional	cutting diameter d_1 decimal	shank diameter d_2	length of cut l_2 (in)	overall length l_1 (in)	no. of flutes	corner radius	order number CEM-V-4R bright	order number CEM-V-4R AP/MAX
3/4*	.7500	3/4	7/8	3	4	0.030	C60071	C80071
3/4*	.7500	3/4	1	3	4	0.000	C60072	C80072
3/4*	.7500	3/4	1	3	4	0.030	C60073	C80073
3/4*	.7500	3/4	1-1/2	4	4	0.000	C60074	C80074
3/4*	.7500	3/4	1-1/2	4	4	0.030	C60075	C80075
3/4*	.7500	3/4	1-1/2	4	4	0.060	C60076	C80076
3/4*	.7500	3/4	1-1/2	4	4	0.090	C60077	C80077
3/4*	.7500	3/4	1-1/2	4	4	0.125	C60078	C80078
3/4*	.7500	3/4	2-1/4	5	4	0.000	C60079	C80079
3/4*	.7500	3/4	2-1/4	5	4	0.030	C60080	C80080
3/4*	.7500	3/4	2-1/4	5	4	0.060	C60081	C80081
3/4*	.7500	3/4	2-1/4	5	4	0.090	C60082	C80082
3/4*	.7500	3/4	2-1/4	5	4	0.125	C60083	C80083
1*	1.0000	1	1-1/2	4	4	0.000	C60084	C80084
1*	1.0000	1	1-1/2	4	4	0.030	C60085	C80085
1*	1.0000	1	1-1/2	4	4	0.060	C60086	C80086
1*	1.0000	1	1-1/2	4	4	0.090	C60087	C80087
1*	1.0000	1	1-1/2	4	4	0.125	C60088	C80088
1*	1.0000	1	2-1/4	5	4	0.000	C60089	C80089
1*	1.0000	1	2-1/4	5	4	0.030	C60090	C80090
1*	1.0000	1	2-1/4	5	4	0.060	C60091	C80091
1*	1.0000	1	2-1/4	5	4	0.090	C60092	C80092
1*	1.0000	1	2-1/4	5	4	0.125	C60093	C80093
1*	1.0000	1	3	6	4	0.000	C60094	C80094
1*	1.0000	1	3	6	4	0.030	C60095	C80095
1*	1.0000	1	3	6	4	0.060	C60096	C80096
1*	1.0000	1	3	6	4	0.090	C60097	C80097
1*	1.0000	1	3	6	4	0.125	C60098	C80098

** Weldon flats available on 1/2" and over, please specify when ordering and call customer service for pricing.*

Material Reference

	Steel (HRc)				Stainless Steel			Cast Iron (HRc)		Aluminum and Non-Ferrous	Hi-Temp Alloy		Hardened Steel (HRc)
	Low Carbon		Alloy		Austenitic	Martensitic	PH	Gray	Nodular		Ni, Co, Fe Based Super Alloy	Titanium	
Hardness	13-38	>38	16-38	> 38	300 Series	400 series		18-22	22-32				>45
AP/MAX	☆	✦	☆	✦	☆	☆	✦				☆	☆	✦

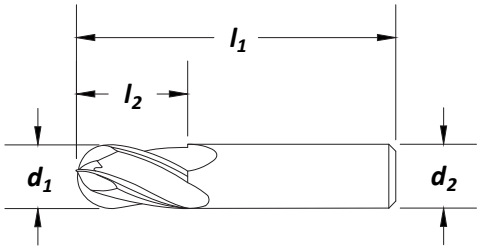
☆ = Best Performance ✦ = Acceptable

Styles: CEM-V-4B

Note
**Weldon flats available 1/2" and larger.*

Solid Carbide | 4 Flute CC | Helix 38° | Ball End

Surface Treatment: Bright | AP/MAX



cutting diameter d_1 fractional	cutting diameter d_1 decimal	shank diameter d_2	length of cut l_2 (in)	overall length l_1 (in)	no. of flutes	order number CEM-V-4B bright	order number CEM-V-4B AP/MAX
1/8	.1250	1/8	3/8	1-1/2	4	C60108	C80108
3/16	.1875	3/16	7/16	2	4	C60109	C80109
1/4	.2500	1/4	3/4	2-1/2	4	C60110	C80110
5/16	.3125	5/16	13/16	2-1/2	4	C60111	C80111
3/8	.3750	3/8	7/8	2-1/2	4	C60112	C80112
7/16	.4375	7/16	1	3	4	C60113	C80113
1/2	.5000	1/2	5/8	2-1/2	4	C60114	C80114
1/2*	.5000	1/2	1	3	4	C60115	C80115
5/8*	.6250	5/8	1-1/4	3-1/2	4	C60116	C80116
3/4*	.7500	3/4	1-1/2	4	4	C60117	C80117
1*	1.0000	1	2-1/4	5	4	C60118	C80118

** Weldon flats available on 1/2" and over, please specify when ordering and call customer service for pricing.*

Material Reference

	Steel (HRc)				Stainless Steel			Cast Iron (HRc)		Aluminum and Non-Ferrous	Hi-Temp Alloy		Hardened Steel (HRc)
	Low Carbon		Alloy		Austenitic	Martensitic	PH	Gray	Nodular		Ni, Co, Fe Based Super Alloy	Titanium	
Hardness	13-38	>38	16-38	> 38	300 Series	400 series		18-22	22-32				>45
AP/MAX	☆	✦	☆	✦	☆	☆	✦				☆	☆	✦

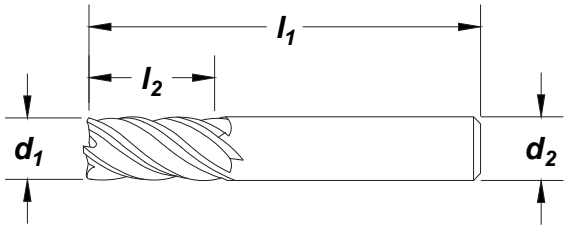
☆ = Best Performance ✦ = Acceptable

Styles: CEM-V2-5R

Note
For slotting up to 1 x D.
Minimized chatter from unequal flute spacing.
**Weldon flats available 1/2" and larger.*

Solid Carbide | 5 Flute CC | Helix 38° | Radius End | Square End

Surface Treatment: Bright | AP/MAX



Feature
Use one tool for roughing and finishing operations. **Improved Geometry**

