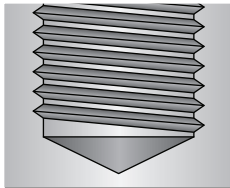
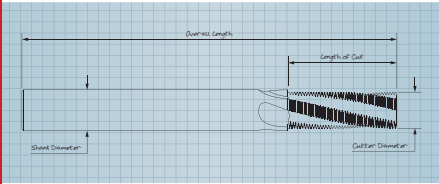


THREAD MILLING

A Quick Reference Pocket Guide



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Holmaking Solutions for Today's Manufacturing



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What We Offer



AccuThread™ 856
Solid Carbide



ThreadMills USA™
Solid Carbide



AccuThread™ T3
Solid Carbide



AccuThread™ 856
Bolt-in Style Indexable Inserts



AccuThread™ 856
Pin Style Indexable Inserts

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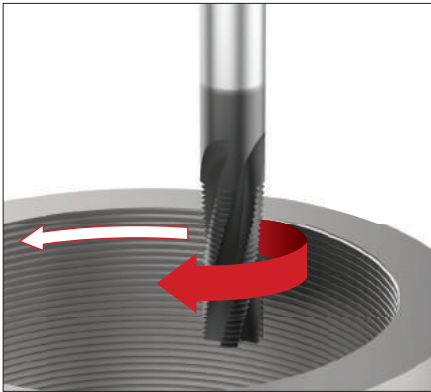


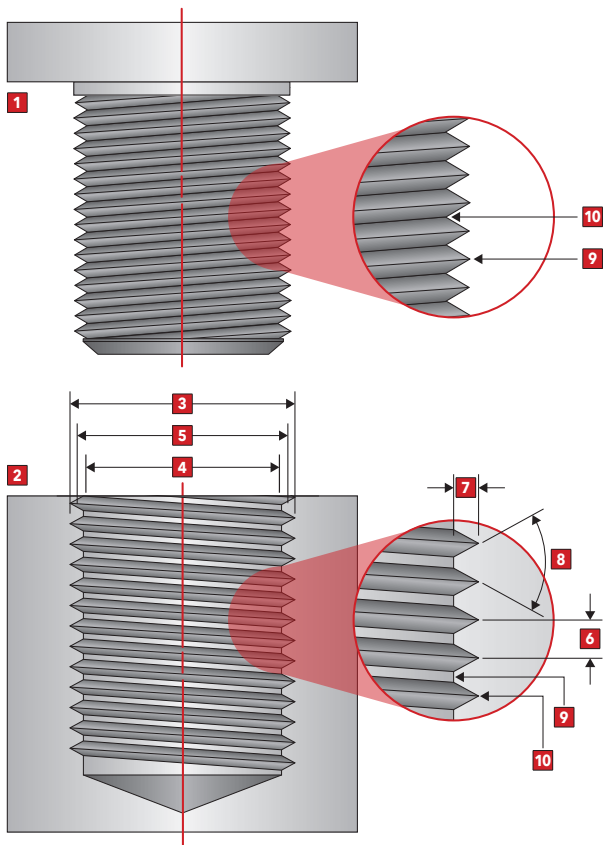
Offline Version Update

A thread mill can be thought of as an end mill with the profile of the thread on the side. Using multiple axes of a CNC machine allows you to helically interpolate the thread profile into a work piece.

Unlike a tap, a thread mill has a smaller diameter than the thread size being produced because the mill must be able to enter into the drilled hole and interpolate.

Thread milling provides excellent control of the thread's major diameter because it can be controlled using the machine's cutter compensation.







1 External Thread: The mating part with threads on the external surface.

2 Internal Thread: The mating part with threads on the internal surface.

(Nominal Diameter: The theoretical diameter of the threaded assembly.)

3 Major Diameter: The largest diameter of either the internal or external thread.

4 Minor Diameter: The smallest diameter of either the internal or external thread.

5 Pitch Diameter: A theoretical diameter used to correlate the dimensions between an internal and external thread assembly.

6 Pitch: The distance between like points on a thread and is typically measured between crests.

7 Thread Depth: The distance from root to crest when measuring perpendicular to the thread's axis.

8 Thread Angle: The included angle from crest to root of each thread.

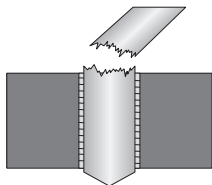
9 Crest: The surface area of each thread's peak on either an internal or external thread.

10 Root: The surface area of each thread's valley on either an internal or external thread.



Right on size!

Using the machine's cutter compensation, a thread's major diameter can easily be altered to produce precise threads. Tool life is increased over common tapping because wear can be compensated when using thread mills.



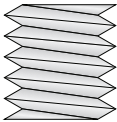
No more broken taps!

When taps break it can be very costly to salvage the work piece. If a thread mill breaks during a cut, a new thread mill can re-enter into the hole and start from the beginning with very little time lost. Producing threads in large or expensive parts is no longer a risk. A presetter is suggested for tool height accuracy.

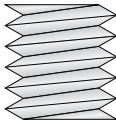


Multiple diameters? No problem.

A thread mill is simply an end mill with the thread form and a specific pitch. The machine can be programmed to helically interpolate to the desired diameter. A 1/4-20 thread mill can produce a 1/2-20 or even a 7/8-20 thread making it an excellent choice for uncommon thread sizes or large diameter threads.



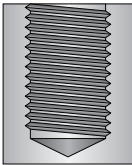
Left



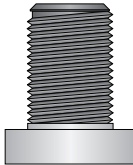
Right

Left and right handed threads

Thread mills are not left hand or right hand specific. While the thread mill is interpolating, the thread mill must move up or down 1 pitch in the Z axis to create the thread's helix. If the Z axis is not moving, the thread mill will just produce grooves inside of the hole. No more ordering a special left handed tap. One thread mill provides multiple solutions.



Internal



External

Internal and external threads

Unlike tapping, threads can be milled inside of the hole or on the outside of the material; however, not all thread forms have identical details for their internal and external mating surfaces. Some threads may require an internal or external specific thread mill.



Low horsepower required

The diameter of a tap is completely engaged in the hole and requires more torque especially on large diameter threads. Cutting large diameter threads with coarse pitches becomes even more difficult. Thread mills only cut a portion of the circumference at a time which significantly reduces the torque and horse power requirements.



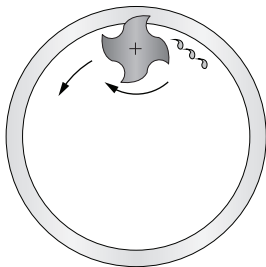
G Codes and M Codes

G Codes	
G00	Send to position with rapid feed
G01	Send to position with linear movement and control by feed
G02	Clockwise circular interpolation
G03	Counter-clockwise circular interpolation
G40	Cutter compensation cancel
G41	Turn on left hand cutter compensation
G42	Turn on right hand cutter compensation
G54-59	Available workpiece coordinate settings
G90	Absolute positioning
G91	Incremental positioning

M Codes	
M00	Program stop
M01	Program optional stop
M03	Turn on spindle clockwise direction
M04	Turn on spindle counter-clockwise direction
M05	Turn off spindle rotation
M06	Tool change
M08	Coolant on
M09	Coolant off
M30	Program end and reset to start of program

When milling a workpiece, the cutting tool can be fed in different directions along the workpiece. Both directions will achieve material removal but can have significant effects on the cutting tool and the milled surface.

