Your Partner for
Solid Carbide Tools

2018.V1 EN

CERATIZIT is a high-tech engineering group for tooling and hard material technology.

Tooling the Future

www.ceratizit.com

CUTTING SOLUTIONS BY
CERATIZIT

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Safety Precautions

Carbide cutting tools can break or shatter under improper or severe use. Always wear the proper personal protective equipment when performing metal cutting operations. Carbide cutting tools have sharp edges. Use caution while handling cutting tools to avoid injury.

Pictograms

Best Used In Material	UN Universal; TI Titanium; VA Stainless Steel; H Hardened Steel; AL Aluminum; ST Steel
Number Of Flutes	2 FL; 3 FL; 4 FL; 5 FL; 6 FL; 7 FL
End Mill Corner / End Style	S Square; PC Protective Corner; PR Protective Radius; R Corner Radius; R Ball Radius
Application Uses	Peripheral; Ramping; Helical; Slotting; Plunging; Corner Radius Contouring; Corner Radius Profiling; Ball Contouring; Ball Profiling
Geometry Information	Shank Flat; Cb Chip Breakers; $\lambda_S = 35° 38°$ Helix; $\gamma_S = 9°$ Rake Angle; UE Unequal Index; Balanced; Coarse Pitch; Fine Pitch

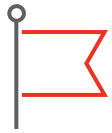
The CERATIZIT Group

For over **95 years**, CERATIZIT has been a **pioneer** developing exceptional hard material products for cutting tools and wear protection.

The privately owned company, based in Mamer, Luxembourg, develops and manufactures highly specialized carbide cutting tools, inserts and rods made of hard materials as well as wear parts.

The CERATIZIT Group is the **global market leader** in a number of cutting tool application areas. We successfully develop new types of cemented carbide, cermet and ceramic grades, which are used for instance in wheel set and turbine machining, in the aerospace and automotive industries, for heavy machining and bar peeling – always with the goal of increased stability, process reliability and performance.

Facts and figures



1 headquarters
Mamer, Luxembourg

34
production sites

> 70
sales subsidiaries

> 9,000
employees

> 100,000
different products

> 1,000
patents and
utility models

> 200
employees in R&D

> 10
innovation awards

30%
of products
developed in the last 5 years


Modern machines,
experienced specialists
and our mastery of
the entire process chain
are your guarantee
of excellent product quality
and stable processes.

Always the best quality

Cutting Solutions by CERATIZIT is a quality leader, combining the entire process expertise and far-ranging production skills of the whole CERATIZIT Group.

- Highly skilled and trained specialists in a great variety of fields
- We monitor and control every step of the production process
- Our modern machine park is constantly being expanded and updated
- Optimized production processes reduce the process costs and ensure the highest quality as well as environmental compatibility of our products
- Independently checked and certified products

Powder preparation and mixing

Forming / pressing

Sintering

Grinding

Dispatch

Recycling


Sophisticated logistics processes,
a global sales
network and a flexible
high-capacity production
guarantee the fast and reliable
delivery of your solution.

Reliable availability

A majority of our standard products are available from stock. A well-organized warehouse means that we can respond quickly and reliably to your order, even for bulk quantities. Thanks to our advanced supply chain management, our production capacity is flexible and able to produce very large quantities, even in a short time frame.

You can order stock products online around the clock at our E-Techstore.

e-techstore.com
Available 24/7
for you

Your benefits:

- Live product availability check
- Detailed up-to-date technical information and graphic illustrations
- Fast delivery: orders up to 5:00 pm will ship on the same day
- Reliable delivery: we work only with the best and most reliable service providers in the sector

Cutting Solutions by CERATIZIT

Best-in-class brand Cutting Solutions by CERATIZIT offers you a comprehensive range of premium cutting tools. Benefit from our inserts and solid carbide tools engineered for maximum precision and best performance. As a creative partner, we develop industry-specific applications and individual solutions in consultation with you. You can count on real value and quality, from raw material to ready-to-use tooling solutions.

Industry Solutions

Every industry has specific demands, just as you demand maximum cutting performance and wear resistance as well as precision and quality in your tools and materials. From heavy duty machining, aerospace and automotive to power engineering, from the machining of high alloyed steels and super alloys to titanium: as the leading supplier of solutions for numerous industry-specific applications, we use our know-how to provide you with innovative advice and support. No matter what you need, together we will create a successful solution to optimize your production.

Unique requirements? We love challenges!

Do you face new challenges over and over again? Do you need to improve production, reduce costs or create innovations? Rely on Cutting Solutions by CERATIZIT. We manage the carbide production process from beginning to end, so we can develop complete and individual solutions upon request.

Our expertise in solutions includes the capacity to analyze existing products, then optimize or create product innovations from scratch. Our product range is continuously adapted to meet your needs.

»Why Cutting Solutions by CERATIZIT is the best partner for your specific industry«

Our customers only want the best. We get that. So if you are considering a cutting tool partner, we have compelling reasons why Cutting Solutions by CERATIZIT, a global leader in carbide solutions, is your best choice.

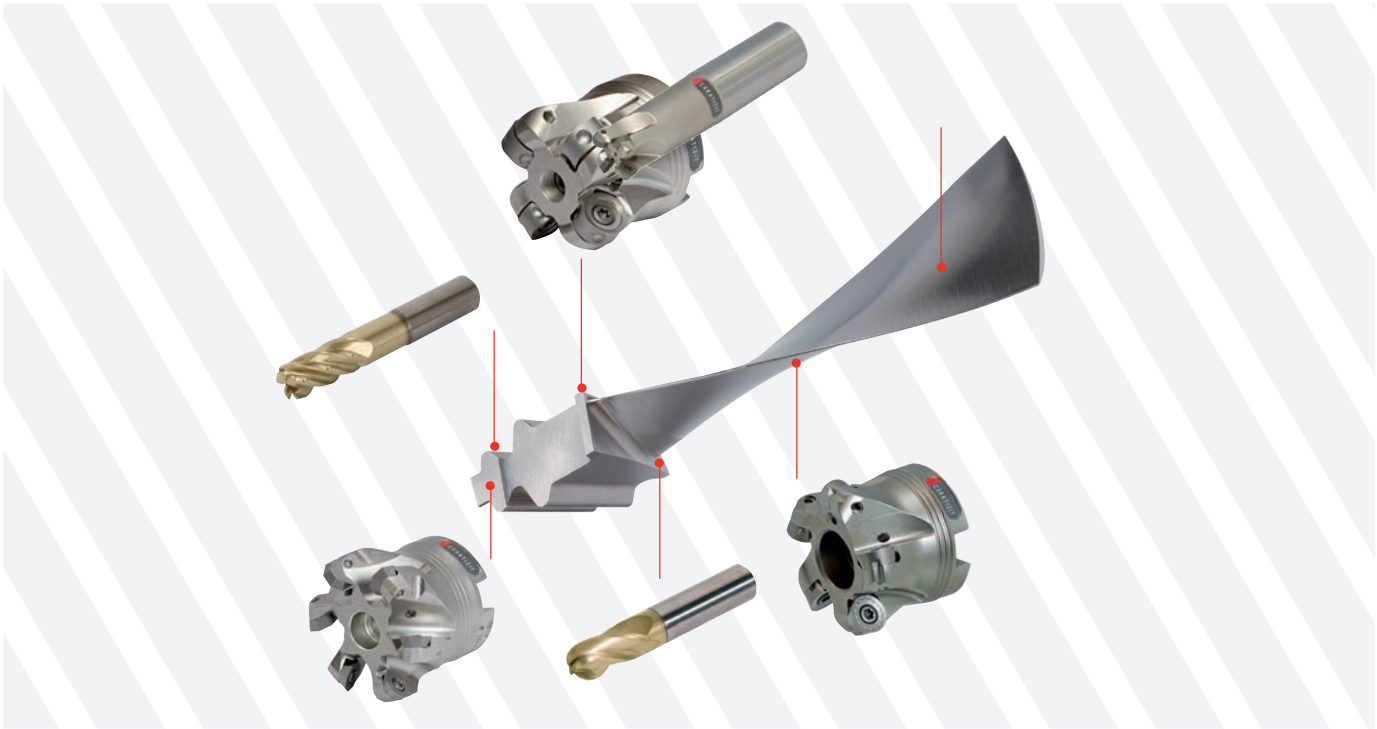
Quality

At Cutting Solutions by CERATIZIT, we control the entire carbide production process while ensuring precision and performance at the highest level. Our quality promise to you is a premium-class cutting tool solution with maximum tool life, optimal process security and guaranteed added value.

Expertise in solutions

Our products will increase the economic efficiency of your production, whether they are off-the-shelf tools with a great price-performance ratio or industry-specific and individually customised product innovations.

As a creative partner, we consult with you to be sure we understand your requirements and develop exactly the solution you need. Accordingly, we can be counted on to develop the right solution for your challenges.



High Precision Coating for High Precision Tools

TiCN
(Titanium Carbonitride)

This multipurpose gradient coating is used for milling in general purpose applications in which interrupted cutting is encountered as it has a higher edge stability than TiCN-grey. It is also ideal where high feed and speed rates are desirable.

AlTiN
(Aluminum Titanium Nitride)

Our AlTiN is a monoblock and gradient, multilayer coating designed specifically for use on carbide end mills. Use when machining Cast Iron and Steel work pieces as it has excellent oxidation resistance allowing for high speeds in semi-dry or dry machining operations where increased heat is generated.

ZrN
(Zirconium Nitride)

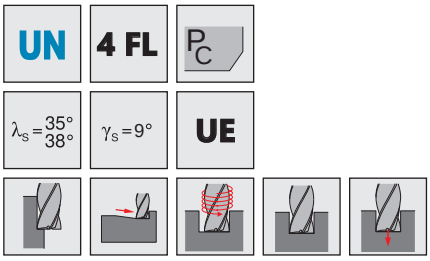
This monolayer coating effectively reduces built-up edges when machining aluminum and titanium alloys. Recommended when machining medical grade materials and in other high heat resistant applications. Also for use in machining Steels, Alloyed Steels, Superalloys, Aluminium > 12% Si, Aluminium < 12% Si, Copper, Bronze and Brass Plastics.

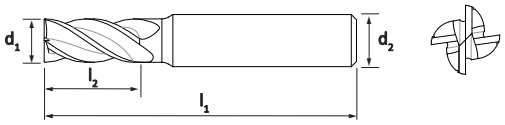
nACRo®
(Aluminum-Chromium-Silicon)

The latest generation in tool coatings, nACRo®, has a nanocomposite structure that has increased hardness for scratch and higher heat resistance. Add to these qualities increased tool life and decreased tool changes, this coating will maximize machine time in “tough” difficult to cut materials including Steels, Hardened Steels, Alloyed Steels, and Superalloys. nACRo® coated tools have been proven to reduce production time by up to 30%.

Series US451

4 Flute Universal





Tolerances

Shank:	1/8” - 1” = -.0001/-.0004
Cutting Dia:	1/8” - 1” = +.000/-.002
Chamfer:	1/8” - 1” = +/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	Flute	AlTiN	nACRo®
1/8	1/8	3/8	1 - 1/2	4	12185639	12185640
5/32	3/16	1/2	2	4	12185641	12185642
5/32	3/16	3/8	2	4	12185643	12185644
3/16	3/16	5/8	2	4	12185645	12185646
3/16	3/16	3/8	2	4	12185647	12185648
7/32	1/4	3/4	2 - 1/2	4	12185649	12185650
7/32	1/4	3/8	2	4	12185651	12185652
1/4	1/4	3/4	2 - 1/2	4	12185653	12185654
1/4	1/4	3/8	2	4	12185655	12185656
1/4	1/4	1 - 1/4	3	4	12185657	12185658
5/16	5/16	3/4	2 - 1/2	4	12185659	12185660
5/16	5/16	1/2	2 - 1/2	4	12185661	12185662
3/8	3/8	7/8	3	4	12185663	12185664
3/8	3/8	5/8	2 - 1/2	4	12185665	12185666
3/8	3/8	1 - 1/2	4	4	12185667	12185668
7/16	7/16	1	2 - 3/4	4	12185669	12185670
1/2	1/2	1	3	4	12271040	12271042
1/2	1/2	1 - 1/4	3 - 1/2	4	12185671	12185672
1/2	1/2	5/8	2 - 1/2	4	12185673	12185674
1/2	1/2	2	4	4	12185675	12185676
5/8	5/8	1 - 1/4	3 - 1/2	4	12185677	12185678
5/8	5/8	7/8	3	4	12185679	12185680
5/8	5/8	2 - 1/2	5	4	12185681	12185682
3/4	3/4	1 - 5/8	4	4	12185683	12185684
3/4	3/4	2 - 1/2	5	4	12185685	12185686
1	1	1 - 1/2	4	4	12185687	12185688
1	1	2 - 3/4	6	4	12185689	12185690

Application Range:

Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●		●	●	●	●			●	

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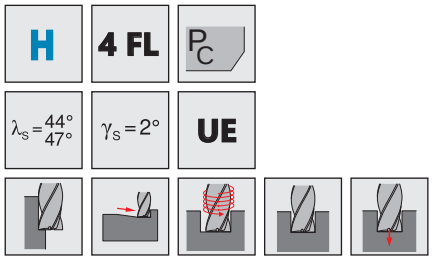
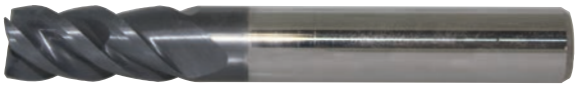
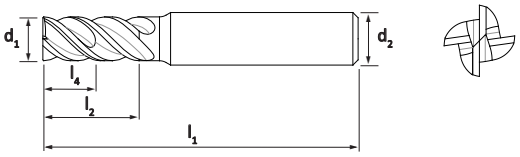
Series US453

4 Flute Hardened Steel







Tolerances

Shank:	1/8” - 3/4” = -.0001/-.0004
Cutting Dia:	1/8” - 3/4” = +.000/-.002
Chamfer:	1/8” - 3/4” = +/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_4 TCL	l_1 OAL	Flute	nACRo®
1/8	1/8	3/8	0.150	2	4	12185691
3/16	3/16	7/16	0.225	2 - 1/2	4	12185692
1/4	1/4	1/2	0.300	2 - 1/2	4	12185693
5/16	5/16	3/4	0.375	2 - 1/2	4	12185694
3/8	3/8	7/8	0.450	3	4	12185695
7/16	7/16	1	0.525	2 - 3/4	4	12185696
1/2	1/2	1	0.600	3	4	12185697
1/2	1/2	1 - 1/2	0.600	4	4	12185698
5/8	5/8	1 - 1/4	0.750	3 - 1/2	4	12185699
5/8	5/8	1 - 7/8	0.750	5	4	12185700
3/4	3/4	1 - 5/8	0.900	4	4	12185701
3/4	3/4	2 - 3/8	0.900	5	4	12185702

Application Range:

Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●	●								

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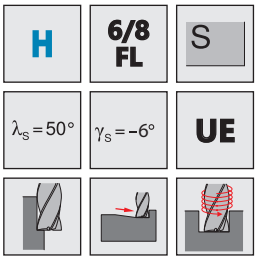
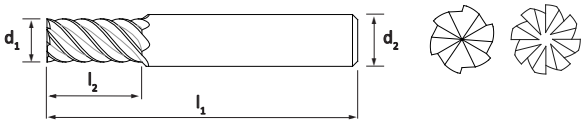
Series US367

6 & 8 Flute Hardened Steel





Tolerances

Shank: 1/8" - 3/4" = -.0001/-.0004
Cutting Dia: 1/8" - 3/4" = +.000/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	Flute	nACRo®
1/8	1/8	3/8	2	6	12185578
3/16	3/16	7/16	2	6	12185579
3/16	3/16	5/8	2 - 1/2	6	12185580
1/4	1/4	1/2	2	6	12185581
1/4	1/4	11/16	2 - 1/2	6	12185582
5/16	5/16	3/4	2 - 1/2	6	12185583
5/16	5/16	1	3	6	12185584
3/8	3/8	7/8	3	6	12185585
3/8	3/8	1 - 1/8	3 - 1/2	6	12185586
1/2	1/2	1	3	6	12271034
1/2	1/2	1 - 1/4	3 - 1/2	6	12185587
1/2	1/2	1 - 1/2	4	6	12185588
5/8	5/8	1 - 1/4	3 - 1/2	8	12185589
5/8	5/8	1 - 7/8	5	8	12185590
3/4	3/4	1 - 1/2	4	8	12185591
3/4	3/4	2 - 1/4	5	8	12185592

Application Range:

Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●	●								

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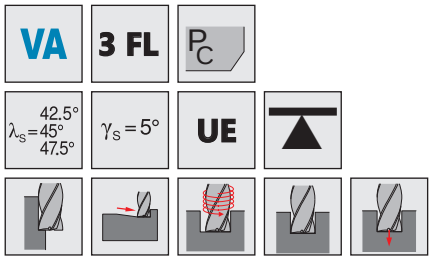
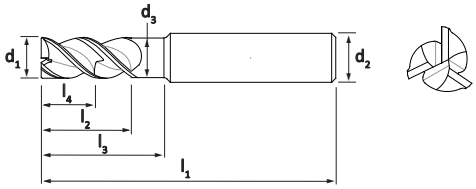
Series US340

3 Flute Stainless Steel





Tolerances

Shank: 1/8" - 3/4" = -.0001/-.0004
Cutting Dia: 1/8" - 3/4" = +.000/-.002
Chamfer: 1/8" - 3/4" = +/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_4 TCL	l_1 OAL	l_3 LOR	d_3 Neck Dia	Flute	AlTiN	nACRo®
1/8	1/8	3/8	0.163	2 - 1/4	1/2	0.120	3	12185474	12185475
3/16	3/16	7/16	0.243	2 - 1/2	11/16	0.180	3	12185480	12185482
3/16	3/16	5/8	0.243	2 - 1/2	1	0.180	3	12185477	12185479
3/16	3/16	3/8	0.206	2 - 1/2	5/8	0.180	3	12185481	12185483
3/16	3/16	5/8	0.243	2 - 1/2			3	12185476	12185478
1/4	1/4	1/2	0.325	2 - 1/2	3/4	0.240	3	12185488	12185490
1/4	1/4	3/4	0.325	2 - 1/2	1	0.240	3	12185485	12185487
1/4	1/4	3/8	0.275	2 - 1/2	5/8	0.240	3	12185489	12185491
1/4	1/4	3/4	0.325	2 - 1/2			3	12185484	12185486
5/16	5/16	3/4	0.406	2 - 1/2	1	0.300	3	12185492	12185494
5/16	5/16	1/2	0.343	2 - 1/2	3/4	0.300	3	12185496	12185497
5/16	5/16	15/16	0.406	2 - 1/2			3	12185493	12185495
3/8	3/8	7/8	0.487	2 - 1/2	1 - 1/8	0.360	3	12185502	12185504
3/8	3/8	1 - 3/16	0.487	3	1 - 1/2	0.360	3	12185499	12185501
3/8	3/8	1/2	0.412	2 - 1/2	7/8	0.360	3	12185503	12185505
3/8	3/8	1 - 3/16	0.487	3			3	12185498	12185500
1/2	1/2	1	0.650	3	1 - 3/8	0.480	3	12185510	12185512
1/2	1/2	1 - 1/2	0.650	4	1 - 7/8	0.480	3	12185507	12185509
1/2	1/2	5/8	0.550	3	1	0.480	3	12185511	12185513
1/2	1/2	1 - 1/2	0.650	4			3	12185506	12185508
5/8	5/8	1 - 1/4	0.812	3 - 1/2	1 - 5/8	0.600	3	12185518	12185520
5/8	5/8	1 - 5/8	0.812	4	2 - 1/4	0.600	3	12185515	12185517
5/8	5/8	7/8	0.687	3 - 1/2	1 - 1/4	0.600	3	12185519	12185521
5/8	5/8	1 - 5/8	0.812	4			3	12185514	12185516
3/4	3/4	1 - 1/2	0.975	4	1	0.720	3	12185526	12185528
3/4	3/4	2 - 3/8	0.975	6	2 - 7/8	0.720	3	12185523	12185525
3/4	3/4	1	0.825	4	1 - 1/2	0.720	3	12185527	12185529
3/4	3/4	2 - 3/8	0.975	6			3	12185522	12185524

Application Range:

Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●			●	●	●	●			●	

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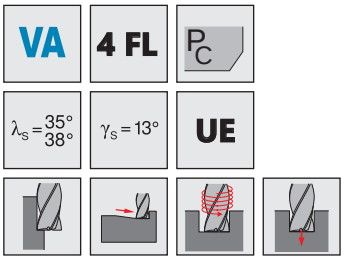
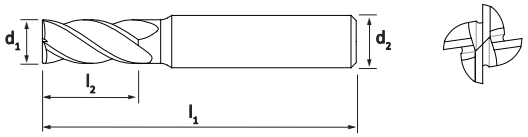
Series US445

4 Flute Stainless Steel





Tolerances

Shank:	3/16” - 3/4” = -.0001/-.0004
Cutting Dia:	3/16” - 3/4” = +.000/-.002
Chamfer:	3/16” - 3/4” = +/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	Flute	AlTiN	nACRo®
3/16	3/16	7/16	2	4	12185623	12185624
1/4	1/4	1/2	2 - 1/2	4	12185625	12185626
5/16	5/16	3/4	2 - 1/2	4	12185627	12185628
3/8	3/8	7/8	3	4	12185629	12185630
7/16	7/16	1	2 - 3/4	4	12185631	12185632
1/2	1/2	1	3	4	12271038	12271039
1/2	1/2	1 - 1/4	3 - 1/2	4	12185633	12185634
5/8	5/8	1 - 1/2	4	4	12185635	12185636
3/4	3/4	1 - 5/8	4	4	12185637	12185638

Application Range:

Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●		●			●				

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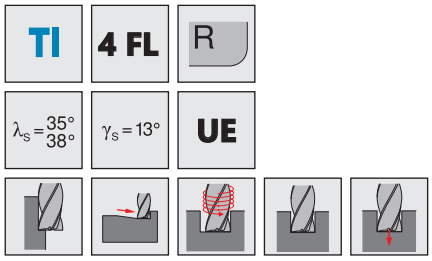
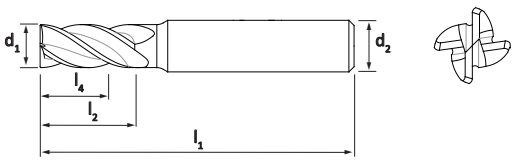
Series US456

4 Flute Titanium





Tolerances

Shank:	1/8” - 1” = -.0001/-.0004
Cutting Dia:	1/8” - 1” = +.000/-.002
Chamfer:	1/8” - 1” = +/-.001

d_1 Dia	d_2 Shank	l_2 LOC	l_4 TCL	l_1 OAL	R Radius	Flute	nACRo®	ZrN
1/8	1/8	3/8	0.300	1 - 1/2	0.004	4	12185703	12185704
3/16	3/16	5/8	0.512	2	0.004	4	12185705	12185706
1/4	1/4	3/4	0.600	2 - 1/2	0.008	4	12185707	12185708
1/4	1/4	3/8	0.275	2	0.008	4	12185709	12185710
1/4	1/4	1 - 1/4	1.100	3	0.008	4	12185711	12185712
5/16	5/16	3/4	0.562	2 - 1/2	0.008	4	12185713	12185714
3/8	3/8	7/8	0.650	3	0.008	4	12185715	12185716
3/8	3/8	5/8	0.412	2 - 1/2	0.008	4	12185717	12185718
3/8	3/8	1 - 1/2	1.275	4	0.008	4	12185719	12185720
7/16	7/16	1	0.737	2 - 3/4	0.008	4	12185721	12185722
1/2	1/2	1	0.550	3	0.012	4	12271043	12271044
1/2	1/2	1 - 1/4	0.950	3 - 1/2	0.012	4	12185723	12185724
1/2	1/2	5/8	0.550	2 - 1/2	0.012	4	12185725	12185726
1/2	1/2	2	1.700	4	0.012	4	12185727	12185728
5/8	5/8	1 - 1/4	0.687	3 - 1/2	0.012	4	12185729	12185730
5/8	5/8	2 - 1/2	2.125	5	0.012	4	12185731	12185732
3/4	3/4	1 - 5/8	0.825	4	0.012	4	12185733	12185734
3/4	3/4	2 - 1/2	2.050	5	0.012	4	12185735	12185736
1	1	1 - 1/2	1.100	4	0.012	4	12185737	12185738

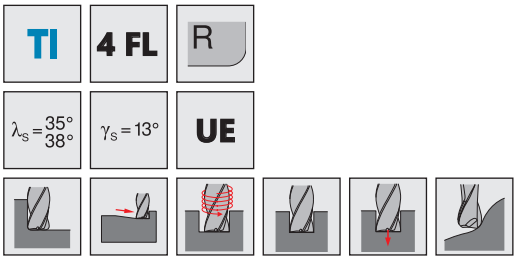
Application Range:

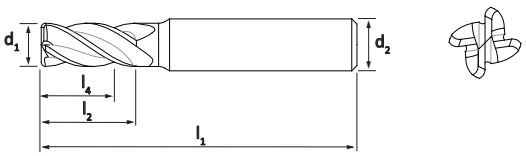
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
				●	●					

Feeds & Speeds Available on Page 46

Series US457

4 Flute Titanium Corner Radius





Tolerances

Shank:	1/8" - 1" = -.0001/-.0004
Cutting Dia:	1/8" - 1" = +.000/-.002
Radius:	Radius < 0.060 = +/-.001
	Radius > 0.060 = +/-.0015

d_1 Dia	d_2 Shank	l_2 LOC	l_4 TCL	l_1 OAL	R Radius	Flute	nACRo®	ZrN
1/8	1/8	3/8	0.300	1 - 1/2	0.010	4	12185739	12185740
1/8	1/8	3/8	0.300	1 - 1/2	0.015	4	12185761	12185762
1/8	1/8	3/8	0.300	1 - 1/2	0.020	4	12185785	12185786
3/16	3/16	3/8	0.206	2	0.010	4	12185743	12185744
3/16	3/16	3/8	0.206	2	0.015	4	12185765	12185766
3/16	3/16	3/8	0.206	2	0.020	4	12185789	12185790
3/16	3/16	5/8	0.512	2	0.010	4	12185741	12185742
3/16	3/16	5/8	0.512	2	0.015	4	12185763	12185764
3/16	3/16	5/8	0.512	2	0.020	4	12185787	12185788
1/4	1/4	3/8	0.275	2	0.010	4	12185747	12185748
1/4	1/4	3/8	0.275	2	0.015	4	12185769	12185770
1/4	1/4	3/8	0.275	2	0.020	4	12185793	12185794
1/4	1/4	3/8	0.275	2	0.030	4	12185813	12185814
1/4	1/4	3/4	0.600	2 - 1/2	0.010	4	12185745	12185746
1/4	1/4	3/4	0.600	2 - 1/2	0.015	4	12185767	12185768
1/4	1/4	3/4	0.600	2 - 1/2	0.020	4	12185791	12185792
1/4	1/4	3/4	0.600	2 - 1/2	0.030	4	12185811	12185812
1/4	1/4	1 - 1/4	1.100	3	0.010	4	12185749	12185750
1/4	1/4	1 - 1/4	1.100	3	0.015	4	12185771	12185772
1/4	1/4	1 - 1/4	1.100	3	0.020	4	12185795	12185796
1/4	1/4	1 - 1/4	1.100	3	0.030	4	12185815	12185816
5/16	5/16	3/4	0.562	2 - 1/2	0.015	4	12185773	12185774
5/16	5/16	3/4	0.562	2 - 1/2	0.020	4	12185797	12185798
5/16	5/16	3/4	0.562	2 - 1/2	0.030	4	12185817	12185818
3/8	3/8	5/8	0.412	2 - 1/2	0.010	4	12185753	12185754
3/8	3/8	5/8	0.412	2 - 1/2	0.015	4	12185777	12185778
3/8	3/8	5/8	0.412	2 - 1/2	0.020	4	12185801	12185802
3/8	3/8	5/8	0.412	2 - 1/2	0.030	4	12185821	12185822
3/8	3/8	7/8	0.650	3	0.010	4	12185751	12185752
3/8	3/8	7/8	0.650	3	0.015	4	12185775	12185776
3/8	3/8	7/8	0.650	3	0.020	4	12185799	12185800
3/8	3/8	7/8	0.650	3	0.030	4	12185819	12185820
3/8	3/8	1 - 1/2	1.275	4	0.010	4	12185755	12185756
3/8	3/8	1 - 1/2	1.275	4	0.015	4	12185779	12185780

Additional Sizes On Page 21

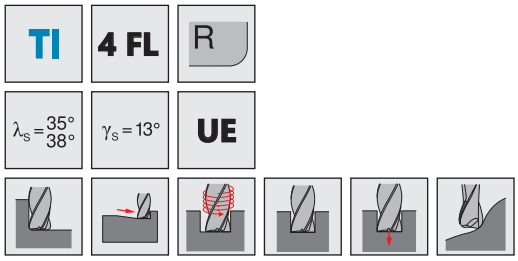
Application Range:

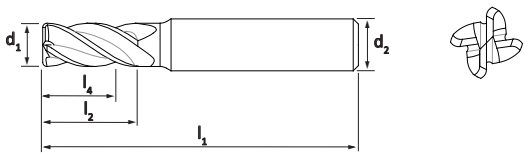
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
				●	●					