cutting diameter d_1 fractional	cutting diameter d_1 decimal	shank diameter d_2	length of cut l_2 (in)	overall length l_1 (in)	no. of flutes	corner radius	order number CEM-V2-5R bright	order number CEM-V2-5R AP/MAX
3/16	.1875	3/16	3/8	2	5	0.000	C60525	C80525
3/16	.1875	3/16	3/8	2	5	0.010	C60526	C80526
3/16	.1875	3/16	7/16	2	5	0.000	C60527	C80527
3/16	.1875	3/16	7/16	2	5	0.010	C60528	C80528
3/16	.1875	3/16	3/4	2-1/2	5	0.000	C60529	C80529
3/16	.1875	3/16	3/4	2-1/2	5	0.010	C60530	C80530
1/4	.2500	1/4	1/2	2	5	0.000	C60531	C80531
1/4	.2500	1/4	1/2	2	5	0.020	C60532	C80532
1/4	.2500	1/4	3/4	2-1/2	5	0.000	C60533	C80533
1/4	.2500	1/4	3/4	2-1/2	5	0.020	C60534	C80534
1/4	.2500	1/4	1-1/8	3	5	0.010	C60535	C80535
1/4	.2500	1/4	1-1/8	3	5	0.020	C60536	C80536
1/4	.2500	1/4	1-1/4	3	5	0.000	C60537	C80537
5/16	.3125	5/16	1/2	2	5	0.000	C60538	C80538
5/16	.3125	5/16	1/2	2	5	0.020	C60539	C80539
5/16	.3125	5/16	13/16	2-1/2	5	0.000	C60540	C80540
5/16	.3125	5/16	13/16	2-1/2	5	0.020	C60541	C80541
5/16	.3125	5/16	1-1/4	3	5	0.000	C60542	C80542
5/16	.3125	5/16	1-1/4	3	5	0.020	C60543	C80543
3/8	.3750	3/8	1/2	2	5	0.030	C60544	C80544
3/8	.3750	3/8	5/8	2	5	0.000	C60545	C80545
3/8	.3750	3/8	5/8	2	5	0.020	C60546	C80546
3/8	.3750	3/8	7/8	2-1/2	5	0.000	C60547	C80547
3/8	.3750	3/8	7/8	2-1/2	5	0.020	C60548	C80548
3/8	.3750	3/8	1-1/8	3	5	0.000	C60549	C80549
3/8	.3750	3/8	1-1/8	3	5	0.020	C60550	C80550
3/8	.3750	3/8	2	4	5	0.000	C60551	C80551
3/8	.3750	3/8	2	4	5	0.020	C60552	C80552
7/16	.4375	7/16	5/8	2-1/2	5	0.000	C60553	C80553
7/16	.4375	7/16	5/8	2-1/2	5	0.020	C60554	C80554
7/16	.4375	7/16	1	3	5	0.000	C60555	C80555
7/16	.4375	7/16	1	3	5	0.020	C60556	C80556
7/16	.4375	7/16	2	4	5	0.000	C60557	C80557
1/2*	.5000	1/2	5/8	2-1/2	5	0.000	C60558	C80558
1/2*	.5000	1/2	5/8	2-1/2	5	0.030	C60559	C80559
1/2*	.5000	1/2	1	3	5	0.000	C60560	C80560
1/2*	.5000	1/2	1	3	5	0.030	C60561	C80561
1/2*	.5000	1/2	1	3	5	0.060	C60562	C80562
1/2*	.5000	1/2	1	3	5	0.090	C60563	C80563
1/2*	.5000	1/2	1	3	5	0.125	C60564	C80564
1/2*	.5000	1/2	1-1/4	3	5	0.000	C60565	C80565
1/2*	.5000	1/2	1-1/4	3	5	0.020	C60566	C80566
1/2*	.5000	1/2	1-1/4	3	5	0.030	C60567	C80567
1/2*	.5000	1/2	1-1/4	3	5	0.060	C60568	C80568
1/2*	.5000	1/2	1-1/4	3	5	0.090	C60569	C80569

** Weldon flats available on 1/2" and over, please specify when ordering and call customer service for pricing.*

continued on next page

Style: CEM-V2-5R (continued)

cutting diameter d_1 fractional	cutting diameter d_1 decimal	shank diameter d_2	length of cut l_2 (in)	overall length l_1 (in)	no. of flutes	corner radius	order number CEM-V2-5R bright	order number CEM-V2-5R AP/MAX
1/2*	.5000	1/2	1-1/4	3	5	0.125	C60570	C80570
1/2*	.5000	1/2	2	4	5	0.000	C60571	C80571
1/2*	.5000	1/2	2	4	5	0.030	C60572	C80572
1/2*	.5000	1/2	2	4	5	0.060	C60573	C80573
1/2*	.5000	1/2	2	4	5	0.090	C60574	C80574
1/2*	.5000	1/2	2	4	5	0.125	C60575	C80575
5/8*	.6250	5/8	3/4	3	5	0.000	C60576	C80576
5/8*	.6250	5/8	3/4	3	5	0.030	C60577	C80577
5/8*	.6250	5/8	1-1/4	3-1/2	5	0.000	C60578	C80578
5/8*	.6250	5/8	1-1/4	3-1/2	5	0.030	C60579	C80579
5/8*	.6250	5/8	1-1/4	3-1/2	5	0.060	C60580	C80580
5/8*	.6250	5/8	1-1/4	3-1/2	5	0.090	C60581	C80581
5/8*	.6250	5/8	1-1/4	3-1/2	5	0.125	C60582	C80582
5/8*	.6250	5/8	2-1/4	5	5	0.000	C60583	C80583
5/8*	.6250	5/8	2-1/4	5	5	0.030	C60584	C80584
5/8*	.6250	5/8	2-1/4	5	5	0.060	C60585	C80585
5/8*	.6250	5/8	2-1/4	5	5	0.090	C60586	C80586
5/8*	.6250	5/8	2-1/4	5	5	0.125	C60587	C80587
3/4*	.7500	3/4	1	3	5	0.000	C60588	C80588
3/4*	.7500	3/4	1	3	5	0.015	C60511	C80511
3/4*	.7500	3/4	1	3	5	0.030	C60589	C80589
3/4*	.7500	3/4	1-1/2	4	5	0.000	C60590	C80590
3/4*	.7500	3/4	1-1/2	4	5	0.015	C60512	C80512
3/4*	.7500	3/4	1-1/2	4	5	0.030	C60591	C80591
3/4*	.7500	3/4	1-1/2	4	5	0.060	C60592	C80592
3/4*	.7500	3/4	1-1/2	4	5	0.090	C60593	C80593
3/4*	.7500	3/4	1-1/2	4	5	0.125	C60594	C80594
3/4*	.7500	3/4	2-1/4	5	5	0.000	C60595	C80595
3/4*	.7500	3/4	2-1/4	5	5	0.015	C60513	C80513
3/4*	.7500	3/4	2-1/4	5	5	0.030	C60596	C80596
3/4*	.7500	3/4	2-1/4	5	5	0.060	C60597	C80597
3/4*	.7500	3/4	2-1/4	5	5	0.090	C60598	C80598
3/4*	.7500	3/4	2-1/4	5	5	0.125	C60599	C80599
1*	1.0000	1	1-1/2	4	5	0.000	C60600	C80600
1*	1.0000	1	1-1/2	4	5	0.015	C60514	C80514
1*	1.0000	1	1-1/2	4	5	0.030	C60601	C80601
1*	1.0000	1	1-1/2	4	5	0.060	C60602	C80602
1*	1.0000	1	1-1/2	4	5	0.090	C60603	C80603
1*	1.0000	1	1-1/2	4	5	0.125	C60604	C80604
1*	1.0000	1	2-1/4	5	5	0.000	C60605	C80605
1*	1.0000	1	2-1/4	5	5	0.015	C60515	C80515
1*	1.0000	1	2-1/4	5	5	0.030	C60606	C80606
1*	1.0000	1	2-1/4	5	5	0.060	C60607	C80607
1*	1.0000	1	2-1/4	5	5	0.090	C60608	C80608
1*	1.0000	1	2-1/4	5	5	0.125	C60609	C80609
1*	1.0000	1	3	6	5	0.000	C60610	C80610
1*	1.0000	1	3	6	5	0.015	C60516	C80516
1*	1.0000	1	3	6	5	0.030	C60611	C80611
1*	1.0000	1	3	6	5	0.060	C60612	C80612
1*	1.0000	1	3	6	5	0.090	C60613	C80613
1*	1.0000	1	3	6	5	0.125	C60614	C80614

** Weldon flats available on 1/2" and over, please specify when ordering and call customer service for pricing.*

Material Reference

	Steel (HRc)				Stainless Steel			Cast Iron (HRc)		Aluminum and Non-Ferrous	Hi-Temp Alloy		Hardened Steel (HRc)
	Low Carbon		Alloy		Austenitic	Martensitic	PH	Gray	Nodular		Ni, Co, Fe Based Super Alloy	Titanium	
Hardness	13-38	>38	16-38	> 38	300 Series	400 series		18-22	22-32				>45
AP/MAX	☆	✦	☆	✦	☆	☆	✦				☆	☆	✦

☆ = Best Performance ✦ = Acceptable

Styles: CEM-V3-7R

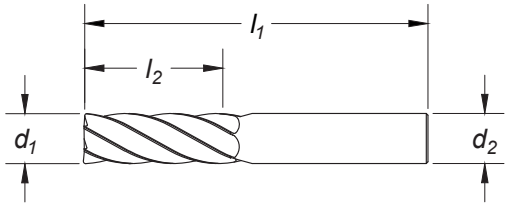
CLEVELAND

Note

Ideal for High Efficiency Machining (HEM)
Minimized chatter from unequal flute spacing.
**Weldon flats available 1/2" and larger.*