Climb Milling



Improved Finish and Tool Life

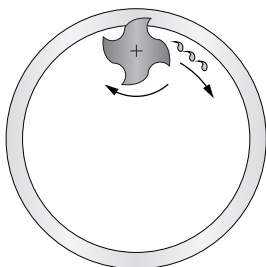
Less Heat:

Chips evacuate away from cutter faster.

Less Deflection:

Cutting tooth enters the workpiece in a manner that creates a chip that's thicker at the beginning and thinner at the end.

Conventional Milling



Poor Finish and Tool Life

Increased Heat:

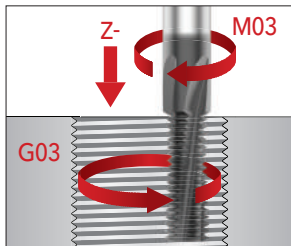
Chips evacuate in front of the cutting tool, allowing for the chips to be recut and generate heat.

Less Deflection:

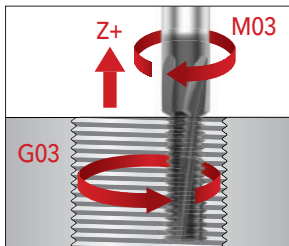
Cutting tooth enters the workpiece in a rubbing manner that creates a chip that's thinner at the beginning and thicker at the end.



Climb Milling

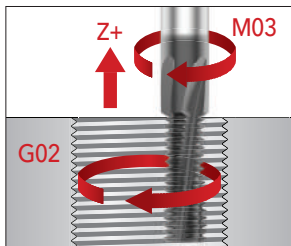


Internal left hand thread

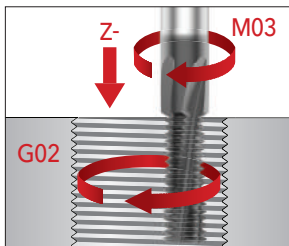


Internal right hand thread

Conventional Milling

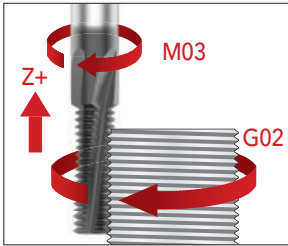


Internal left hand thread

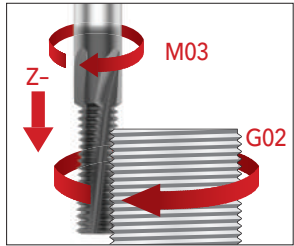


Internal right hand thread

Climb Milling

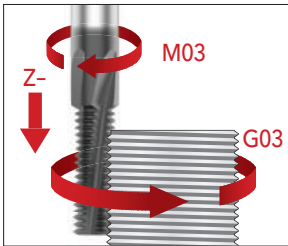


External left hand thread

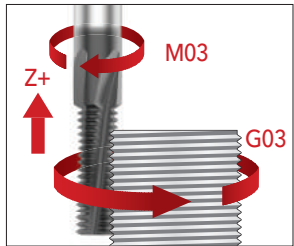


External right hand thread

Conventional Milling



External left hand thread



External right hand thread



What you need to know

- Thread milling can be easily accomplished with simple G code programming
- If your machine is capable of 3 axis (helical) interpolation, you can utilize thread milling
- Basic programming of a one pass thread mill can be achieved in 6 basic steps

The following are examples of how to calculate and program a 7/16-20 right hand thread that will be 1/2 deep produced in one pass.

Major thread diameter <i>Major diameter of thread (7/16 = 0.4375)</i>	0.4375
Threads per inch <i>Number of threads per inch (20 is from 7/16-20 designation)</i>	20
Length of thread <i>Desired length of cut</i>	0.5
SFM <i>Recommended surface footage for material to be cut</i>	475
Feed per flute <i>Recommended feed rate per cutting edge</i>	0.0025
Number of flutes <i>Number of flutes on tool to be used</i>	4
Tool diameter <i>Diameter of cutting tool</i>	0.335

Pre-program notes: The start point for the AMEC program is the X, Y, and Z center of the top of the hole. Your program should change to the thread mill tool and move it into position. Insert the thread mill program at each location where the thread mill sequence is desired. The AMEC program will switch the machine to incremental, machine one pitch, return to the top/center of the hole, and switch the machine back to absolute.

Helical interpolation reference: When using a G02 or G03 for helical interpolation, the X and Y values are the landing location for the cutting tool. The I and J values are the center point for the rotation. The I value is relative to the X starting point, and the J value is relative to the Y starting point.



Using the information on the previous page, the values can be calculated:

Pitch <i>= 1 / thread per inch</i>	0.05
RPM <i>(SFM • 3.82) / Tool diameter</i>	5416
Linear feed <i>RPM • Feed per flute • Number of flutes</i>	54.16
Feed rate for thread milling <i>Linear feed • ((Major thread Ø - Tool Ø) / Major thread Ø)</i>	12.69
Z axis move on arc on <i>(Pitch / 8)</i>	0.0063
Z axis move for full thread <i>(Pitch / 8) + Length of cut</i>	0.5063
Arc on/off <i>(Major thread diameter - Tool diameter) / 4</i>	0.0256
Full rotation value <i>(Major thread diameter - Tool diameter) / 2</i>	0.05125

Major thread diameter	0.4375	Z axis for arc on/off	0.0063
Tool diameter	0.335	Arc on/off value (X,Y)	0.0256
Length of thread	0.5	Full rotation value (X,Y)	0.05125
Feed rate for thread milling	12.69	Pitch value	0.05
Z axis depth for full thread	0.5063		

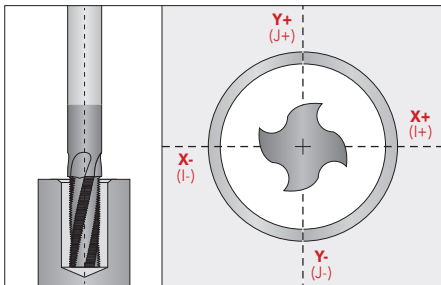
WARNING: The program is based off the center of the tool. No diameter value should be stored in the machine's controller for the thread mill. This will cause a machine controller error.



1 Spindle on | ▶ S5416 M03 | Turn on spindle in clockwise direction.

2 Lower tool

▶ G90 G01 Z-0.5063 F50.0

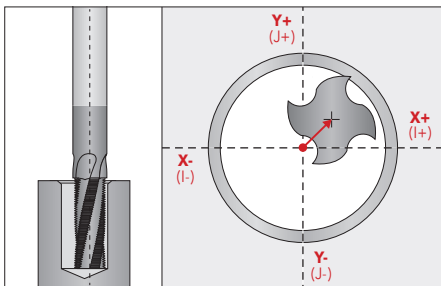


Lower tool the depth required plus an additional 1/8 pitch for the arc on.

Tool remains in center line of hole.

3 Position for arc on

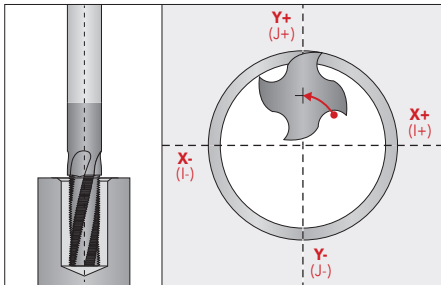
▶ G41 G01 X0.0256 Y0.0256 D1 F3.17



Position tool for the arc on motion and turn on cutter compensation.