Feeds & Speeds Available on Page 46

Series US457

4 Flute Titanium Corner Radius





Tolerances

Shank:	1/8" - 1" = -.0001/-.0004
Cutting Dia:	1/8" - 1" = +.000/-.002
Radius:	Radius < 0.060 = +/-.001
	Radius > 0.060 = +/-.0015

d_1 Dia	d_2 Shank	l_2 LOC	l_4 TCL	l_1 OAL	R Radius	Flute	nACRo®	ZrN
3/8	3/8	1 - 1/2	1.275	4	0.020	4	12185803	12185804
3/8	3/8	1 - 1/2	1.275	4	0.030	4	12185823	12185824
7/16	7/16	1	0.737	2 - 3/4	0.020	4	12185805	12185806
1/2	1/2	5/8	0.550	2 - 1/2	0.010	4	12185759	12185760
1/2	1/2	5/8	0.550	2 - 1/2	0.015	4	12185783	12185784
1/2	1/2	5/8	0.550	2 - 1/2	0.020	4	12185809	12185810
1/2	1/2	5/8	0.550	2 - 1/2	0.030	4	12185827	12185828
1/2	1/2	5/8	0.550	2 - 1/2	0.060	4	12185845	12185846
1/2	1/2	1	0.550	3	0.010	4	12271045	12271046
1/2	1/2	1	0.550	3	0.015	4	12271047	12271048
1/2	1/2	1	0.550	3	0.020	4	12271049	12271050
1/2	1/2	1	0.550	3	0.030	4	12271051	12271052
1/2	1/2	1	0.550	3	0.060	4	12271053	12271054
1/2	1/2	1 - 1/4	0.950	3 - 1/2	0.010	4	12185757	12185758
1/2	1/2	1 - 1/4	0.950	3 - 1/2	0.015	4	12185781	12185782
1/2	1/2	1 - 1/4	0.950	3 - 1/2	0.020	4	12185807	12185808
1/2	1/2	1 - 1/4	0.950	3 - 1/2	0.030	4	12185825	12185826
1/2	1/2	1 - 1/4	0.950	3 - 1/2	0.060	4	12185843	12185844
5/8	5/8	7/8	0.687	3	0.030	4	12185831	12185832
5/8	5/8	7/8	0.687	3	0.060	4	12185849	12185850
5/8	5/8	1 - 1/4	0.687	3 - 1/2	0.030	4	12185829	12185830
5/8	5/8	1 - 1/4	0.687	3 - 1/2	0.060	4	12185847	12185848
5/8	5/8	2 - 1/2	2.125	5	0.030	4	12185833	12185834
5/8	5/8	2 - 1/2	2.125	5	0.060	4	12185851	12185852
3/4	3/4	1 - 5/8	0.825	4	0.030	4	12185835	12185836
3/4	3/4	1 - 5/8	0.825	4	0.060	4	12185853	12185854
3/4	3/4	1 - 5/8	0.825	4	0.125	4	12185861	12185862
3/4	3/4	2 - 1/2	2.050	5	0.030	4	12185837	12185838
3/4	3/4	2 - 1/2	2.050	5	0.060	4	12185855	12185856
1	1	1 - 1/2	1.100	4	0.030	4	12185839	12185840
1	1	1 - 1/2	1.100	4	0.060	4	12185857	12185858
1	1	1 - 1/2	1.100	4	0.125	4	12185863	12185864
1	1	2 - 3/4	2.150	6	0.030	4	12185841	12185842
1	1	2 - 3/4	2.150	6	0.060	4	12185859	12185860
1	1	2 - 3/4	2.150	6	0.125	4	12185865	12185866

Additional Sizes On Page 20

Application Range:

Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
				●	●					

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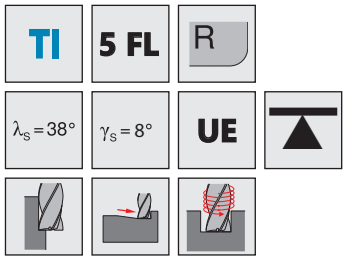
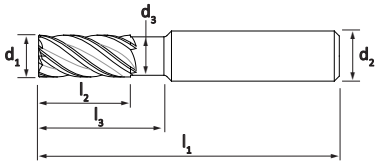
Series US556

5 Flute Titanium





Tolerances

Shank:	1/8” - 3/4” = -.0001/-.0004
Cutting Dia:	1/8” - 3/4” = +.000/-.002
Chamfer:	1/8” - 3/4” = +/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	l_3 LOR	d_3 Neck Dia	R Radius	Flute	nACRo®
1/8	1/8	3/8	2	1/2	0.120	0.004	5	12185867
3/16	3/16	7/16	2	5/8	0.180	0.004	5	12185868
1/4	1/4	1/2	2 - 1/2	3/4	0.240	0.008	5	12185869
5/16	5/16	3/4	2 - 1/2	1	0.300	0.008	5	12185870
3/8	3/8	7/8	3	1 - 1/8	0.360	0.008	5	12185871
7/16	7/16	1	2 - 3/4	1 - 3/8	0.420	0.008	5	12185872
1/2	1/2	1	3	1 - 1/4	0.480	0.012	5	12271055
1/2	1/2	1 - 1/4	3 - 1/2	1 - 1/2	0.480	0.012	5	12185873
5/8	5/8	1 - 1/4	3 - 1/2	1 - 5/8	0.600	0.012	5	12185874
3/4	3/4	1 - 5/8	4	2	0.720	0.012	5	12185875

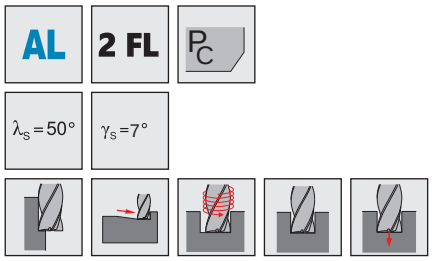
Application Range:

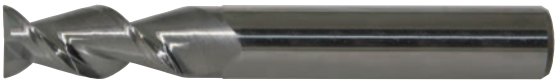
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
			●	●	●					

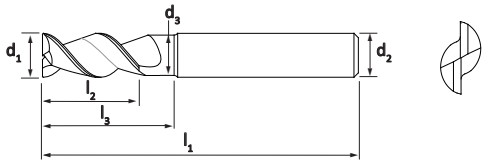
Feeds & Speeds Available on Page 46

Series US220

2 Flute Aluminum







Tolerances

Shank:	1/8" - 3/4" = -.0001/-.0004
Cutting Dia:	1/8" - 3/4" = +.000/-.002
Chamfer:	1/8" - 3/4" = +/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	l_3 LOR	d_3 Neck Dia	Flute	Uncoated
1/8	1/8	3/8	2	3/4	0.120	2	12185466
3/16	3/16	7/16	2	3/4	0.180	2	12185467
1/4	1/4	1/2	2 - 1/2	13/16	0.240	2	12185468
5/16	5/16	3/4	3	1	0.300	2	12185469
3/8	3/8	7/8	3	1 - 1/8	0.360	2	12185470
1/2	1/2	1	3	1 - 3/8	0.480	2	12271031
1/2	1/2	1 - 1/4	3 - 1/2	1 - 5/8	0.480	2	12185471
5/8	5/8	1 - 1/4	4	1 - 7/8	0.600	2	12185472
3/4	3/4	1 - 1/2	5	2 - 1/4	0.720	2	12185473

Application Range:

Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
							●	●	●	

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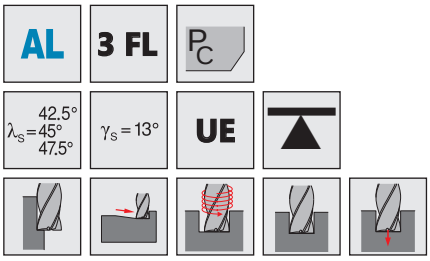
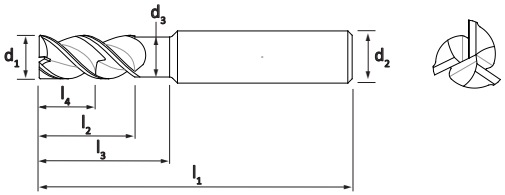
Series US360

3 Flute Aluminum





Tolerances

Shank:	1/8" - 3/4" = -.0001/-.0004
Cutting Dia:	1/8" - 3/4" = +.000/-.002
Chamfer:	1/8" - 3/4" = +/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_4 TCL	l_1 OAL	l_3 LOR	d_3 Neck Dia	Flute	Uncoated	ZrN
1/8	1/8	5/16	0.2030	2 - 1/4	1/2	0.120	3	12185530	12185531
1/8	1/8	1/4		3	3/4	0.120	3	12185532	12185533
5/32	3/16	7/16	0.2430	2 - 1/2	3/4	0.150	3	12185534	12185535
5/32	3/16	1/4		3	1	0.150	3	12185536	12185537
3/16	3/16	1/2	0.2480	2 - 1/2	3/4	0.180	3	12185538	12185539
3/16	3/16	5/16		3	1 - 1/4	0.180	3	12185540	12185541
1/4	1/4	1/2	0.3850	2 - 1/2	3/4	0.240	3	12185542	12185543
1/4	1/4	1/2	0.3850	3	1 - 5/8	0.240	3	12185546	12185547
1/4	1/4	3/8		3	1 - 5/8	0.240	3	12185544	12185545
5/16	5/16	3/4	0.4660	2 - 1/2	1	0.300	3	12185548	12185549
5/16	5/16	3/4	0.4660	4	2 -1/2	0.300	3	12185552	12185553
5/16	5/16	1/2		4	2 - 1/2	0.300	3	12185550	12185551
3/8	3/8	7/8	0.5480	3	1 - 1/8	0.360	3	12185554	12185555
3/8	3/8	7/8	0.5480	4	2 - 1/4	0.360	3	12185558	12185559
3/8	3/8	5/8		4	2 - 1/4	0.360	3	12185556	12185557
7/16	7/16	1	0.6290	2 - 3/4	1 - 1/4	0.420	3	12185560	12185561
1/2	1/2	1	0.7100	3	1 - 3/8	0.480	3	12271032	12271033
1/2	1/2	1	0.7100	3 - 1/2	1 - 3/8	0.480	3	12185562	12185563
1/2	1/2	1	0.7100	5	2 - 7/8	0.480	3	12185566	12185567
1/2	1/2	3/4		5	2 - 7/8	0.480	3	12185564	12185565
5/8	5/8	1 - 1/4	0.8730	3 - 1/2	1 - 5/8	0.600	3	12185568	12185569
5/8	5/8	1 - 1/4	0.8730	6	4	0.600	3	12185572	12185573
5/8	5/8	1		6	4	0.600	3	12185570	12185571
3/4	3/4	1 - 5/8	1.0350	4	2-1/8	0.720	3	12185574	12185575
3/4	3/4	1 - 1/4		6	4	0.720	3	12185576	12185577

Application Range:

Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
							●	●	●	

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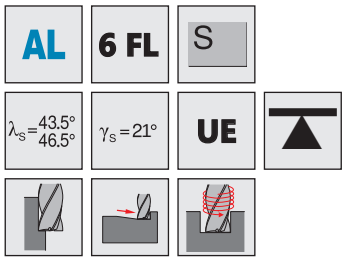
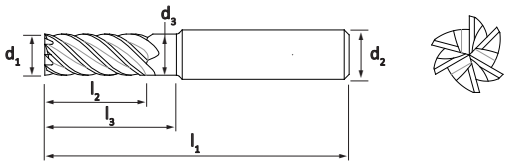
Series US376

6 Flute Aluminum





Tolerances

Shank: 1/4" - 1" = -.0001/-.0004
Cutting Dia: 1/4" - 1" = +.000/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	l_3 LOR	d_3 Neck Dia	Flute	Uncoated	ZrN
1/4	1/4	5/8	2 - 1/2	7/8	0.240	6	12185593	12185594
1/4	1/4	5/8	3	1 - 5/8	0.240	6	12185595	12185596
5/16	5/16	3/4	2 - 1/2	1	0.300	6	12185597	12185598
5/16	5/16	3/4	4	2 - 3/8	0.300	6	12185599	12185600
3/8	3/8	1	3	1 - 1/4	0.360	6	12185601	12185602
3/8	3/8	1	4	2 - 1/4	0.360	6	12185603	12185604
1/2	1/2	1	3	1 - 1/4	0.480	6	12271036	12271037
1/2	1/2	1 - 1/4	3 - 1/2	1 - 1/2	0.480	6	12185605	12185606
1/2	1/2	1 - 1/4	5	3	0.480	6	12185607	12185608
1/2	1/2	1 - 7/8	5			6	12185609	12185610
5/8	5/8	1 - 1/4	3 - 1/2	1 - 1/2	0.600	6	12185611	12185612
5/8	5/8	1 - 1/4	6	3 - 5/8	0.600	6	12185613	12185614
5/8	5/8	2 - 1/2	6			6	12185615	12185616
3/4	3/4	1 - 5/8	4	2	0.720	6	12185617	12185618
3/4	3/4	1 - 5/8	6	3 - 5/8	0.720	6	12185619	12185620
1	1	2	6	3 - 7/8	0.960	6	12185621	12185622

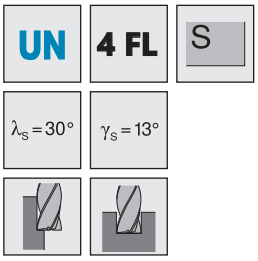
Application Range:

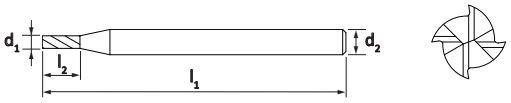
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
							●	●	●	

Feeds & Speeds Available on Page 47

Series US501

4 Flute Micro





Tolerances

Shank:	1/8" - 3/4" = -.0001/-.0004
Cutting Dia:	1/8" - 3/4" = +.000/-.002
Chamfer:	1/8" - 3/4" = +/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	Flute	AlTiN
0.005	1/8	0.015	1-1/2	4	12276316
0.006	1/8	0.018	1-1/2	4	12276317
0.007	1/8	0.021	1-1/2	4	12276318
0.008	1/8	0.024	1-1/2	4	12276319
0.009	1/8	0.027	1-1/2	4	12276320
0.010	1/8	0.030	1-1/2	4	12276321
0.011	1/8	0.033	1-1/2	4	12276322
0.012	1/8	0.036	1-1/2	4	12276323
0.013	1/8	0.039	1-1/2	4	12276324
0.014	1/8	0.042	1-1/2	4	12276325
0.015	1/8	0.045	1-1/2	4	12276326
0.016	1/8	0.048	1-1/2	4	12276327
0.017	1/8	0.051	1-1/2	4	12276328
0.018	1/8	0.054	1-1/2	4	12276329
0.019	1/8	0.057	1-1/2	4	12276330
0.020	1/8	0.060	1-1/2	4	12276331
0.021	1/8	0.063	1-1/2	4	12276332
0.022	1/8	0.066	1-1/2	4	12276333
0.023	1/8	0.069	1-1/2	4	12276334
0.024	1/8	0.072	1-1/2	4	12276335
0.025	1/8	0.075	1-1/2	4	12276336
0.026	1/8	0.078	1-1/2	4	12276337
0.027	1/8	0.081	1-1/2	4	12276338
0.028	1/8	0.084	1-1/2	4	12276339
0.029	1/8	0.087	1-1/2	4	12276340
0.030	1/8	0.090	1-1/2	4	12276341
0.031	1/8	0.093	1-1/2	4	12276342
0.032	1/8	0.096	1-1/2	4	12276343
0.033	1/8	0.099	1-1/2	4	12276344
0.034	1/8	0.102	1-1/2	4	12276345
0.035	1/8	0.105	1-1/2	4	12276346
0.036	1/8	0.108	1-1/2	4	12276347

Additional Sizes On Pages 27, 28, & 29

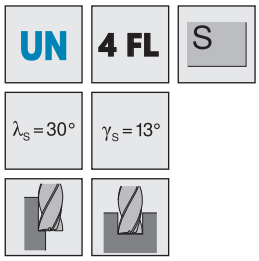
Application Range:

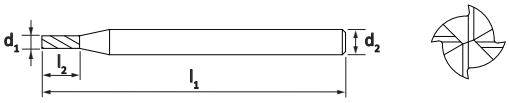
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●	●	●	●	●	●		●	●	

Feeds & Speeds Available on Page 48

Series US501

4 Flute Micro





Tolerances

Shank:	1/8" - 3/4" = -.0001/-.0004
Cutting Dia:	1/8" - 3/4" = +.000/-.002
Chamfer:	1/8" - 3/4" = +/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	Flute	AlTiN
0.037	1/8	0.111	1-1/2	4	12276348
0.038	1/8	0.114	1-1/2	4	12276349
0.039	1/8	0.117	1-1/2	4	12276350
0.040	1/8	0.120	1-1/2	4	12276351
0.041	1/8	0.123	1-1/2	4	12276352
0.042	1/8	0.126	1-1/2	4	12276353
0.043	1/8	0.129	1-1/2	4	12276354
0.044	1/8	0.132	1-1/2	4	12276355
0.045	1/8	0.135	1-1/2	4	12276356
0.046	1/8	0.138	1-1/2	4	12276357
0.047	1/8	0.141	1-1/2	4	12276358
0.048	1/8	0.144	1-1/2	4	12276359
0.049	1/8	0.147	1-1/2	4	12276360
0.050	1/8	0.150	1-1/2	4	12276361
0.051	1/8	0.153	1-1/2	4	12276362
0.052	1/8	0.156	1-1/2	4	12276363
0.053	1/8	0.159	1-1/2	4	12276364
0.054	1/8	0.162	1-1/2	4	12276365
0.055	1/8	0.165	1-1/2	4	12276366
0.056	1/8	0.168	1-1/2	4	12276367
0.057	1/8	0.171	1-1/2	4	12276368
0.058	1/8	0.174	1-1/2	4	12276369
0.059	1/8	0.177	1-1/2	4	12276370
0.060	1/8	0.180	1-1/2	4	12276371
0.061	1/8	0.183	1-1/2	4	12276372
0.062	1/8	0.186	1-1/2	4	12276373
0.063	1/8	0.189	1-1/2	4	12276374
0.064	1/8	0.192	1-1/2	4	12276375
0.065	1/8	0.195	1-1/2	4	12276376
0.066	1/8	0.198	1-1/2	4	12276377
0.067	1/8	0.201	1-1/2	4	12276378
0.068	1/8	0.204	1-1/2	4	12276379

Additional Sizes On Pages 26, 28, & 29

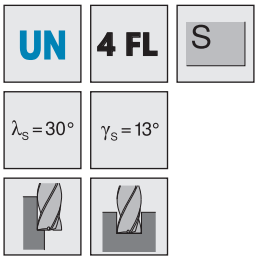
Application Range:

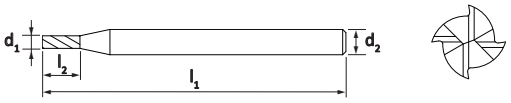
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●	●	●	●	●	●		●	●	

Feeds & Speeds Available on Page 48

Series US501

4 Flute Micro





Tolerances

Shank: 1/8" - 3/4" = -.0001/-.0004
Cutting Dia: 1/8" - 3/4" = +.000/-.002
Chamfer: 1/8" - 3/4" = +/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	Flute	AlTiN
0.069	1/8	0.207	1-1/2	4	12276380
0.070	1/8	0.210	1-1/2	4	12276381
0.071	1/8	0.213	1-1/2	4	12276382
0.072	1/8	0.216	1-1/2	4	12276383
0.073	1/8	0.219	1-1/2	4	12276384
0.074	1/8	0.222	1-1/2	4	12276385
0.075	1/8	0.225	1-1/2	4	12276386
0.076	1/8	0.228	1-1/2	4	12276387
0.077	1/8	0.231	1-1/2	4	12276388
0.078	1/8	0.234	1-1/2	4	12276389
0.079	1/8	0.237	1-1/2	4	12276390
0.080	1/8	0.240	1-1/2	4	12276391
0.081	1/8	0.243	1-1/2	4	12276392
0.082	1/8	0.246	1-1/2	4	12276393
0.083	1/8	0.249	1-1/2	4	12276394
0.084	1/8	0.252	1-1/2	4	12276395
0.085	1/8	0.255	1-1/2	4	12276396
0.086	1/8	0.258	1-1/2	4	12276397
0.087	1/8	0.261	1-1/2	4	12276398
0.088	1/8	0.264	1-1/2	4	12276399
0.089	1/8	0.267	1-1/2	4	12276400
0.090	1/8	0.270	1-1/2	4	12276401
0.091	1/8	0.273	1-1/2	4	12276402
0.092	1/8	0.276	1-1/2	4	12276403
0.093	1/8	0.279	1-1/2	4	12276404
0.094	1/8	0.282	1-1/2	4	12276405
0.095	1/8	0.285	1-1/2	4	12276406
0.096	1/8	0.288	1-1/2	4	12276407
0.097	1/8	0.291	1-1/2	4	12276408
0.098	1/8	0.294	1-1/2	4	12276409
0.099	1/8	0.297	1-1/2	4	12276410
0.100	1/8	0.300	1-1/2	4	12276411

Additional Sizes On Pages 26, 27 & 29

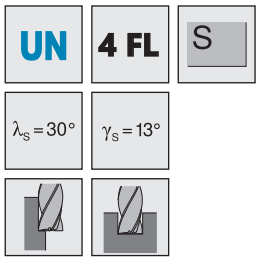
Application Range:

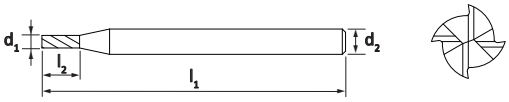
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●	●	●	●	●	●		●	●	

Feeds & Speeds Available on Page 48

Series US501

4 Flute Micro





Tolerances

Shank:	1/8" - 3/4" = -.0001/-.0004
Cutting Dia:	1/8" - 3/4" = +.000/-.002
Chamfer:	1/8" - 3/4" = +/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	Flute	AlTiN
0.101	1/8	0.303	1-1/2	4	12276412
0.102	1/8	0.306	1-1/2	4	12276413
0.103	1/8	0.309	1-1/2	4	12276414
0.104	1/8	0.312	1-1/2	4	12276415
0.105	1/8	0.315	1-1/2	4	12276416
0.106	1/8	0.318	1-1/2	4	12276417
0.107	1/8	0.321	1-1/2	4	12276418
0.108	1/8	0.324	1-1/2	4	12276419
0.109	1/8	0.327	1-1/2	4	12276420
0.110	1/8	0.330	1-1/2	4	12276421
0.111	1/8	0.333	1-1/2	4	12276422
0.112	1/8	0.336	1-1/2	4	12276423
0.113	1/8	0.339	1-1/2	4	12276424
0.114	1/8	0.341	1-1/2	4	12276425
0.115	1/8	0.345	1-1/2	4	12276426
0.116	1/8	0.348	1-1/2	4	12276427
0.117	1/8	0.351	1-1/2	4	12276428
0.118	1/8	0.354	1-1/2	4	12276429
0.119	1/8	0.357	1-1/2	4	12276430
0.120	1/8	0.360	1-1/2	4	12276431

Additional Sizes On Pages 26, 27 & 28

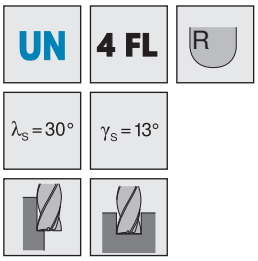
Application Range:

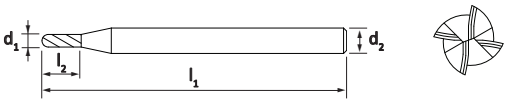
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●	●	●	●	●	●		●	●	

Feeds & Speeds Available on Page 48

Series US503

4 Flute Micro Ball





Tolerances

Shank:	1/8” - 3/4” = -.0001/-.0004
Cutting Dia:	1/8” - 3/4” = +.000/-.002
Chamfer:	1/8” - 3/4” = +/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	Flute	AlTiN
0.005	1/8	0.015	1-1/2	4	12276432
0.006	1/8	0.018	1-1/2	4	12276433
0.007	1/8	0.021	1-1/2	4	12276434
0.008	1/8	0.024	1-1/2	4	12276435
0.009	1/8	0.027	1-1/2	4	12276436
0.010	1/8	0.030	1-1/2	4	12276437
0.011	1/8	0.033	1-1/2	4	12276438
0.012	1/8	0.036	1-1/2	4	12276439
0.013	1/8	0.039	1-1/2	4	12276440
0.014	1/8	0.042	1-1/2	4	12276441
0.015	1/8	0.045	1-1/2	4	12276442
0.016	1/8	0.048	1-1/2	4	12276443
0.017	1/8	0.051	1-1/2	4	12276444
0.018	1/8	0.054	1-1/2	4	12276445
0.019	1/8	0.057	1-1/2	4	12276446
0.020	1/8	0.060	1-1/2	4	12276447
0.021	1/8	0.063	1-1/2	4	12276448
0.022	1/8	0.066	1-1/2	4	12276449
0.023	1/8	0.069	1-1/2	4	12276450
0.024	1/8	0.072	1-1/2	4	12276451
0.025	1/8	0.075	1-1/2	4	12276452
0.026	1/8	0.078	1-1/2	4	12276453
0.027	1/8	0.081	1-1/2	4	12276454
0.028	1/8	0.084	1-1/2	4	12276455
0.029	1/8	0.087	1-1/2	4	12276456
0.030	1/8	0.090	1-1/2	4	12276457
0.031	1/8	0.093	1-1/2	4	12276458
0.032	1/8	0.096	1-1/2	4	12276459
0.033	1/8	0.099	1-1/2	4	12276460
0.034	1/8	0.102	1-1/2	4	12276461
0.035	1/8	0.105	1-1/2	4	12276462
0.036	1/8	0.108	1-1/2	4	12276463
0.037	1/8	0.111	1-1/2	4	12276464
0.038	1/8	0.114	1-1/2	4	12276465

Additional Sizes On Pages 31, 32 & 33

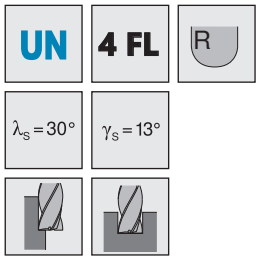
Application Range:

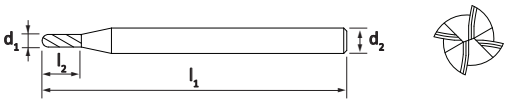
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●	●	●	●	●	●		●	●	

Feeds & Speeds Available on Page 48

Series US503

4 Flute Micro Ball





Tolerances

Shank:	1/8” - 3/4” = -.0001/-.0004
Cutting Dia:	1/8” - 3/4” = +.000/-.002
Chamfer:	1/8” - 3/4” = +/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	Flute	AlTiN
0.039	1/8	0.117	1-1/2	4	12276466
0.040	1/8	0.120	1-1/2	4	12276467
0.041	1/8	0.123	1-1/2	4	12276468
0.042	1/8	0.126	1-1/2	4	12276469
0.043	1/8	0.129	1-1/2	4	12276470
0.044	1/8	0.132	1-1/2	4	12276471
0.045	1/8	0.135	1-1/2	4	12276472
0.046	1/8	0.138	1-1/2	4	12276473
0.047	1/8	0.141	1-1/2	4	12276474
0.048	1/8	0.144	1-1/2	4	12276475
0.049	1/8	0.147	1-1/2	4	12276476
0.050	1/8	0.150	1-1/2	4	12276477
0.051	1/8	0.153	1-1/2	4	12276478
0.052	1/8	0.156	1-1/2	4	12276479
0.053	1/8	0.159	1-1/2	4	12276480
0.054	1/8	0.162	1-1/2	4	12276481
0.055	1/8	0.165	1-1/2	4	12276482
0.056	1/8	0.168	1-1/2	4	12276483
0.057	1/8	0.171	1-1/2	4	12276484
0.058	1/8	0.174	1-1/2	4	12276485
0.059	1/8	0.177	1-1/2	4	12276486
0.060	1/8	0.180	1-1/2	4	12276487
0.061	1/8	0.183	1-1/2	4	12276488
0.062	1/8	0.186	1-1/2	4	12276489
0.063	1/8	0.189	1-1/2	4	12276490
0.064	1/8	0.192	1-1/2	4	12276491
0.065	1/8	0.195	1-1/2	4	12276492
0.066	1/8	0.198	1-1/2	4	12276493
0.067	1/8	0.201	1-1/2	4	12276494
0.068	1/8	0.204	1-1/2	4	12276495
0.069	1/8	0.207	1-1/2	4	12276496
0.070	1/8	0.210	1-1/2	4	12276497

Additional Sizes On Pages 30, 32 & 33

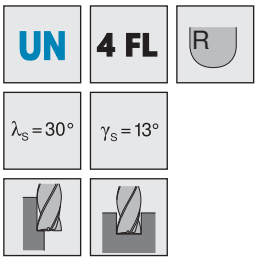
Application Range:

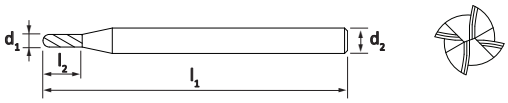
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●	●	●	●	●	●		●	●	

Feeds & Speeds Available on Page 48

Series US503

4 Flute Micro Ball





Tolerances

Shank:	1/8” - 3/4” = -.0001/-.0004
Cutting Dia:	1/8” - 3/4” = +.000/-.002
Chamfer:	1/8” - 3/4” = +/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	Flute	AlTiN
0.071	1/8	0.213	1-1/2	4	12276498
0.072	1/8	0.216	1-1/2	4	12276499
0.073	1/8	0.219	1-1/2	4	12276500
0.074	1/8	0.222	1-1/2	4	12276501
0.075	1/8	0.225	1-1/2	4	12276502
0.076	1/8	0.228	1-1/2	4	12276503
0.077	1/8	0.231	1-1/2	4	12276504
0.078	1/8	0.234	1-1/2	4	12276505
0.079	1/8	0.237	1-1/2	4	12276506
0.080	1/8	0.240	1-1/2	4	12276507
0.081	1/8	0.243	1-1/2	4	12276508
0.082	1/8	0.246	1-1/2	4	12276509
0.083	1/8	0.249	1-1/2	4	12276510
0.084	1/8	0.252	1-1/2	4	12276511
0.085	1/8	0.255	1-1/2	4	12276512
0.086	1/8	0.258	1-1/2	4	12276513
0.087	1/8	0.261	1-1/2	4	12276514
0.088	1/8	0.264	1-1/2	4	12276515
0.089	1/8	0.267	1-1/2	4	12276516
0.090	1/8	0.270	1-1/2	4	12276517
0.091	1/8	0.273	1-1/2	4	12276518
0.092	1/8	0.276	1-1/2	4	12276519
0.093	1/8	0.279	1-1/2	4	12276520
0.094	1/8	0.282	1-1/2	4	12276521
0.095	1/8	0.285	1-1/2	4	12276522
0.096	1/8	0.288	1-1/2	4	12276523
0.097	1/8	0.291	1-1/2	4	12276524
0.098	1/8	0.294	1-1/2	4	12276525
0.099	1/8	0.297	1-1/2	4	12276526
0.100	1/8	0.300	1-1/2	4	12276527
0.101	1/8	0.303	1-1/2	4	12276528
0.102	1/8	0.306	1-1/2	4	12276529