Solid Carbide | 7 Flute CC | Helix 38° | Radius End | Square End

Surface Treatment: AP/MAX



Feature

Use one tool for roughing and finishing operations.

cutting diameter d_1 fractional	cutting diameter d_1 decimal	shank diameter d_2	length of cut l_2 (in)	overall length l_1 (in)	no. of flutes	corner radius	order number CEM-V3-7R AP/MAX
3/8	0.375	3/8	3/4	2-1/2	7	0.000	C76270
3/8	0.375	3/8	3/4	2-1/2	7	0.015	C76271
3/8	0.375	3/8	3/4	2-1/2	7	0.030	C76272
3/8	0.375	3/8	15/16	2-1/2	7	0.000	C76273
3/8	0.375	3/8	15/16	2-1/2	7	0.015	C76274
3/8	0.375	3/8	15/16	2-1/2	7	0.030	C76275
3/8	0.375	3/8	1-1/8	3	7	0.000	C76276
3/8	0.375	3/8	1-1/8	3	7	0.015	C76277
3/8	0.375	3/8	1-1/8	3	7	0.030	C76278
3/8	0.375	3/8	1-1/2	3-1/2	7	0.000	C76279
3/8	0.375	3/8	1-1/2	3-1/2	7	0.015	C76280
3/8	0.375	3/8	1-1/2	3-1/2	7	0.030	C76281
1/2	0.500	1/2	5/8	2 1/2	7	0.000	C76372
1/2	0.500	1/2	5/8	2 1/2	7	0.015	C76373
1/2	0.500	1/2	5/8	2 1/2	7	0.030	C76374
1/2	0.500	1/2	1	3	7	0.000	C76282
1/2	0.500	1/2	1	3	7	0.030	C76283
1/2	0.500	1/2	1	3	7	0.060	C76284
1/2	0.500	1/2	1	3	7	0.090	C76285
1/2	0.500	1/2	1-1/4	3	7	0.000	C76286
1/2	0.500	1/2	1-1/4	3	7	0.015	C76375
1/2	0.500	1/2	1-1/4	3	7	0.030	C76287
1/2	0.500	1/2	1-1/4	3	7	0.060	C76288
1/2	0.500	1/2	1-1/4	3	7	0.090	C76289
1/2	0.500	1/2	1-1/2	3-1/2	7	0.000	C76290
1/2	0.500	1/2	1-1/2	3-1/2	7	0.030	C76291
1/2	0.500	1/2	1-1/2	3-1/2	7	0.060	C76292
1/2	0.500	1/2	1-1/2	3-1/2	7	0.090	C76293
1/2	0.500	1/2	2	4	7	0.000	C76294
1/2	0.500	1/2	2	4	7	0.030	C76295
1/2	0.500	1/2	2	4	7	0.060	C76296
1/2	0.500	1/2	2	4	7	0.090	C76297
1/2	0.500	1/2	2-1/4	4	7	0.000	C76298
1/2	0.500	1/2	2-1/4	4	7	0.030	C76299
1/2	0.500	1/2	2-1/4	4	7	0.060	C76300
1/2	0.500	1/2	2-1/4	4	7	0.090	C76301
5/8	0.625	5/8	1-7/8	4	7	0.000	C76302
5/8	0.625	5/8	1-7/8	4	7	0.030	C76303
5/8	0.625	5/8	1-7/8	4	7	0.060	C76304
5/8	0.625	5/8	1-7/8	4	7	0.090	C76305
5/8	0.625	5/8	2-1/4	4	7	0.000	C76306
5/8	0.625	5/8	2-1/4	4	7	0.030	C76307
5/8	0.625	5/8	2-1/4	4	7	0.060	C76308

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Styles: CEM-V3-7R

cutting diameter d_1 fractional	cutting diameter d_1 decimal	shank diameter d_2	length of cut l_2 (in)	overall length l_1 (in)	no. of flutes	corner radius	order number CEM-V3-7R AP/MAX
5/8	0.625	5/8	2-1/4	4	7	0.090	C76309
5/8	0.625	5/8	3	6	7	0.000	C76310
5/8	0.625	5/8	3	6	7	0.030	C76311
5/8	0.625	5/8	3	6	7	0.060	C76312
3/4	0.750	3/4	1-1/2	4	7	0.000	C76313
3/4	0.750	3/4	1-1/2	4	7	0.030	C76314
3/4	0.750	3/4	1-1/2	4	7	0.060	C76315
3/4	0.750	3/4	1-1/2	4	7	0.125	C76316
3/4	0.750	3/4	1-7/8	4	7	0.000	C76317
3/4	0.750	3/4	1-7/8	4	7	0.030	C76318
3/4	0.750	3/4	1-7/8	4	7	0.060	C76319
3/4	0.750	3/4	1-7/8	4	7	0.090	C76320
3/4	0.750	3/4	1-7/8	4	7	0.125	C76321
3/4	0.750	3/4	2-1/4	5	7	0.000	C76322
3/4	0.750	3/4	2-1/4	5	7	0.030	C76323
3/4	0.750	3/4	2-1/4	5	7	0.060	C76324
3/4	0.750	3/4	2-1/4	5	7	0.090	C76325
3/4	0.750	3/4	2-1/4	5	7	0.125	C76326
3/4	0.750	3/4	2-5/8	5	7	0.000	C76327
3/4	0.750	3/4	2-5/8	5	7	0.030	C76328
3/4	0.750	3/4	2-5/8	5	7	0.060	C76329
3/4	0.750	3/4	2-5/8	5	7	0.090	C76330
3/4	0.750	3/4	2-5/8	5	7	0.125	C76331
3/4	0.750	3/4	3	6	7	0.000	C76332
3/4	0.750	3/4	3	6	7	0.030	C76333
3/4	0.750	3/4	3	6	7	0.060	C76334
3/4	0.750	3/4	3	6	7	0.125	C76335
1	1.000	1	3	6	7	0.000	C76341
1	1.000	1	3	6	7	0.030	C76342
1	1.000	1	3	6	7	0.060	C76343
1	1.000	1	3	6	7	0.125	C76344
1	1.000	1	3-1/2	6	7	0.000	C76345
1	1.000	1	3-1/2	6	7	0.030	C76346
1	0.375	1	3-1/2	6	7	0.060	C76347
1	0.375	1	3-1/2	6	7	0.125	C76348

Material Reference

	Steel (HRc)				Stainless Steel			Cast Iron (HRc)		Aluminum and Non-Ferrous	Hi-Temp Alloy		Hardened Steel (HRc)
	Low Carbon		Alloy		Austenitic	Martensitic	PH	Gray	Nodular		Ni, Co, Fe Based Super Alloy	Titanium	
Hardness	13-38	>38	16-38	> 38	300 Series	400 series		18-22	22-32				>45
AP/MAX	☆	✦	☆	✦	☆	☆	✦	✦	✦		☆	☆	✦

☆ = Best Performance ✦ = Acceptable

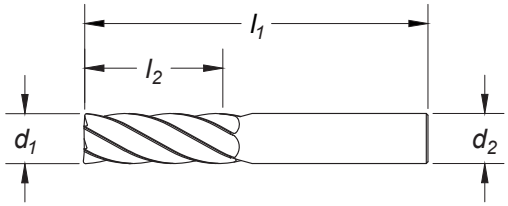
Styles: CEM-V3-7RCB

Note

Chip breaking geometry for improved High Efficiency Machining (HEM)
Ideal for High Efficiency Machining (HEM)
Minimized chatter from unequal flute spacing.
**Weldon flats available 1/2" and larger.*

Solid Carbide | 7 Flute CC | Helix 38° | Radius End | Square End

Surface Treatment: AP/MAX



Feature

Use one tool for roughing and finishing operations.