4 Arc on

► G03 X-0.0256 Y0.0256 Z0.0063 I-0.0256 J0.0000 F12.69

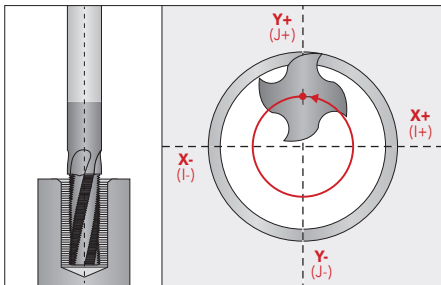


Arc on to engage the tool to the major thread \varnothing while moving the tool up in the Z-axis 1/8 pitch.

NOTE: X and Y is the end point. I and J is the center point of the arc.

5 Full pass (see page #'s for tapered thread example)

► G03 X0.0000 Y0.0000 Z0.0500 I0.0000 J-0.0513 F12.69



Interpolate the thread mill inside the major thread \varnothing while moving the tool up 1 pitch in the Z axis.

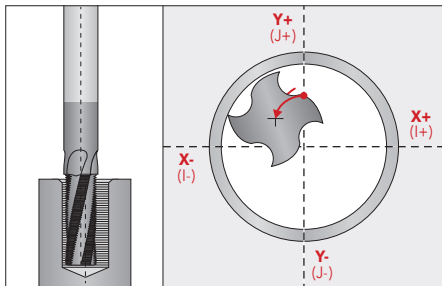
CONTINUE





6 Arc off

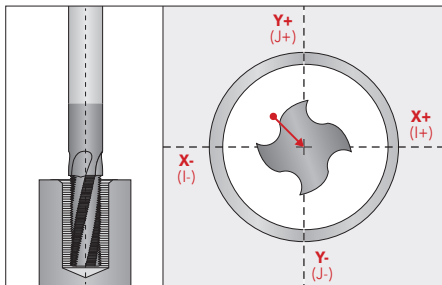
▶ G03 X-0.0256 Y-0.0256 Z0.0063 I0.0000 J-0.0256 F25.38



Arc off to disengage the tool from the major thread \varnothing while moving the tool up in the Z-axis 1/8 pitch.

7 Return to center

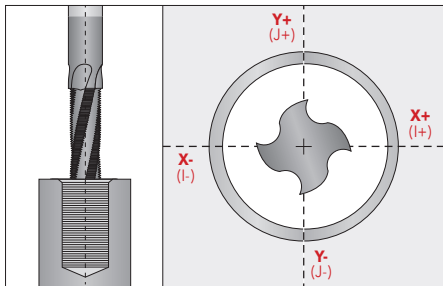
▶ G40 G01 X0.0256 Y-0.0256 Z0.0000 F50.0



Turn off cutter compensation and move the tool back to center.

8 Return to top

► G00 Z0.4438



Rapid the tool back to the top of the threaded hole.

9 Back to absolute

► G90

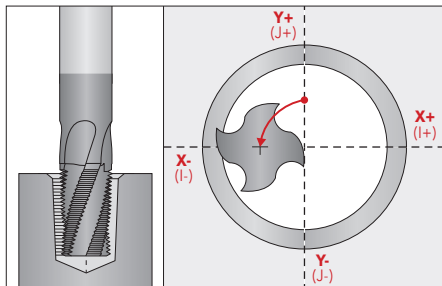
Switch back to absolute to continue.



Even though the thread mill is tapered, the thread mill must move out in X and Y as it moves up in Z. This will allow the tool to follow the taper being created. The helical interpolation shown in **Step 5** on the previous page must be broken into segments to make the diameter adjustments. Typically, this adjustment is done in quadrants for simplicity:

5A First quadrant

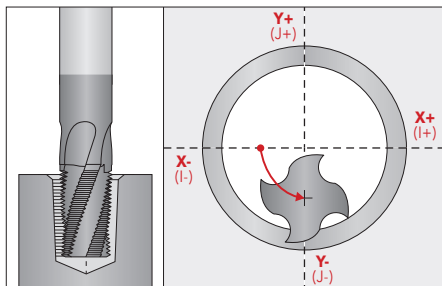
▶ G03 X-0.1819 Y-0.1815 Z0.0139 I0.0000 J-0.1819



Move to 9 o'clock position, move Z-axis 1/4 of the pitch.

5B Second quadrant

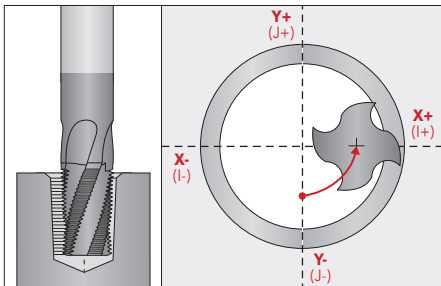
▶ G03 X0.1819 Y-0.1824 Z0.0139 I0.1824 J0.0000



Move to 6 o'clock position, move Z-axis 1/4 of the pitch.

5C Third quadrant

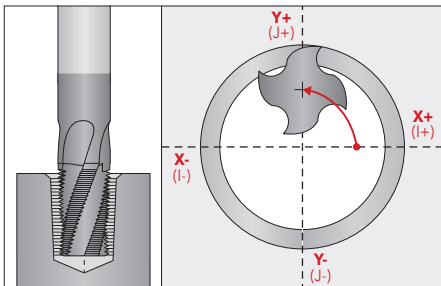
► G03 X0.1828 Y0.1824 Z0.0139 I0.0000 J0.1828



Move to 3 o'clock position, move Z-axis 1/4 of the pitch.

5D Fourth quadrant

► G03 X-0.1828 Y0.1832 Z0.0139 I-0.1832 J0.0000



Move to 12 o'clock position, move Z-axis 1/4 of the pitch.

Example values are from 3/8-18 NPT right hand thread.

NOTE: The radial adjustment needed for producing one thread can be found by multiplying the taper by one pitch. Divide by four to segment this adjustment into quadrants.



AccuThread T3 is designed to cut minimal threads at a time to reduce side deflection in hard or difficult-to-machine materials.



To improve rigidity, they are intended to be programmed to cut each thread starting at the top and progressing down in Z-axis.

Because right hand threads are most common, AccuThread T3 thread mills are left hand cutting (M04) to maintain the climb milling method.

1 Spindle on | ▶ S5416 M04

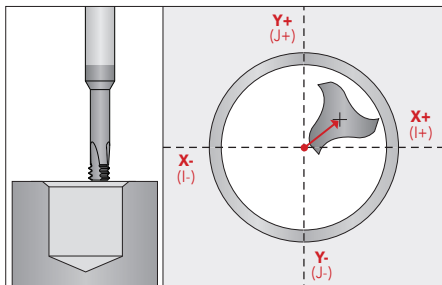
Turn on spindle in counter-clockwise direction.

2 Lower tool | ▶ G91 G42 D1

Switch to incremental programming and turn on cutter compensation.

3 Position for arc on

▶ G01 X0.0314 Y0.0314 Z0 F23.6

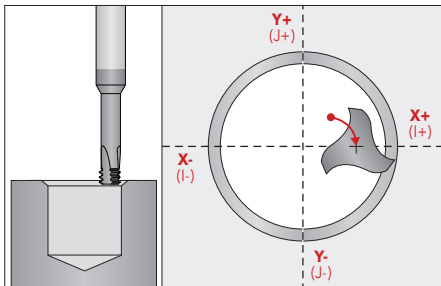


Position tool for the arc on motion.