Additional Sizes On Pages 30, 30 & 33

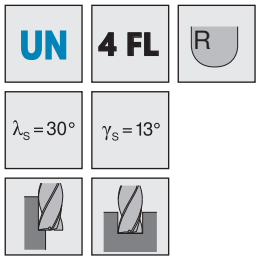
Application Range:

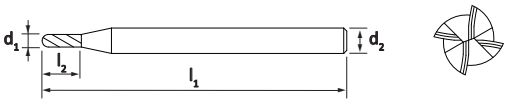
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●	●	●	●	●	●		●	●	

Feeds & Speeds Available on Page 48

Series US503

4 Flute Micro Ball





Tolerances

Shank:	1/8” - 3/4” = -.0001/-.0004
Cutting Dia:	1/8” - 3/4” = +.000/-.002
Chamfer:	1/8” - 3/4” = +/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	Flute	AlTiN
0.103	1/8	0.309	1-1/2	4	12276530
0.104	1/8	0.312	1-1/2	4	12276531
0.105	1/8	0.315	1-1/2	4	12276532
0.106	1/8	0.318	1-1/2	4	12276533
0.107	1/8	0.321	1-1/2	4	12276534
0.108	1/8	0.324	1-1/2	4	12276535
0.109	1/8	0.327	1-1/2	4	12276536
0.110	1/8	0.330	1-1/2	4	12276537
0.111	1/8	0.333	1-1/2	4	12276538
0.112	1/8	0.336	1-1/2	4	12276539
0.113	1/8	0.339	1-1/2	4	12276540
0.114	1/8	0.341	1-1/2	4	12276541
0.115	1/8	0.345	1-1/2	4	12276542
0.116	1/8	0.348	1-1/2	4	12276543
0.117	1/8	0.351	1-1/2	4	12276544
0.118	1/8	0.354	1-1/2	4	12276545
0.119	1/8	0.357	1-1/2	4	12276546
0.120	1/8	0.360	1-1/2	4	12276547

Additional Sizes On Pages 30, 31 & 32

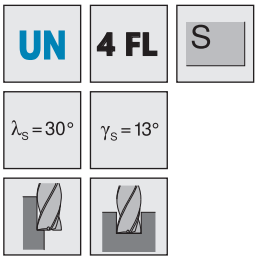
Application Range:

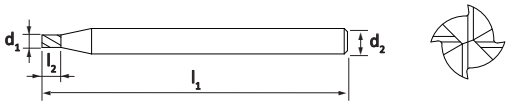
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●	●	●	●	●	●		●	●	

Feeds & Speeds Available on Page 48

Series US504

4 Flute Micro Stub





Tolerances

Shank:	1/8” - 3/4” = -.0001/-.0004
Cutting Dia:	1/8” - 3/4” = +.000/-.002
Chamfer:	1/8” - 3/4” = +/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	Flute	AlTiN
0.005	1/8	0.008	1-1/2	4	12276548
0.006	1/8	0.009	1-1/2	4	12276549
0.007	1/8	0.011	1-1/2	4	12276550
0.008	1/8	0.012	1-1/2	4	12276551
0.009	1/8	0.014	1-1/2	4	12276552
0.010	1/8	0.015	1-1/2	4	12276553
0.011	1/8	0.017	1-1/2	4	12276554
0.012	1/8	0.018	1-1/2	4	12276555
0.013	1/8	0.020	1-1/2	4	12276556
0.014	1/8	0.021	1-1/2	4	12276557
0.015	1/8	0.023	1-1/2	4	12276558
0.016	1/8	0.024	1-1/2	4	12276559
0.017	1/8	0.026	1-1/2	4	12276560
0.018	1/8	0.027	1-1/2	4	12276561
0.019	1/8	0.029	1-1/2	4	12276562
0.020	1/8	0.030	1-1/2	4	12276563
0.021	1/8	0.032	1-1/2	4	12276564
0.022	1/8	0.033	1-1/2	4	12276565
0.023	1/8	0.035	1-1/2	4	12276566
0.024	1/8	0.036	1-1/2	4	12276567
0.025	1/8	0.038	1-1/2	4	12276568
0.026	1/8	0.039	1-1/2	4	12276569
0.027	1/8	0.041	1-1/2	4	12276570
0.028	1/8	0.042	1-1/2	4	12276571
0.029	1/8	0.044	1-1/2	4	12276572
0.03	1/8	0.045	1-1/2	4	12276573
0.031	1/8	0.047	1-1/2	4	12276574
0.032	1/8	0.048	1-1/2	4	12276575
0.033	1/8	0.050	1-1/2	4	12276576
0.034	1/8	0.051	1-1/2	4	12276577
0.035	1/8	0.053	1-1/2	4	12276578
0.036	1/8	0.054	1-1/2	4	12276579

Additional Sizes On Pages 35 & 36

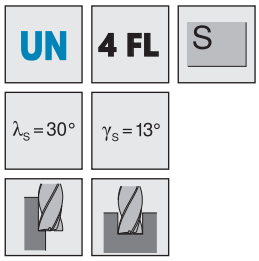
Application Range:

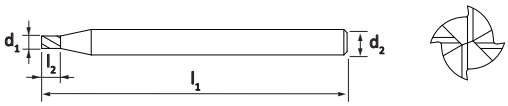
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●	●	●	●	●	●		●	●	

Feeds & Speeds Available on Page 49

Series US504

4 Flute Micro Stub





Tolerances

Shank:	1/8" - 3/4" = -.0001/-.0004
Cutting Dia:	1/8" - 3/4" = +.000/-.002
Chamfer:	1/8" - 3/4" = +/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	Flute	AlTiN
0.037	1/8	0.056	1-1/2	4	12276580
0.038	1/8	0.057	1-1/2	4	12276581
0.039	1/8	0.059	1-1/2	4	12276582
0.040	1/8	0.060	1-1/2	4	12276583
0.041	1/8	0.062	1-1/2	4	12276584
0.042	1/8	0.063	1-1/2	4	12276585
0.043	1/8	0.065	1-1/2	4	12276586
0.044	1/8	0.066	1-1/2	4	12276587
0.045	1/8	0.068	1-1/2	4	12276588
0.046	1/8	0.069	1-1/2	4	12276589
0.047	1/8	0.071	1-1/2	4	12276590
0.048	1/8	0.072	1-1/2	4	12276591
0.049	1/8	0.074	1-1/2	4	12276592
0.050	1/8	0.075	1-1/2	4	12276593
0.051	1/8	0.077	1-1/2	4	12276594
0.052	1/8	0.078	1-1/2	4	12276595
0.053	1/8	0.080	1-1/2	4	12276596
0.054	1/8	0.081	1-1/2	4	12276597
0.055	1/8	0.083	1-1/2	4	12276598
0.056	1/8	0.084	1-1/2	4	12276599
0.057	1/8	0.086	1-1/2	4	12276600
0.058	1/8	0.087	1-1/2	4	12276601
0.059	1/8	0.089	1-1/2	4	12276602
0.060	1/8	0.090	1-1/2	4	12276603
0.061	1/8	0.092	1-1/2	4	12276604
0.062	1/8	0.093	1-1/2	4	12276605
0.063	1/8	0.095	1-1/2	4	12276606
0.064	1/8	0.096	1-1/2	4	12276607
0.065	1/8	0.098	1-1/2	4	12276608
0.066	1/8	0.099	1-1/2	4	12276609
0.067	1/8	0.101	1-1/2	4	12276610
0.068	1/8	0.102	1-1/2	4	12276611

Additional Sizes On Pages 34 & 36

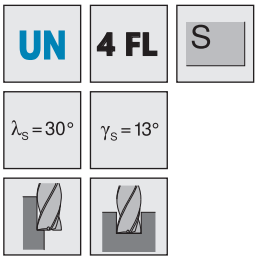
Application Range:

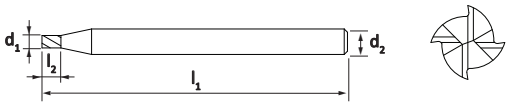
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●	●	●	●	●	●		●	●	

Feeds & Speeds Available on Page 49

Series US504

4 Flute Micro Stub





Tolerances

Shank:	1/8” - 3/4” = -.0001/-.0004
Cutting Dia:	1/8” - 3/4” = +.000/-.002
Chamfer:	1/8” - 3/4” = +/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	Flute	AlTiN
0.069	1/8	0.104	1-1/2	4	12276612
0.070	1/8	0.105	1-1/2	4	12276613
0.071	1/8	0.107	1-1/2	4	12276614
0.072	1/8	0.108	1-1/2	4	12276615
0.073	1/8	0.110	1-1/2	4	12276616
0.074	1/8	0.111	1-1/2	4	12276617
0.075	1/8	0.113	1-1/2	4	12276618
0.076	1/8	0.114	1-1/2	4	12276619
0.077	1/8	0.116	1-1/2	4	12276620
0.078	1/8	0.117	1-1/2	4	12276621
0.079	1/8	0.119	1-1/2	4	12276622
0.080	1/8	0.120	1-1/2	4	12276623
0.081	1/8	0.122	1-1/2	4	12276624
0.082	1/8	0.123	1-1/2	4	12276625
0.083	1/8	0.125	1-1/2	4	12276626
0.084	1/8	0.126	1-1/2	4	12276627
0.085	1/8	0.128	1-1/2	4	12276628
0.086	1/8	0.129	1-1/2	4	12276629
0.087	1/8	0.131	1-1/2	4	12276630
0.088	1/8	0.132	1-1/2	4	12276631
0.089	1/8	0.134	1-1/2	4	12276632
0.090	1/8	0.135	1-1/2	4	12276633

Additional Sizes On Pages 34 & 35

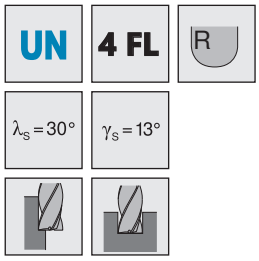
Application Range:

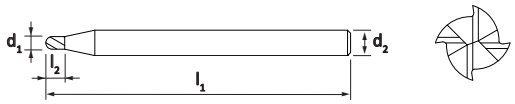
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●	●	●	●	●	●		●	●	

Feeds & Speeds Available on Page 49

Series US506

4 Flute Micro Stub Ball





Tolerances

Shank:	1/8" - 3/4" = -.0001/-.0004
Cutting Dia:	1/8" - 3/4" = +.000/-.002
Chamfer:	1/8" - 3/4" = +/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	Flute	AlTiN
0.005	1/8	0.008	1-1/2	4	12276664
0.006	1/8	0.009	1-1/2	4	12276665
0.007	1/8	0.011	1-1/2	4	12276666
0.008	1/8	0.012	1-1/2	4	12276667
0.009	1/8	0.014	1-1/2	4	12276668
0.010	1/8	0.015	1-1/2	4	12276669
0.011	1/8	0.017	1-1/2	4	12276670
0.012	1/8	0.018	1-1/2	4	12276671
0.013	1/8	0.020	1-1/2	4	12276672
0.014	1/8	0.021	1-1/2	4	12276673
0.015	1/8	0.023	1-1/2	4	12276674
0.016	1/8	0.024	1-1/2	4	12276675
0.017	1/8	0.026	1-1/2	4	12276676
0.018	1/8	0.027	1-1/2	4	12276677
0.019	1/8	0.029	1-1/2	4	12276678
0.020	1/8	0.030	1-1/2	4	12276679
0.021	1/8	0.032	1-1/2	4	12276680
0.022	1/8	0.033	1-1/2	4	12276681
0.023	1/8	0.035	1-1/2	4	12276682
0.024	1/8	0.036	1-1/2	4	12276683
0.025	1/8	0.038	1-1/2	4	12276684
0.026	1/8	0.039	1-1/2	4	12276685
0.027	1/8	0.041	1-1/2	4	12276686
0.028	1/8	0.042	1-1/2	4	12276687
0.029	1/8	0.044	1-1/2	4	12276688
0.030	1/8	0.045	1-1/2	4	12276689
0.031	1/8	0.047	1-1/2	4	12276690
0.032	1/8	0.048	1-1/2	4	12276691
0.033	1/8	0.050	1-1/2	4	12276692
0.034	1/8	0.051	1-1/2	4	12276693
0.035	1/8	0.053	1-1/2	4	12276694
0.036	1/8	0.054	1-1/2	4	12276695

Additional Sizes On Pages 38, 39 & 40

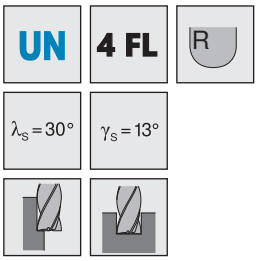
Application Range:

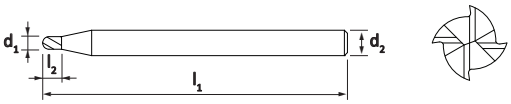
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●	●	●	●	●	●		●	●	

Feeds & Speeds Available on Page 49

Series US506

4 Flute Micro Stub Ball





Tolerances

Shank:	1/8" - 3/4" = -.0001/-.0004
Cutting Dia:	1/8" - 3/4" = +.000/-.002
Chamfer:	1/8" - 3/4" = +/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	Flute	AlTiN
0.037	1/8	0.056	1-1/2	4	12276696
0.038	1/8	0.057	1-1/2	4	12276697
0.039	1/8	0.059	1-1/2	4	12276698
0.040	1/8	0.060	1-1/2	4	12276699
0.041	1/8	0.062	1-1/2	4	12276700
0.042	1/8	0.063	1-1/2	4	12276701
0.043	1/8	0.065	1-1/2	4	12276702
0.044	1/8	0.066	1-1/2	4	12276703
0.045	1/8	0.068	1-1/2	4	12276704
0.046	1/8	0.069	1-1/2	4	12276705
0.047	1/8	0.071	1-1/2	4	12276706
0.048	1/8	0.072	1-1/2	4	12276707
0.049	1/8	0.074	1-1/2	4	12276708
0.050	1/8	0.075	1-1/2	4	12276709
0.051	1/8	0.077	1-1/2	4	12276710
0.052	1/8	0.078	1-1/2	4	12276711
0.053	1/8	0.080	1-1/2	4	12276712
0.054	1/8	0.081	1-1/2	4	12276713
0.055	1/8	0.083	1-1/2	4	12276714
0.056	1/8	0.084	1-1/2	4	12276715
0.057	1/8	0.086	1-1/2	4	12276716
0.058	1/8	0.087	1-1/2	4	12276717
0.059	1/8	0.089	1-1/2	4	12276718
0.060	1/8	0.090	1-1/2	4	12276719
0.061	1/8	0.092	1-1/2	4	12276720
0.062	1/8	0.093	1-1/2	4	12276721
0.063	1/8	0.095	1-1/2	4	12276722
0.064	1/8	0.096	1-1/2	4	12276723
0.065	1/8	0.098	1-1/2	4	12276724
0.066	1/8	0.099	1-1/2	4	12276725
0.067	1/8	0.101	1-1/2	4	12276726
0.068	1/8	0.102	1-1/2	4	12276727

Additional Sizes On Pages 37, 39 & 40

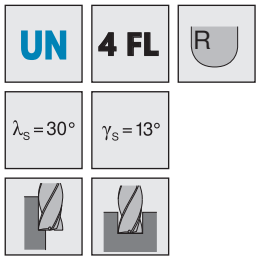
Application Range:

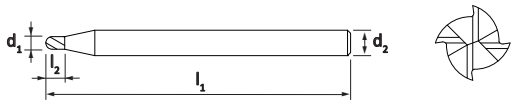
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●	●	●	●	●	●		●	●	

Feeds & Speeds Available on Page 49

Series US506

4 Flute Micro Stub Ball





Tolerances

Shank:	1/8" - 3/4" = -.0001/-.0004
Cutting Dia:	1/8" - 3/4" = +.000/-.002
Chamfer:	1/8" - 3/4" = +/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	Flute	AlTiN
0.069	1/8	0.104	1-1/2	4	12276728
0.070	1/8	0.105	1-1/2	4	12276729
0.071	1/8	0.107	1-1/2	4	12276730
0.072	1/8	0.108	1-1/2	4	12276731
0.073	1/8	0.110	1-1/2	4	12276732
0.074	1/8	0.111	1-1/2	4	12276733
0.075	1/8	0.113	1-1/2	4	12276734
0.076	1/8	0.114	1-1/2	4	12276735
0.077	1/8	0.116	1-1/2	4	12276736
0.078	1/8	0.117	1-1/2	4	12276737
0.079	1/8	0.119	1-1/2	4	12276738
0.080	1/8	0.120	1-1/2	4	12276739
0.081	1/8	0.122	1-1/2	4	12276740
0.082	1/8	0.123	1-1/2	4	12276741
0.083	1/8	0.125	1-1/2	4	12276742
0.084	1/8	0.126	1-1/2	4	12276743
0.085	1/8	0.128	1-1/2	4	12276744
0.086	1/8	0.129	1-1/2	4	12276745
0.087	1/8	0.131	1-1/2	4	12276746
0.088	1/8	0.132	1-1/2	4	12276747
0.089	1/8	0.134	1-1/2	4	12276748
0.090	1/8	0.135	1-1/2	4	12276749
0.091	1/8	0.137	1-1/2	4	12276750
0.092	1/8	0.138	1-1/2	4	12276751
0.093	1/8	0.140	1-1/2	4	12276752
0.094	1/8	0.141	1-1/2	4	12276753
0.095	1/8	0.143	1-1/2	4	12276754
0.096	1/8	0.144	1-1/2	4	12276755
0.097	1/8	0.146	1-1/2	4	12276756
0.098	1/8	0.147	1-1/2	4	12276757
0.099	1/8	0.149	1-1/2	4	12276758
0.100	1/8	0.150	1-1/2	4	12276759

Additional Sizes On Pages 37, 38 & 40

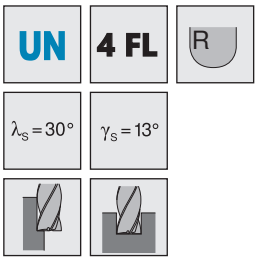
Application Range:

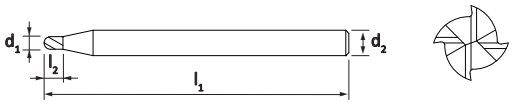
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●	●	●	●	●	●		●	●	

Feeds & Speeds Available on Page 49

Series US506

4 Flute Micro Stub Ball





Tolerances

Shank:	1/8” - 3/4” = -.0001/-.0004
Cutting Dia:	1/8” - 3/4” = +.000/-.002
Chamfer:	1/8” - 3/4” = +/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	Flute	AlTiN
0.101	1/8	0.152	1-1/2	4	12276760
0.102	1/8	0.153	1-1/2	4	12276761
0.103	1/8	0.155	1-1/2	4	12276762
0.104	1/8	0.156	1-1/2	4	12276763
0.105	1/8	0.158	1-1/2	4	12276764
0.106	1/8	0.159	1-1/2	4	12276765
0.107	1/8	0.161	1-1/2	4	12276766
0.108	1/8	0.162	1-1/2	4	12276767
0.109	1/8	0.164	1-1/2	4	12276768
0.110	1/8	0.165	1-1/2	4	12276769
0.111	1/8	0.167	1-1/2	4	12276770
0.112	1/8	0.168	1-1/2	4	12276771
0.113	1/8	0.170	1-1/2	4	12276772
0.114	1/8	0.171	1-1/2	4	12276773
0.115	1/8	0.173	1-1/2	4	12276774
0.116	1/8	0.174	1-1/2	4	12276775
0.117	1/8	0.176	1-1/2	4	12276776
0.118	1/8	0.177	1-1/2	4	12276777
0.119	1/8	0.179	1-1/2	4	12276778
0.120	1/8	0.180	1-1/2	4	12276779

Additional Sizes On Pages 37, 38 & 39

Application Range:

Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●	●	●	●	●	●		●	●	

Feeds & Speeds Available on Page 49

Universal - US451

Material Designation		SFM [ft/min]	ae max [inch]	ap max [inch]	Chip Load Per Tooth [Inch] 1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
Machining Steel	< 500 N/mm²	853	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
	> 500 N/mm²	787	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
Construction Steel	Non-Alloy < 500 N/mm²	820	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
	Non-Alloy > 500 N/mm²	755	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	Alloy	722	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
Cementation Steel	< 150 HB	689	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	150-200 HB	656	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	> 200 HB	623	1xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
Nitriding Steel	< 1000 N/mm²	623	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	> 1000 N/mm²	558	1xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
Quenched & Tempered Steel	Non-Alloy < 800 N/mm²	656	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	Non-Alloy 800-1000 N/mm²	623	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	Alloy < 800 N/mm²	623	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	Alloy 800-1000 N/mm²	591	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	Alloy 1000-1300 N/mm²	558	1xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
	Alloy 1300-1600 N/mm²	492	1xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
Non-Alloy Tool Steel	General	607	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
Tool Steel for Cold Processing	Low Alloy < 1000 N/mm²	591	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	Low Alloy < 1200 N/mm²	558	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	Low Alloy < 1500 N/mm²	492	1xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
	High Alloy Annealed < 1000 N/mm²	525	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	High Alloy Hardened < 1300 N/mm²	459	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
Tool Steel for Warm Processing	Low Alloy < 1200 N/mm²	656	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	Low Alloy < 1500 N/mm²	591	1xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
	High Alloy Annealed < 1000 N/mm²	492	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	High Alloy Hardened < 1300 N/mm²	459	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	High Alloy Hardened < 1600 N/mm²	427	1xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
Stainless Steel	Ferric	328	1xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028	0.0035
	Martensitic	262	1xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028	0.0035
	Austenitic A5 < 40%	328	1xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028	0.0035
	Austenitic A5 > 40%	328	1xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028	0.0035
	Sulphured	361	1xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028	0.0035
High Temperature Alloy	Fe-Alloy	98	1xø	0.5xø	0.0004	0.0008	0.0012	0.0016	0.0020	0.0024
	Ni-Alloy not hardened	98	1xø	0.5xø	0.0004	0.0008	0.0012	0.0016	0.0020	0.0024
	Ni-Alloy hardened	98	1xø	0.5xø	0.0004	0.0008	0.0012	0.0016	0.0020	0.0024
	Co-Alloy	98	1xø	0.5xø	0.0004	0.0008	0.0012	0.0016	0.0020	0.0024
Cast Iron	Non-Alloy	656	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	Low-Alloy	525	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	High-Alloy	394	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
Stainless Cast Steel	Ferric/Martensitic	328	1xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028	0.0035
	Austenitic	328	1xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028	0.0035
Cast Iron with Lamellar Graphite	Non-Alloy < 180 HB	656	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
	Non-Alloy > 180 HB	591	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
	Alloy	525	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	High Alloy	394	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
Spheroidal Cast Iron	Non-Alloy < 180 HB	623	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	Non-Alloy > 180 HB	558	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	Alloy	492	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
White Malleable Cast Iron	< 180 HB	591	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	> 180 HB	525	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
Black Malleable Cast Iron	< 180 HB	591	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	> 180 HB	525	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
Copper	Non-Alloy	919	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
	Wrought Alloy Non-Hardened	787	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
	Wrought Alloy Hardened	656	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
	CuNi-Alloy	787	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
	CuNiZn-Alloy Long-Chipping	656	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
	CuNiZn-Alloy Short-Chipping	787	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
CuZn (Brass)	Long-Chipping	984	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
	Short-Chipping	1148	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
CuSn (Bronze)	Long-Chipping	787	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
	Short-Chipping	919	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
CuAlFe (Ampco)	Long-Chipping	459	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
	Short-Chipping	525	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
Titanium	Non-Alloy	295	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	Alloyed-Annealed	262	1xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
	Alloyed-Hardened	164	1xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028	0.0035

*** Feeds and Speeds are starting points for Overall Lengths of 3" and shorter.**
For End Mills with Overall Lengths over 3" decrease the Feeds and Speeds.

Hardened Steel - US367

Material Designation		SFM [ft/min]	ae max [inch]	ap max [inch]	Chip Load Per Tooth [Inch]					
					1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
Spring Steel	Annealed < 250 HB	427	0.05xø	1.5xø	0.0016	0.0018	0.0024	0.0028	0.0039	0.0049
	Natural Hardened 250-350 HB	394	0.05xø	1.5xø	0.0016	0.0018	0.0024	0.0028	0.0039	0.0049
	Spring Hardened 1200-1600 N/mm²	377	0.05xø	1.5xø	0.0016	0.0018	0.0024	0.0028	0.0039	0.0049
Nitriding Steel	> 1000 N/mm²	394	0.05xø	1.5xø	0.0016	0.0018	0.0024	0.0028	0.0039	0.0049
Quenched & Tempered Steel	Alloy 1000-1300 N/mm²	394	0.05xø	1.5xø	0.0016	0.0018	0.0024	0.0028	0.0039	0.0049
	Alloy 1300-1600 N/mm²	361	0.05xø	1.5xø	0.0016	0.0018	0.0024	0.0028	0.0039	0.0049
Non-Alloy Tool Steel	General	443	0.05xø	1.5xø	0.0016	0.0018	0.0024	0.0028	0.0039	0.0049
Tool Steel for Cold Processing	Low Alloy < 1000 N/mm²	427	0.05xø	1.5xø	0.0016	0.0018	0.0024	0.0028	0.0039	0.0049
	Low Alloy < 1200 N/mm²	394	0.05xø	1.5xø	0.0016	0.0018	0.0024	0.0028	0.0039	0.0049
	Low Alloy < 1500 N/mm²	361	0.05xø	1.5xø	0.0016	0.0018	0.0024	0.0028	0.0039	0.0049
	High Alloy Annealed < 1000 N/mm²	328	0.05xø	1.5xø	0.0016	0.0018	0.0024	0.0028	0.0039	0.0049
	High Alloy Hardened < 1300 N/mm²	295	0.05xø	1.5xø	0.0016	0.0018	0.0024	0.0028	0.0039	0.0049
Tool Steel for Warm Processing	Low Alloy < 1200 N/mm²	394	0.05xø	1.5xø	0.0016	0.0018	0.0024	0.0028	0.0039	0.0049
	Low Alloy < 1500 N/mm²	361	0.05xø	1.5xø	0.0016	0.0018	0.0024	0.0028	0.0039	0.0049
	High Alloy Annealed < 1000 N/mm²	328	0.05xø	1.5xø	0.0016	0.0018	0.0024	0.0028	0.0039	0.0049
	High Alloy Hardened < 1300 N/mm²	295	0.05xø	1.5xø	0.0016	0.0018	0.0024	0.0028	0.0039	0.0049
	High Alloy Hardened < 1600 N/mm²	279	0.05xø	1.5xø	0.0016	0.0018	0.0024	0.0028	0.0039	0.0049
Hardened Tool Steel	< 55 HRC	262	0.05xø	1.5xø	0.0016	0.0018	0.0024	0.0028	0.0039	0.0049
	55–58 HRC	230	0.03xø	1.5xø	0.0016	0.0018	0.0024	0.0028	0.0039	0.0049
	58–60 HRC	197	0.03xø	1.5xø	0.0016	0.0018	0.0024	0.0028	0.0039	0.0049
	60–62 HRC	148	0.03xø	1.5xø	0.0016	0.0018	0.0024	0.0028	0.0039	0.0049
	62–64 HRC	115	0.03xø	1.5xø	0.0016	0.0018	0.0024	0.0028	0.0039	0.0049

Hardened Steel - US453

Material Designation		SFM [ft/min]	ae max [inch]	ap max [inch]	Chip Load Per Tooth [Inch]					
					1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
Spring Steel	Annealed < 250 HB	525	1xø	1xø	0.0006	0.0012	0.0016	0.0020	0.0024	0.0030
	Natural Hardened 250-350 HB	443	1xø	1xø	0.0006	0.0012	0.0016	0.0020	0.0024	0.0030
	Spring Hardened 1200-1600 N/mm²	328	1xø	1xø	0.0004	0.0008	0.0012	0.0016	0.0020	0.0024
Nitriding Steel	> 1000 N/mm²	525	1xø	1xø	0.0006	0.0012	0.0016	0.0020	0.0024	0.0030
Quenched & Tempered Steel	Alloy 800-1000 N/mm²	525	1xø	1xø	0.0006	0.0012	0.0016	0.0020	0.0024	0.0030
	Alloy 1000-1300 N/mm²	443	1xø	1xø	0.0006	0.0012	0.0016	0.0020	0.0024	0.0030
	Alloy 1300-1600 N/mm²	377	1xø	1xø	0.0006	0.0012	0.0016	0.0020	0.0024	0.0030
Tool Steel for Cold Processing	Low Alloy < 1000 N/mm²	525	1xø	1xø	0.0006	0.0012	0.0016	0.0020	0.0024	0.0030
	Low Alloy < 1200 N/mm²	377	1xø	1xø	0.0006	0.0012	0.0016	0.0020	0.0024	0.0030
	Low Alloy < 1500 N/mm²	295	1xø	1xø	0.0006	0.0012	0.0016	0.0020	0.0024	0.0030
	High Alloy Annealed < 1000 N/mm²	443	1xø	1xø	0.0004	0.0008	0.0012	0.0016	0.0020	0.0024
	High Alloy Hardened < 1300 N/mm²	427	1xø	1xø	0.0004	0.0008	0.0012	0.0016	0.0020	0.0024
Tool Steel for Warm Processing	Low Alloy < 1200 N/mm²	410	1xø	1xø	0.0006	0.0012	0.0016	0.0020	0.0024	0.0030
	Low Alloy < 1500 N/mm²	377	1xø	1xø	0.0006	0.0012	0.0016	0.0020	0.0024	0.0030
	High Alloy Annealed < 1000 N/mm²	443	1xø	1xø	0.0006	0.0012	0.0016	0.0020	0.0024	0.0030
	High Alloy Hardened < 1300 N/mm²	410	1xø	1xø	0.0004	0.0008	0.0012	0.0016	0.0020	0.0024
	High Alloy Hardened < 1600 N/mm²	377	1xø	1xø	0.0004	0.0008	0.0012	0.0016	0.0020	0.0024
Hardened Tool Steel	< 55 HRC	164	1xø	1xø	0.0004	0.0008	0.0012	0.0016	0.0020	0.0024
	55–58 HRC	115	1xø	0.5xø	0.0004	0.0008	0.0012	0.0016	0.0020	0.0024
	58–60 HRC	82	1xø	0.5xø	0.0003	0.0004	0.0008	0.0012	0.0016	0.0020
	60–62 HRC	66	1xø	0.5xø	0.0003	0.0004	0.0008	0.0012	0.0016	0.0020
	62–64 HRC	49	1xø	0.5xø	0.0003	0.0004	0.0008	0.0012	0.0016	0.0020

*** Feeds and Speeds are starting points for Overall Lengths of 3" and shorter.**
For End Mills with Overall Lengths over 3" decrease the Feeds and Speeds.