cutting diameter d_1 fractional	cutting diameter d_1 decimal	shank diameter d_2	length of cut l_2 (in)	overall length l_1 (in)	no. of flutes	corner radius	order number CEM-V3-7RCB AP/MAX
3/8	0.375	3/8	1-1/8	3	7	0.030	C76350
3/8	0.375	3/8	1-1/2	3-1/2	7	0.030	C76351
1/2	0.500	1/2	1-1/2	3-1/2	7	0.030	C76352
1/2	0.500	1/2	1-1/2	3-1/2	7	0.060	C76353
1/2	0.500	1/2	2	4	7	0.030	C76354
1/2	0.500	1/2	2	4	7	0.060	C76355
5/8	0.625	5/8	1-7/8	4	7	0.030	C76356
5/8	0.625	5/8	1-7/8	4	7	0.060	C76357
5/8	0.625	5/8	3	6	7	0.030	C76358
5/8	0.625	5/8	3	6	7	0.060	C76359
3/4	0.750	3/4	1-1/2	4	7	0.030	C76360
3/4	0.750	3/4	1-1/2	4	7	0.060	C76361
3/4	0.750	3/4	2-1/4	5	7	0.030	C76364
3/4	0.750	3/4	2-1/4	5	7	0.060	C76365
3/4	0.750	3/4	2-5/8	5	7	0.030	C76366
3/4	0.750	3/4	2-5/8	5	7	0.060	C76367
3/4	0.750	3/4	3	6	7	0.030	C76368
3/4	0.750	3/4	3	6	7	0.060	C76369
1	1.000	1	3	6	7	0.030	C76370
1	1.000	1	3	6	7	0.060	C76371

Material Reference

	Steel (HRc)				Stainless Steel			Cast Iron (HRc)		Aluminum and Non-Ferrous	Hi-Temp Alloy		Hardened Steel (HRc)
	Low Carbon		Alloy		Austenitic	Martensitic	PH	Gray	Nodular		Ni, Co, Fe Based Super Alloy	Titanium	
Hardness	13-38	>38	16-38	> 38	300 Series	400 series		18-22	22-32				>45
AP/MAX	☆	✦	☆	✦	☆	☆	✦	✦	✦		☆	☆	✦

☆ = Best Performance ✦ = Acceptable

The new Cleveland CEM-V3-7R High Performance 7 Flute Variable Index End Mills were specifically designed to excel at HEM Trochoidal Milling. High Efficiency Milling (HEM) is a style of machining that features high axial depths of cut and low radial depths of cut. One common type of HEM is Trochoidal Milling. The modified cutting depths in Trochoidal Milling allow the CNC Machine to implement a spiral machining pattern that reduces tool load and wear in a part. This is accomplished by allowing the end mill to alternate between repeated short cutting times within a part and longer spiral rotations outside of the part. Trochoidal Milling uses a much smaller tool diameter than one would typically use in slotting applications. By implementing this smaller tool, a wider slot in the part is created, allowing additional space for the chips produced and the spiral tool path of the end mill.

The process of Trochoidal Milling developed as a result of the theory of chip thinning. This theory holds that tools have an ideal chip load that creates chips with the perfect size and width. To prevent chips from thinning in the cut outside of this ideal range, it is best to maintain a higher chip load in the milling operation to maintain this ideal chip thickness. This need to maintain a higher and ever changing chip load while milling a part requires that HEM Trochoidal Milling only be attempted on CNC Machines with Trochoidal Milling capabilities.

Benefits:

- Lower heat and cycle times for machining applications.
- Better end mill tool life and accuracy.
- The ability to use one tool for multiple applications and different slots.

Challenges:

Trochoidal Milling must be used on a CNC Machine capable of running the changing feed rates necessary in this process with software adept at generating HEM Tool Paths.

Material	Peripheral/Roughing HEM		Speed (SFM)	Feed (IPT)						
	Axial DOC	Radial DOC		3/16	1/4	3/8	1/2	5/8	3/4	1
Gray Cast Iron	≤ 3 x D	.1 x D	400	0.002	0.003	0.005	0.007	0.009	0.010	0.014
	3 x D - 4 x D	.08 x D		0.002	0.003	0.004	0.006	0.007	0.009	0.012
Malleable Cast Iron	≤ 3 x D	.08 x D	400	0.002	0.002	0.004	0.005	0.007	0.008	0.011
	3 x D - 4 x D			0.001	0.002	0.003	0.004	0.006	0.007	0.009
Low Carbon Steels	≤ 3 x D	.08 x D	500	0.002	0.003	0.005	0.007	0.009	0.011	0.015
	3 x D - 4 x D		450	0.002	0.003	0.004	0.006	0.007	0.010	0.012
Medium Carbon Steels	≤ 3 x D	.08 x D	450	0.002	0.003	0.005	0.007	0.008	0.010	0.014
	3 x D - 4 x D			0.002	0.003	0.004	0.006	0.007	0.009	0.012
Tool and Die Steels	≤ 3 x D	.08 x D	400	0.002	0.003	0.004	0.006	0.008	0.009	0.012
	3 x D - 4 x D			0.002	0.002	0.004	0.005	0.006	0.008	0.01
Austenitic Stainless Steels, FeNi Alloys, 300 Series Stainless Steels	≤ 3 x D	.08 x D	400	0.002	0.003	0.004	0.006	0.008	0.009	0.012
	3 x D - 4 x D	.07 x D	450	0.002	0.002	0.004	0.005	0.006	0.008	0.01
Martensitic and Ferritic Stainless Steels	≤ 3 x D	.08 x D	450	0.002	0.003	0.005	0.007	0.009	0.011	0.015
	3 x D - 4 x D			0.002	0.003	0.004	0.006	0.007	0.009	0.012
Precipitation Hardening Stainless Steels	≤ 3 x D	.08 x D	450	0.002	0.003	0.004	0.006	0.007	0.009	0.012
	3 x D - 4 x D	.07 x D	400	0.002	0.002	0.003	0.005	0.006	0.007	0.01
Titanium Alloys	≤ 3 x D	.1 x D	400	0.001	0.002	0.003	0.004	0.005	0.006	0.008
	3 x D - 4 x D	.08 x D		0.001	0.001	0.002	0.003	0.004	0.005	0.007
Difficult to Machine Titanium Alloys	≤ 2.5 x D	.08 x D	350	0.001	0.002	0.003	0.004	0.005	0.006	0.008
	2.5 x D - 4 x D	.06 x D	300	0.001	0.001	0.002	0.003	0.004	0.005	0.006
Hi Temp Alloys	≤ 1.5 x D	.07 x D	100	0.003	0.004	0.007	0.009	0.011	0.014	0.018
	1.5 x D - 3 x D	.06 x D		0.002	0.003	0.005	0.007	0.009	0.011	0.015

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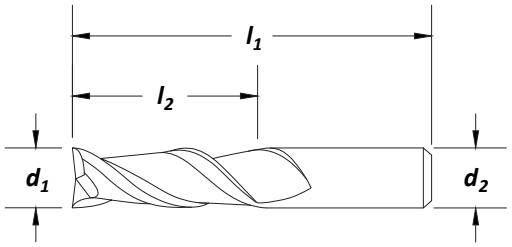
Material	Finishing		Speed (SFM)	Feed (IPT)						
	Axial DOC	Radial DOC		3/16	1/4	3/8	1/2	5/8	3/4	1
Gray Cast Iron	3 x D	.015 x D	450	0.001	0.001	0.002	0.002	0.003	0.003	0.005
Malleable Cast Iron			350	0.001	0.001	0.001	0.002	0.002	0.003	0.004
Low Carbon Steels			400	0.001	0.001	0.002	0.002	0.003	0.004	0.005
Medium Carbon Steels			400	0.001	0.001	0.001	0.002	0.003	0.003	0.005
Tool and Die Steels			350	0.001	0.001	0.001	0.002	0.002	0.003	0.004
Austenitic Stainless Steels, FeNi Alloys, 300 Series Stainless Steels			400	0.001	0.001	0.002	0.002	0.003	0.004	0.005
Martensitic and Ferritic Stainless Steels			400	0.001	0.001	0.001	0.002	0.003	0.003	0.005
Precipitation Hardening Stainless Steels			350	0.001	0.001	0.001	0.002	0.002	0.003	0.004
Titanium Alloys			350	0.001	0.001	0.001	0.001	0.002	0.002	0.003
Difficult to Machine Titanium Alloys		.01 x D	300	0.001	0.001	0.001	0.001	0.001	0.002	0.002
Hi Temp Alloys	2 x D		100	0.001	0.002	0.003	0.004	0.006	0.007	0.009