Example shows right hand thread.

4 Arc on

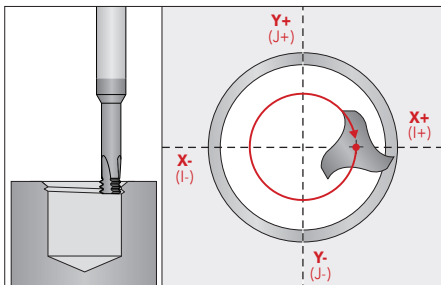
► G02 X0.0314 Y-0.0314 Z-0.0063 I0 J-0.0314 F7.87



Arc on to engage the tool to the major thread \varnothing while moving the tool down in the Z-axis 1/8 pitch.

5 Full pass

► G02 X0 Y0 Z-0.0500 I-0.0628 J0



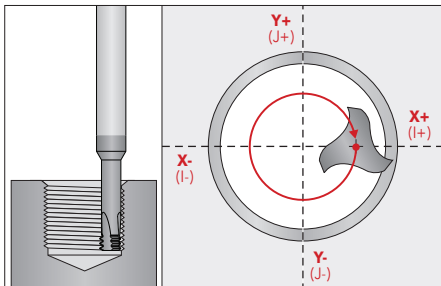
Interpolate the thread mill inside the major thread diameter while moving the tool down 1 pitch in the Z-axis.

CONTINUE



5A Repeat full pass

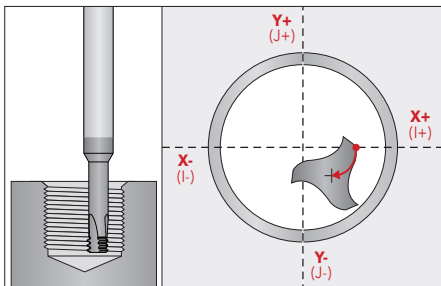
▶ G02 X0 Y0 Z-0.0500 I-0.0628 J0



Repeat interpolation the number of times to create length of thread needed. Use the **length of thread / pitch** and round the result to determine the number of Z-axis passes required.

6 Arc off

▶ G02 X-0.0314 Y-0.0314 Z-0.0063 I-0.0314 J0

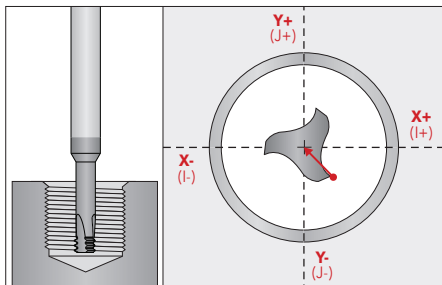


Arc off to disengage the tool from the major thread \emptyset while moving the tool up in the Z-axis 1/8 pitch.

Example shows right hand thread.

7 Return to center

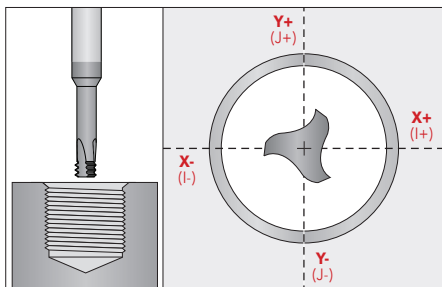
► G01 G40 X-0.0314 Y0.0314 F39.34



Return tool back to center and turn off cutter compensation.

8 Return to top

► G00 Z1.0126



Return tool to 1 pitch above the part.

9 Back to absolute

► G90

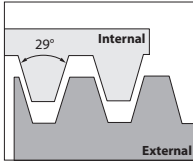
Switch back to absolute to continue.



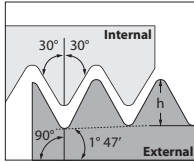
Conversion Chart

FRACTIONS	DECIMALS	MM
1/64	.0156	0.396
1/32	.0312	0.793
3/64	.0468	1.190
1/16	.0625	1.587
5/64	.0781	1.984
3/32	.0937	2.381
7/64	.1093	2.778
1/8	.1250	3.175
9/64	.1406	3.571
5/32	.1562	3.968
11/64	.1718	4.365
3/16	.1875	4.762
13/64	.2031	5.159
7/32	.2187	5.556
15/64	.2343	5.953
1/4	.2500	6.350
17/64	.2656	6.746
9/32	.2812	7.143
19/64	.2968	7.540
5/16	.3125	7.937
21/64	.3281	8.334
11/32	.3437	8.731
23/64	.3593	9.128
3/8	.3750	9.525
25/64	.3906	9.921
13/32	.4026	10.318
27/64	.4218	10.715
7/16	.4375	11.112
29/64	.4531	11.509
15/32	.4687	11.906
31/64	.4843	12.303
1/2	.5000	12.700

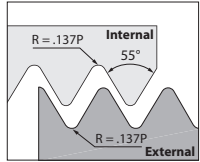
FRACTIONS	DECIMALS	MM
33/64	.5156	13.096
17/32	.5312	13.493
35/64	.5468	13.890
9/16	.5625	14.287
37/64	.5781	14.684
19/32	.5937	15.081
39/64	.6093	15.478
5/8	.6250	15.875
41/64	.6406	16.271
21/32	.6562	16.668
43/64	.6718	17.065
11/16	.6875	17.462
45/64	.7031	17.859
23/32	.7187	18.256
47/64	.7343	18.653
3/4	.7500	19.050
49/64	.7656	19.446
25/32	.7812	19.843
51/64	.7968	20.240
13/16	.8125	20.637
53/64	.8281	21.034
27/32	.8437	21.431
55/64	.8593	21.828
7/8	.8750	22.225
57/64	.8906	22.621
29/32	.9062	23.018
59/64	.9218	23.415
15/16	.9375	23.812
61/64	.9531	24.209
31/32	.9687	24.606
63/64	.9843	25.003
1	1.0000	25.400



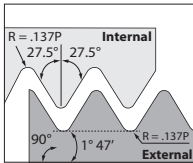
ACME (full profile)