Stainless Steel - US445

Material Designation		SFM [ft/min]	ae max [inch]	ap max [inch]	Chip Load Per Tooth [Inch]					
					1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
Machining Steel	> 500 N/mm²	787	0.8xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
Construction Steel	Non-Alloy < 500 N/mm²	820	0.8xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	Non-Alloy > 500 N/mm²	755	0.8xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
	Alloy	722	0.8xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
Cementation Steel	< 150 HB	689	0.8xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
	150-200 HB	656	0.8xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
	> 200 HB	623	0.8xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028	0.0035
Nitriding Steel	< 1000 N/mm²	623	0.8xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
	> 1000 N/mm²	558	0.8xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028	0.0035
Quenched & Tempered Steel	Non-Alloy < 800 N/mm²	656	0.8xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
	Non-Alloy 800-1000 N/mm²	623	0.8xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
	Alloy < 800 N/mm²	623	0.8xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
	Alloy 800-1000 N/mm²	591	0.8xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
	Alloy 1000-1300 N/mm²	558	0.8xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028	0.0035
	Alloy 1300-1600 N/mm²	492	0.8xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028	0.0035
Non-Alloy Tool Steel	General	607	0.8xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
Tool Steel for Cold Processing	Low Alloy < 1000 N/mm²	591	0.8xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
	Low Alloy < 1200 N/mm²	558	0.8xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
	Low Alloy < 1500 N/mm²	492	0.8xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028	0.0035
	High Alloy Annealed < 1000 N/mm²	525	0.8xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
	High Alloy Hardened < 1300 N/mm²	459	0.8xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
Tool Steel for Warm Processing	Low Alloy < 1200 N/mm²	656	0.8xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
	Low Alloy < 1500 N/mm²	591	0.8xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028	0.0035
	High Alloy Annealed < 1000 N/mm²	492	0.8xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
	High Alloy Hardened < 1300 N/mm²	459	0.8xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
	High Alloy Hardened < 1600 N/mm²	427	0.8xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028	0.0035
Stainless Steel	Ferric	328	0.8xø	1xø	0.0006	0.0008	0.0012	0.0020	0.0024	0.0028
	Martensitic	262	0.8xø	1xø	0.0006	0.0008	0.0012	0.0020	0.0024	0.0028
	Austenitic A5 < 40%	328	0.8xø	1xø	0.0006	0.0008	0.0012	0.0020	0.0024	0.0028
	Austenitic A5 > 40%	328	0.8xø	1xø	0.0006	0.0008	0.0012	0.0020	0.0024	0.0028
	Sulphured	361	0.8xø	1xø	0.0006	0.0008	0.0012	0.0020	0.0024	0.0028
Cast Iron	Non-Alloy	656	0.8xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	Low-Alloy	525	0.8xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	High-Alloy	394	0.8xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
Stainless Cast Steel	Ferric/Martensitic	328	0.8xø	1xø	0.0006	0.0008	0.0012	0.0020	0.0024	0.0028
	Austenitic	328	0.8xø	1xø	0.0006	0.0008	0.0012	0.0020	0.0024	0.0028
Cast Iron with Lamellar Graphite	Non-Alloy < 180 HB	656	0.8xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	Non-Alloy > 180 HB	591	0.8xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	Alloy	525	0.8xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
	High Alloy	394	0.8xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
Spheroidal Cast Iron	Non-Alloy < 180 HB	623	0.8xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
	Non-Alloy > 180 HB	558	0.8xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
	Alloy	492	0.8xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
White Malleable Cast Iron	< 180 HB	591	0.8xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
	> 180 HB	525	0.8xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
Black Malleable Cast Iron	< 180 HB	591	0.8xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
	> 180 HB	525	0.8xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039

*** Feeds and Speeds are starting points for Overall Lengths of 3" and shorter.**
For End Mills with Overall Lengths over 3" decrease the Feeds and Speeds.

Stainless Steel - US340

Material Designation		SFM [ft/min]	ae max [inch]	ap max [inch]	Chip Load Per Tooth [Inch]					
					1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
Machining Steel	< 500 N/mm²	853	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
	> 500 N/mm²	787	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
Construction Steel	Non-Alloy < 500 N/mm²	820	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
	Non-Alloy > 500 N/mm²	755	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	Alloy	722	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
Cementation Steel	< 150 HB	689	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	150-200 HB	656	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	> 200 HB	623	1xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
Nitriding Steel	< 1000 N/mm²	623	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	> 1000 N/mm²	558	1xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
Quenched & Tempered Steel	Non-Alloy < 800 N/mm²	656	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	Non-Alloy 800-1000 N/mm²	623	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	Alloy < 800 N/mm²	623	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	Alloy 800-1000 N/mm²	591	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	Alloy 1000-1300 N/mm²	558	1xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
Stainless Steel	Ferric	328	1xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028	0.0035
	Martensitic	262	1xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028	0.0035
	Austenitic A5 < 40%	328	1xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028	0.0035
	Austenitic A5 > 40%	328	1xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028	0.0035
	Sulphured	361	1xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028	0.0035
High Temperature Alloy	Fe-Alloy	82	1xø	0.5xø	0.0004	0.0008	0.0012	0.0016	0.0020	0.0024
	Ni-Alloy not hardened	82	1xø	0.5xø	0.0004	0.0008	0.0012	0.0016	0.0020	0.0024
	Ni-Alloy hardened	82	1xø	0.5xø	0.0004	0.0008	0.0012	0.0016	0.0020	0.0024
	Co-Alloy	82	1xø	0.5xø	0.0004	0.0008	0.0012	0.0016	0.0020	0.0024
Cast Iron	Non-Alloy	656	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	Low-Alloy	525	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	High-Alloy	394	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
Stainless Cast Steel	Ferric/Martensitic	328	1xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028	0.0035
	Austenitic	328	1xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028	0.0035
Cast iron with Lamellar Graphite	Non-Alloy < 180 HB	656	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
	Non-Alloy > 180 HB	591	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
	Alloy	525	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	High Alloy	394	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
Spheroidal Cast Iron	Non-Alloy < 180 HB	623	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	Non-Alloy > 180 HB	558	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	Alloy	492	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
White Malleable Cast Iron	< 180 HB	591	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	> 180 HB	525	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
Black Malleable Cast Iron	< 180 HB	591	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	> 180 HB	525	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
Copper	Non-Alloy	919	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
	Wrought Alloy Non-Hardened	787	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
	Wrought Alloy Hardened	656	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
	CuNi-Alloy	787	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
	CuNiZn-Alloy Long-Chipping	656	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
	CuNiZn-Alloy Short-Chipping	787	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
CuZn (Brass)	Long-Chipping	984	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
	Short-Chipping	1148	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
CuSn (Bronze)	Long-Chipping	787	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
	Short-Chipping	919	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
CuAlFe (Ampco)	Long-Chipping	459	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
	Short-Chipping	525	1xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
Titanium	Non-Alloy	295	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	Alloyed-Annealed	262	1xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039
	Alloyed-Hardened	164	1xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028	0.0035

*** Feeds and Speeds are starting points for Overall Lengths of 3" and shorter.**
For End Mills with Overall Lengths over 3" decrease the Feeds and Speeds.

Titanium - US456 / US457

Material Designation		SFM [ft/min]	ae max [inch]	ap max [inch]	Chip Load Per Tooth [Inch]					
					1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
High Temperature Alloy	Fe-Alloy	180	1xø	0.5xø	0.0008	0.0016	0.0020	0.0024	0.0028	0.0031
	Ni-Alloy not hardened	180	1xø	0.5xø	0.0008	0.0016	0.0020	0.0024	0.0028	0.0031
	Ni-Alloy hardened	180	1xø	0.5xø	0.0008	0.0016	0.0020	0.0024	0.0028	0.0031
	Co-Alloy	180	1xø	0.5xø	0.0008	0.0016	0.0020	0.0024	0.0028	0.0031
Titanium	Non-Alloy	394	1xø	0.5xø	0.0010	0.0018	0.0028	0.0039	0.0047	0.0055
	Alloyed-Annealed	328	1xø	0.5xø	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047
	Alloyed-Hardened	262	1xø	0.5xø	0.0006	0.0012	0.0020	0.0024	0.0031	0.0039

Titanium - US556

Material Designation		SFM [ft/min]	ae max [inch]	ap max [inch]	Chip Load Per Tooth [Inch]				
					1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"
Stainless Steel	Ferric	328	0.5xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028
	Martensitic	262	0.5xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028
	Austenitic A5 < 40%	328	0.5xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028
	Austenitic A5 > 40%	328	0.5xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028
	Sulphured	361	0.5xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028
High Temperature Alloy	Fe-Alloy	180	0.5xø	1xø	0.0008	0.0016	0.0020	0.0024	0.0028
	Ni-Alloy not hardened	180	0.5xø	1xø	0.0008	0.0016	0.0020	0.0024	0.0028
	Ni-Alloy hardened	180	0.5xø	1xø	0.0008	0.0016	0.0020	0.0024	0.0028
	Co-Alloy	180	0.5xø	1xø	0.0008	0.0016	0.0020	0.0024	0.0028
Stainless Cast Steel	Ferric/Martensitic	328	0.5xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028
	Austenitic	328	0.5xø	1xø	0.0005	0.0010	0.0016	0.0020	0.0028
Titanium	Non-Alloy	394	0.5xø	1xø	0.0010	0.0018	0.0028	0.0039	0.0047
	Alloyed-Annealed	328	0.5xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0039
	Alloyed-Hardened	262	0.5xø	1xø	0.0006	0.0012	0.0020	0.0024	0.0031

Aluminum - US360

Material Designation		SFM [ft/min]	ae max [inch]	ap max [inch]	Chip Load Per Tooth [Inch]					
					1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
Aluminium	Non-Alloy	1968	1xø	1xø	0.0014	0.0024	0.0028	0.0035	0.0047	0.0055
	Wrought Alloy Non-Hardened	1968	1xø	1xø	0.0014	0.0024	0.0028	0.0035	0.0047	0.0055
	Wrought Alloy Hardened	1968	1xø	1xø	0.0014	0.0024	0.0028	0.0035	0.0047	0.0055
	Casting Alloy < 6% Si	1575	1xø	1xø	0.0014	0.0024	0.0028	0.0035	0.0047	0.0055
	Casting Alloy 6-12% Si	1181	1xø	1xø	0.0012	0.0020	0.0028	0.0047	0.0067	0.0083
	Casting Alloy > 6% Si	787	1xø	1xø	0.0012	0.0020	0.0028	0.0047	0.0067	0.0083
Magnesium	Wrought Alloy	722	1xø	1xø	0.0012	0.0020	0.0028	0.0047	0.0067	0.0083
	Casting Alloy	656	1xø	1xø	0.0012	0.0020	0.0028	0.0047	0.0067	0.0083
Copper	Non-Alloy	558	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0047	0.0055
	Wrought Alloy Non-Hardened	509	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0047	0.0055
	Wrought Alloy Hardened	394	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0047	0.0055
	CuNi-Alloy	492	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0047	0.0055
	CuNiZn-Alloy Long-Chipping	394	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0047	0.0055
	CuNiZn-Alloy Short-Chipping	492	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0047	0.0055
CuZn (Brass)	Long-Chipping	591	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0047	0.0055
	Short-Chipping	787	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0047	0.0055
CuSn (Bronze)	Long-Chipping	492	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0047	0.0055
	Short-Chipping	558	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0047	0.0055
CuAlFe (Ampco)	Long-Chipping	180	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0047	0.0055
	Short-Chipping	230	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0047	0.0055

*** Feeds and Speeds are starting points for Overall Lengths of 3" and shorter.**
For End Mills with Overall Lengths over 3" decrease the Feeds and Speeds.

Aluminum - US376

Material Designation		SFM [ft/min]	ae max [inch]	ap max [inch]	Chip Load Per Tooth [Inch]					
					1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
Aluminium	Non-Alloy	1640	0.05xø	2xø	0.0008	0.0016	0.0020	0.0024	0.0028	0.0031
	Wrought Alloy Non-Hardened	1640	0.05xø	2xø	0.0008	0.0016	0.0020	0.0024	0.0028	0.0031
	Wrought Alloy Hardened	1640	0.05xø	2xø	0.0008	0.0016	0.0020	0.0024	0.0028	0.0031
	Casting Alloy < 6% Si	1312	0.05xø	2xø	0.0008	0.0016	0.0020	0.0024	0.0028	0.0031
	Casting Alloy 6-12% Si	984	0.05xø	2xø	0.0006	0.0008	0.0012	0.0020	0.0024	0.0028
	Casting Alloy > 6% Si	689	0.05xø	2xø	0.0006	0.0008	0.0012	0.0020	0.0024	0.0028
Magnesium	Wrought Alloy	656	0.05xø	2xø	0.0006	0.0008	0.0012	0.0020	0.0024	0.0028
	Casting Alloy	558	0.05xø	2xø	0.0006	0.0008	0.0012	0.0020	0.0024	0.0028
Copper	Non-Alloy	492	0.05xø	2xø	0.0006	0.0008	0.0012	0.0020	0.0024	0.0028
	Wrought Alloy Non-Hardened	459	0.05xø	2xø	0.0006	0.0008	0.0012	0.0020	0.0024	0.0028
	Wrought Alloy Hardened	361	0.05xø	2xø	0.0006	0.0008	0.0012	0.0020	0.0024	0.0028
	CuNi-Alloy	427	0.05xø	2xø	0.0006	0.0008	0.0012	0.0020	0.0024	0.0028
	CuNiZn-Alloy Long-Chipping	361	0.05xø	2xø	0.0006	0.0008	0.0012	0.0020	0.0024	0.0028
	CuNiZn-Alloy Short-Chipping	427	0.05xø	2xø	0.0006	0.0008	0.0012	0.0020	0.0024	0.0028
CuZn (Brass)	Long-Chipping	492	0.05xø	2xø	0.0006	0.0008	0.0012	0.0020	0.0024	0.0028
	Short-Chipping	689	0.05xø	2xø	0.0006	0.0008	0.0012	0.0020	0.0024	0.0028
CuSn (Bronze)	Long-Chipping	427	0.05xø	2xø	0.0006	0.0008	0.0012	0.0020	0.0024	0.0028
	Short-Chipping	459	0.05xø	2xø	0.0006	0.0008	0.0012	0.0020	0.0024	0.0028
CuAlFe (Ampco)	Long-Chipping	197	0.05xø	2xø	0.0006	0.0008	0.0012	0.0020	0.0024	0.0028
	Short-Chipping	230	0.05xø	2xø	0.0006	0.0008	0.0012	0.0020	0.0024	0.0028

Aluminum - US220

Material Designation		SFM [ft/min]	ae max [inch]	ap max [inch]	Chip Load Per Tooth [Inch]					
					1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
Aluminium	Non-Alloy	1968	1xø	1xø	0.0016	0.0024	0.0031	0.0059	0.0079	0.0089
	Wrought Alloy Non-Hardened	1968	1xø	1xø	0.0016	0.0024	0.0031	0.0059	0.0079	0.0089
	Wrought Alloy Hardened	1968	1xø	1xø	0.0016	0.0024	0.0031	0.0059	0.0079	0.0089
	Casting Alloy < 6% Si	1575	1xø	1xø	0.0016	0.0024	0.0031	0.0059	0.0079	0.0089
	Casting Alloy 6-12% Si	1181	1xø	1xø	0.0012	0.0020	0.0028	0.0047	0.0067	0.0083
	Casting Alloy > 6% Si	787	1xø	1xø	0.0012	0.0020	0.0028	0.0047	0.0067	0.0083
Magnesium	Wrought Alloy	722	1xø	1xø	0.0012	0.0020	0.0028	0.0047	0.0067	0.0083
	Casting Alloy	656	1xø	1xø	0.0012	0.0020	0.0028	0.0047	0.0067	0.0083
Copper	Non-Alloy	558	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0047	0.0055
	Wrought Alloy Non-Hardened	509	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0047	0.0055
	Wrought Alloy Hardened	394	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0047	0.0055
	CuNi-Alloy	492	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0047	0.0055
	CuNiZn-Alloy Long-Chipping	394	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0047	0.0055
	CuNiZn-Alloy Short-Chipping	492	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0047	0.0055
CuZn (Brass)	Long-Chipping	591	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0047	0.0055
	Short-Chipping	787	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0047	0.0055
CuSn (Bronze)	Long-Chipping	492	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0047	0.0055
	Short-Chipping	558	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0047	0.0055
CuAlFe (Ampco)	Long-Chipping	180	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0047	0.0055
	Short-Chipping	230	1xø	1xø	0.0008	0.0016	0.0024	0.0031	0.0047	0.0055

*** Feeds and Speeds are starting points for Overall Lengths of 3" and shorter.**
For End Mills with Overall Lengths over 3" decrease the Feeds and Speeds.

Micro - US501/US503

Hardness: ≤ 28 Rc													
Material		Chip Load - IPT				Depth of Cut		Chip Load - IPT				Depth of Cut	
		SFM	0.005 - 0.015	0.015 - 0.031	0.031 - 0.047	Radial	Axial	0.047 - 0.062	0.062 - 0.078	0.078 - 0.093	0.093 - 0.120	Radial	Axial
Aluminum Alloys	Castings	750	0.00015	0.00031	0.00047	.13xDia.	3xDia.	0.00055	0.00069	0.00082	0.00110	.25xDia.	3xDia.
	Wrought	1000	0.00015	0.00031	0.00047	.13xDia.	3xDia.	0.00055	0.00069	0.00082	0.00110	.25xDia.	3xDia.
Copper Alloys	Coppers	225	0.00012	0.00025	0.00038	.13xDia.	3xDia.	0.00044	0.00055	0.00065	0.00088	.13xDia.	3xDia.
	Brass	500	0.00012	0.00025	0.00038	.13xDia.	3xDia.	0.00044	0.00055	0.00065	0.00088	.13xDia.	3xDia.
	Bronze	225	0.00012	0.00025	0.00038	.13xDia.	3xDia.	0.00044	0.00055	0.00065	0.00088	.13xDia.	3xDia.
	Aluminum Bronze	500	0.00012	0.00025	0.00038	.13xDia.	3xDia.	0.00044	0.00055	0.00065	0.00088	.13xDia.	3xDia.
	Nickel	225	0.00012	0.00025	0.00038	.13xDia.	3xDia.	0.00044	0.00055	0.00065	0.00088	.13xDia.	3xDia.
	Copper Alloys	550	0.00012	0.00025	0.00038	.13xDia.	3xDia.	0.00044	0.00055	0.00065	0.00088	.13xDia.	3xDia.
Cast Iron	Ductile	300	0.00005	0.00010	0.00015	.13xDia.	3xDia.	0.00017	0.00021	0.00025	0.00034	.13xDia.	3xDia.
	Gray	400	0.00005	0.00010	0.00015	.13xDia.	3xDia.	0.00017	0.00021	0.00025	0.00034	.13xDia.	3xDia.
	Malleable	250	0.00005	0.00010	0.00015	.13xDia.	3xDia.	0.00017	0.00021	0.00025	0.00034	.13xDia.	3xDia.
Magnesium Alloys	General	1500	0.00015	0.00031	0.00048	.13xDia.	3xDia.	0.00055	0.00069	0.00082	0.00110	.13xDia.	3xDia.
Zinc Alloys	General	800	0.00015	0.00031	0.00048	.13xDia.	3xDia.	0.00055	0.00069	0.00082	0.00110	.13xDia.	3xDia.

Hardness: 29 - 37 Rc													
Material		Chip Load - IPT				Depth of Cut		Chip Load - IPT				Depth of Cut	
		SFM	0.005 - 0.015	0.015 - 0.031	0.031 - 0.047	Radial	Axial	0.047 - 0.062	0.062 - 0.078	0.078 - 0.093	0.093 - 0.120	Radial	Axial
Carbon Steel	Low Carbon	600	0.00005	0.00010	0.00015	.13xDia.	3xDia.	0.00170	0.00021	0.00025	0.00034	.25xDia.	3xDia.
	Medium Carbon	200	0.00004	0.00009	0.00013	.13xDia.	3xDia.	0.00020	0.00025	0.00030	0.00040	.25xDia.	3xDia.
Stainless Steels	Martensitic\ Ferritic	450	0.00005	0.00010	0.00015	.13xDia.	3xDia.	0.00017	0.00021	0.00025	0.00034	.25xDia.	3xDia.
	Austenitic	200	0.00004	0.00009	0.00013	.13xDia.	3xDia.	0.00015	0.00019	0.00023	0.00031	.25xDia.	3xDia.
Tool Steels	Low Alloy	200	0.00004	0.00009	0.00013	.13xDia.	3xDia.	0.00015	0.00019	0.00023	0.00031	.25xDia.	3xDia.
	High Alloy	150	0.00003	0.00006	0.00008	.13xDia.	3xDia.	0.00010	0.00012	0.00014	0.00019	.25xDia.	3xDia.
Titanium Alloys	General	150	0.00003	0.00006	0.00008	.13xDia.	3xDia.	0.00010	0.00012	0.00014	0.00019	.25xDia.	3xDia.
High Temp Alloys	Iron Alloy	70	0.00003	0.00006	0.00009	.13xDia.	3xDia.	0.00010	0.00012	0.00014	0.00019	.25xDia.	3xDia.
	Nickel Alloy	70	0.00003	0.00006	0.00009	.13xDia.	3xDia.	0.00010	0.00012	0.00014	0.00019	.25xDia.	3xDia.
	Hardened Nickel Alloy	70	0.00003	0.00006	0.00009	.13xDia.	3xDia.	0.00010	0.00012	0.00014	0.00019	.25xDia.	3xDia.
	Cobalt Alloy	70	0.00003	0.00006	0.00009	.13xDia.	3xDia.	0.00010	0.00012	0.00014	0.00019	.25xDia.	3xDia.

Hardness: 38- 45 Rc													
Material		Chip Load - IPT				Depth of Cut		Chip Load - IPT				Depth of Cut	
		SFM	0.005 - 0.015	0.015 - 0.031	0.031 - 0.047	Radial	Axial	0.047 - 0.062	0.062 - 0.078	0.078 - 0.093	0.093 - 0.120	Radial	Axial
Stainless Steels	Austenitic	100	0.00002	0.00004	0.00007	.13xDia.	3xDia.	0.00008	0.00100	0.00012	0.00016	.25xDia.	3xDia.
Tool Steels	Low Alloy	100	0.00002	0.00004	0.00007	.13xDia.	3xDia.	0.00008	0.00100	0.00012	0.00016	.25xDia.	3xDia.
	High Alloy	90	0.00001	0.00003	0.00004	.13xDia.	3xDia.	0.00005	0.00006	0.00007	0.00010	.25xDia.	3xDia.
Titanium Alloys	General	75	0.00001	0.00003	0.00004	.13xDia.	3xDia.	0.00005	0.00006	0.00007	0.00010	.25xDia.	3xDia.
High Temp Alloys	Iron Alloy	50	0.00001	0.00003	0.00004	.13xDia.	3xDia.	0.00005	0.00006	0.00007	0.00010	.25xDia.	3xDia.
	Nickel Alloy	50	0.00001	0.00003	0.00004	.13xDia.	3xDia.	0.00005	0.00006	0.00007	0.00010	.25xDia.	3xDia.
	Hardened Nickel Alloy	50	0.00001	0.00003	0.00004	.13xDia.	3xDia.	0.00005	0.00006	0.00007	0.00010	.25xDia.	3xDia.
	Cobalt Alloy	50	0.00001	0.00003	0.00004	.13xDia.	3xDia.	0.00005	0.00006	0.00007	0.00010	.25xDia.	3xDia.

Micro US504/US506

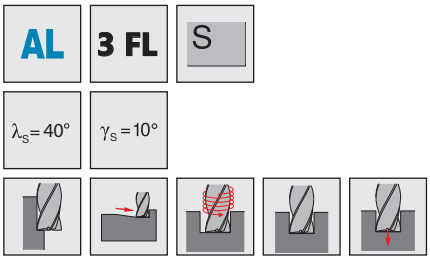
Hardness: ≤ 28 Rc													
Material		Chip Load - IPT				Depth of Cut		Chip Load - IPT				Depth of Cut	
		SFM	0.005 - 0.015	0.015 - 0.031	0.031 - 0.047	Radial	Axial	0.047 - 0.062	0.062 - 0.078	0.078 - 0.093	0.093 - 0.120	Radial	Axial
Aluminum Alloys	Castings	750	0.00022	0.00045	0.00068	.30xDia.	1xDia	0.00780	0.00099	0.00118	0.00158	.60xDia.	1xDia.
	Wrought	1000	0.00022	0.00045	0.00068	.30xDia.	1xDia	0.00780	0.00099	0.00118	0.00158	.60xDia.	1xDia.
Copper Alloys	Coppers	225	0.00017	0.00036	0.00055	.30xDia.	1xDia	0.00063	0.00079	0.00094	0.00127	.60xDia.	1xDia.
	Brass	500	0.00017	0.00036	0.00055	.30xDia.	1xDia	0.00063	0.00079	0.00094	0.00127	.60xDia.	1xDia.
	Bronze	225	0.00017	0.00036	0.00055	.30xDia.	1xDia	0.00063	0.00079	0.00094	0.00127	.60xDia.	1xDia.
	Aluminum Bronze	500	0.00017	0.00036	0.00055	.30xDia.	1xDia	0.00063	0.00079	0.00094	0.00127	.60xDia.	1xDia.
	Nickel	225	0.00017	0.00036	0.00055	.30xDia.	1xDia	0.00063	0.00079	0.00094	0.00127	.60xDia.	1xDia.
	Copper Alloys	550	0.00017	0.00036	0.00055	.30xDia.	1xDia	0.00063	0.00079	0.00094	0.00127	.60xDia.	1xDia.
Cast Iron	Ductile	300	0.00007	0.00014	0.00021	.30xDia.	1xDia	0.00024	0.00031	0.00036	0.00049	.60xDia.	1xDia.
	Gray	400	0.00007	0.00014	0.00021	.30xDia.	1xDia	0.00024	0.00031	0.00036	0.00049	.60xDia.	1xDia.
	Malleable	250	0.00007	0.00014	0.00021	.30xDia.	1xDia	0.00024	0.00031	0.00036	0.00049	.60xDia.	1xDia.
Magnesium Alloys	General	1500	0.00022	0.00045	0.00068	.30xDia.	1xDia	0.00078	0.00099	0.00118	0.00158	.60xDia.	1xDia.
Zinc Alloys	General	800	0.00022	0.00045	0.00068	.30xDia.	1xDia	0.00078	0.00099	0.00118	0.00158	.60xDia.	1xDia.

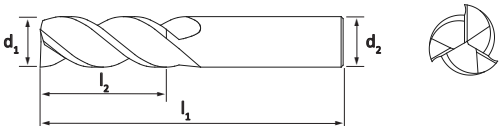
Hardness: 29 - 37 Rc													
Material		Chip Load - IPT				Depth of Cut		Chip Load - IPT				Depth of Cut	
		SFM	0.005 - 0.015	0.015 - 0.031	0.031 - 0.047	Radial	Axial	0.047 - 0.062	0.062 - 0.078	0.078 - 0.093	0.093 - 0.120	Radial	Axial
Carbon Steel	Low Carbon	600	0.00007	0.00014	0.00021	.30xDia.	1xDia	0.00024	0.00031	0.00036	0.00049	.60xDia.	1xDia.
	Medium Carbon	200	0.00006	0.00013	0.00019	.30xDia.	1xDia	0.00022	0.00028	0.00033	0.00045	.60xDia.	1xDia.
Stainless Steels	Martensitic\ Ferritic	450	0.00007	0.00014	0.00021	.30xDia.	1xDia	0.00024	0.00031	0.00036	0.00049	.60xDia.	1xDia.
	Austenitic	200	0.00006	0.00013	0.00019	.30xDia.	1xDia	0.00022	0.00028	0.00033	0.00045	.60xDia.	1xDia.
Tool Steels	Low Alloy	200	0.00006	0.00013	0.00019	.30xDia.	1xDia	0.00022	0.00028	0.00033	0.00045	.60xDia.	1xDia.
	High Alloy	150	0.00004	0.00008	0.00012	.30xDia.	1xDia	0.00014	0.00017	0.00021	0.00028	.60xDia.	1xDia.
Titanium Alloys	General	150	0.00004	0.00008	0.00012	.30xDia.	1xDia	0.00014	0.00017	0.00021	0.00028	.60xDia.	1xDia
High Temp Alloys	Iron Alloy	70	0.00004	0.00008	0.00012	.30xDia.	1xDia	0.00014	0.00017	0.00021	0.00028	.60xDia.	1xDia.
	Nickel Alloy	70	0.00004	0.00008	0.00012	.30xDia.	1xDia	0.00014	0.00017	0.00021	0.00028	.60xDia.	1xDia.
	Hardened Nickel Alloy	70	0.00004	0.00008	0.00012	.30xDia.	1xDia	0.00014	0.00017	0.00021	0.00028	.60xDia.	1xDia.
	Cobalt Alloy	70	0.00004	0.00008	0.00012	.30xDia.	1xDia	0.00014	0.00017	0.00021	0.00028	.60xDia.	1xDia.