Style: CEM-AM2

Solid Carbide | 2 Flute CC | Helix 45° | Square End | Surface Treatment: Bright, ZrN



cutting diameter d_1 fractional	cutting diameter d_1 decimal	shank diameter d_2	length of cut l_2 (in)	overall length l_1 (in)	no. of flutes	order number CEM-AM2 bright	order number CEM-AM2 ZrN
1/8	.1250	1/8	1/4	1-1/2	2	C60477	C84000
1/8	.1250	1/8	3/8	1-1/2	2	C60478	C84001
3/16	.1875	3/16	5/16	2	2	C60479	C84002
3/16	.1875	3/16	9/16	2	2	C60480	C84003
1/4	.2500	1/4	3/8	2-1/2	2	C60481	C84004
1/4	.2500	1/4	3/4	2-1/2	2	C60482	C84005
1/4	.2500	1/4	1-1/4	3	2	C60483	C84006
5/16	.3125	5/16	7/16	2-1/2	2	C60484	C84007
5/16	.3125	5/16	13/16	2-1/2	2	C60485	C84008
5/16	.3125	5/16	1-1/4	3-3/4	2	C60486	C84009
5/16	.3125	5/16	2-1/8	4	2	C60487	C84010
3/8	.3750	3/8	1/2	2-1/2	2	C60488	C84011
3/8	.3750	3/8	1	2-1/2	2	C60489	C84012
3/8	.3750	3/8	1-1/2	4	2	C60490	C84013
3/8	.3750	3/8	2-1/2	6	2	C60491	C84014
7/16	.4375	7/16	9/16	2-1/2	2	C60492	C84015
7/16	.4375	7/16	1	2-1/2	2	C60493	C84016
7/16	.4375	7/16	2	4	2	C60494	C84017
1/2	.5000	1/2	5/8	3	2	C60495	C84018
1/2	.5000	1/2	1-1/4	3	2	C60496	C84019
1/2	.5000	1/2	2	4	2	C60497	C84020
1/2	.5000	1/2	3-1/8	6	2	C60498	C84021
5/8	.6250	5/8	3/4	3-1/2	2	C60499	C84022
5/8	.6250	5/8	1-5/8	4	2	C60500	C84023
5/8	.6250	5/8	2-1/2	5	2	C60501	C84024
5/8	.6250	5/8	3-3/4	6	2	C60502	C84025
3/4	.7500	3/4	1	4	2	C60503	C84026
3/4	.7500	3/4	1-5/8	4	2	C60504	C84027
3/4	.7500	3/4	3-1/4	6	2	C60505	C84028
1	1.0000	1	1-1/4	5	2	C60507	C84029
1	1.0000	1	2	5	2	C60508	C84030
1	1.0000	1	3-1/4	6	2	C60509	C84031
1	1.0000	1	4-1/8	7	2	C60510	C84032

Material Reference

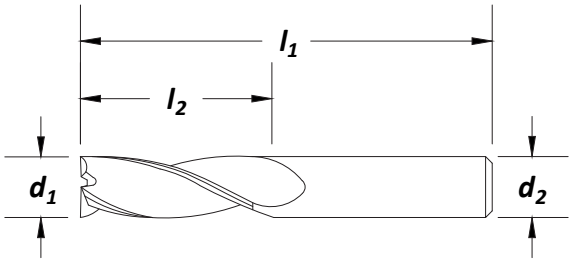
	Steel (HRc)				Stainless Steel			Cast Iron (HRc)		Aluminum and Non-Ferrous	Hi-Temp Alloy		Hardened Steel (HRc)
	Low Carbon		Alloy		Austenitic	Martensitic	PH	Gray	Nodular		Ni, Co, Fe Based Super Alloy	Titanium	
Hardness	13-38	>38	16-38	> 38	300 Series	400 series		18-22	22-32				>45
Bright										✦			
ZrN										☆			

☆ = Best Performance ✦ = Acceptable

Style: CEM-AM3

CLEVELAND

Solid Carbide | 3 Flute CC | Helix 35° | Square End | Surface Treatment: Bright, ZrN



cutting diameter d_1 fractional	cutting diameter d_1 decimal	shank diameter d_2	length of cut l_2 (in)	overall length l_1 (in)	no. of flutes	corner radius	order number CEM-AM3 bright	order number CEM-AM3 ZrN
1/8	.1250	1/8	1/4	1-1/2	3	.000	C60616	C72340
1/8	.1250	1/8	3/8	1-1/2	3	.000	C60617	C72341
1/8	.1250	1/8	3/8	1-1/2	3	.015	C72375	C84150
3/16	.1875	3/16	5/16	2	3	.000	C60618	C72342
3/16	.1875	3/16	9/16	2	3	.000	C60619	C72343
3/16	.1875	3/16	9/16	2	3	.015	C72376	C84151
1/4	.2500	1/4	3/8	2	3	.000	C60620	C72344
1/4	.2500	1/4	3/8	2	3	.015	C72377	C84152
1/4	.2500	1/4	3/8	2	3	.030	C72378	C84153
1/4	.2500	1/4	3/4	2-1/2	3	.000	C60621	C72345
1/4	.2500	1/4	3/4	2-1/2	3	.015	C72379	C84154
1/4	.2500	1/4	3/4	2-1/2	3	.030	C72380	C84155
1/4	.2500	1/4	1-1/4	3	3	.000	C60622	C72346
1/4	.2500	1/4	1-1/4	3	3	.015	C72381	C84156
1/4	.2500	1/4	1-1/4	3	3	.030	C72382	C84157
5/16	.3125	5/16	7/16	2	3	.000	C60623	C72347
5/16	.3125	5/16	5/8	2-1/2	3	.000	C60624	C72348
5/16	.3125	5/16	1-1/4	3-3/4	3	.000	C60625	C72349
5/16	.3125	5/16	1-1/4	3-3/4	3	.015	C72383	C84158
5/16	.3125	5/16	1-1/4	3-3/4	3	.030	C72384	C84159
5/16	.3125	5/16	2-1/8	4	3	.000	C60626	C72350
3/8	.3750	3/8	1/2	2	3	.000	C60627	C72351
3/8	.3750	3/8	1/2	2	3	.015	C72385	C84160
3/8	.3750	3/8	1	2-1/2	3	.000	C60628	C72352
3/8	.3750	3/8	1	2-1/2	3	.015	C72386	C84161
3/8	.3750	3/8	1	2-1/2	3	.030	C72387	C84162
3/8	.3750	3/8	1	2-1/2	3	.060	C72388	C84163
3/8	.3750	3/8	1-1/2	3-1/2	3	.000	C60629	C72353
3/8	.3750	3/8	1-1/2	3-1/2	3	.015	C72389	C84164
3/8	.3750	3/8	1-1/2	3-1/2	3	.030	C72390	C84165
3/8	.3750	3/8	1-1/2	3-1/2	3	.060	C72391	C84166
3/8	.3750	3/8	2-1/2	6	3	.000	C60630	C72354
7/16	.4375	7/16	9/16	2-1/2	3	.000	C60631	C72355
7/16	.4375	7/16	9/16	2-1/2	3	.015	C72392	C84167
7/16	.4375	7/16	9/16	2-1/2	3	.030	C72393	C84168
7/16	.4375	7/16	9/16	2-1/2	3	.060	C72394	C84169
7/16	.4375	7/16	1-1/4	2-1/2	3	.000	C60632	C72356
7/16	.4375	7/16	2	4	3	.000	C60633	C72357
1/2	.5000	1/2	5/8	2-1/2	3	.000	C60634	C72358
1/2	.5000	1/2	5/8	2-1/2	3	.060	C72395	C84170
1/2	.5000	1/2	1-1/4	3	3	.000	C60635	C72359
1/2	.5000	1/2	1-1/4	3	3	.015	C72396	C84171
1/2	.5000	1/2	1-1/4	3	3	.030	C72397	C84172