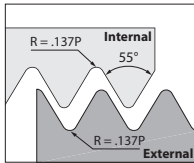
API Round



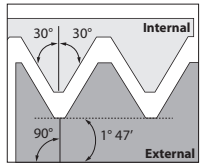
BSPB



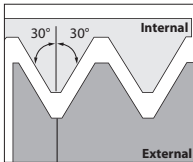
BSPT



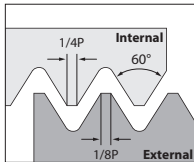
BSW



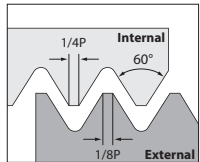
NPT / NPTF



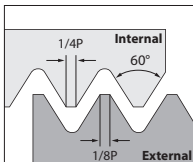
NPS / NPSF



UNC / UNF



UNJC / UNJF



ISO



Ø	UNC		UNF	
	Pitch (TPI)	Drill Size (inch)	Pitch (TPI)	Drill Size (inch)
#0	–	–	80	3/64
#1	64	0.059 (#53)	72	0.059 (#53)
#2	56	0.067 (#51)	64	0.070 (#50)
#3	48	5/64	56	0.081 (#46)
#4	40	0.089 (#43)	48	0.093 (#42)
#5	40	0.099 (#39)	44	0.104 (#37)
#6	32	0.106 (#36)	40	0.113 (#33)
#8	32	0.136 (#29)	36	0.136 (#29)
#10	24	0.149 (#25)	32	0.159 (#21)
#12	24	0.173 (#17)	28	0.180 (#15)
1/4	20	0.201 (#7)	28	0.213 (#3)
5/16	18	0.257 (F)	24	0.272 (I)
3/8	16	5/16	24	0.332 (Q)
7/16	14	0.368 (U)	20	0.386 (W)
1/2	13	27/64	20	29/64
9/16	12	31/64	18	33/64
5/8	11	17/32	18	37/64
3/4	10	21/32	16	11/16
7/8	9	49/64	14	13/16
1	8	7/8	12	15/16
1-1/8	7	63/64	12	1-1/32
1-1/4	7	1-7/64	12	1-11/64
1-3/8	6	1-7/32	12	1-19/64
1-1/2	6	1-11/32	12	1-27/64
1-3/4	5	1-35/64	12	1-43/64
2	4-1/2	1-25/32	12	1-59/64



UNJC		Minor Ø		Recommended Drill Size	
Ø	Pitch (TPI)	Min	Max	Drill Size	Decimal (in)
#4	40	.0877	.0942	2.30mm	.0906
#5	40	.1007	.1072	2.60mm	.1024
#6	32	.1076	.1157	#33	.1130
#8	32	.1336	.1417	3.50mm	.1378
#10	24	.1494	.1600	3.90mm	.1535
#12	24	.1754	.1852	4.60mm	.1811
1/4	20	.2013	.2121	5.30mm	.2087
5/16	18	.2584	.2690	6.70mm	.2638
3/8	16	.3141	.3250	8.10mm	.3189
7/16	14	.3680	.3795	9.50mm	.3740
1/2	13	.4251	.4368	10.90mm	.4291
9/16	12	.4814	.4914	31/64"	.4844
5/8	11	.5365	.5474	13.80mm	.5433
3/4	10	.6526	.6646	16.75mm	.6594
7/8	9	.7668	.7801	19.60mm	.7717
1	8	.8783	.8933	22.50mm	.8858
UNJF		Minor Ø		Recommended Drill Size	
Ø	Pitch (TPI)	Min	Max	Drill Size	Decimal (in)
#4	48	.0917	.0971	2.40mm	.0945
#5	44	.1029	.1088	2.70mm	.1063
#6	40	.1137	.1202	3.00mm	.1181
#8	36	.1370	.1442	#28	.1405
#10	32	.1596	.1675	4.20mm	.1654
#12	28	.1812	.1896	#13	.1850
1/4	28	.2152	.2229	7/32"	.2188
5/16	24	.2719	.2799	7.00mm	.2756
3/8	24	.3344	.3417	8.60mm	.3386
7/16	20	.3888	.3970	10.00mm	.3937
1/2	20	.4513	.4591	11.60mm	.4567
9/16	18	.5084	.5166	13.00mm	.5118
5/8	18	.5709	.5788	14.60mm	.5748
3/4	16	.6892	.6977	17.60mm	.6929
7/8	14	.8055	.8152	13/16"	.8125
1	12	.9189	.9289	59/64"	.9219



Ø	Metric			Metric Fine		
	Pitch	Drill Size		Pitch	Drill Size	
		mm	in		mm	in
M1.6	0.35	1.25	3/64	–	–	–
M1.8	0.35	1.45	0.059 (#53)	–	–	–
M2	0.4	1.60	0.063 (#52)	–	–	–
M2.2	0.45	1.75	0.070 (#50)	–	–	–
M2.5	0.45	2.05	0.081 (#46)	–	–	–
M3	0.5	2.50	0.099 (#39)	–	–	–
M3.5	0.6	2.90	0.116 (#32)	–	–	–
M4	0.7	3.30	0.128 (#30)	–	–	–
M4.5	0.75	3.70	0.147 (#26)	–	–	–
M5	0.8	4.20	0.166 (#19)	–	–	–
M6	1	5.00	0.199 (#8)	–	–	–
M7	1	6.00	0.238 (B)	–	–	–
M8	1.25	6.80	0.266 (H)	1	7.00	0.277 (J)
M10	1.5	8.50	0.339 (R)	1.25	8.80	11/32
M12	1.75	10.20	0.404 (Y)	1.50	10.50	0.413 (Z)
M14	2	12.00	15/32	1.50	12.50	1/2
M16	2	14.00	9/16	1.5	14.50	37/64
M18	2.5	15.50	39/64	1.5	16.50	21/32
M20	2.5	17.50	11/16	1.5	18.50	47/64
M22	2.5	19.50	49/64	1.5	20.50	13/16
M24	3	21.00	53/64	2	22.00	7/8
M27	3	24.00	61/64	2	25.00	63/64
M30	3.5	26.50	1-3/64	2	28.00	1-7/64
M33	3.5	29.50	1-11/64	2	31.00	1-7/32
M36	4	32.00	1-17/64	3	33.00	1-19/64
M39	4	35.00	1-25/64	3	36.00	1-27/64



Ø	Metric		Metric Fine	
	Pitch	Drill Size (mm)	Pitch	Drill Size (mm)
M2	0.4	1.65	–	–
M2.5	0.45	2.10	–	–
M3	0.5	2.60	–	–
M3.5	0.6	3.00	–	–
M4	0.7	3.40	–	–
M5	0.8	4.30	–	–
M6	1	5.10	–	–
M7	1	6.10	–	–
M8	1.25	6.90	1	7.10
M10	1.5	8.70	1.25	8.90
M12	1.75	10.50	1.25	10.90
M14	–	–	1.5	12.60
M16	2	14.30	1.5	14.60
M18	–	–	1.5	16.60
M20	–	–	1.5	18.60



Pipe Tap Size	NPT & NPTF		NPS & NPSF	
	Pitch (TPI)	Drill Size* (inch)	Pitch (TPI)	Drill Size (inch)
1/16	27	0.242 (C)	–	–
1/8	27	0.332 (Q)	27	0.348 (S)
1/4	18	7/16	18	29/64
3/8	18	9/16	18	19/32
1/2	14	45/64	14	47/64
3/4	14	29/32	14	15/16
1	11-1/2	1-9/64	11-1/2	1-3/16
1-1/4	11-1/2	1-31/64	11-1/2	1-33/64
1-1/2	11-1/2	1-23/32	11-1/2	1-3/4
2	11-1/2	2-7/32	11-1/2	2-7/32
2-1/2	8	2-5/8	8	2-21/32
3	8	3-1/4	8	3-9/32
3-1/2	8	3-3/4	8	3-25/32
4	8	4-1/4	8	4-9/32

*Without taper reamer



Pipe Tap Size	BSW		BSPP		BSPT	
	Pitch (TPI)	Drill Size (inch)	Pitch (TPI)	Drill Size (inch)	Pitch (TPI)	Drill Size* (inch)
1/16	60	0.046 (#56)	28	0.261 (G)	–	–
1/8	40	0.098 (#40)	28	11/32	28	21/64
1/4	20	0.196 (#9)	19	29/64	19	7/16
5/16	18	1/4	–	–	–	–
3/8	16	5/16	19	19/32	19	37/64
7/16	14	23/64	–	–	–	–
1/2	12	0.413 (Z)	14	3/4	14	23/32
9/16	12	17/32	–	–	–	–
5/8	11	35/64	14	53/64	–	–
3/4	10	41/64	14	31/32	14	15/16
7/8	9	3/4	14	1-7/64	–	–
1	8	55/64	11	1-13/64	11	1-11/64
1-1/4	7	1-3/32	11	1-35/64	11	1-33/64
1-1/2	6	1-5/16	11	1-25/32	11	1-3/4
1-3/4	5	1-17/32	11	2	11	–
2	4.5	1-3/4	11	2-1/4	11	2-3/16