Hardness: 38- 45 Rc													
Material		Chip Load - IPT				Depth of Cut		Chip Load - IPT				Depth of Cut	
		SFM	0.005 - 0.015	0.015 - 0.031	0.031 - 0.047	Radial	Axial	0.047 - 0.062	0.062 - 0.078	0.078 - 0.093	0.093 - 0.120	Radial	Axial
Stainless Steels	Austenitic	100	0.00003	0.00006	0.00010	.30xDia.	1xDia	0.00011	0.00014	0.00017	0.00022	.60xDia.	1xDia.
Tool Steels	Low Alloy	100	0.00003	0.00006	0.00010	.30xDia.	1xDia	0.00011	0.00014	0.00017	0.00022	.60xDia.	1xDia.
	High Alloy	90	0.00002	0.00004	0.00006	.30xDia.	1xDia	0.00007	0.00009	0.00012	0.00018	.60xDia.	1xDia.
Titanium Alloys	General	75	0.00002	0.00004	0.00006	.30xDia.	1xDia	0.00007	0.00009	0.00012	0.00018	.60xDia.	1xDia.
High Temp Alloys	Iron Alloy	50	0.00002	0.00004	0.00006	.30xDia.	1xDia	0.00007	0.00009	0.00012	0.00018	.60xDia.	1xDia.
	Nickel Alloy	50	0.00002	0.00004	0.00006	.30xDia.	1xDia	0.00007	0.00009	0.00012	0.00018	.60xDia.	1xDia.
	Hardened Nickel Alloy	50	0.00002	0.00004	0.00006	.30xDia.	1xDia	0.00007	0.00009	0.00012	0.00018	.60xDia.	1xDia.
	Cobalt Alloy	50	0.00002	0.00004	0.00006	.30xDia.	1xDia	0.00007	0.00009	0.00012	0.00018	.60xDia.	1xDia.

Series 109

3 Flute Aluminum





Tolerances

Shank: 1/8" - 1" = -.0001/-.0004
Cutting Dia: 1/8" - 1" = +.000/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	l_3 LOR	d_3 Neck Dia	Flutes	Uncoated	AlTiN	ZrN
1/8	1/8	1/4	1-1/2			3	12178577	12179695	12179696
1/8	1/8	1/2	1-1/2			3	12178576	12179693	12179694
5/32	3/16	1/2	2			3	12178578	12179697	12179698
5/32	3/16	3/8	2			3	12178579	12179699	12179700
3/16	3/16	3/8	2			3	12178581	12179703	12179704
3/16	3/16	5/8	2			3	12178580	12179701	12179702
7/32	1/4	3/4	2-1/2			3	12178585	12179705	12179706
7/32	1/4	3/8	2			3	12178586	12179707	12179708
1/4	1/4	3/8	2			3	12178588	12179711	12179712
1/4	1/4	3/4	2-1/2			3	12178587	12179709	12179710
1/4	1/4	1-1/4	3			3	12178589	12179713	12179714
1/4	1/4	1-1/2	3-1/2			3	12178590	12179715	12179716
1/4	1/4	3/4	4	2-1/8	0.240	3	12178591	12179717	12179718
9/32	5/16	1/2	2-1/2			3	12178593	12179721	12179722
9/32	5/16	3/4	2-1/2			3	12178592	12179719	12179720
5/16	5/16	1/2	2-1/2			3	12178595	12179725	12179726
5/16	5/16	3/4	2-1/2			3	12178594	12179723	12179724
3/8	3/8	5/8	2			3	12178600	12179729	12179730
3/8	3/8	7/8	2-1/2			3	12178599	12179727	12179728
3/8	3/8	1-1/2	3-1/2			3	12178601	12179731	12179732
3/8	3/8	2	4			3	12178602	12179733	12179734
3/8	3/8	1	6	2-3/8	0.360	3	12178603	12179735	12179736
7/16	7/16	1	2-3/4			3	12178604	12179737	12179738
1/2	1/2	5/8	2-1/2			3	12178606	12179741	12179742
1/2	1/2	1-1/4	3			3	12178605	12179739	12179740
1/2	1/2	1-1/2	3-1/2			3	12178607	12179743	12179744
1/2	1/2	2	4			3	12178608	12179745	12179746
9/16	9/16	1-1/4	3-1/2			3	12178609	12179747	12179748
5/8	5/8	7/8	3			3	12178611	12179751	12179752
5/8	5/8	1-1/4	3-1/2			3	12178610	12179749	12179750
5/8	5/8	1-3/4	4			3	12178612	12179753	12179754
5/8	5/8	2-1/2	5			3	12178613	12179755	12179756
3/4	3/4	1	3			3	12178618	12179759	12179760
3/4	3/4	1-5/8	4			3	12178617	12179757	12179758
3/4	3/4	2-1/2	5			3	12178619	12179761	12179762
3/4	3/4	3-1/4	6			3	12178620	12179763	12179764
1	1	1-3/4	4			3	12178621	12179765	12179766
1	1	2-3/4	5			3	12178622	12179767	12179768
1	1	3-3/8	6			3	12178623	12179769	12179770

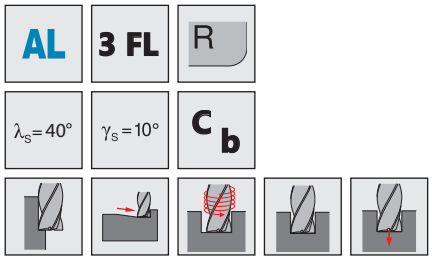
Application Range:

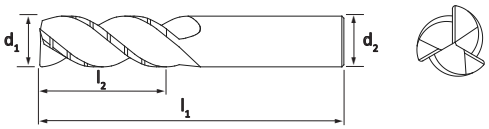
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
							●	●	●	

Feeds & Speeds Available on Page 86

Series 119

3 Flute Aluminum Rougher-Finisher





Tolerances

Shank:	1/8" - 1" = -.0001/-.0004
Cutting Dia:	1/8" - 1" = +.000/-.002
Chamfer:	1/8" - 1" = +/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	R Radius	Flutes	AlTiN	ZrN
1/8	1/8	1/4	1-1/2	0.010	3	12180002	12180003
1/8	1/8	1/2	1-1/2	0.010	3	12180000	12180001
5/32	3/16	3/8	2	0.010	3	12180006	12180007
5/32	3/16	1/2	2	0.010	3	12180004	12180005
3/16	3/16	3/8	2	0.010	3	12180010	12180011
3/16	3/16	5/8	2	0.010	3	12180008	12180009
7/32	1/4	3/8	2	0.020	3	12180014	12180015
7/32	1/4	3/4	2-1/2	0.020	3	12180012	12180013
1/4	1/4	3/8	2	0.020	3	12180018	12180019
1/4	1/4	3/4	2-1/2	0.020	3	12180016	12180017
1/4	1/4	1-1/4	3	0.020	3	12180020	12180021
1/4	1/4	1-1/2	3-1/2	0.020	3	12180022	12180023
9/32	5/16	1/2	2-1/2	0.020	3	12180026	12180027
9/32	5/16	3/4	2-1/2	0.020	3	12180024	12180025
5/16	5/16	1/2	2-1/2	0.020	3	12180030	12180031
5/16	5/16	3/4	2-1/2	0.020	3	12180028	12180029
11/32	3/8	5/8	2	0.020	3	12180034	12180035
11/32	3/8	7/8	2-1/2	0.020	3	12180032	12180033
3/8	3/8	5/8	2	0.020	3	12180038	12180039
3/8	3/8	7/8	2-1/2	0.020	3	12180036	12180037
3/8	3/8	1-1/2	3-1/2	0.020	3	12180040	12180041
3/8	3/8	2	4	0.020	3	12180042	12180043
7/16	7/16	1	2-3/4	0.020	3	12180044	12180045
1/2	1/2	5/8	2-1/2	0.020	3	12180048	12180049
1/2	1/2	1-1/4	3	0.020	3	12180046	12180047
1/2	1/2	1-1/2	3-1/2	0.020	3	12180050	12180051
1/2	1/2	2	4	0.020	3	12180052	12180053
9/16	9/16	1-1/4	3-1/2	0.030	3	12180054	12180055
5/8	5/8	7/8	3	0.030	3	12180058	12180059
5/8	5/8	1-1/4	3-1/2	0.030	3	12180056	12180057
5/8	5/8	1-3/4	4	0.030	3	12180060	12180061
5/8	5/8	2-1/2	5	0.030	3	12180062	12180063
3/4	3/4	1	3	0.030	3	12180066	12180067
3/4	3/4	1-5/8	4	0.030	3	12180064	12180065
3/4	3/4	2-1/2	5	0.030	3	12180068	12180069
3/4	3/4	3-1/4	6	0.030	3	12180070	12180071
1	1	1-3/4	4	0.030	3	12180072	12180073
1	1	2-3/4	5	0.030	3	12180074	12180075
1	1	3-3/8	6	0.030	3	12180076	12180077

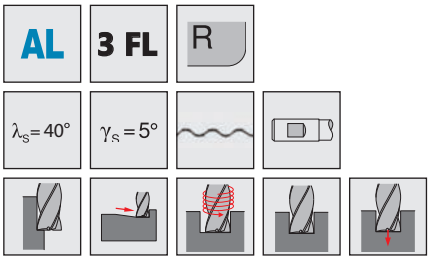
Application Range:

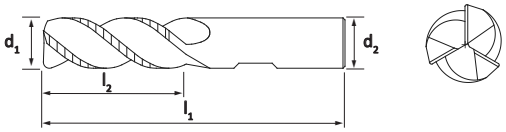
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
							●	●	●	

Feeds & Speeds Available on Page 86

Series 102

3 Flute Aluminum Rougher





Tolerances

Shank:	3/16" - 1" = -.0001/-.0004
Cutting Dia:	3/16" - 1" = +.000/-.002
Chamfer:	3/16" - 1" = +/-.005

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	R Radius	Flutes	AlTiN	ZrN
3/16	3/16	3/8	2	0.030	3	12179625	12179626
3/16	3/16	5/8	2	0.030	3	12179623	12179624
1/4	1/4	3/8	2	0.045	3	12179629	12179630
1/4	1/4	3/4	2-1/2	0.045	3	12179627	12179628
5/16	5/16	1/2	2-1/2	0.045	3	12179633	12179634
5/16	5/16	3/4	2	0.045	3	12179631	12179632
3/8	3/8	5/8	2	0.060	3	12179637	12179638
3/8	3/8	7/8	2-1/2	0.060	3	12179635	12179636
7/16	7/16	1	2-3/4	0.060	3	12179639	12179640
1/2	1/2	5/8	2-1/2	0.060	3	12179643	12179644
1/2	1/2	1-1/4	3	0.060	3	12179641	12179642
1/2	1/2	1-1/2	3-1/2	0.060	3	12179645	12179646
9/16	9/16	1-1/4	3-1/2	0.060	3	12179647	12179648
5/8	5/8	1-1/4	3-1/2	0.060	3	12179649	12179650
3/4	3/4	1-5/8	4	0.060	3	12179651	12179652
3/4	3/4	2-1/4	5	0.060	3	12179653	12179654
1	1	1-3/4	4	0.060	3	12179655	12179656
1	1	2-5/8	5	0.060	3	12179657	12179658

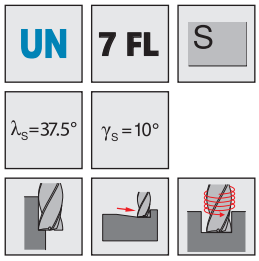
Application Range:

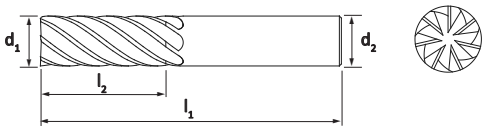
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
							●	●	●	

Feeds & Speeds Available on Page 86

Series 160

7 Flute Universal





Tolerances

Shank: 1/4" - 1" = -.0001/-.0004

Cutting Dia: 1/4" - 1" = +.000/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	l_3 LOR	d_3 Neck Dia	Flutes	nACRo®
1/4	1/4	3/4	2-1/2			7	12180821
3/8	3/8	7/8	2-1/2			7	12180822
3/8	3/8	1-1/4	3			7	12180823
3/8	3/8	1/2	6	3-1/8	0.360	7	12180824
1/2	1/2	1-1/4	3			7	12180825
1/2	1/2	1-5/8	4			7	12180826
1/2	1/2	5/8	6	3-1/8	0.480	7	12180827
5/8	5/8	1-5/8	3-1/2			7	12180828
5/8	5/8	2-1/8	4			7	12180829
5/8	5/8	3/4	6	3 1/8	0.600	7	12180830
3/4	3/4	1-5/8	4			7	12180831
3/4	3/4	2-1/4	5			7	12180832
3/4	3/4	1	6	3-1/8	0.720	7	12180833
1	1	2	4			7	12180834
1	1	2-5/8	5			7	12180835

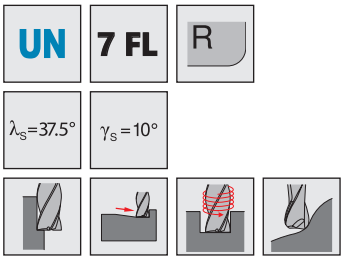
Application Range:

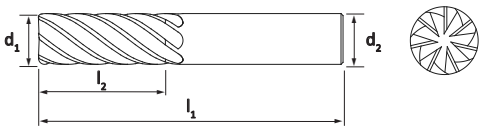
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●		●	●	●	●				

Feeds & Speeds Available on Page 87

Series 161

7 Flute Universal Corner Radius





Tolerances

Shank:	1/4" - 1" = -.0001/-.0004
Cutting Dia:	1/4" - 1" = +.000/-.002
Chamfer:	1/4" - 1" = +/-.001

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	l_3 LOR	d_3 Neck Dia	R Radius	Flutes	nACRo®
1/4	1/4	3/4	2-1/2			0.020	7	12180836
1/4	1/4	3/4	2-1/2			0.030	7	12180845
1/4	1/4	1-1/8	3			0.020	7	12180837
1/4	1/4	3/8	4	2-1/2	0.240	0.020	7	12180838
1/4	1/4	3/8	4	2-1/2	0.240	0.030	7	12180846
3/8	3/8	7/8	2-1/2			0.020	7	12180839
3/8	3/8	7/8	2-1/2			0.030	7	12180847
3/8	3/8	1-1/4	3			0.020	7	12180840
3/8	3/8	1-1/4	3			0.030	7	12180848
3/8	3/8	1/2	6	3-1/8	0.360	0.020	7	12180841
1/2	1/2	1-1/4	3			0.020	7	12180842
1/2	1/2	1-1/4	3			0.030	7	12180849
1/2	1/2	1-5/8	4			0.020	7	12180843
1/2	1/2	1-5/8	4			0.030	7	12180850
1/2	1/2	5/8	6	3-1/8	0.480	0.020	7	12180844
1/2	1/2	5/8	6	3-1/8	0.480	0.030	7	12180851
5/8	5/8	1-5/8	3-1/2			0.030	7	12180852
5/8	5/8	2-1/8	4			0.030	7	12180853
5/8	5/8	3/4	6	3-1/8	0.600	0.030	7	12180854
3/4	3/4	1-5/8	4			0.030	7	12180855
3/4	3/4	2-1/4	5			0.030	7	12180856
3/4	3/4	1	6	3-1/8	0.720	0.030	7	12180857
1	1	2-5/8	5			0.030	7	12180858

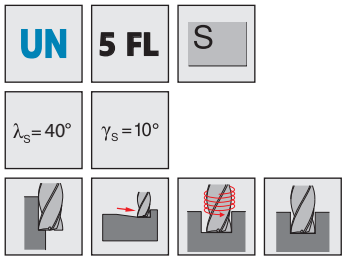
Application Range:

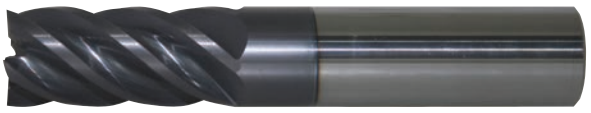
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●		●	●	●	●				

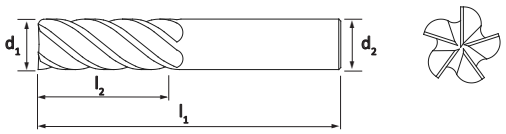
Feeds & Speeds Available on Page 87

Series 112

5 Flute Universal







Tolerances

Shank: 1/8" - 1" = -.0001/-.0004

Cutting Dia: 1/8" - 1" = +.000/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	Flutes	TiCN	AlTiN	nACRo®
1/8	1/8	1/4	1-1/2	5	12179847	12179848	12179849
1/8	1/8	1/2	1-1/2	5	12179844	12179845	12179846
5/32	3/16	3/8	2	5	12179853	12179854	12179855
5/32	3/16	1/2	2	5	12179850	12179851	12179852
3/16	3/16	3/8	2	5	12179859	12179860	12179861
3/16	3/16	5/8	2	5	12179856	12179857	12179858
7/32	1/4	3/4	2-1/2	5	12179862	12179863	12179864
1/4	1/4	3/8	2	5	12179868	12179869	12179870
1/4	1/4	3/4	2-1/2	5	12179865	12179866	12179867
5/16	5/16	1/2	2-1/2	5	12179874	12179875	12179876
5/16	5/16	3/4	2-1/2	5	12179871	12179872	12179873
3/8	3/8	5/8	2	5	12179880	12179881	12179882
3/8	3/8	7/8	2-1/2	5	12179877	12179878	12179879
3/8	3/8	1-1/2	3-1/2	5	12179883	12179884	12179885
7/16	7/16	1	2-3/4	5	12179886	12179887	12179888
1/2	1/2	5/8	2-1/2	5	12179892	12179893	12179894
1/2	1/2	1-1/4	3	5	12179889	12179890	12179891
1/2	1/2	1-1/2	3-1/2	5	12179895	12179896	12179897
1/2	1/2	2	4	5	12179898	12179899	12179900
9/16	9/16	1-1/4	3-1/2	5	12179901	12179902	12179903
5/8	5/8	7/8	3	5	12179907	12179908	12179909
5/8	5/8	1-1/4	3-1/2	5	12179904	12179905	12179906
5/8	5/8	1-3/4	4	5	12179910	12179911	12179912
3/4	3/4	1	3	5	12179916	12179917	12179918
3/4	3/4	1-5/8	4	5	12179913	12179914	12179915
3/4	3/4	2-1/2	5	5	12179919	12179920	12179921
3/4	3/4	3-1/4	6	5	12179922	12179923	12179924
1	1	1-3/4	4	5	12179925	12179926	12179927
1	1	2-3/4	5	5	12179928	12179929	12179930
1	1	3-3/8	6	5	12179931	12179932	12179933

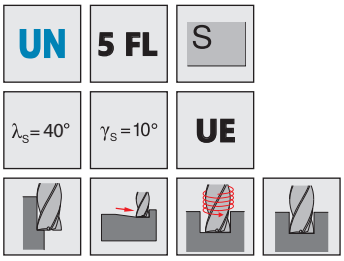
Application Range:

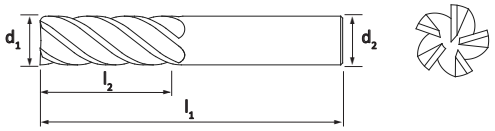
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●		●	●	●	●				

Feeds & Speeds Available on Page 88

Series 158

5 Flute Universal





Tolerances

Shank: 1/8" - 1" = -.0001/-.0004
Cutting Dia: 1/8" - 1" = +.000/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	Flutes	AlTiN	nACRo®
1/8	1/8	1/2	1-1/2	5	12180710	12180711
5/32	3/16	1/2	2	5	12180712	12180713
3/16	3/16	3/8	2	5	12180716	12180717
3/16	3/16	5/8	2	5	12180714	12180715
7/32	1/4	3/4	2-1/2	5	12180718	12180719
1/4	1/4	3/8	2	5	12180722	12180723
1/4	1/4	3/4	2-1/2	5	12180720	12180721
1/4	1/4	1-1/4	3	5	12180724	12180725
5/16	5/16	3/4	2-1/2	5	12180726	12180727
3/8	3/8	5/8	2	5	12180730	12180731
3/8	3/8	7/8	2-1/2	5	12180728	12180729
3/8	3/8	1-1/2	3-1/2	5	12180732	12180733
7/16	7/16	1	2-3/4	5	12180734	12180735
1/2	1/2	5/8	2-1/2	5	12180738	12180739
1/2	1/2	1-1/4	3	5	12180736	12180737
1/2	1/2	1-1/2	3-1/2	5	12180740	12180741
1/2	1/2	2	4	5	12180742	12180743
9/16	9/16	1-1/4	3-1/2	5	12180744	12180745
5/8	5/8	7/8	3	5	12180748	12180749
5/8	5/8	1-1/4	3-1/2	5	12180746	12180747
5/8	5/8	1-3/4	4	5	12180750	12180751
5/8	5/8	2-1/2	5	5	12180752	12180753
3/4	3/4	1	3	5	12180756	12180757
3/4	3/4	1-5/8	4	5	12180754	12180755
3/4	3/4	2-1/2	5	5	12180758	12180759
3/4	3/4	3-1/4	6	5	12180760	12180761
1	1	1-3/4	4	5	12180762	12180763
1	1	2-3/4	5	5	12180764	12180765
1	1	3-3/8	6	5	12180766	12180767

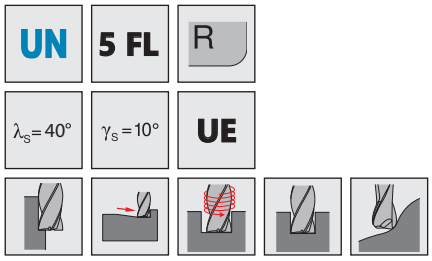
Application Range:

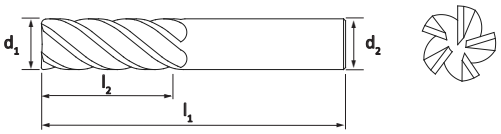
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●		●	●	●	●				

Feeds & Speeds Available on Page 89

Series 159

5 Flute Universal Corner Radius





Tolerances

Shank:	1/8" - 1" = -.0001/-.0004
Cutting Dia:	1/8" - 1" = +.000/-.002
Radius:	1/8" - 1" = +/-.001

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	R Radius	Flutes	nACRo®
1/8	1/8	1/2	1-1/2	0.010	5	12179382
1/8	1/8	1/2	1-1/2	0.015	5	12180778
5/32	3/16	1/2	2	0.010	5	12180768
3/16	3/16	3/8	2	0.010	5	12180770
3/16	3/16	3/8	2	0.020	5	12180789
3/16	3/16	5/8	2	0.010	5	12180769
3/16	3/16	5/8	2	0.020	5	12180788
7/32	1/4	3/4	2-1/2	0.015	5	12180779
1/4	1/4	3/8	2	0.010	5	12180772
1/4	1/4	3/8	2	0.015	5	12180781
1/4	1/4	3/8	2	0.020	5	12180791
1/4	1/4	3/8	2	0.030	5	12180797
1/4	1/4	3/4	2-1/2	0.010	5	12180771
1/4	1/4	3/4	2-1/2	0.015	5	12180780
1/4	1/4	3/4	2-1/2	0.020	5	12180790
1/4	1/4	3/4	2-1/2	0.030	5	12180796
1/4	1/4	1-1/4	3	0.030	5	12180798
5/16	5/16	3/4	2-1/2	0.015	5	12180782
3/8	3/8	5/8	2	0.010	5	12180774
3/8	3/8	5/8	2	0.015	5	12180784
3/8	3/8	5/8	2	0.020	5	12180793
3/8	3/8	5/8	2	0.030	5	12180800
3/8	3/8	7/8	2-1/2	0.010	5	12180773
3/8	3/8	7/8	2-1/2	0.015	5	12180783
3/8	3/8	7/8	2-1/2	0.020	5	12180792
3/8	3/8	7/8	2-1/2	0.030	5	12180799
3/8	3/8	1-1/2	3-1/2	0.010	5	12180775
3/8	3/8	1-1/2	3-1/2	0.015	5	12180785
3/8	3/8	1-1/2	3-1/2	0.030	5	12180801

Additional Sizes On Page 58

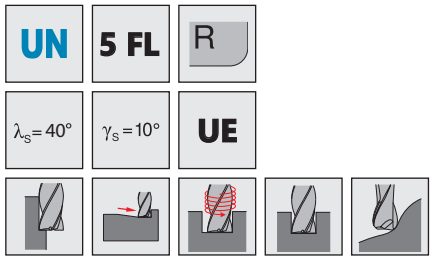
Application Range:

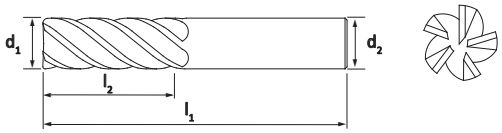
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●		●	●	●	●				

Feeds & Speeds Available on Page 89

Series 159

5 Flute Universal Corner Radius





Tolerances

Shank:	1/8" - 1" = -.0001/-.0004
Cutting Dia:	1/8" - 1" = +.000/-.002
Radius:	1/8" - 1" = +/-.001

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	R Radius	Flutes	nACRo®
1/2	1/2	5/8	2-1/2	0.010	5	12180777
1/2	1/2	5/8	2-1/2	0.015	5	12180787
1/2	1/2	5/8	2-1/2	0.020	5	12180795
1/2	1/2	5/8	2-1/2	0.030	5	12180803
1/2	1/2	5/8	2-1/2	0.060	5	12180815
1/2	1/2	1-1/4	3	0.010	5	12180776
1/2	1/2	1-1/4	3	0.015	5	12180786
1/2	1/2	1-1/4	3	0.020	5	12180794
1/2	1/2	1-1/4	3	0.030	5	12180802
1/2	1/2	1-1/4	3	0.060	5	12180814
1/2	1/2	2	4	0.030	5	12180804
1/2	1/2	2	4	0.060	5	12180816
5/8	5/8	7/8	3	0.030	5	12180806
5/8	5/8	7/8	3	0.060	5	12180817
5/8	5/8	1-1/4	3-1/2	0.030	5	12180805
5/8	5/8	2-1/2	5	0.030	5	12180807
5/8	5/8	2-1/2	5	0.060	5	12180818
3/4	3/4	1	3	0.030	5	12180809
3/4	3/4	1-5/8	4	0.030	5	12180808
3/4	3/4	2-1/2	5	0.030	5	12180810
3/4	3/4	2-1/2	5	0.060	5	12180819
1	1	1-3/4	4	0.030	5	12180811
1	1	2-3/4	5	0.030	5	12180812
1	1	2-3/4	5	0.060	5	12180820
1	1	3-3/8	6	0.030	5	12180813

Additional Sizes On Page 57

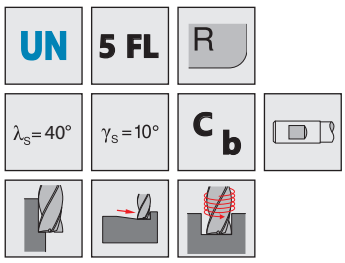
Application Range:

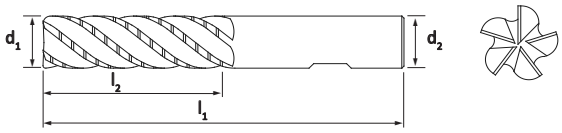
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●		●	●	●	●				

Feeds & Speeds Available on Page 89

Series 121

5 Flute Universal Rougher-Finisher





Tolerances

Shank:	3/4” - 1” = -.0001/-.0004
Cutting Dia:	3/4” - 1” = +.000/-.003
Radius:	3/4” - 1” = +.002/-.001

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	R Radius	Flutes	TiCN	AlTiN	nACRo®
3/4	3/4	2-1/2	5	0.030	5	12180201	12180202	12180203
3/4	3/4	3-1/4	6	0.030	5	12180204	12180205	12180206
1	1	2-3/4	5	0.030	5	12180207	12180208	12180209
1	1	3-3/8	6	0.030	5	12180210	12180211	12180212

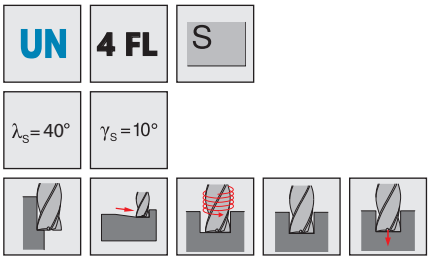
Application Range:

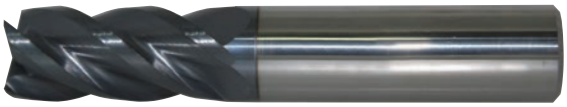
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●									