continued on next page

cutting diameter d_1 fractional	cutting diameter d_1 decimal	shank diameter d_2	length of cut l_2 (in)	overall length l_1 (in)	no. of flutes	corner radius	order number CEM-AM3 bright	order number CEM-AM3 ZrN
1/2	.5000	1/2	1-1/4	3	3	.060	C72398	C84173
1/2	.5000	1/2	1-1/4	3	3	.125	C72399	C84174
1/2	.5000	1/2	2	4	3	.000	C60636	C72360
1/2	.5000	1/2	2	4	3	.015	C72400	C84175
1/2	.5000	1/2	2	4	3	.030	C72401	C84176
1/2	.5000	1/2	2	4	3	.060	C72402	C84177
1/2	.5000	1/2	2	4	3	.125	C72403	C84178
1/2	.5000	1/2	2-1/2	4	3	.000	C72404	C84179
1/2	.5000	1/2	2-1/2	4	3	.015	C72405	C84180
1/2	.5000	1/2	2-1/2	4	3	.030	C72406	C84181
1/2	.5000	1/2	2-1/2	4	3	.060	C72407	C84182
1/2	.5000	1/2	2-1/2	4	3	.125	C72408	C84183
1/2	.5000	1/2	3-1/8	6	3	.000	C60637	C72361
1/2	.5000	1/2	3-1/8	6	3	.030	C72409	C84184
5/8	.6250	5/8	3/4	3	3	.000	C60638	C72362
5/8	.6250	5/8	3/4	3	3	.030	C72410	C84185
5/8	.6250	5/8	1-5/8	4	3	.000	C60639	C72363
5/8	.6250	5/8	1-5/8	4	3	.030	C72411	C84186
5/8	.6250	5/8	1-5/8	4	3	.125	C72412	C84187
5/8	.6250	5/8	2-1/2	5	3	.000	C60640	C72364
5/8	.6250	5/8	2-1/2	5	3	.030	C72413	C84188
5/8	.6250	5/8	2-1/2	5	3	.125	C72414	C84189
5/8	.6250	5/8	3-3/4	6	3	.000	C60641	C72365
5/8	.6250	5/8	3-3/4	6	3	.030	C72415	C84190
3/4	.7500	3/4	1	3	3	.000	C60642	C72366
3/4	.7500	3/4	1	3	3	.030	C72416	C84191
3/4	.7500	3/4	1	3	3	.060	C72417	C84192
3/4	.7500	3/4	1	3	3	.125	C72418	C84193
3/4	.7500	3/4	1-5/8	4	3	.000	C60643	C72367
3/4	.7500	3/4	1-5/8	4	3	.030	C72419	C84194
3/4	.7500	3/4	1-5/8	4	3	.060	C72420	C84195
3/4	.7500	3/4	1-5/8	4	3	.125	C72421	C84196
3/4	.7500	3/4	2-1/2	5	3	.000	C72422	C84197
3/4	.7500	3/4	2-1/2	5	3	.030	C72423	C84198
3/4	.7500	3/4	2-1/2	5	3	.060	C72424	C84199
3/4	.7500	3/4	2-1/2	5	3	.125	C72425	C84200
3/4	.7500	3/4	3-1/4	6	3	.000	C60644	C72368
3/4	.7500	3/4	3-1/4	6	3	.030	C72426	C84201
3/4	.7500	3/4	3-1/4	6	3	.125	C72427	C84202
1	1.0000	1	1-1/2	4	3	.000	C60645	C72369
1	1.0000	1	1-1/2	4	3	.030	C72428	C84203
1	1.0000	1	2	5	3	.000	C60646	C72370
1	1.0000	1	2	5	3	.030	C72429	C84204
1	1.0000	1	2-1/2	5	3	.000	C72430	C84205
1	1.0000	1	2-1/2	5	3	.030	C72431	C84206
1	1.0000	1	3-1/2	6	3	.000	C60647	C72371
1	1.0000	1	3-1/2	6	3	.030	C72432	C84207

Material Reference

	Steel (HRc)				Stainless Steel			Cast Iron (HRc)		Aluminum and Non-Ferrous	Hi-Temp Alloy		Hardened Steel (HRc)
	Low Carbon		Alloy		Austenitic	Martensitic	PH	Gray	Nodular		Ni, Co, Fe Based Super Alloy	Titanium	
Hardness	13-38	>38	16-38	> 38	300 Series	400 series		18-22	22-32				>45
Bright										✦			
ZrN										☆			

☆ = Best Performance ✦ = Acceptable

Aluminum End Mills

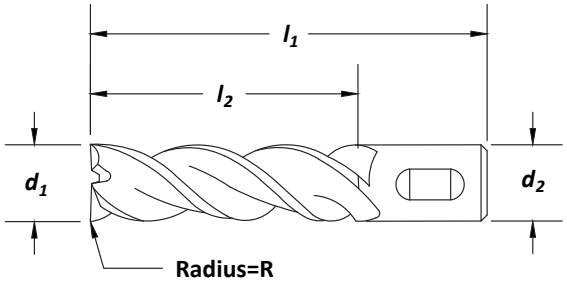
Finisher
PM Plus™, High Helix

Style: PM-539R

Note
Operating parameters begin on page 310.

POWDER METAL | ANSI SIZES | 3 Flute CC | Helix 42° | Radius End | Square End

Surface Treatment: Bright | TiCN



cutting diameter d_1	decimal equiv.	shank dia d_2 (in)	length of cut l_2 (in)	overall length l_1 (in)	no. of flutes	order number PM-539R Bright R = 0°	TiCN R = 0°	TiCN R = .060°	TiCN R = .090°	TiCN R = .120°
3/8	.3750	.375	.750	2.500	3	C40072	C40073	–	–	–
3/8	.3750	.375	1.500	3.250	3	C40074	C40075	–	–	–
1/2	.5000	.500	1.250	3.250	3	C40076	C40077	–	–	–
1/2	.5000	.500	2.000	4.000	3	C40078	C40079	–	–	–
1/2	.5000	.500	3.000	5.000	3	C40080	C40081	–	–	–
5/8	.6250	.625	1.625	3.750	3	C40082	C40083	–	–	–
5/8	.6250	.625	2.500	4.625	3	C40084	C40085	–	–	–
5/8	.6225	.625	3.000	5.125	3	C40086	C40087	–	–	–
3/4	.7500	.750	1.625	3.875	3	C40345	C40346	C40347	C40348	C40349
3/4	.7500	.750	2.250	4.500	3	C40390	C40391	C40392	C40393	C40394
3/4	.7500	.750	3.000	5.250	3	C40350	C40351	C40352	C40353	C40354
1	1.0000	1.000	2.000	4.500	3	C40355	C40356	C40357	C40358	C40359
1	1.0000	1.000	3.000	5.500	3	C40360	C40361	C40362	C40363	C40364
1	1.0000	1.000	4.000	6.500	3	C40365	C40366	C40367	C40368	C40369
1-1/4	1.2500	1.250	2.000	4.500	3	C40370	–	–	–	C40374
1-1/4	1.2500	1.250	3.000	5.500	3	C40375	–	–	–	C40379
1-1/4	1.2500	1.250	4.000	6.500	3	C40380	–	–	–	C40384
1-1/4	1.2500	1.250	6.000	8.500	3	C40385	–	–	–	–

Material Reference

	Steel (HRc)				Stainless Steel			Cast Iron (HRc)		Aluminum and Non-Ferrous	Hi-Temp Alloy		Hardened Steel (HRc)
	Low Carbon		Alloy		Austenitic	Martensitic	PH	Gray	Nodular		Ni, Co, Fe Based Super Alloy	Titanium	
Hardness	13-38	>38	16-38	> 38	300 Series	400 series		18-22	22-32				>45
Bright										✦			
TiCN										☆			

☆ = Best Performance ✦ = Acceptable

Style: PM-539L - Left

Note

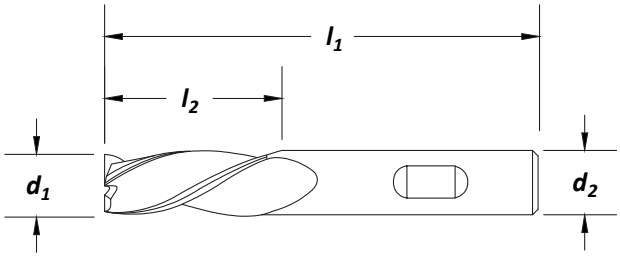
Left hand spiral.