*Without taper reamer



ACME			
Nominal Ø	Pitch (TPI)	Min (inch)	Max (inch)
1/4	16	.1875	.1925
5/16	14	.2411	.2461
3/8	12	.2917	.2967
7/16	12	.3542	.3592
1/2	10	.4000	.4050
5/8	8	.5000	.5062
3/4	6	.5833	.5916
7/8	6	.7083	.7166
1	5	.8000	.8100
1-1/8	5	.9250	.9350
1-1/4	5	1.0500	1.0600
1-3/8	4	1.1250	1.1375
1-1/2	4	1.2500	1.2625
1-3/4	4	1.5000	1.5125
2	4	1.7500	1.7625
2-1/4	3	1.9167	1.9334
2-1/2	3	2.1667	2.1834
2-3/4	3	2.4167	2.4334
3	2	2.5000	2.5250
3-1/2	2	3.0000	3.0250
4	2	3.5000	3.5250
4-1/2	2	4.0000	4.0250
5	2	4.5000	4.5250

When applying side pressure on any milling tool, rigidity is important for success. For best results, use tool holders with accurate and secure clamping to reduce tool deflection. Collet chucks should be avoided for applications with side loading pressure.

	Solid Carbide	Indexable
Collet Chuck		
Hydraulic Chuck	●	●
Shrink Fit	●	
Milling Chuck	●	●
End Mill Holder	○	●
Shell Mill Holder		●

● = Recommended ○ = Use with caution *Blank* = Not recommended





ISO	Material	Hardness (BHN)	Machinability*	Speed (SFM)
P	Free Machining Steel 1118, 1215, 12L14, etc.	100 - 150	Easy	725
		150 - 200	Easy	550
		200 - 250	Easy	450
	Low Carbon Steel 1010, 1020, 1025, 1522, 1144	85 - 125	Average	725
		125 - 175	Average	550
		175 - 225	Average	450
		225 - 275	Average	400
	Medium Carbon Steel 1010, 1040, 1050, 1527, 1140	125 - 175	Average	450
		175 - 225	Average	400
		225 - 275	Average	350
		275 - 325	Average	300
	Alloy Steel 4140, 5140, 8640	125 - 175	Average	450
		175 - 225	Average	400
		225 - 275	Average	350
		275 - 325	Difficult	300
		325 - 375	Difficult	250
	High Strength Alloy 4340, 4330V, 300M	225 - 300	Average	350
		300 - 350	Difficult	300
		350 - 400	Difficult	250
	Structural Steel A36, A285, A516	100 - 150	Average	450
		150 - 250	Average	400
250 - 350		Difficult	300	

NOTE: Feed rates provided are safe starting recommendations and may be increased to reduce cycle times. Solid carbide thread mills may perform at double or triple these feed recommendations.



Recommended Feed (inch/tooth) by Cutter Diameter							
0.060 to 0.125	0.126 to 0.188	0.189 to 0.250	0.251 to 0.312	0.313 to 0.375	0.376 to 0.500	0.501 to 0.625	0.626 to 0.750
0.0004	0.0005	0.0007	0.0009	0.0010	0.0015	0.0020	0.0025
0.0004	0.0005	0.0007	0.0009	0.0010	0.0015	0.0020	0.0025
0.0004	0.0005	0.0007	0.0009	0.0010	0.0015	0.0020	0.0025
0.0004	0.0005	0.0007	0.0009	0.0010	0.0015	0.0020	0.0025
0.0004	0.0005	0.0007	0.0009	0.0010	0.0015	0.0020	0.0025
0.0004	0.0005	0.0007	0.0009	0.0010	0.0015	0.0020	0.0025
0.0004	0.0005	0.0007	0.0009	0.0010	0.0015	0.0020	0.0025
0.0004	0.0005	0.0006	0.0008	0.0010	0.0013	0.0018	0.0020
0.0004	0.0005	0.0006	0.0008	0.0010	0.0013	0.0018	0.0020
0.0004	0.0005	0.0006	0.0008	0.0010	0.0013	0.0018	0.0020
0.0004	0.0005	0.0006	0.0008	0.0010	0.0013	0.0018	0.0020
0.0004	0.0005	0.0006	0.0008	0.0010	0.0013	0.0018	0.0020
0.0004	0.0005	0.0006	0.0008	0.0010	0.0013	0.0018	0.0020
0.0004	0.0005	0.0006	0.0008	0.0010	0.0013	0.0018	0.0020
0.0004	0.0005	0.0006	0.0008	0.0010	0.0013	0.0018	0.0020
0.0004	0.0005	0.0006	0.0008	0.0010	0.0013	0.0018	0.0020
0.0004	0.0005	0.0006	0.0008	0.0010	0.0013	0.0018	0.0020
0.0004	0.0005	0.0006	0.0008	0.0010	0.0013	0.0018	0.0020
0.0004	0.0005	0.0006	0.0008	0.0010	0.0013	0.0018	0.0020
0.0004	0.0005	0.0006	0.0008	0.0010	0.0013	0.0018	0.0020
0.0004	0.0005	0.0006	0.0008	0.0010	0.0013	0.0018	0.0020
0.0004	0.0005	0.0007	0.0009	0.0010	0.0015	0.0020	0.0025
0.0004	0.0005	0.0007	0.0009	0.0010	0.0015	0.0020	0.0025
0.0004	0.0005	0.0007	0.0009	0.0010	0.0015	0.0020	0.0025

*Refer to recommended pass chart on page 43 when referencing material machinability



ISO	Material	Hardness (BHN)	Machinability*	Speed (SFM)
S	High Temp Alloy	140 - 220	Difficult	100
	Hastelloy B, Inconel 600	220 - 310	Difficult	75
M	Stainless Steel	135 - 185	Difficult	425
	303, 416, 420	185 - 275	Difficult	400
	Stainless Steel PH	185 - 275	Difficult	250
	17-4	275 - 325	Difficult	125
	Tool Steel	150 - 200	Difficult	325
	H-13, H21, A-4	200 - 250	Difficult	225
K	Cast Iron	120 - 150	Easy	550
	Grey, Ductile, Nodular	150 - 200	Easy	500
		200 - 220	Easy	450
		220 - 260	Average	400
		260 - 320	Average	375
N	Wrought Aluminum	30	Easy	1000
	6061 T6	180	Easy	900
	Cast Aluminum** up to 10% silicon	120	Easy	500
	Brass	30 - 125	Easy	1000

NOTE: Feed rates provided are safe starting recommendations and may be increased to reduce cycle times. Solid carbide thread mills may perform at double or triple these feed recommendations.