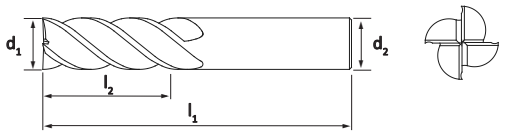
Feeds & Speeds Available on Page 90

Series 111

4 Flute Universal







Tolerances

Shank: 1/32" - 1" = -.0001/-.0004
Cutting Dia: 1/31" - 7/64" = +/—.0005
1/8" - 1" = +.000/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	Flutes	TiCN	AlTiN
1/32	1/8	3/32	1-1/2	4	12180963	12180964
3/64	1/8	9/64	1-1/2	4	12180965	12180966
1/16	1/8	1/8	1-1/2	4	12180969	12180970
1/16	1/8	3/16	1-1/2	4	12180967	12180968
5/64	1/8	1/4	1-1/2	4	12180971	12180972
3/32	1/8	3/16	1-1/2	4	12180975	12180976
3/32	1/8	9/32	1-1/2	4	12180973	12180974
7/64	1/8	3/16	1-1/2	4	12180979	12180980
7/64	1/8	3/8	1-1/2	4	12180977	12180978
1/8	1/8	1/4	1-1/2	4	12179774	12179775
1/8	1/8	1/2	1-1/2	4	12179772	12179773
5/32	3/16	3/8	2	4	12179778	12179779
5/32	3/16	1/2	2	4	12179776	12179777
3/16	3/16	3/8	2	4	12179782	12179783
3/16	3/16	5/8	2	4	12179780	12179781
7/32	1/4	3/4	2-1/2	4	12179784	12179785
1/4	1/4	3/8	2	4	12179788	12179789
1/4	1/4	3/4	2-1/2	4	12179786	12179787
1/4	1/4	1-1/4	3	4	12179790	12179791
1/4	1/4	1-1/2	3-1/2	4	12179792	12179793
1/4	1/4	3/8	4	4	12179794	12179795
5/16	5/16	1/2	2-1/2	4	12179798	12179799
5/16	5/16	3/4	2-1/2	4	12179796	12179797
5/16	5/16	7/16	4	4	12179800	12179801

Additional Sizes On Page 61

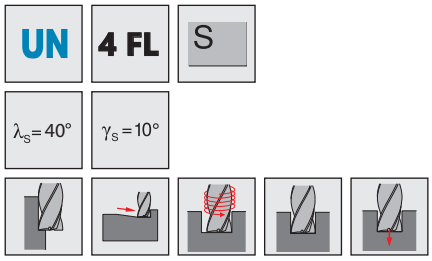
Application Range:

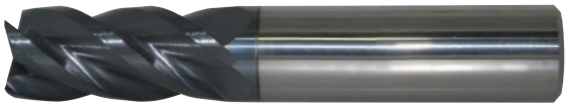
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●			●	●	●	●			●	

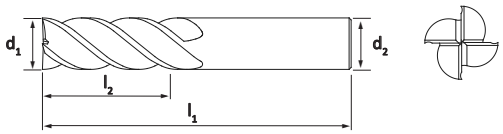
Feeds & Speeds Available on Page 90-91

Series 111

4 Flute Universal







Tolerances

Shank: 1/32" - 1" = -.0001/-.0004
Cutting Dia: 1/31" - 7/64" = +/–.0005
1/8" - 1" = +.000/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	Flutes	TiCN	AlTiN
3/8	3/8	5/8	2	4	12179804	12179805
3/8	3/8	7/8	2-1/2	4	12179802	12179803
3/8	3/8	1-1/2	3-1/2	4	12179806	12179807
3/8	3/8	2	4	4	12179808	12179809
3/8	3/8	1/2	6	4	12179810	12179811
7/16	7/16	1	2-3/4	4	12179812	12179813
1/2	1/2	5/8	2-1/2	4	12179816	12179817
1/2	1/2	1-1/4	3	4	12179814	12179815
1/2	1/2	1-1/2	3-1/2	4	12179818	12179819
1/2	1/2	2	4	4	12179820	12179821
1/2	1/2	5/8	6	4	12179822	12179823
9/16	9/16	1-1/4	3-1/2	4	12179824	12179825
5/8	5/8	7/8	3	4	12179828	12179829
5/8	5/8	1-1/4	3-1/2	4	12179826	12179827
5/8	5/8	1-3/4	4	4	12179830	12179831
5/8	5/8	2-1/2	5	4	12179832	12179833
3/4	3/4	1-5/8	4	4	12179834	12179835
3/4	3/4	2-1/2	5	4	12179836	12179837
3/4	3/4	3-1/4	6	4	12179838	12179839
1	1	1-3/4	4	4	12179840	12179841
1	1	2-3/4	5	4	12179842	12179843

Additional Sizes On Page 60

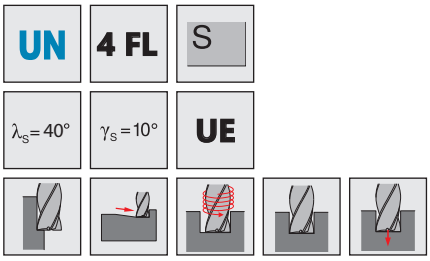
Application Range:

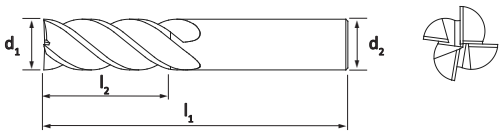
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●			●	●	●	●			●	

Feeds & Speeds Available on Page 90-91

Series 155

4 Flute Universal





Tolerances

Shank: 1/8" - 1" = -.0001/-.0004
Cutting Dia: 1/8" - 1" = +.000/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	l_3 LOR	d_3 Neck Dia	Flutes	AlTiN	nACRo®
1/8	1/8	1/4	1-1/2			4	12180413	12180414
1/8	1/8	1/2	1-1/2			4	12180411	12180412
5/32	3/16	3/8	2			4	12180417	12180418
5/32	3/16	1/2	2			4	12180415	12180416
3/16	3/16	3/8	2			4	12180421	12180422
3/16	3/16	5/8	2			4	12180419	12180420
7/32	1/4	3/8	2			4	12180425	12180426
7/32	1/4	3/4	2-1/2			4	12180423	12180424
1/4	1/4	3/8	2			4	12180429	12180430
1/4	1/4	3/4	2-1/2			4	12180427	12180428
1/4	1/4	3/4	4	2-1/8	0.240	4	12180433	12180434
1/4	1/4	1-1/4	3			4	12180431	12180432
5/16	5/16	1/2	2-1/2			4	12180437	12180438
5/16	5/16	3/4	2-1/2			4	12180435	12180436
3/8	3/8	5/8	2			4	12180441	12180442
3/8	3/8	7/8	2-1/2			4	12180439	12180440
3/8	3/8	1-1/2	3-1/2			4	12180443	12180444
3/8	3/8	7/8	4	2-3/8	0.360	4	12180445	12180446
3/8	3/8	7/8	6	3-3/8	0.360	4	12180447	12180448
7/16	7/16	1	2-3/4			4	12180449	12180450
1/2	1/2	5/8	2-1/2			4	12180453	12180454
1/2	1/2	1-1/4	3			4	12180451	12180452
1/2	1/2	2	4			4	12180455	12180456
1/2	1/2	1	6	2-3/8	0.480	4	12180457	12180458
1/2	1/2	1	6	3-3/8	0.480	4	12180459	12180460
9/16	9/16	1-1/4	3-1/2			4	12180461	12180462
5/8	5/8	7/8	3			4	12180465	12180466
5/8	5/8	1-1/4	3-1/2			4	12180463	12180464
5/8	5/8	2-1/2	5			4	12180467	12180468
3/4	3/4	1	3			4	12180471	12180472
3/4	3/4	1-5/8	4			4	12180469	12180470
3/4	3/4	2-1/2	5			4	12180473	12180474
1	1	1-3/4	4			4	12180475	12180476
1	1	2-3/4	5			4	12180477	12180478
1	1	3-3/8	6			4	12180479	12180480

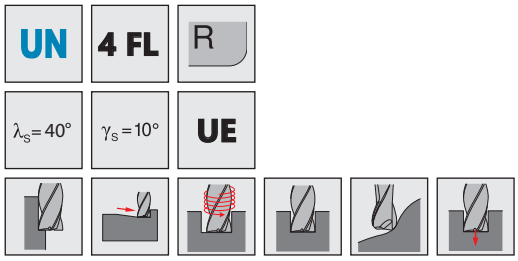
Application Range:

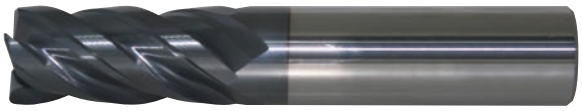
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●		●	●	●	●				

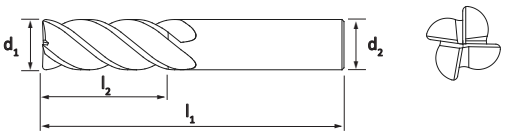
Feeds & Speeds Available on Page 91

Series 156

4 Flute Universal Corner Radius







Tolerances

Shank:	1/8" - 1" = -.0001/-.0004
Cutting Dia:	1/8" - 1" = +.000/-.002
Radius:	1/8" - 1" = +/-.001

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	l_3 LOR	d_3 Neck Dia	R Radius	Flutes	AlTiN	nACRo®
1/8	1/8	1/4	1-1/2			0.010	4	12179380	12179381
1/8	1/8	1/4	1-1/2			0.020	4	12180540	12180541
1/8	1/8	1/2	1-1/2			0.010	4	12179378	12179379
1/8	1/8	1/2	1-1/2			0.015	4	12180513	12180514
1/8	1/8	1/2	1-1/2			0.020	4	12180538	12180539
5/32	3/16	3/8	2			0.010	4	12180483	12180484
5/32	3/16	3/8	2			0.015	4	12180517	12180518
5/32	3/16	3/8	2			0.020	4	12180544	12180545
5/32	3/16	1/2	2			0.010	4	12180481	12180482
5/32	3/16	1/2	2			0.015	4	12180515	12180516
5/32	3/16	1/2	2			0.020	4	12180542	12180543
3/16	3/16	3/8	2			0.010	4	12180487	12180488
3/16	3/16	3/8	2			0.020	4	12180548	12180549
3/16	3/16	5/8	2			0.010	4	12180485	12180486
3/16	3/16	5/8	2			0.020	4	12180546	12180547
7/32	1/4	3/8	2			0.020	4	12180552	12180553
7/32	1/4	3/4	2-1/2			0.015	4	12180519	12180520
7/32	1/4	3/4	2-1/2			0.020	4	12180550	12180551
1/4	1/4	3/8	2			0.010	4	12180491	12180492
1/4	1/4	3/8	2			0.015	4	12180523	12180524
1/4	1/4	3/8	2			0.020	4	12180556	12180557
1/4	1/4	3/8	2			0.030	4	12180586	12180587
1/4	1/4	3/4	2-1/2			0.010	4	12180489	12180490
1/4	1/4	3/4	2-1/2			0.015	4	12180521	12180522
1/4	1/4	3/4	2-1/2			0.020	4	12180554	12180555
1/4	1/4	3/4	2-1/2			0.030	4	12180584	12180585
1/4	1/4	1-1/4	3			0.010	4	12180493	12180494
1/4	1/4	1-1/4	3			0.015	4	12180525	12180526
1/4	1/4	1-1/4	3			0.020	4	12180558	12180559
1/4	1/4	1-1/4	3			0.030	4	12180588	12180589
1/4	1/4	3/4	4	2 1/8	0.240	0.015	4	12180527	12180528
1/4	1/4	3/4	4	2 1/8	0.240	0.020	4	12180560	12180561
1/4	1/4	3/4	4	2 1/8	0.240	0.030	4	12180590	12180591
9/32	5/16	3/4	2-1/2			0.020	4	12180562	12180563
5/16	5/16	1/2	2-1/2			0.020	4	12180564	12180565

Additional Sizes On Page 64 & 65

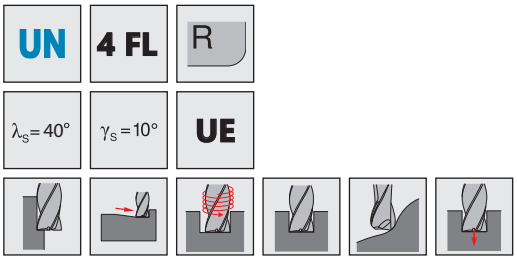
Application Range:

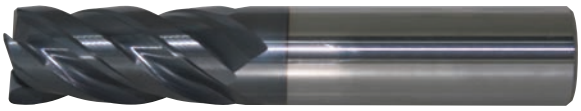
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●		●	●	●	●				

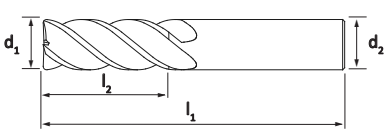
Feeds & Speeds Available on Page 91

Series 156

4 Flute Universal Corner Radius







Tolerances

Shank: 1/8" - 1" = -.0001/-.0004
Cutting Dia: 1/8" - 1" = +.000/-.002
Radius: 1/8" - 1" = +/-.001

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	l_3 LOR	d_3 Neck Dia	R Radius	Flutes	AlTiN	nACRo®
5/16	5/16	3/4	2-1/2			0.030	4	12180592	12180593
3/8	3/8	5/8	2			0.010	4	12180497	12180498
3/8	3/8	5/8	2			0.015	4	12180530	12180531
3/8	3/8	5/8	2			0.020	4	12180568	12180569
3/8	3/8	5/8	2			0.030	4	12180596	12180597
3/8	3/8	7/8	2-1/2			0.010	4	12180495	12180496
3/8	3/8	7/8	2-1/2			0.020	4	12180566	12180567
3/8	3/8	7/8	2-1/2			0.030	4	12180594	12180595
3/8	3/8	1-1/2	3-1/2			0.010	4	12180499	12180500
3/8	3/8	1-1/2	3-1/2			0.020	4	12180570	12180571
3/8	3/8	1-1/2	3-1/2			0.030	4	12180598	12180599
3/8	3/8	7/8	4	2 3/8	0.360	0.030	4	12180600	12180601
7/16	7/16	5/8	2-3/4			0.020	4	12180574	12180575
7/16	7/16	1	2-3/4			0.020	4	12180572	12180573
1/2	1/2	5/8	2-1/2			0.010	4	12180503	12180504
1/2	1/2	5/8	2-1/2			0.015	4	12180535	12180536
1/2	1/2	5/8	2-1/2			0.020	4	12180578	12180579
1/2	1/2	5/8	2-1/2			0.030	4	12180604	12180605
1/2	1/2	5/8	2-1/2			0.060	4	12180636	12180637
1/2	1/2	1-1/4	3			0.010	4	12180501	12180502
1/2	1/2	1-1/4	3			0.015	4	12180533	12180534
1/2	1/2	1-1/4	3			0.020	4	12180576	12180577
1/2	1/2	1-1/4	3			0.030	4	12180602	12180603
1/2	1/2	1-1/4	3			0.060	4	12180634	12180635
1/2	1/2	2	4			0.020	4	12180580	12180581
1/2	1/2	2	4			0.030	4	12180606	12180607
1/2	1/2	2	4			0.060	4	12180638	12180639
1/2	1/2	1	6	2 3/8	0.480	0.030	4	12180608	12180609
9/16	9/16	1-1/4	3-1/2			0.030	4	12180610	12180611

Additional Sizes On Page 63 & 65

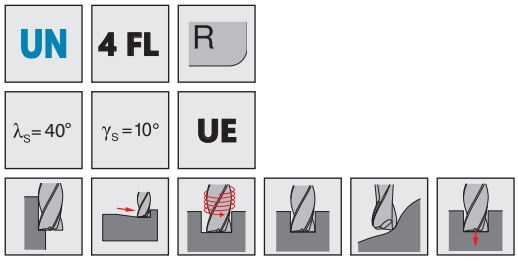
Application Range:

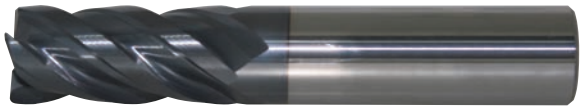
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●		●	●	●	●				

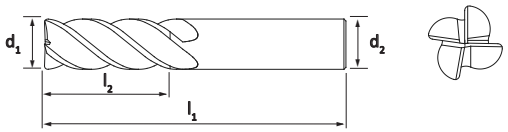
Feeds & Speeds Available on Page 91

Series 156

4 Flute Universal Corner Radius







Tolerances

Shank:	1/8" - 1" = -.0001/-.0004
Cutting Dia:	1/8" - 1" = +.000/-.002
Radius:	1/8" - 1" = +/-.001

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	l_3 LOR	d_3 Neck Dia	R Radius	Flutes	AlTiN	nACRo®
5/8	5/8	7/8	3			0.030	4	12180614	12180615
5/8	5/8	1-1/4	3-1/2			0.010	4	12180507	12180508
5/8	5/8	1-1/4	3-1/2			0.030	4	12180612	12180613
5/8	5/8	1-1/4	3-1/2			0.060	4	12180640	12180641
5/8	5/8	2-1/2	5			0.030	4	12180616	12180617
5/8	5/8	2-1/2	5			0.060	4	12180642	12180643
5/8	5/8	1-1/4	6	2 3/8	0.600	0.030	4	12180618	12180619
3/4	3/4	1	3			0.010	4	12180511	12180512
3/4	3/4	1	3			0.030	4	12180622	12180623
3/4	3/4	1	3			0.060	4	12180646	12180647
3/4	3/4	1-5/8	4			0.010	4	12180509	12180510
3/4	3/4	1-5/8	4			0.020	4	12180582	12180583
3/4	3/4	1-5/8	4			0.030	4	12180620	12180621
3/4	3/4	1-5/8	4			0.060	4	12180644	12180645
3/4	3/4	1-5/8	4			0.125	4	12180656	12180657
3/4	3/4	2-1/2	5			0.030	4	12180624	12180625
3/4	3/4	2-1/2	5			0.060	4	12180648	12180649
3/4	3/4	1-5/8	6	2 1/2	0.720	0.030	4	12180626	12180627
1	1	1-3/4	4			0.030	4	12180628	12180629
1	1	1-3/4	4			0.060	4	12180650	12180651
1	1	2-3/4	5			0.030	4	12180630	12180631
1	1	2-3/4	5			0.060	4	12180652	12180653
1	1	3-3/8	6			0.030	4	12180632	12180633
1	1	3-3/8	6			0.060	4	12180654	12180655

Additional Sizes On Page 63 & 64

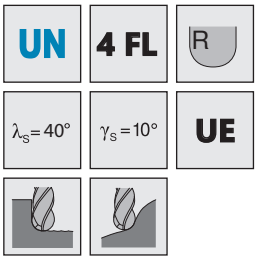
Application Range:

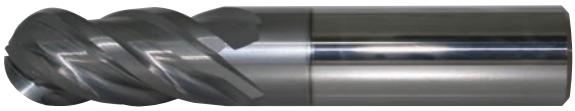
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●		●	●	●	●				

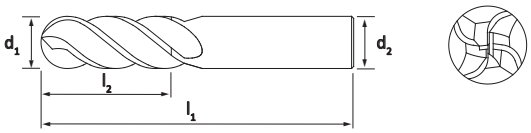
Feeds & Speeds Available on Page 91

Series 157

4 Flute Universal Ball







Tolerances

Shank:	1/8" - 1" = -.0001/-.0004
Cutting Dia:	1/8" - 1" = +.000/-.002
Ball Radius:	1/8" - 1" = +/-.001

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	l_3 LOR	d_3 Neck Dia	R Radius	Flutes	AlTiN	nACRo®
1/8	1/8	1/4	1-1/2			0.063	4	12180660	12180661
1/8	1/8	1/2	1-1/2			0.063	4	12180658	12180659
5/32	3/16	1/2	2			0.078	4	12180662	12180663
3/16	3/16	3/8	2			0.094	4	12180666	12180667
3/16	3/16	5/8	2			0.094	4	12180664	12180665
7/32	1/4	3/8	2			0.109	4	12180670	12180671
7/32	1/4	3/4	2-1/2			0.109	4	12180668	12180669
1/4	1/4	3/8	2			0.125	4	12180674	12180675
1/4	1/4	3/4	2-1/2			0.125	4	12180672	12180673
1/4	1/4	3/4	4	2-1/8	0.240	0.125	4	12180676	12180677
5/16	5/16	1/2	2-1/2			0.156	4	12180680	12180681
5/16	5/16	3/4	2-1/2			0.156	4	12180678	12180679
3/8	3/8	5/8	2			0.188	4	12180684	12180685
3/8	3/8	7/8	2-1/2			0.188	4	12180682	12180683
3/8	3/8	7/8	4	2-3/8	0.360	0.188	4	12180686	12180687
1/2	1/2	5/8	2-1/2			0.250	4	12180690	12180691
1/2	1/2	1	3			0.250	4	12180688	12180689
1/2	1/2	1	6	2-3/8	0.480	0.250	4	12180692	12180693
1/2	1/2	1	6	3-3/8	0.480	0.250	4	12180694	12180695
9/16	9/16	1-1/4	3-1/2			0.281	4	12180696	12180697
5/8	5/8	1-1/4	3-1/2			0.313	4	12180698	12180699
5/8	5/8	1-1/4	6	3-3/8	0.600	0.313	4	12180700	12180701
3/4	3/4	1-5/8	4			0.375	4	12180702	12180703
1	1	1-3/4	4			0.500	4	12180704	12180705
1	1	2-3/4	5			0.500	4	12180706	12180707
1	1	1-7/8	6	3-3/8	0.960	0.500	4	12180708	12180709

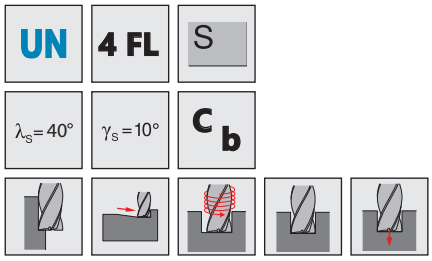
Application Range:

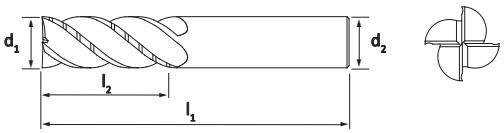
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●		●	●	●	●				

Feeds & Speeds Available on Page 92-93

Series 190

4 Flute Universal Multi-Geometry





Tolerances

Shank: 3/16" - 1" = -.0001/-.0004
Cutting Dia: 3/16" - 1" = +.000/-.002

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	l_3 LOR	d_3 Neck Dia	Flutes	AlTiN	nACRo®
3/16	3/16	5/8	2			4	12180859	12180860
1/4	1/4	3/8	2			4	12180863	12180864
1/4	1/4	3/4	2-1/2			4	12180861	12180862
5/16	5/16	3/4	2-1/2			4	12180865	12180866
3/8	3/8	5/8	2			4	12180869	12180870
3/8	3/8	7/8	2-1/2			4	12180867	12180868
3/8	3/8	7/8	4	2-1/8	0.360	4	12180871	12180872
1/2	1/2	5/8	2-1/2			4	12180875	12180876
1/2	1/2	1-1/4	3			4	12180873	12180874
1/2	1/2	2	4			4	12180877	12180878
1/2	1/2	1	6	2-3/8	0.480	4	12180879	12180880
5/8	5/8	7/8	3			4	12180883	12180884
5/8	5/8	1-1/4	3-1/2			4	12180881	12180882
3/4	3/4	1	3			4	12180887	12180888
3/4	3/4	1-5/8	4			4	12180885	12180886
1	1	1-3/4	4			4	12180889	12180890

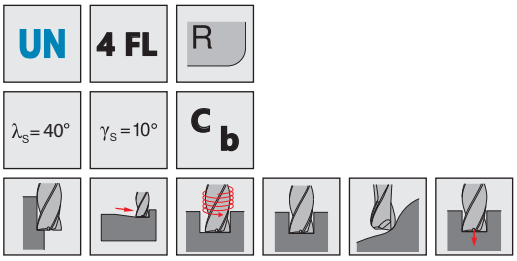
Application Range:

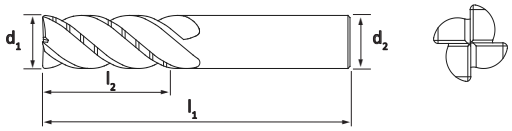
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●			●	●	●	●				

Feeds & Speeds Available on Page 93

Series 191

4 Flute Universal Multi-Geometry Corner Radius





Tolerances

Shank:	3/16” - 1” = -.0001/-.0004
Cutting Dia:	3/16” - 1” = +.000/-.002
Radius:	3/16” - 1” = +/-.001

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	R Radius	Flutes	AlTiN	nACRo®
3/16	3/16	5/8	2	0.010	4	12180891	12180892
1/4	1/4	3/4	2-1/2	0.020	4	12180896	12180897
5/16	5/16	3/4	2-1/2	0.020	4	12180898	12180899
5/16	5/16	3/4	2-1/2	0.030	4	12180898	12180899
3/8	3/8	7/8	2-1/2	0.020	4	12180900	12180901
3/8	3/8	7/8	2-1/2	0.030	4	12180908	12180909
1/2	1/2	5/8	2-1/2	0.020	4	12180904	12180905
1/2	1/2	5/8	2-1/2	0.030	4	12180912	12180913
1/2	1/2	1-1/4	3	0.020	4	12180902	12180903
1/2	1/2	1-1/4	3	0.030	4	12180910	12180911
1/2	1/2	2	4	0.020	4	12180906	12180907
1/2	1/2	2	4	0.030	4	12180914	12180915
5/8	5/8	1-1/4	3-1/2	0.030	4	12180916	12180917
3/4	3/4	1-5/8	4	0.030	4	12180918	12180919
1	1	1-3/4	4	0.030	4	12180920	12180921

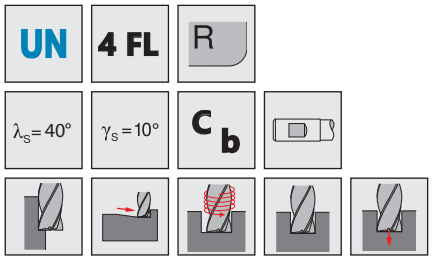
Application Range:

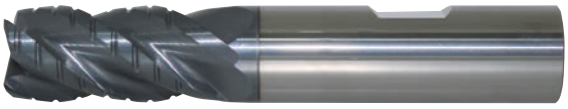
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●			●	●	●	●				

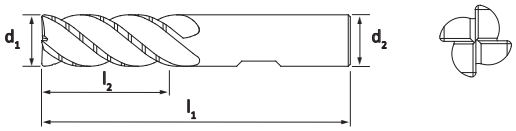
Feeds & Speeds Available on Page 93

Series 120

4 Flute Universal Rougher-Finisher







Tolerances

Shank:	1/8" - 1" = -.0001/-.0004
Cutting Dia:	1/8" - 1" = +.000/-.003
Radius:	1/8" - 1" = +.002/-.001

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	l_3 LOR	d_3 Neck Dia	R Radius	Flutes	TiCN	AlTiN	nACRo®
1/8	1/8	1/4	1-1/2			0.010	4	12180081	12180082	12180083
1/8	1/8	1/2	1-1/2			0.010	4	12180078	12180079	12180080
5/32	3/16	3/8	2			0.010	4	12180087	12180088	12180089
5/32	3/16	1/2	2			0.010	4	12180084	12180085	12180086
3/16	3/16	3/8	2			0.010	4	12180093	12180094	12180095
3/16	3/16	5/8	2			0.010	4	12180090	12180091	12180092
7/32	1/4	3/8	2			0.020	4	12180099	12180100	12180101
7/32	1/4	3/4	2-1/2			0.020	4	12180096	12180097	12180098
1/4	1/4	3/8	2			0.020	4	12180105	12180106	12180107
1/4	1/4	3/4	2-1/2			0.020	4	12180102	12180103	12180104
1/4	1/4	1-1/4	3			0.020	4	12180108	12180109	12180110
1/4	1/4	1-1/2	3-1/2			0.020	4	12180111	12180112	12180113
1/4	1/4	3/4	4	2-1/8	0.240	0.020	4	12180114	12180115	12180116
9/32	5/16	1/2	2-1/2			0.020	4	12180120	12180121	12180122
9/32	5/16	3/4	2-1/2			0.020	4	12180117	12180118	12180119
5/16	5/16	1/2	2-1/2			0.020	4	12180126	12180127	12180128
5/16	5/16	3/4	2-1/2			0.020	4	12180123	12180124	12180125
11/32	3/8	5/8	2			0.020	4	12180132	12180133	12180134
11/32	3/8	7/8	2-1/2			0.020	4	12180129	12180130	12180131
3/8	3/8	5/8	2			0.020	4	12180138	12180139	12180140
3/8	3/8	7/8	2-1/2			0.020	4	12180135	12180136	12180137
3/8	3/8	1-1/2	3-1/2			0.020	4	12180141	12180142	12180143
3/8	3/8	7/8	4	2-1/8	0.360	0.020	4	12180147	12180148	12180149
3/8	3/8	2	4			0.020	4	12180144	12180145	12180146
3/8	3/8	7/8	6	3-3/8	0.360	0.020	4	12180150	12180151	12180152
7/16	7/16	1	2-3/4			0.020	4	12180153	12180154	12180155
1/2	1/2	5/8	2-1/2			0.020	4	12180159	12180160	12180161

Additional Sizes On Page 70

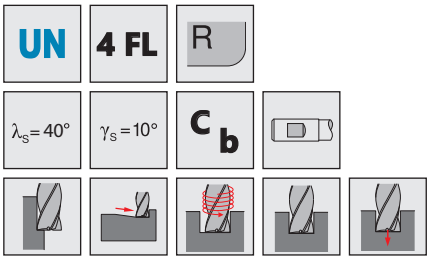
Application Range:

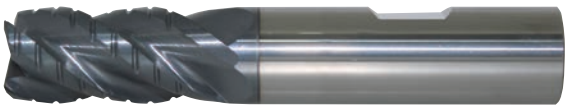
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●		●	●	●	●				