Left hand cut.

Operating parameters begin on page 310.

POWDER METAL | ANSI SIZES | 3 Flute CC | Helix 42° | Square End | LHS / LHC

Surface Treatment: Bright | TiCN



cutting diameter d_1	decimal equiv.	shank dia d_2 (in)	length of cut l_2 (in)	overall length l_1 (in)	no. of flutes	order number PM-539L Bright	order number PM-539L TiCN
1/2	.5000	.500	1.250	3.250	3	C40295	–
1/2	.5000	.500	2.000	4.000	3	C40296	–
1/2	.5000	.500	3.000	5.000	3	C40297	–
5/8	.6250	.625	1.625	3.750	3	C40298	–
5/8	.6250	.625	2.500	4.625	3	C40299	–
3/4	.7500	.750	1.625	3.875	3	C40300	C40301
3/4	.7500	.750	3.000	5.250	3	C40305	C40306
1	1.0000	1.000	2.000	4.500	3	C40310	C40311
1	1.0000	1.000	3.000	5.500	3	C40315	C40316
1	1.0000	1.000	4.000	6.500	3	C40320	C40321

Tech Tip

The PM-539 Advantage

- Exceptional speeds in aluminum.
- Quiet, chatter-free machining and high shear cutting.

Material Reference

	Steel (HRc)				Stainless Steel			Cast Iron (HRc)		Aluminum and Non-Ferrous	Hi-Temp Alloy		Hardened Steel (HRc)
	Low Carbon		Alloy		Austenitic	Martensitic	PH	Gray	Nodular		Ni, Co, Fe Based Super Alloy	Titanium	
Hardness	13-38	>38	16-38	> 38	300 Series	400 series		18-22	22-32				>45
Bright										✦			
TiCN										☆			

☆ = Best Performance ✦ = Acceptable

Rougher
PM Plus™, Coarse Pitch

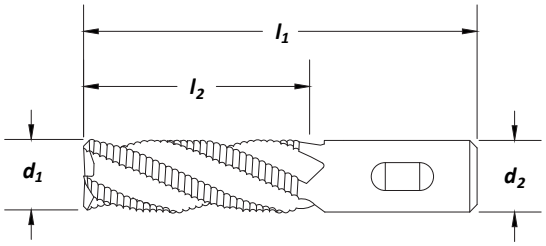
Style: PM-538R

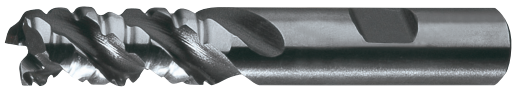
CLEVELAND

Note
Operating parameters begin on page 310.

POWDER METAL | ANSI SIZES | 3 Flute CC | Course Pitch | Radius End | Square End

Surface Treatment: Bright | TiCN





Feature:
For HIGH VOLUME aluminum roughing.

cutting diameter d_1	decimal equiv.	shank dia d_2 (in)	length of cut l_2 (in)	overall length l_1 (in)	no. of flutes	order number PM-538R Bright 0° R	TiCN 0° R	TiCN .060° R	TiCN .120°
1/2	.5000	.500	1.250	3.250	3	C40003	C40015	–	–
1/2	.5000	.500	2.000	4.000	3	C40004	C40016	–	–
5/8	.6250	.625	1.625	3.750	3	C40005	C40017	–	–
5/8	.6250	.625	2.500	4.625	3	C40006	C40018	–	–
3/4	.7500	.750	1.625	3.875	3	C40007	C40019	C40033	C40035
3/4	.7500	.750	2.250	4.500	3	C40062	C40063	C40064	C40066
3/4	.7500	.750	3.000	5.250	3	C40008	C40020	C40036	C40038
1	1.0000	1.000	2.000	4.500	3	C40009	C40021	C40039	C40041
1	1.0000	1.000	3.000	5.500	3	C40010	C40022	C40042	C40044
1	1.0000	1.000	4.000	6.500	3	C40011	C40023	C40045	C40047
1-1/4	1.2500	1.250	2.000	4.500	3	C40048	C40049	C40050	C40052
1-1/4	1.2500	1.250	3.000	5.500	3	C40012	C40024	C40053	C40055
1-1/4	1.2500	1.250	4.000	6.500	3	C40013	C40025	C40056	C40058
1-1/4	1.2500	1.250	6.000	8.500	3	C40014	C40026	C40059	C40061
1-1/2	1.5000	1.250	2.000	4.500	3	C43244	C43246	–	–
1-1/2	1.5000	1.250	3.000	5.500	3	C43247	C43249	–	–
1-1/2	1.5000	1.250	4.000	6.500	3	C43250	C43252	–	–
1-1/2	1.5000	1.250	6.000	8.500	3	C43253	C43255	–	–

Material Reference

	Steel (HRc)				Stainless Steel			Cast Iron (HRc)		Aluminum and Non-Ferrous	Hi-Temp Alloy		Hardened Steel (HRc)
	Low Carbon		Alloy		Austenitic	Martensitic	PH	Gray	Nodular		Ni, Co, Fe Based Super Alloy	Titanium	
Hardness	13-38	>38	16-38	> 38	300 Series	400 series		18-22	22-32				>45
Bright										✦			
TiCN										☆			

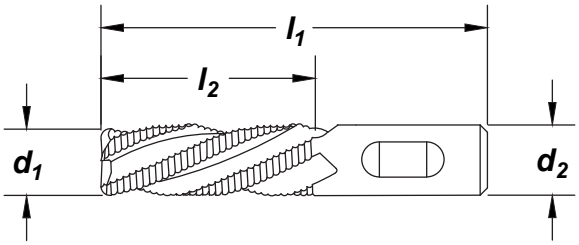
☆ = Best Performance ✦ = Acceptable

Style: PM-538L - Left

Note
Left Hand Spiral.
Left Hand Cut.