Recommended Feed (inch/tooth) by Cutter Diameter							
0.060 to 0.125	0.126 to 0.188	0.189 to 0.250	0.251 to 0.312	0.313 to 0.375	0.376 to 0.500	0.501 to 0.625	0.626 to 0.750
0.0003	0.0004	0.0006	0.0008	0.0009	0.0010	0.0012	0.0015
0.0003	0.0004	0.0006	0.0008	0.0009	0.0010	0.0012	0.0015
0.0004	0.0005	0.0006	0.0008	0.0009	0.0010	0.0015	0.0020
0.0004	0.0005	0.0006	0.0008	0.0009	0.0010	0.0015	0.0020
0.0004	0.0005	0.0006	0.0008	0.0009	0.0010	0.0015	0.0020
0.0004	0.0005	0.0006	0.0008	0.0009	0.0010	0.0015	0.0020
0.0004	0.0005	0.0007	0.0008	0.0010	0.0015	0.0020	0.0025
0.0004	0.0005	0.0007	0.0008	0.0010	0.0015	0.0020	0.0025
0.0004	0.0005	0.0007	0.0009	0.0010	0.0015	0.0020	0.0025
0.0004	0.0005	0.0007	0.0009	0.0010	0.0015	0.0020	0.0025
0.0004	0.0005	0.0007	0.0009	0.0010	0.0015	0.0020	0.0025
0.0004	0.0005	0.0007	0.0009	0.0010	0.0015	0.0020	0.0025
0.0005	0.0006	0.0009	0.0010	0.0015	0.0020	0.0025	0.0030
0.0005	0.0006	0.0009	0.0010	0.0015	0.0020	0.0025	0.0030
0.0005	0.0006	0.0009	0.0010	0.0015	0.0020	0.0025	0.0030
0.0005	0.0006	0.0009	0.0010	0.0015	0.0020	0.0025	0.0030

*Refer to recommended pass chart on page 43 when referencing material machinability

**Uncoated thread mills are recommended for cast aluminum applications



ISO	Material	Hardness (BHN)	Machinability*	Speed (M/min)
P	Free Machining Steel 1118, 1215, 12L14, etc.	100 - 150	Easy	221
		150 - 200	Easy	168
		200 - 250	Easy	137
	Low Carbon Steel 1010, 1020, 1025, 1522, 1144	85 - 125	Average	221
		125 - 175	Average	168
		175 - 225	Average	137
		225 - 275	Average	122
	Medium Carbon Steel 1010, 1040, 1050, 1527, 1140	125 - 175	Average	137
		175 - 225	Average	122
		225 - 275	Average	107
		275 - 325	Average	91
	Alloy Steel 4140, 5140, 8640	125 - 175	Average	137
		175 - 225	Average	122
		225 - 275	Average	107
		275 - 325	Difficult	91
		325 - 375	Difficult	76
	High Strength Alloy 4340, 4330V, 300M	225 - 300	Average	107
		300 - 350	Difficult	91
		350 - 400	Difficult	76
	Structural Steel A36, A285, A516	100 - 150	Average	137
		150 - 250	Average	122
250 - 350		Difficult	91	

NOTE: Feed rates provided are safe starting recommendations and may be increased to reduce cycle times. Solid carbide thread mills may perform at double or triple these feed recommendations.



Recommended Feed (mm/tooth) by Cutter Diameter							
1.50 to 3.18	3.19 to 4.76	4.77 to 6.35	6.36 to 7.94	7.95 to 9.53	9.54 to 12.70	12.71 to 15.88	15.89 to 19.05
0.010	0.013	0.018	0.023	0.025	0.038	0.051	0.064
0.010	0.013	0.018	0.023	0.025	0.038	0.051	0.064
0.010	0.013	0.018	0.023	0.025	0.038	0.051	0.064
0.010	0.013	0.018	0.023	0.025	0.038	0.051	0.064
0.010	0.013	0.018	0.023	0.025	0.038	0.051	0.064
0.010	0.013	0.018	0.023	0.025	0.038	0.051	0.064
0.010	0.013	0.018	0.023	0.025	0.038	0.051	0.064
0.010	0.013	0.015	0.020	0.025	0.038	0.046	0.051
0.010	0.013	0.015	0.020	0.025	0.038	0.046	0.051
0.010	0.013	0.015	0.020	0.025	0.038	0.046	0.051
0.010	0.013	0.015	0.020	0.025	0.038	0.046	0.051
0.010	0.013	0.015	0.020	0.025	0.038	0.046	0.051
0.010	0.013	0.015	0.020	0.025	0.038	0.046	0.051
0.010	0.013	0.015	0.020	0.025	0.038	0.046	0.051
0.010	0.013	0.015	0.020	0.025	0.038	0.046	0.051
0.010	0.013	0.015	0.020	0.025	0.038	0.046	0.051
0.010	0.013	0.015	0.020	0.025	0.038	0.046	0.051
0.010	0.013	0.015	0.020	0.025	0.038	0.046	0.051
0.010	0.013	0.015	0.020	0.025	0.038	0.046	0.051
0.010	0.013	0.015	0.020	0.025	0.038	0.046	0.051
0.010	0.013	0.015	0.020	0.025	0.038	0.046	0.051
0.010	0.013	0.018	0.023	0.025	0.038	0.051	0.064
0.010	0.013	0.018	0.023	0.025	0.038	0.051	0.064
0.010	0.013	0.018	0.023	0.025	0.038	0.051	0.064

*Refer to recommended pass chart on page 43 when referencing material machinability



ISO	Material	Hardness (BHN)	Machinability*	Speed (M/min)
S	High Temp Alloy	140 - 220	Difficult	30
	Hastelloy B, Inconel 600	220 - 310	Difficult	23
M	Stainless Steel	135 - 185	Difficult	130
	303, 416, 420	185 - 275	Difficult	122
	Stainless Steel PH	185 - 275	Difficult	76
	17-4	275 - 325	Difficult	38
	Tool Steel	150 - 200	Difficult	99
	H-13, H21, A-4	200 - 250	Difficult	69
K	Cast Iron	120 - 150	Easy	168
	Grey, Ductile, Nodular	150 - 200	Easy	152
		200 - 220	Easy	137
		220 - 260	Average	122
		260 - 320	Average	114
N	Wrought Aluminum	30	Easy	305
	6061 T6	180	Easy	274
	Cast Aluminum** up to 10% silicon	120	Easy	152
	Brass	30 - 125	Easy	305

NOTE: Feed rates provided are safe starting recommendations and may be increased to reduce cycle times. Solid carbide thread mills may perform at double or triple these feed recommendations.