POWDER METAL | ANSI SIZES | 3 Flute CC | Fine Pitch | Helix 42° | Square End | LHS / LHC

Surface Treatment: Bright



cutting diameter d_1	decimal equiv.	shank dia d_2 (in)	length of cut l_2 (in)	overall length l_1 (in)	no. of flutes	order number PM-538L Bright 0° R
3/4	.7500	.750	1.625	3.875	3	C40400
3/4	.7500	.750	3.000	5.250	3	C40405
1	1.0000	1.000	2.000	4.500	3	C40410
1	1.0000	1.000	3.000	5.500	3	C40415
1	1.0000	1.000	4.000	6.500	3	C40420
1-1/4	1.2500	1.250	2.000	4.500	3	C40425
1-1/4	1.2500	1.250	3.000	5.500	3	C40430
1-1/4	1.2500	1.250	4.000	6.500	3	C40435
1-1/4	1.2500	1.250	6.000	8.500	3	C40440

Material Reference

	Steel (HRc)				Stainless Steel			Cast Iron (HRc)		Aluminum and Non-Ferrous	Hi-Temp Alloy		Hardened Steel (HRc)
	Low Carbon		Alloy		Austenitic	Martensitic	PH	Gray	Nodular		Ni, Co, Fe Based Super Alloy	Titanium	
Hardness	13-38	>38	16-38	> 38	300 Series	400 series		18-22	22-32				>45
Bright										☆			

☆ = Best Performance ✦ = Acceptable

Operating Parameters

*Style: CEM-V-4**

**4R or 4B*

Variable Index End Mills *V-4*

Tolerances for Solid Carbide End Mills

Cutting Diameter: 1/32" through 1": +0.000 –0.002

Shank Diameter: h6

Formula: Regular and **Stub Length**

Side milling axial = 1.5 x D Side milling radial = 0.5 x D Slotting axial = 1 x D

Material	Speed sfm	feed per tooth (inches) 5/32	3/16	1/4	5/16	3/8	1/2	5/8	3/4	1
easy to cut stainless steel (303)	340	0.0010	0.0012	0.0016	0.0020	0.0024	0.0026	0.0028	0.0028	0.0030
moderately difficult to cut stainless (304)	290	0.0008	0.0010	0.0014	0.0018	0.0020	0.0022	0.0024	0.0026	0.0028
difficult to cut stainless steels (316L)	240	0.0006	0.0010	0.0012	0.0016	0.0018	0.0020	0.0022	0.0024	0.0024
soft steels (1020)	600	0.0010	0.0012	0.0016	0.0024	0.0024	0.0028	0.0030	0.0031	0.0039
titanium alpha beta alloys (Ti6Al4V)	200	0.0005	0.0006	0.0008	0.0012	0.0012	0.0016	0.0018	0.0020	0.0028
gray cast iron (GG)	600	0.0010	0.0012	0.0016	0.0024	0.0024	0.0028	0.0030	0.0031	0.0039

Formula: Long Length

Side milling axial = 1.3 x D Side milling radial = 0.2 - 0.3 x D Slotting axial = 0.3 - 0.5 x D

Material	Speed sfm	feed per tooth (inches) 5/32	3/16	1/4	5/16	3/8	1/2	5/8	3/4	1
easy to cut stainless steel (303)	340	0.0009	0.0011	0.0014	0.0018	0.0022	0.0023	0.0025	0.0025	0.0027
moderately difficult to cut stainless (304)	290	0.0007	0.0009	0.0013	0.0016	0.0018	0.0020	0.0022	0.0023	0.0025
difficult to cut stainless steels (316L)	240	0.0005	0.0009	0.0011	0.0014	0.0016	0.0018	0.0020	0.0022	0.0022
soft steels (1020)	600	0.0009	0.0011	0.0014	0.0022	0.0022	0.0025	0.0027	0.0028	0.0035
titanium alpha beta alloys (Ti6Al4V)	200	0.0005	0.0005	0.0007	0.0011	0.0011	0.0014	0.0016	0.0018	0.0025
gray cast iron (GG)	600	0.0009	0.0011	0.0014	0.0022	0.0022	0.0025	0.0027	0.0028	0.0035

Operating Parameters

Style: CEM-V2-5R

Variable Index End Mills *V2-5R*

Formula: **ENHANCED GEOMETRY**

Side milling axial = 1.5 x D Side milling radial = 0.5 x D Slotting axial = 1 x D

Material	Speed sfm	chip load per tooth (inches) 3/16	1/4	5/16	3/8	1/2	5/8	3/4	1
medium and high carbon steels >0.3% C	600-750	0.0015	0.0021	0.0023	0.0026	0.0028	0.0030	0.0031	0.0039
alloy steels and tool steels <330HB, <35HRc	600-700	0.0011	0.0017	0.0020	0.0023	0.0028	0.0030	0.0031	0.0039
alloy steels and tool steels 340-450 HB, 36-48 HRc	525-625	0.0010	0.0015	0.0016	0.0020	0.0028	0.0030	0.0031	0.0039
austenitic stainless steel 302, 303, 304	350-445	0.0011	0.0017	0.0020	0.0023	0.0022	0.0024	0.0026	0.0028
austenitic stainless steel 316, 316L	225-315	0.0009	0.0013	0.0016	0.0019	0.0020	0.0024	0.0024	0.0024
austenitic stainless steel duplex	190-230	0.0008	0.0010	0.0014	0.0015	0.0020	0.0024	0.0024	0.0024
cast iron, gray GG	520-660	0.0014	0.0022	0.0025	0.0030	0.0028	0.0030	0.0031	0.0039
ductile and maleable cast iron CGI < 80 KSI	430-660	0.0009	0.0013	0.0018	0.0019	0.0028	0.0030	0.0031	0.0039
nickel-based heat-resistant alloys	100-160	0.0004	0.0007	0.0011	0.0015	0.0016	0.0019	0.0023	0.0028
alpha-beta titanium alloys Ti6Al4V	195-240	0.0008	0.0010	0.0014	0.0015	0.0016	0.0018	0.0020	0.0028

Aluminum End Mills

Formula:

RPM = (SFM x 3.82) / tool diameter IPM = number of flutes x RPM x chip load per tooth

Type of Cut	Aluminum Alloys 6061-T6, 7075-T6, 440, 356, 380, 61300	Depth of Cut % of Tool diameter	Speed sfm	End Mills Diameter Chip Load per Tooth 1/4"	3/8"	1/2"	5/8"	3/4"	1"
medium radial 1.0 x dia depth	< 32 HRC	30% x dia. radial	1200 +	.0045	.0071	.0100	.0123	.0149	.0200
	> 32 HRC		600 +	.0036	.0057	.0080	.0098	.0119	.0160
heavy radial 1.0 x dia depth	< 32 HRC	50% x dia. radial	1200 +	.0036	.0057	.0080	.0098	.0119	.0160
medium radial 2.0 x dia depth	< 32 HRC	30% x dia. radial	1200 +	.0045	.0071	.0100	.0123	.0149	.0200
	> 32 HRC		600+	.0036	.0057	.0080	.0098	.0119	.0160
heavy radial 2.0 x dia depth	< 32 HRC	50% x dia. radial	1200 +	.0036	.0057	.0080	.0098	.0119	.0160
finishing medium radial	< 32 HRC	< 25% of dia.	1200 +	.0045	.0071	.0100	.0123	.0149	.0200
	> 32 HRC		600 +	.0036	.0057	.0080	.0098	.0119	.0160
finishing light radial	< 32HRC	< 10% of dia.	1200 +	.0045	.0071	.0100	.0123	.0149	.0200
finishing	< 32 HRC	< .010 radial depth	1200 +	.0054	.0086	.0120	.0147	.0178	.0240
	> 32 HRC		600+	.0045	.0071	.0100	.0123	.0149	.0200

This chart represents starting points based on a coated tool. Reduce rates up to 50% when using an uncoated tool.

These speed and feed rates are suggested as general guidelines. Machine type, horsepower, spindle speed limitations, toolholding and workholding devices all may impact a cutting tool's ability to perform properly. Greenfield Industries is not responsible for tool failure, part damage, or injury that may be caused by following these general recommendations.

PM Plus™ Powder Metal End Mills

Speed & Feed Data
Style: PM-538 and PM-539

Speed and Feed Data in Selected Materials
Styles: PM-538 and PM-539

	Surface Feet per Minute SFM Bright	TiCN	Chip Load Per Tooth by Cutting Diameter 1/8"	1/4"	1/2"	1"	2"
Aluminum, soft/gummy	250-500	400-2500	.005"	.007"	.010"	.012"	.015"
Aluminum alloys < 10% silicon	250-750	500-3250	.005"	.007"	.010"	.012"	.015"
Aluminum alloys > 105 silicon	N/R	N/R	N/R	N/R	N/R	N/R	N/R
Copper alloys, long chipping	250-500	350-1500	.005"	.007"	.009"*	.012"	.015"
Copper alloys, short chipping	150-250	200-1250	.003"	.006"	.008"	.010"	.013"

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