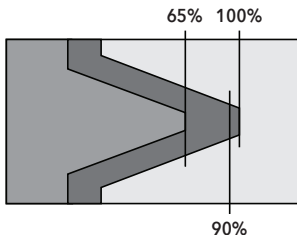
Recommended Feed (mm/tooth) by Cutter Diameter							
1.50 to 3.18	3.19 to 4.76	4.77 to 6.35	6.36 to 7.94	7.95 to 9.53	9.54 to 12.70	12.71 to 15.88	15.89 to 19.05
0.008	0.010	0.015	0.020	0.023	0.025	0.030	0.038
0.008	0.010	0.015	0.020	0.023	0.025	0.030	0.038
0.010	0.013	0.015	0.020	0.023	0.025	0.038	0.051
0.010	0.013	0.015	0.020	0.023	0.025	0.038	0.051
0.010	0.013	0.015	0.020	0.023	0.025	0.038	0.051
0.010	0.013	0.015	0.020	0.023	0.025	0.038	0.051
0.010	0.013	0.018	0.023	0.025	0.038	0.051	0.064
0.010	0.013	0.018	0.023	0.025	0.038	0.051	0.064
0.010	0.013	0.018	0.023	0.025	0.038	0.051	0.064
0.010	0.013	0.018	0.023	0.025	0.038	0.051	0.064
0.010	0.013	0.018	0.023	0.025	0.038	0.051	0.064
0.010	0.013	0.018	0.023	0.025	0.038	0.051	0.064
0.013	0.015	0.023	0.025	0.038	0.051	0.064	0.076
0.013	0.015	0.023	0.025	0.038	0.051	0.064	0.076
0.013	0.015	0.023	0.025	0.038	0.051	0.064	0.076
0.013	0.015	0.023	0.025	0.038	0.051	0.064	0.076

*Refer to recommended pass chart on page 43 when referencing material machinability

**Uncoated thread mills are recommended for cast aluminum applications



Thread milling is like any other material removal process. Depending on how much material needs to be removed and the material's machinability, multiple machining passes may be required. The coarser the pitch, the more material that needs removed. Use the chart below for the suggested number of radial passes.



The percentage of material removal for each machining pass is determined based off total thread height. Percentage of material removal varies depending on the application, but general starting percentages are:

1 pass	100%			
2 passes	75%	100%		
3 passes	60%	80%	100%	
4 passes	60%	80%	90%	100%

NPT / NPTF / BSPT / API			
Pitch Size	Machinability		
	E	A	D
28	1	1	2
27	1	1	2
19	1	1	2
18	1	1	2
14	1	2	3
11.5	1	2	3
11	1	2	3
10	1	2	3
8	2	3	4

ISO			
Pitch Size	Machinability		
	E	A	D
0.40	1	1	2
0.45	1	1	2
0.50	1	1	2
0.70	1	1	2
0.75	1	1	2
0.80	1	1	2
1.00	1	1	2
1.25	1	2	3
1.50	1	2	3
1.75	1	2	3
2.00	1	2	3
2.50	2	3	4
3.00	2	3	4
3.50	2	3	4
4.00	2	3	4
4.50	2	3	4
5.00	2	3	4
6.00	2	3	4

UN / UNJ / BSPP BSW / NPS / NPSF			
Pitch Size	Machinability		
	E	A	D
64	1	1	2
56	1	1	2
48	1	1	2
44	1	1	2
40	1	1	2
36	1	1	2
32	1	1	2
28	1	1	2
27	1	1	2
24	1	1	2
20	1	2	3
19	1	2	3
18	1	2	3
16	1	2	3
14	1	2	3
13	1	2	3
12	1	2	3
11.5	2	2	4
11	2	2	4
10	2	3	4
9	2	3	4
8	2	3	4
7	2	3	4
6	2	3	4



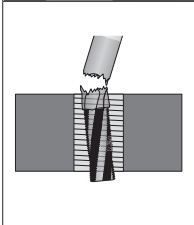

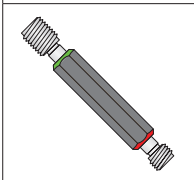
- 1 Pass
- 2 Passes
- 3 Passes
- 4 Passes

Machinability codes:


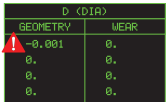

E = Easy A = Average D = Difficult

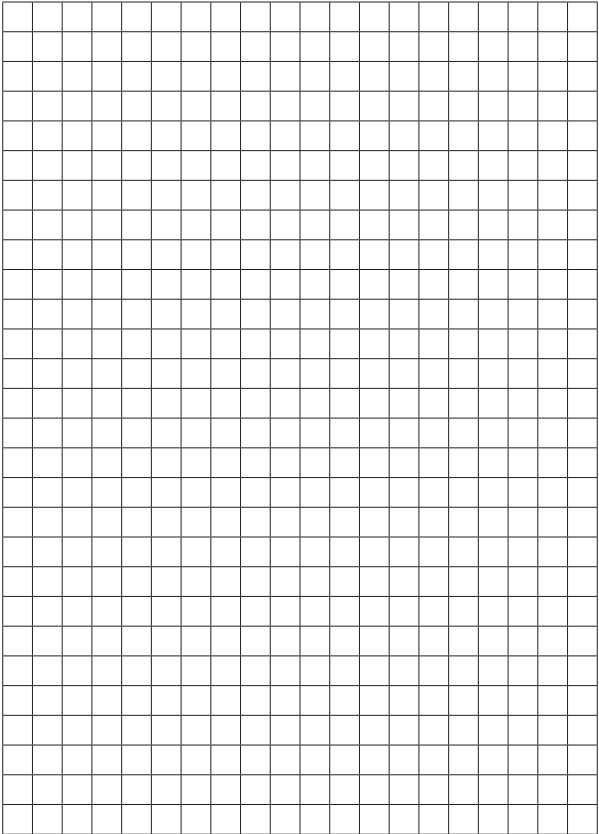


Cutting Tool Problems

	<p>Excessive Wear</p> <ul style="list-style-type: none">● Decrease speed● Use preferred tool holder (see page 33)
	<p>Chipping Cutting Edges</p> <ul style="list-style-type: none">● Reduce feed rate● Add additional radial pass● Reduce tool overhang● Use preferred tool holder (see page 33)
	<p>Immediate Tool Failure</p> <ul style="list-style-type: none">● Check tool selection (reduce cutter diameter)● Reduce feed rate● Use arc on programming method● Check cutter compensation D value in program and registrar value● Check program variables (use Insta-Code™ for program)
	<p>Excessive Chatter</p> <ul style="list-style-type: none">● Reduce tool overhang● Reduce feed rate● Add additional radial pass● Use preferred tool holder (see page 33)
	<p>Go and No-Go Gage Fit</p> <ul style="list-style-type: none">● Reduce feed rate● Add additional radial pass● Reduce tool overhang● Use preferred tool holder (see page 33)● Tool is worn, replace tool

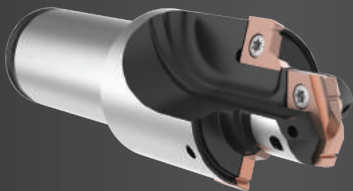
Machine Controller Problems

	<p>Spindle Alarm</p> <ul style="list-style-type: none"> • Check RPM maximum for machine 												
 <table border="1"> <thead> <tr> <th colspan="2">D (DIA)</th> </tr> <tr> <th>GEOMETRY</th> <th>WEAR</th> </tr> </thead> <tbody> <tr> <td>⚠ -0.001</td> <td>0.</td> </tr> <tr> <td>0.</td> <td>0.</td> </tr> <tr> <td>0.</td> <td>0.</td> </tr> <tr> <td>0.</td> <td>0.</td> </tr> </tbody> </table>	D (DIA)		GEOMETRY	WEAR	⚠ -0.001	0.	0.	0.	0.	0.	0.	0.	<p>Negative Cutter Compensation</p> <ul style="list-style-type: none"> • If machine does not accept negative cutter compensation, change compensation direction and use positive offset in registrar
D (DIA)													
GEOMETRY	WEAR												
⚠ -0.001	0.												
0.	0.												
0.	0.												
0.	0.												
	<p>Alarm Regarding Tool Path</p> <ul style="list-style-type: none"> • Remove tool diameter from controller's tool page. Most thread mill programs are based off center of tool and diameter is not necessary for controller. 												



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