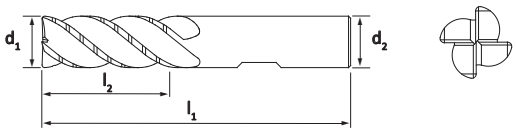
Feeds & Speeds Available on Page 94

Series 120

4 Flute Universal Rougher-Finisher







Tolerances

Shank:	1/8" - 1" = -.0001/-.0004
Cutting Dia:	1/8" - 1" = +.000/-.003
Radius:	1/8" - 1" = +.002/-.001

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	l_3 LOR	d_3 Neck Dia	R Radius	Flutes	TiCN	AlTiN	nACRo®
1/2	1/2	1-1/4	3			0.020	4	12180156	12180157	12180158
1/2	1/2	1-1/2	3-1/2			0.020	4	12180162	12180163	12180164
1/2	1/2	2	4			0.020	4	12180165	12180166	12180167
1/2	1/2	1	6	2-3/8	0.480	0.020	4	12180168	12180169	12180170
1/2	1/2	1	6	3-3/8	0.480	0.020	4	12180171	12180172	12180173
9/16	9/16	1-1/4	3-1/2			0.030	4	12180174	12180175	12180176
5/8	5/8	7/8	3			0.030	4	12180180	12180181	12180182
5/8	5/8	1-1/4	3-1/2			0.030	4	12180177	12180178	12180179
5/8	5/8	1-3/4	4			0.030	4	12180183	12180184	12180185
5/8	5/8	2-1/2	5			0.030	4	12180186	12180187	12180188
3/4	3/4	1	3			0.030	4	12180192	12180193	12180194
3/4	3/4	1-5/8	4			0.030	4	12180189	12180190	12180191
3/4	3/4	1-5/8	6	2-1/2	0.720	0.030	4	12180195	12180196	12180197
1	1	1-3/4	4			0.030	4	12180198	12180199	12180200

Additional Sizes On Page 69

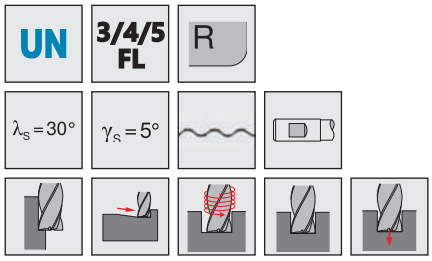
Application Range:

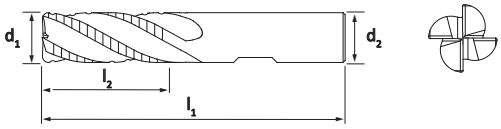
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●		●	●	●	●				

Feeds & Speeds Available on Page 94

Series 100

Multi Flute Universal





Tolerances

Shank:	3/16” - 1” = -.0001/-.0004
Cutting Dia:	3/16” - 1” = +.000/-.005
Radius:	3/16” - 1” = +/-.005

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	R Radius	Flutes	TiCN	AlTiN
3/16	3/16	3/8	2	0.030	3	12179520	12179521
3/16	3/16	5/8	2	0.030	3	12179518	12179519
1/4	1/4	3/8	2	0.045	4	12179524	12179525
1/4	1/4	3/4	2-1/2	0.045	4	12179522	12179523
5/16	5/16	1/2	2-1/2	0.045	4	12179528	12179529
5/16	5/16	3/4	2-1/2	0.045	4	12179526	12179527
3/8	3/8	5/8	2	0.060	4	12179532	12179533
3/8	3/8	7/8	2-1/2	0.060	4	12179530	12179531
7/16	7/16	1	2-3/4	0.060	4	12179534	12179535
1/2	1/2	5/8	2-1/2	0.060	4	12179538	12179539
1/2	1/2	1-1/4	3	0.060	4	12179536	12179537
1/2	1/2	1-1/2	3-1/2	0.060	4	12179540	12179541
9/16	9/16	1-1/4	3-1/2	0.060	4	12179542	12179543
5/8	5/8	7/8	3	0.060	4	12179546	12179547
5/8	5/8	1-1/4	3-1/2	0.060	4	12179544	12179545
5/8	5/8	2	4	0.060	4	12179548	12179549
3/4	3/4	1	3	0.060	4	12179552	12179553
3/4	3/4	1-5/8	4	0.060	4	12179550	12179551
3/4	3/4	2-1/4	5	0.060	4	12179554	12179555
1	1	1-3/4	4	0.060	5	12179556	12179557
1	1	2-5/8	5	0.060	5	12179558	12179559

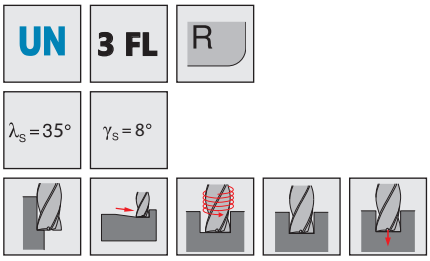
Application Range:

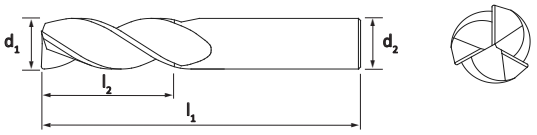
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●			●			●				

Feeds & Speeds Available on Page 94-95

Series 106

3 Flute Universal





Tolerances

Shank: 1/8" - 3/4" = -.0001/-.0004
Cutting Dia: 1/8" - 3/4" = +.000/-.002
Chamfer: 1/8" - 3/4" = +/-.001

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	l_3 LOR	d_3 Neck Dia	R Radius	Flutes	TiCN	AlTiN
1/8	1/8	1/4	1-1/2			0.010	3	12179661	12179662
1/8	1/8	1/2	1-1/2			0.010	3	12179659	12179660
5/32	3/16	5/16	2			0.010	3	12180995	12180996
3/16	3/16	5/16	2			0.010	3	12179665	12179666
3/16	3/16	5/8	2			0.010	3	12179663	12179664
1/4	1/4	3/8	2			0.020	3	12179669	12179670
1/4	1/4	3/4	2-1/2			0.020	3	12179667	12179668
1/4	1/4	3/8	4	2-1/8	0.240	0.020	3	12179671	12179672
5/16	5/16	13/16	2-1/2			0.020	3	12179673	12179674
3/8	3/8	1/2	2			0.020	3	12179677	12179678
3/8	3/8	1	2-1/2			0.020	3	12179675	12179676
3/8	3/8	1/2	6	2-1/8	0.360	0.020	3	12179679	12179680
7/16	7/16	1	2-3/4			0.020	3	12179681	12179682
1/2	1/2	5/8	2-1/2			0.020	3	12179685	12179686
1/2	1/2	1-1/4	3			0.020	3	12179683	12179684
1/2	1/2	5/8	6	2-3/8	0.480	0.020	3	12179687	12179688
5/8	5/8	1-5/8	3-1/2			0.030	3	12179689	12179690
3/4	3/4	1-5/8	4			0.030	3	12179691	12179692

Application Range:

Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●						●				

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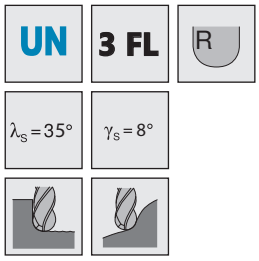
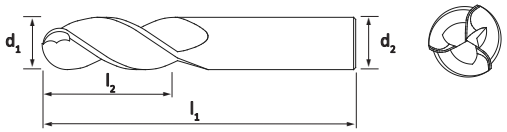
Series 113

3 Flute Universal Ball





Tolerances

Shank:	1/8" - 1" = -.0001/-.0004
Cutting Dia:	1/8" - 1" = +.000/-.002
Ball Radius:	1/8" - 1" = +/-.001

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	l_3 LOR	d_3 Neck Dia	R Radius	Flutes	TiCN	AlTiN
1/8	1/8	1/4	1-1/2			0.063	3	12179936	12179937
1/8	1/8	1/2	1-1/2			0.063	3	12179934	12179935
3/16	3/16	5/8	2			0.094	3	12179938	12179939
1/4	1/4	3/4	2-1/2			0.125	3	12179940	12179941
1/4	1/4	3/8	4	2-1/8	0.240	0.125	3	12179942	12179943
5/16	5/16	13/16	2-1/2			0.156	3	12179944	12179945
5/16	5/16	7/16	4	2-1/8	0.300	0.156	3	12179946	12179947
3/8	3/8	1	2-1/2			0.188	3	12179948	12179949
3/8	3/8	1/2	6	2-1/8	0.360	0.188	3	12179950	12179951
3/8	3/8	1/2	6	3-3/8	0.360	0.188	3	12179952	12179953
1/2	1/2	1-1/4	3			0.250	3	12179954	12179955
1/2	1/2	5/8	6	2-3/8	0.480	0.250	3	12179956	12179957
5/8	5/8	1-1/4	3-1/2			0.313	3	12179958	12179959
3/4	3/4	1-5/8	4			0.375	3	12179960	12179961
1	1	1-3/4	4			0.500	3	12179962	12179963

Application Range:

Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●						●				

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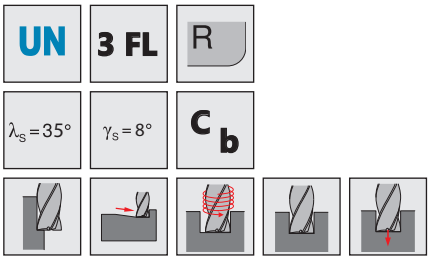
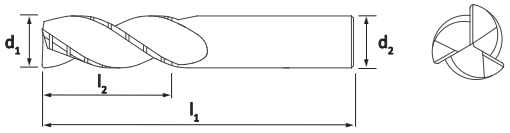
Series 117

3 Flute Universal Rougher-Finisher





Tolerances

Shank:	1/8” - 3/4” = -.0001/-.0004
Cutting Dia:	1/8” - 3/4” = +.000/-.002
Radius:	1/8” - 3/4” = +.002/-.001

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	R Radius	Flutes	TiCN	AlTiN
1/8	1/8	1/2	1-1/2	0.010	3	12179964	12179965
3/16	3/16	5/16	2	0.010	3	12179970	12179971
3/16	3/16	5/8	2	0.010	3	12179968	12179969
1/4	1/4	3/8	2	0.020	3	12179976	12179977
1/4	1/4	3/4	2-1/2	0.020	3	12179974	12179975
5/16	5/16	13/16	2-1/2	0.020	3	12179980	12179981
3/8	3/8	1	2-1/2	0.020	3	12179984	12179985
7/16	7/16	5/8	2-3/4	0.020	3	12179988	12179989
7/16	7/16	1	2-3/4	0.020	3	12179986	12179987
1/2	1/2	5/8	2-1/2	0.020	3	12179992	12179993
1/2	1/2	1-1/4	3	0.020	3	12179990	12179991
5/8	5/8	1-1/4	3-1/2	0.030	3	12179994	12179995
3/4	3/4	1-5/8	4	0.030	3	12179998	12179999

Application Range:

Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●						●				

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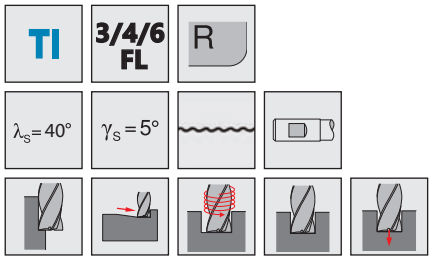
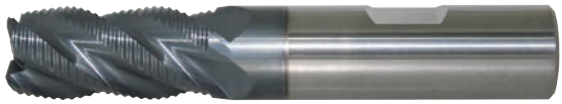
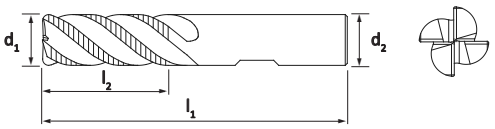
Series 101

Multi Flute Titanium Rougher







Tolerances

Shank:	3/16” - 1” = -.0001/-.0004
Cutting Dia:	3/16” - 1” = +.000/-.005
Radius:	3/16” - 1” = +/-.005

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	R Radius	Flutes	TiCN	AlTiN	nACRo®
3/16	3/16	3/8	2	0.030	3	12179563	12179564	12179565
3/16	3/16	5/8	2	0.030	3	12179560	12179561	12179562
1/4	1/4	3/8	2	0.045	4	12179569	12179570	12179571
1/4	1/4	3/4	2-1/2	0.045	4	12179566	12179567	12179568
5/16	5/16	1/2	2-1/2	0.045	4	12179575	12179576	12179577
5/16	5/16	3/4	2-1/2	0.045	4	12179572	12179573	12179574
3/8	3/8	5/8	2	0.060	4	12179581	12179582	12179583
3/8	3/8	7/8	2-1/2	0.060	4	12179578	12179579	12179580
7/16	7/16	1	2-3/4	0.060	4	12179584	12179585	12179586
1/2	1/2	5/8	2-1/2	0.060	4	12179590	12179591	12179592
1/2	1/2	1-1/4	3	0.060	4	12179587	12179588	12179589
1/2	1/2	1-1/2	3-1/2	0.060	4	12179593	12179594	12179595
9/16	9/16	1-1/4	3-1/2	0.060	4	12179596	12179597	12179598
5/8	5/8	7/8	3	0.060	4	12179602	12179603	12179604
5/8	5/8	1-1/4	3-1/2	0.060	4	12179599	12179600	12179601
5/8	5/8	2	4	0.060	4	12179605	12179606	12179607
3/4	3/4	1	3	0.060	4	12179611	12179612	12179613
3/4	3/4	1-5/8	4	0.060	4	12179608	12179609	12179610
3/4	3/4	2-1/4	5	0.060	4	12179614	12179615	12179616
1	1	1-3/4	4	0.060	6	12179617	12179618	12179619
1	1	2-5/8	5	0.060	6	12179620	12179621	12179622

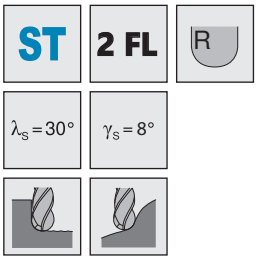
Application Range:

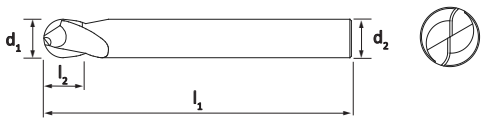
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
	●		●	●	●					

Feeds & Speeds Available on Page 97

Series 250

2 Flute 0° Die and Mold Tool Ball





Tolerances

Shank:	1/8" - 1/2" = -.0001/-.0004
Cutting Dia:	1/8" - 1/2" = +.000/-.0008
Ball Radius:	1/8" - 1/2" = +.000/-.0004

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	R Radius	Flutes	AlTiN
1/8	1/8	1/8	3	0.063	2	12180923
3/16	3/16	3/16	3	0.094	2	12180924
1/4	1/4	1/4	4	0.125	2	12180925
3/8	3/8	3/8	4	0.188	2	12180926
3/8	3/8	3/8	6	0.188	2	12180927
1/2	1/2	1/2	4	0.250	2	12180928
1/2	1/2	1/2	6	0.250	2	12180929

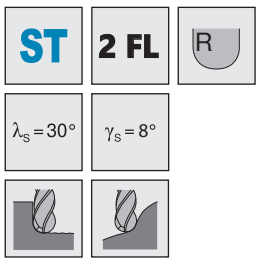
Application Range:

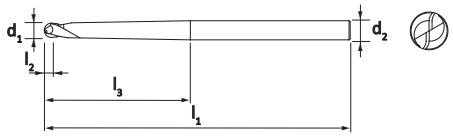
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●		●							

Feeds & Speeds Available on Page 97

Series 251

2 Flute 1° Die and Mold Tool Ball





Tolerances

Shank:	1/32” - 3/16” = -.0001/-.0004
Cutting Dia:	1/32” - 3/16” = +.000/-.0008
Ball Radius:	1/32” - 3/16” = +.000/-.0004

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	l_3 LOR	R Radius	Flutes	AlTiN
1/32	1/4	1/32	4	0.625	0.016	2	12180930
0.06	1/4	.060	4	1.250	0.030	2	12180931
0.06	1/4	.080	4	1.625	0.040	2	12180932
3/32	1/4	3/32	4	1.875	0.047	2	12180933
1/8	1/4	1/8	4	2.500	0.063	2	12180934
3/16	1/4	3/16	4	2.265	0.094	2	12180935

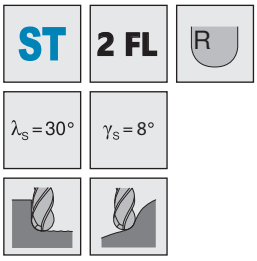
Application Range:

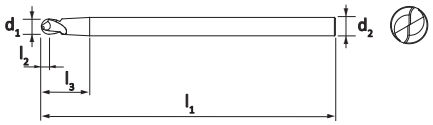
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●		●							

Feeds & Speeds Available on Page 98

Series 252

2 Flute 3° Die and Mold Tool Ball





Tolerances

Shank:	1/32” - 3/16” = -.0001/-.0004
Cutting Dia:	1/32” - 3/16” = +.000/-.0008
Ball Radius:	1/32” - 3/16” = +.000/-.0004

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	l_3 LOR	R Radius	Flutes	AlTiN
1/32	1/4	1/32	4	2.112	0.016	2	12180936
0.06	1/4	.060	4	1.875	0.030	2	12180937
0.06	1/4	.080	4	1.704	0.040	2	12180938
3/32	1/4	3/32	4	1.584	0.047	2	12180939
1/8	1/4	1/8	4	1.324	0.063	2	12180940
3/16	1/4	3/16	4	0.786	0.094	2	12180941

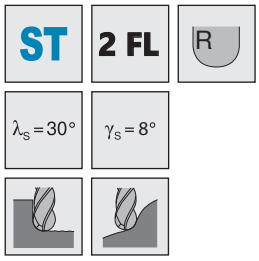
Application Range:

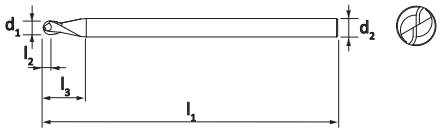
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●		●							

Feeds & Speeds Available on Page 98

Series 253

2 Flute 5° Die and Mold Tool Ball





Tolerances

Shank:	1/32” - 3/16” = -.0001/-.0004
Cutting Dia:	1/32” - 3/16” = +.000/-.0008
Ball Radius:	1/32” - 3/16” = +.000/-.0004

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	l_3 LOR	R Radius	Flutes	AlTiN
1/32	1/4	1/32	4	1.282	0.016	2	12180942
0.06	1/4	.060	4	1.175	0.030	2	12180943
0.06	1/4	.080	4	1.084	0.040	2	12180944
3/32	1/4	3/32	4	1.018	0.047	2	12180945
1/8	1/4	1/8	4	0.897	0.063	2	12180946
3/16	1/4	3/16	4	0.680	0.094	2	12180947

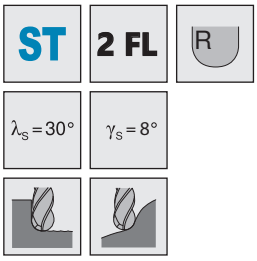
Application Range:

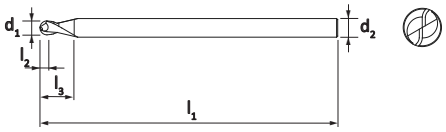
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●		●							

Feeds & Speeds Available on Page 98

Series 254

2 Flute 8° Die and Mold Tool Ball





Tolerances

Shank:	1/32” - 3/16” = -.0001/-.0004
Cutting Dia:	1/32” - 3/16” = +.000/-.0008
Ball Radius:	1/32” - 3/16” = +.000/-.0004

d_1 Dia	d_2 Shank	l_2 LOC	l_1 OAL	l_3 LOR	R Radius	Flutes	AlTiN
1/32	1/4	1/32	4	0.851	0.016	2	12180948
0.06	1/4	.060	4	0.773	0.030	2	12180949
0.06	1/4	.080	4	0.726	0.040	2	12180950
3/32	1/4	3/32	4	0.690	0.047	2	12180951
1/8	1/4	1/8	4	0.636	0.063	2	12180952
3/16	1/4	3/16	4	0.454	0.094	2	12180953

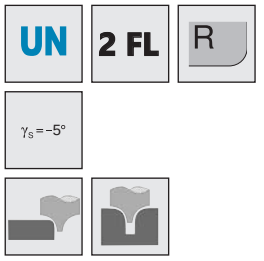
Application Range:

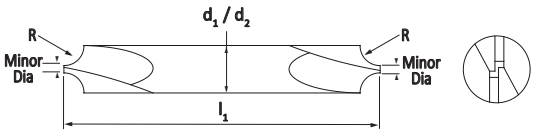
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●		●							

Feeds & Speeds Available on Page 98

Series 137

2 Flute Corner Rounder





Tolerances

Shank: 1/8" - 3/8" = -.0001/-.0004
Radius: 1/8" - 3/8" = +/-.001

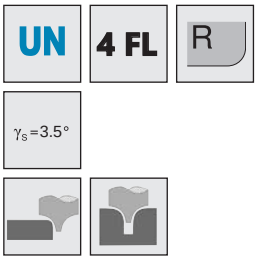
d_1 Dia	d_2 Shank	l_1 OAL	Minor Dia	R Radius	Flutes	Uncoated	TiCN	AlTiN
1/8	1/8	1-1/2	0.105	0.010	2	12180297	12180298	12180299
1/8	1/8	1-1/2	0.095	0.015	2	12180300	12180301	12180302
1/8	1/8	1-1/2	0.085	0.020	2	12180303	12180304	12180305
1/8	1/8	1-1/2	0.075	0.025	2	12180306	12180307	12180308
1/8	1/8	1-1/2	0.063	0.031	2	12180309	12180310	12180311
1/8	1/8	1-1/2	0.055	0.035	2	12180312	12180313	12180314
1/8	1/8	1-1/2	0.045	0.040	2	12180315	12180316	12180317
3/16	3/16	2	0.095	0.046	2	12180318	12180319	12180320
3/16	3/16	2	0.087	0.050	2	12180321	12180322	12180323
3/16	3/16	2	0.077	0.055	2	12180324	12180325	12180326
3/16	3/16	2	0.058	0.062	2	12180327	12180328	12180329
1/4	1/4	2-1/2	0.106	0.072	2	12180330	12180331	12180332
1/4	1/4	2-1/2	0.094	0.078	2	12180333	12180334	12180335
1/4	1/4	2-1/2	0.080	0.085	2	12180336	12180337	12180338
1/4	1/4	2-1/2	0.062	0.094	2	12180339	12180340	12180341
1/4	1/4	2-1/2	0.050	0.100	2	12180342	12180343	12180344
1/4	1/4	2-1/2	0.094	0.109	2	12180345	12180346	12180347
5/16	5/16	2-1/2	0.076	0.118	2	12180348	12180349	12180350
5/16	5/16	2-1/2	0.063	0.125	2	12180351	12180352	12180353
3/8	3/8	2-1/2	0.095	0.140	2	12180354	12180355	12180356
3/8	3/8	2-1/2	0.063	0.156	2	12180357	12180358	12180359

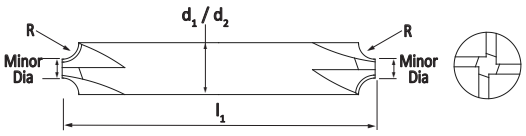
Application Range:

Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●		●							

Series 139

4 Flute Corner Rounder





Tolerances

Shank: 3/16” - 1/2” = -.0001/-.0004
Radius: 3/16” - 1/2” = +/-.001

d_1 Dia	d_2 Shank	l_1 OAL	Minor Dia	R Radius	Flutes	Uncoated	TiCN	AlTiN
3/16	3/16	2	0.162	0.010	4	12180360	12180361	12180362
3/16	3/16	2	0.152	0.015	4	12180363	12180364	12180365
3/16	3/16	2	0.142	0.020	4	12180366	12180367	12180368
3/16	3/16	2	0.132	0.025	4	12180369	12180370	12180371
3/16	3/16	2	0.120	0.031	4	12180372	12180373	12180374
3/16	3/16	2	0.112	0.035	4	12180375	12180376	12180377
1/4	1/4	2-1/2	0.165	0.040	4	12180378	12180379	12180380
1/4	1/4	2-1/2	0.153	0.046	4	12180381	12180382	12180383
1/4	1/4	2-1/2	0.145	0.050	4	12180384	12180385	12180386
1/4	1/4	2-1/2	0.135	0.055	4	12180390	12180391	12180392
1/4	1/4	2-1/2	0.121	0.062	4	12180387	12180388	12180389
3/8	3/8	2-1/2	0.214	0.078	4	12180393	12180394	12180395
3/8	3/8	2-1/2	0.182	0.094	4	12180396	12180397	12180398
3/8	3/8	2-1/2	0.170	0.100	4	12180399	12180400	12180401
3/8	3/8	2-1/2	0.134	0.118	4	12180402	12180403	12180404
3/8	3/8	2-1/2	0.120	0.125	4	12180405	12180406	12180407
1/2	1/2	3	0.183	0.156	4	12180408	12180409	12180410

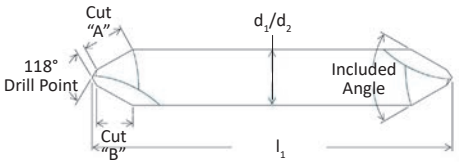
Application Range:

Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●		●							

Series 132 & 133

2 & 4 Flute 60° Chamfer-Spot

UN | 2 FL | 4 FL



Tolerances
Shank: 1/8" - 1/2" = -.0001/-.0004

d_1 Dia	d_2 Shank	l_1 OAL	Included Angle	Cut "A"	Cut "B"	Flutes	Uncoated	TiCN	AlTiN
* 1/8	1/8	1-1/2	60°	0.098	0.085	2	12180249	12180250	12180251
* 3/16	3/16	2	60°	0.147	0.127	2	12180252	12180253	12180254
1/4	1/4	2-1/2	60°	0.200	0.173	2	12180255	12180256	12180257
3/8	3/8	2-1/2	60°	0.313	0.271	2	12180258	12180259	12180260
1/2	1/2	3	60°	0.430	0.372	2	12180261	12180262	12180263

* No Drill Point
Standard with 118° Drill Point

d_1 Dia	d_2 Shank	l_1 OAL	Included Angle	Cut "A"	Cut "B"	Flutes	Uncoated	TiCN	AlTiN
1/4	1/4	2-1/2	60°	0.200	0.173	4	12180264	12180265	12180266
3/8	3/8	2-1/2	60°	0.313	0.271	4	12180267	12180268	12180269
1/2	1/2	3	60°	0.430	0.372	4	12180270	12180271	12180272

Standard with 118° Drill Point

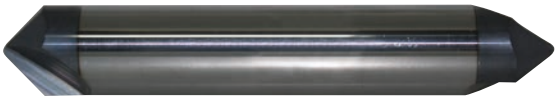
Application Range:

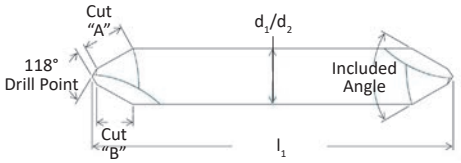
Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●	●	●	●	●	●	●	●	●	●

Series 134 & 135

2 & 4 Flute 90° Chamfer-Spot

UN | 2 FL | 4 FL





Tolerances
Shank: 1/8" - 1/2" = -.0001/-.0004

d_1 Dia	d_2 Shank	l_1 OAL	Included Angle	Cut "A"	Cut "B"	Flutes	Uncoated	TiCN	AlTiN
* 1/8	1/8	1-1/2	90°	0.071	0.050	2	12180273	12180274	12180275
* 3/16	3/16	2	90°	0.107	0.076	2	12180276	12180277	12180278
1/4	1/4	2-1/2	90°	0.141	0.100	2	12180279	12180280	12180281
3/8	3/8	2-1/2	90°	0.221	0.157	2	12180282	12180283	12180284
1/2	1/2	3	90°	0.304	0.215	2	12180285	12180286	12180287

* No Drill Point
Standard with 118° Drill Point

d_1 Dia	d_2 Shank	l_1 OAL	Included Angle	Cut "A"	Cut "B"	Flutes	Uncoated	TiCN	AlTiN
1/4	1/4	2-1/2	90°	0.141	0.100	4	12180288	12180289	12180290
3/8	3/8	2-1/2	90°	0.221	0.157	4	12180291	12180292	12180293
1/2	1/2	3	90°	0.304	0.215	4	12180294	12180295	12180296

Standard with 118° Drill Point

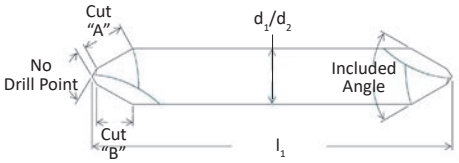
Application Range:

Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●	●	●	●	●	●	●	●	●	●

Series 130 & 131

2 & 4 Flute 120° Chamfer-Spot

UN | 2 FL | 4 FL



Tolerances
Shank: 1/4" - 1/2" = -.0001/-.0004

d_1 Dia	d_2 Shank	l_1 OAL	Included Angle	Cut "A"	Cut "B"	Cut "B"	Uncoated	TiCN	AlTiN
* 1/4	1/4	2-1/2	120°	0.124	0.062	2	12180231	12180232	12180233
* 3/8	3/8	2-1/2	120°	0.199	0.100	2	12180234	12180235	12180236
* 1/2	1/2	3	120°	0.266	0.133	2	12180237	12180238	12180239

* No Drill Point

d_1 Dia	d_2 Shank	l_1 OAL	Included Angle	Cut "A"	Cut "B"	Cut "B"	Uncoated	TiCN	AlTiN
* 1/4	1/4	2-1/2	120°	0.144	0.072	4	12180240	12180241	12180242
* 3/8	3/8	2-1/2	120°	0.217	0.108	4	12180243	12180244	12180245
* 1/2	1/2	3	120°	0.289	0.144	4	12180246	12180247	12180248

* No Drill Point

Application Range:

Steel	Tool Steel	Hardened Steel	Stainless Steel	Titanium	High Temp Alloys	Cast Iron	Aluminum	Aluminum High Silicone	Copper, Brass	Plastic, Composites
●	●	●	●	●	●	●	●	●	●	●

Aluminum - 109

Material Designation		SFM [ft/min]	ae max. [inch]	ap max [inch]	Chip Load per Tooth [inch]					
					1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
Aluminium	Non-Alloy	1230	0.05xø	1.4xø	0.0008	0.0016	0.002	0.0041	0.0048	0.0055
	Wrought Alloy Non-Hardened	1230	0.05xø	1.4xø	0.0008	0.0016	0.002	0.0041	0.0048	0.0055
	Wrought Alloy Hardened	1230	0.05xø	1.4xø	0.0008	0.0016	0.002	0.0041	0.0048	0.0055
	Casting Alloy < 6% Si	984	0.05xø	1.4xø	0.0008	0.0016	0.002	0.0041	0.0048	0.0055
	Casting Alloy 6-12% Si	738	0.05xø	1.4xø	0.0006	0.0008	0.0012	0.0034	0.0041	0.0048
	Casting Alloy > 6% Si	517	0.05xø	1.4xø	0.0006	0.0008	0.0012	0.0034	0.0041	0.0048
Magnesium	Wrought Alloy	492	0.05xø	1.4xø	0.0006	0.0008	0.0012	0.0034	0.0041	0.0048
	Casting Alloy	418	0.05xø	1.4xø	0.0006	0.0008	0.0012	0.0034	0.0041	0.0048
Copper	Non-Alloy	369	0.05xø	1.4xø	0.0006	0.0008	0.0012	0.0034	0.0041	0.0048
	Wrought Alloy Non-Hardened	344	0.05xø	1.4xø	0.0006	0.0008	0.0012	0.0034	0.0041	0.0048
	Wrought Alloy Hardened	271	0.05xø	1.4xø	0.0006	0.0008	0.0012	0.0034	0.0041	0.0048
	CuNi-Alloy	320	0.05xø	1.4xø	0.0006	0.0008	0.0012	0.0034	0.0041	0.0048
	CuNiZn-Alloy Long-Chipping	271	0.05xø	1.4xø	0.0006	0.0008	0.0012	0.0034	0.0041	0.0048
	CuNiZn-Alloy Short-Chipping	320	0.05xø	1.4xø	0.0006	0.0008	0.0012	0.0034	0.0041	0.0048
CuZn (Brass)	Long-Chipping	369	0.05xø	1.4xø	0.0006	0.0008	0.0012	0.0034	0.0041	0.0048
	Short-Chipping	517	0.05xø	1.4xø	0.0006	0.0008	0.0012	0.0034	0.0041	0.0048
CuSn (Bronze)	Long-Chipping	320	0.05xø	1.4xø	0.0006	0.0008	0.0012	0.0034	0.0041	0.0048
	Short-Chipping	344	0.05xø	1.4xø	0.0006	0.0008	0.0012	0.0034	0.0041	0.0048
CuAlFe (Ampco)	Long-Chipping	148	0.05xø	1.4xø	0.0006	0.0008	0.0012	0.0034	0.0041	0.0048
	Short-Chipping	172	0.05xø	1.4xø	0.0006	0.0008	0.0012	0.0034	0.0041	0.0048

Aluminum - 102 / 119

Material Designation		SFM [ft/min]	ae max. [inch]	ap max [inch]	Chip Load per Tooth [inch]					
					1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
Aluminium	Non-Alloy	1230	1xø	1xø	0.001	0.0017	0.0028	0.0035	0.0047	0.0055
	Wrought Alloy Non-Hardened	1230	1xø	1xø	0.001	0.0017	0.0028	0.0035	0.0047	0.0055
	Wrought Alloy Hardened	1230	1xø	1xø	0.001	0.0017	0.0028	0.0035	0.0047	0.0055
	Casting Alloy < 6% Si	984	1xø	1xø	0.001	0.0017	0.0028	0.0035	0.0047	0.0055
	Casting Alloy 6-12% Si	738	1xø	1xø	0.0008	0.0014	0.0028	0.0047	0.0067	0.0083
	Casting Alloy > 6% Si	517	1xø	1xø	0.0008	0.0014	0.0028	0.0047	0.0067	0.0083
Magnesium	Wrought Alloy	492	1xø	1xø	0.0008	0.0014	0.0028	0.0047	0.0067	0.0083
	Casting Alloy	418	1xø	1xø	0.0008	0.0014	0.0028	0.0047	0.0067	0.0083
Copper	Non-Alloy	369	1xø	1xø	0.0006	0.0011	0.0024	0.0031	0.0047	0.0055
	Wrought Alloy Non-Hardened	344	1xø	1xø	0.0006	0.0011	0.0024	0.0031	0.0047	0.0055
	Wrought Alloy Hardened	271	1xø	1xø	0.0006	0.0011	0.0024	0.0031	0.0047	0.0055
	CuNi-Alloy	320	1xø	1xø	0.0006	0.0011	0.0024	0.0031	0.0047	0.0055
	CuNiZn-Alloy Long-Chipping	271	1xø	1xø	0.0006	0.0011	0.0024	0.0031	0.0047	0.0055
	CuNiZn-Alloy Short-Chipping	320	1xø	1xø	0.0006	0.0011	0.0024	0.0031	0.0047	0.0055
CuZn (Brass)	Long-Chipping	369	1xø	1xø	0.0006	0.0011	0.0024	0.0031	0.0047	0.0055
	Short-Chipping	517	1xø	1xø	0.0006	0.0011	0.0024	0.0031	0.0047	0.0055
CuSn (Bronze)	Long-Chipping	320	1xø	1xø	0.0006	0.0011	0.0024	0.0031	0.0047	0.0055
	Short-Chipping	344	1xø	1xø	0.0006	0.0011	0.0024	0.0031	0.0047	0.0055
CuAlFe (Ampco)	Long-Chipping	148	1xø	1xø	0.0006	0.0011	0.0024	0.0031	0.0047	0.0055
	Short-Chipping	172	1xø	1xø	0.0006	0.0011	0.0024	0.0031	0.0047	0.0055

*** Feeds and Speeds are starting points for Overall Lengths of 4" and shorter.**
For End Mills with Overall Lengths over 4" decrease the Feeds and Speeds.

Universal - 160 / 161

Material Designation		SFM [ft/min]	ae max. [inch]	ap max [inch]	Chip Load per Tooth [inch]					
					1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
Machining Steel	< 500 N/mm²	533	0.05xø	1.4xø	0.0007	0.0012	0.0019	0.0028	0.0033	0.0039
	> 500 N/mm²	492	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Construction Steel	Non-Alloy < 500 N/mm²	509	0.05xø	1.4xø	0.0007	0.0012	0.0019	0.0028	0.0033	0.0039
	Non-Alloy > 500 N/mm²	476	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloy	459	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Spring Steel	Annealed < 250 HB	262	0.05xø	1.4xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
	Natural Hardened 250-350 HB	246	0.05xø	1.4xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
	Spring Hardened 1200-1600 N/mm²	230	0.05xø	1.4xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
Cementation Steel	< 150 HB	427	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	150-200 HB	410	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	> 200 HB	377	0.05xø	1.4xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
Nitriding Steel	< 1000 N/mm²	377	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	> 1000 N/mm²	344	0.05xø	1.4xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
Quenched & Tempered Steel	Non-Alloy < 800 N/mm²	410	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Non-Alloy 800-1000 N/mm²	377	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloy < 800 N/mm²	377	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloy 800-1000 N/mm²	361	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloy 1000-1300 N/mm²	344	0.05xø	1.4xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
	Alloy 1300-1600 N/mm²	312	0.05xø	1.4xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
Non-Alloy Tool Steel	General	377	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Tool Steel for Cold Processing	Low Alloy < 1000 N/mm²	361	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Low Alloy < 1200 N/mm²	344	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Low Alloy < 1500 N/mm²	303	0.05xø	1.4xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
	High Alloy Annealed < 1000 N/mm²	328	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	High Alloy Hardened < 1300 N/mm²	287	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Tool Steel for Warm Processing	Low Alloy < 1200 N/mm²	336	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Low Alloy < 1500 N/mm²	303	0.05xø	1.4xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
	High Alloy Annealed < 1000 N/mm²	303	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	High Alloy Hardened < 1300 N/mm²	287	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	High Alloy Hardened < 1600 N/mm²	262	0.05xø	1.4xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
Stainless Steel	Ferric	197	0.05xø	1.4xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
	Martensitic	164	0.05xø	1.4xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
	Austenitic A5 < 40%	197	0.05xø	1.4xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
	Austenitic A5 > 40%	197	0.05xø	1.4xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
	Sulphured	213	0.05xø	1.4xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
High Temperature Alloy	Fe-Alloy	66	0.05xø	1.4xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
	Ni-Alloy not hardened	66	0.05xø	1.4xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
	Ni-Alloy hardened	66	0.05xø	1.4xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
	Co-Alloy	66	0.05xø	1.4xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
Cast Iron	Non-Alloy	410	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Low-Alloy	328	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	High-Alloy	246	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Stainless Cast Steel	Ferric/Martensitic	197	0.05xø	1.4xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
	Austenitic	197	0.05xø	1.4xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
Cast Iron with Lamellar Graphite	Non-Alloy < 180 HB	410	0.05xø	1.4xø	0.0007	0.0012	0.0019	0.0028	0.0033	0.0039
	Non-Alloy > 180 HB	361	0.05xø	1.4xø	0.0007	0.0012	0.0019	0.0028	0.0033	0.0039
	Alloy	328	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	High Alloy	246	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Spheroidal Cast Iron	Non-Alloy < 180 HB	377	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Non-Alloy > 180 HB	344	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloy	303	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
White Malleable Cast Iron	< 180 HB	361	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	> 180 HB	328	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Black Malleable Cast Iron	< 180 HB	361	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	> 180 HB	328	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Titanium	Non-Alloy	328	0.05xø	1.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloyed-Annealed	287	0.05xø	1.4xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
	Alloyed-Hardened	205	0.05xø	1.4xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025

*** Feeds and Speeds are starting points for Overall Lengths of 4" and shorter.**
For End Mills with Overall Lengths over 4" decrease the Feeds and Speeds.

Universal - 112

Material Designation		SFM [ft/min]	ae max. [inch]	ap max [inch]	Chip Load per Tooth [inch]					
					1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
Machining Steel	< 500 N/mm²	427	1xø	0.7xø	0.0007	0.0012	0.0019	0.0028	0.0033	0.0039
	> 500 N/mm²	394	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Construction Steel	Non-Alloy < 500 N/mm²	410	1xø	0.7xø	0.0007	0.0012	0.0019	0.0028	0.0033	0.0039
	Non-Alloy > 500 N/mm²	377	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloy	361	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Cementation Steel	< 150 HB	344	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	150-200 HB	328	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	> 200 HB	312	1xø	0.7xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
Nitriding Steel	< 1000 N/mm²	312	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	> 1000 N/mm²	279	1xø	0.7xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
Quenched & Tempered Steel	Non-Alloy < 800 N/mm²	328	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Non-Alloy 800-1000 N/mm²	312	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloy < 800 N/mm²	312	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloy 800-1000 N/mm²	295	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloy 1000-1300 N/mm²	279	1xø	0.7xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
	Alloy 1300-1600 N/mm²	246	1xø	0.7xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
Non-Alloy Tool Steel	General	303	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Tool Steel for Cold Processing	Low Alloy < 1000 N/mm²	295	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Low Alloy < 1200 N/mm²	279	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Low Alloy < 1500 N/mm²	246	1xø	0.7xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
	High Alloy Annealed < 1000 N/mm²	262	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	High Alloy Hardened < 1300 N/mm²	230	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Tool Steel for Warm Processing	Low Alloy < 1200 N/mm²	328	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Low Alloy < 1500 N/mm²	295	1xø	0.7xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
	High Alloy Annealed < 1000 N/mm²	246	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	High Alloy Hardened < 1300 N/mm²	230	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	High Alloy Hardened < 1600 N/mm²	213	1xø	0.7xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
Stainless Steel	Ferric	164	1xø	0.7xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
	Martensitic	131	1xø	0.7xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
	Austenitic A5 < 40%	164	1xø	0.7xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
	Austenitic A5 > 40%	164	1xø	0.7xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
	Sulphured	180	1xø	0.7xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
High Temperature Alloy	Fe-Alloy	90	0.5xø	0.7xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	Ni-Alloy not hardened	90	0.5xø	0.7xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	Ni-Alloy hardened	90	0.5xø	0.7xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	Co-Alloy	90	0.5xø	0.7xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
Cast Iron	Non-Alloy	328	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Low-Alloy	262	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	High-Alloy	197	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Stainless Cast Steel	Ferric/Martensitic	164	1xø	0.7xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
	Austenitic	164	1xø	0.7xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
Cast Iron with Lamellar Graphite	Non-Alloy < 180 HB	328	1xø	0.7xø	0.0007	0.0012	0.0019	0.0028	0.0033	0.0039
	Non-Alloy > 180 HB	295	1xø	0.7xø	0.0007	0.0012	0.0019	0.0028	0.0033	0.0039
	Alloy	262	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	High Alloy	197	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Spheroidal Cast Iron	Non-Alloy < 180 HB	312	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Non-Alloy > 180 HB	279	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloy	246	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
White Malleable Cast Iron	< 180 HB	295	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	> 180 HB	262	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Black Malleable Cast Iron	< 180 HB	295	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	> 180 HB	262	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Titanium	Non-Alloy	197	0.5xø	0.7xø	0.0007	0.0012	0.0019	0.0028	0.0033	0.0039
	Alloyed-Annealed	164	0.5xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloyed-Hardened	131	0.5xø	0.7xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028

*** Feeds and Speeds are starting points for Overall Lengths of 4" and shorter.**
For End Mills with Overall Lengths over 4" decrease the Feeds and Speeds.

Universal - 158 / 159

Material Designation		SFM [ft/min]	ae max. [inch]	ap max [inch]	Chip load per tooth [inch]					
					1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
Machining Steel	< 500 N/mm²	427	1xø	0.7xø	0.0007	0.0012	0.0019	0.0028	0.0033	0.0039
	> 500 N/mm²	394	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Construction Steel	Non-Alloy < 500 N/mm²	410	1xø	0.7xø	0.0007	0.0012	0.0019	0.0028	0.0033	0.0039
	Non-Alloy > 500 N/mm²	377	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloy	361	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Cementation Steel	< 150 HB	344	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	150-200 HB	328	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	> 200 HB	312	1xø	0.7xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
Nitriding Steel	< 1000 N/mm²	312	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	> 1000 N/mm²	279	1xø	0.7xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
Quenched & Tempered Steel	Non-Alloy < 800 N/mm²	328	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Non-Alloy 800-1000 N/mm²	312	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloy < 800 N/mm²	312	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloy 800-1000 N/mm²	295	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloy 1000-1300 N/mm²	279	1xø	0.7xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
	Alloy 1300-1600 N/mm²	246	1xø	0.7xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
Non-Alloy Tool Steel	General	303	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Tool Steel for Cold Processing	Low Alloy < 1000 N/mm²	295	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Low Alloy < 1200 N/mm²	279	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Low Alloy < 1500 N/mm²	246	1xø	0.7xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
	High Alloy Annealed < 1000 N/mm²	262	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	High Alloy Hardened < 1300 N/mm²	230	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Tool Steel for Warm Processing	Low Alloy < 1200 N/mm²	328	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Low Alloy < 1500 N/mm²	295	1xø	0.7xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
	High Alloy Annealed < 1000 N/mm²	246	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	High Alloy Hardened < 1300 N/mm²	230	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	High Alloy Hardened < 1600 N/mm²	213	1xø	0.7xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
Stainless Steel	Ferric	164	1xø	0.7xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
	Martensitic	131	1xø	0.7xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
	Austenitic A5 < 40%	164	1xø	0.7xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
	Austenitic A5 > 40%	164	1xø	0.7xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
	Sulphured	180	1xø	0.7xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
High Temperature Alloy	Fe-Alloy	90	1xø	0.4xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	Ni-Alloy not hardened	90	1xø	0.4xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	Ni-Alloy hardened	90	1xø	0.4xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	Co-Alloy	90	1xø	0.4xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
Cast Iron	Non-Alloy	328	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Low-Alloy	262	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	High-Alloy	197	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Stainless Cast Steel	Ferric/Martensitic	164	1xø	0.7xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
	Austenitic	164	1xø	0.7xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
Cast Iron with Lamellar Graphite	Non-Alloy < 180 HB	328	1xø	0.7xø	0.0007	0.0012	0.0019	0.0028	0.0033	0.0039
	Non-Alloy > 180 HB	295	1xø	0.7xø	0.0007	0.0012	0.0019	0.0028	0.0033	0.0039
	Alloy	262	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	High Alloy	197	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Spheroidal Cast Iron	Non-Alloy < 180 HB	312	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Non-Alloy > 180 HB	279	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloy	246	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
White Malleable Cast Iron	< 180 HB	295	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	> 180 HB	262	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Black Malleable Cast Iron	< 180 HB	295	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	> 180 HB	262	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Titanium	Non-Alloy	197	1xø	0.4xø	0.0007	0.0012	0.0019	0.0028	0.0033	0.0039
	Alloyed-Annealed	164	1xø	0.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloyed-Hardened	131	1xø	0.4xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028

*** Feeds and Speeds are starting points for Overall Lengths of 4" and shorter.**
For End Mills with Overall Lengths over 4" decrease the Feeds and Speeds.

Universal - 121

Material Designation		SFM [ft/min]	ae max. [inch]	ap max [inch]	Chip Load per Tooth [inch]					
					1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
Machining Steel	< 500 N/mm²	287	1xø	0.7xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	> 500 N/mm²	246	1xø	0.7xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
Construction Steel	Non-Alloy < 500 N/mm²	287	1xø	0.7xø	0.0008	0.0012	0.0014	0.0019	0.0022	0.0025
	Non-Alloy > 500 N/mm²	246	1xø	0.7xø	0.0008	0.0012	0.0014	0.0019	0.0022	0.0025
	Alloy	246	1xø	0.7xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
Spring Steel	Annealed < 250 HB	246	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Cementation Steel	< 150 HB	287	1xø	0.7xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	150-200 HB	246	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	> 200 HB	246	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Nitriding Steel	< 1000 N/mm²	246	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	> 1000 N/mm²	230	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Quenched & Tempered Steel	Non-Alloy < 800 N/mm²	246	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	Non-Alloy 800-1000 N/mm²	246	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	Alloy < 800 N/mm²	246	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	Alloy 800-1000 N/mm²	246	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	Alloy 1000-1300 N/mm²	230	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Non-Alloy Tool Steel	General	246	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Tool Steel for Cold Processing	Low Alloy < 1000 N/mm²	230	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	Low Alloy < 1200 N/mm²	230	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	High Alloy Annealed < 1000 N/mm²	230	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Tool Steel for Warm Processing	High Alloy Annealed < 1000 N/mm²	230	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019

Universal - 111

Material Designation		SFM [ft/min]	ae max. [inch]	ap max [inch]	Chip Load per Tooth [inch]					
					1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
Machining Steel	< 500 N/mm²	427	1xø	1.1xø	0.0007	0.0012	0.0019	0.0028	0.0033	0.0039
	> 500 N/mm²	394	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Construction Steel	Non-Alloy < 500 N/mm²	410	1xø	1.1xø	0.0007	0.0012	0.0019	0.0028	0.0033	0.0039
	Non-Alloy > 500 N/mm²	377	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloy	361	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Spring Steel	Annealed < 250 HB	213	1xø	1.1xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
	Natural Hardened 250-350 HB	197	1xø	1.1xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
	Spring Hardened 1200-1600 N/mm²	180	1xø	1.1xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
Cementation Steel	< 150 HB	344	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	150-200 HB	328	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	> 200 HB	312	1xø	1.1xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
Nitriding Steel	< 1000 N/mm²	312	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	> 1000 N/mm²	279	1xø	1.1xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
Quenched & Tempered Steel	Non-Alloy < 800 N/mm²	328	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Non-Alloy 800-1000 N/mm²	312	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloy < 800 N/mm²	312	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloy 800-1000 N/mm²	295	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloy 1000-1300 N/mm²	279	1xø	1.1xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
	Alloy 1300-1600 N/mm²	246	1xø	1.1xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
Non-Alloy Tool Steel	General	303	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Stainless Steel	Ferric	164	0.8xø	0.7xø	0.0004	0.0006	0.0008	0.0014	0.0017	0.0019
	Martensitic	131	0.8xø	0.7xø	0.0004	0.0006	0.0008	0.0014	0.0017	0.0019
	Austenitic A5 < 40%	164	0.8xø	0.7xø	0.0004	0.0006	0.0008	0.0014	0.0017	0.0019
	Austenitic A5 > 40%	164	0.8xø	0.7xø	0.0004	0.0006	0.0008	0.0014	0.0017	0.0019
	Sulphured	180	0.8xø	0.7xø	0.0004	0.0006	0.0008	0.0014	0.0017	0.0019
High Temperature Alloy	Fe-Alloy	90	1xø	0.4xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	Ni-Alloy not hardened	90	1xø	0.4xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	Ni-Alloy hardened	90	1xø	0.4xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	Co-Alloy	90	1xø	0.4xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
Cast Iron	Non-Alloy	328	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Low-Alloy	262	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	High-Alloy	197	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Stainless Cast Steel	Ferric/Martensitic	197	1xø	1.1xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
	Austenitic	197	1xø	1.1xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025

*** Feeds and Speeds are starting points for Overall Lengths of 4" and shorter.**
For End Mills with Overall Lengths over 4" decrease the Feeds and Speeds.

Universal - 111 (Continued)

Material Designation		SFM [ft/min]	ae max. [inch]	ap max [inch]	Chip Load per Tooth [inch]					
					1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
Cast Iron with Lamellar Graphite	Non-Alloy < 180 HB	328	1xø	1.1xø	0.0007	0.0012	0.0019	0.0028	0.0033	0.0039
	Non-Alloy > 180 HB	295	1xø	1.1xø	0.0007	0.0012	0.0019	0.0028	0.0033	0.0039
	Alloy	262	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	High Alloy	197	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Spheroidal Cast Iron	Non-Alloy < 180 HB	312	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Non-Alloy > 180 HB	279	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloy	246	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
White Malleable Cast Iron	< 180 HB	295	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	> 180 HB	262	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Black Malleable Cast Iron	< 180 HB	295	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	> 180 HB	262	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Titanium	Non-Alloy	197	1xø	0.4xø	0.0007	0.0012	0.0019	0.0028	0.0033	0.0039
	Alloyed-Annealed	164	1xø	0.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloyed-Hardened	131	1xø	0.4xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028

Universal - 155 / 156

Material Designation		SFM [ft/min]	ae max. [inch]	ap max [inch]	Chip Load per Tooth [inch]					
					1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
Machining Steel	< 500 N/mm²	427	1xø	1.1xø	0.0007	0.0012	0.0019	0.0028	0.0033	0.0039
	> 500 N/mm²	394	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Construction Steel	Non-Alloy < 500 N/mm²	410	1xø	1.1xø	0.0007	0.0012	0.0019	0.0028	0.0033	0.0039
	Non-Alloy > 500 N/mm²	377	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloy	361	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Spring Steel	Annealed < 250 HB	213	1xø	1.1xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
	Natural Hardened 250-350 HB	197	1xø	1.1xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
	Spring Hardened 1200-1600 N/mm²	180	1xø	1.1xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
Cementation Steel	< 150 HB	344	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	150-200 HB	328	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	> 200 HB	312	1xø	1.1xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
Nitriding Steel	< 1000 N/mm²	312	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	> 1000 N/mm²	279	1xø	1.1xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
Quenched & Tempered Steel	Non-Alloy < 800 N/mm²	328	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Non-Alloy 800-1000 N/mm²	312	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloy < 800 N/mm²	312	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloy 800-1000 N/mm²	295	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloy 1000-1300 N/mm²	279	1xø	1.1xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
	Alloy 1300-1600 N/mm²	246	1xø	1.1xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
Non-Alloy Tool Steel	General	303	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Tool Steel for Cold Processing	Low Alloy < 1000 N/mm²	295	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Low Alloy < 1200 N/mm²	279	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Low Alloy < 1500 N/mm²	246	1xø	1.1xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
	High Alloy Annealed < 1000 N/mm²	262	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	High Alloy Hardened < 1300 N/mm²	230	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Tool Steel for Warm Processing	Low Alloy < 1200 N/mm²	328	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Low Alloy < 1500 N/mm²	295	1xø	1.1xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
	High Alloy Annealed < 1000 N/mm²	246	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	High Alloy Hardened < 1300 N/mm²	230	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	High Alloy Hardened < 1600 N/mm²	213	1xø	1.1xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
Stainless Steel	Ferric	164	1xø	0.7xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
	Martensitic	131	1xø	0.7xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
	Austenitic A5 < 40%	164	1xø	0.7xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
	Austenitic A5 > 40%	164	1xø	0.7xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
	Sulphured	180	1xø	0.7xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
High Temperature Alloy	Fe-Alloy	90	1xø	0.4xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	Ni-Alloy not hardened	90	1xø	0.4xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	Ni-Alloy hardened	90	1xø	0.4xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	Co-Alloy	90	1xø	0.4xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
Cast Iron	Non-Alloy	328	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Low-Alloy	262	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	High-Alloy	197	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033

*** Feeds and Speeds are starting points for Overall Lengths of 4" and shorter.**
For End Mills with Overall Lengths over 4" decrease the Feeds and Speeds.

Universal - 155 / 156 (Continued)

Material Designation		SFM [ft/min]	ae max. [inch]	ap max [inch]	Chip Load per Tooth [inch] 1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
Stainless Cast Steel	Ferric/Martensitic	197	1xø	1.1xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
	Austenitic	197	1xø	1.1xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
Cast Iron with Lamellar Graphite	Non-Alloy < 180 HB	328	1xø	1.1xø	0.0007	0.0012	0.0019	0.0028	0.0033	0.0039
	Non-Alloy > 180 HB	295	1xø	1.1xø	0.0007	0.0012	0.0019	0.0028	0.0033	0.0039
	Alloy	262	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	High Alloy	197	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Spheroidal Cast Iron	Non-Alloy < 180 HB	312	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Non-Alloy > 180 HB	279	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloy	246	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
White Malleable Cast Iron	< 180 HB	295	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	> 180 HB	262	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Black Malleable Cast Iron	< 180 HB	295	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	> 180 HB	262	1xø	1.1xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Titanium	Non-Alloy	197	1xø	0.4xø	0.0007	0.0012	0.0019	0.0028	0.0033	0.0039
	Alloyed-Annealed	164	1xø	0.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloyed-Hardened	131	1xø	0.4xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028

Universal - 157

Material Designation		SFM [ft/min]	ae max. [inch]	ap max [inch]	Chip Load Per Tooth [inch] 1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
Machining Steel	< 500 N/mm²	968	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	> 500 N/mm²	755	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
Construction Steel	Non-Alloy < 500 N/mm²	968	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	Non-Alloy > 500 N/mm²	755	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	Alloy	640	0.05xø	0.08xø	0.0011	0.0017	0.0022	0.0041	0.0055	0.0062
Spring Steel	Annealed < 250 HB	853	0.04xø	0.05xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	Natural Hardened 250-350 HB	755	0.04xø	0.05xø	0.0011	0.0017	0.0022	0.0041	0.0055	0.0062
	Spring Hardened 1200-1600 N/mm²	509	0.04xø	0.05xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
Cementation Steel	< 150 HB	919	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	150-200 HB	853	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	> 200 HB	656	0.05xø	0.08xø	0.0011	0.0017	0.0022	0.0041	0.0055	0.0062
Nitriding Steel	< 1000 N/mm²	771	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	> 1000 N/mm²	574	0.05xø	0.08xø	0.0011	0.0017	0.0022	0.0041	0.0055	0.0062
Quenched & Tempered Steel	Non-Alloy < 800 N/mm²	853	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	Non-Alloy 800-1000 N/mm²	689	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	Alloy < 800 N/mm²	574	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	Alloy 800-1000 N/mm²	640	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	Alloy 1000-1300 N/mm²	574	0.05xø	0.08xø	0.0011	0.0017	0.0022	0.0041	0.0055	0.0062
	Alloy 1300-1600 N/mm²	476	0.04xø	0.05xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
Non-Alloy Tool Steel	General	755	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
Tool Steel for Cold Processing	Low Alloy < 1000 N/mm²	640	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	Low Alloy < 1200 N/mm²	541	0.04xø	0.05xø	0.0011	0.0017	0.0022	0.0041	0.0055	0.0062
	Low Alloy < 1500 N/mm²	427	0.04xø	0.05xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
	High Alloy Annealed < 1000 N/mm²	541	0.05xø	0.08xø	0.0011	0.0017	0.0022	0.0041	0.0055	0.0062
	High Alloy Hardened < 1300 N/mm²	377	0.04xø	0.05xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
Tool Steel for Warm Processing	Low Alloy < 1200 N/mm²	543	0.04xø	0.05xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	Low Alloy < 1500 N/mm²	427	0.04xø	0.05xø	0.0011	0.0017	0.0022	0.0041	0.0055	0.0062
	High Alloy Annealed < 1000 N/mm²	541	0.05xø	0.08xø	0.0011	0.0017	0.0022	0.0041	0.0055	0.0062
	High Alloy Hardened < 1300 N/mm²	377	0.04xø	0.05xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
	High Alloy Hardened < 1600 N/mm²	344	0.04xø	0.05xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
Stainless Steel	Ferric	82	0.05xø	0.08xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
	Martensitic	66	0.05xø	0.08xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
	Austenitic A5 < 40%	82	0.05xø	0.08xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
	Austenitic A5 > 40%	66	0.05xø	0.08xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
	Sulphured	98	0.05xø	0.08xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
High Temperature Alloy	Fe-Alloy	90	1xø	0.4xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	Ni-Alloy not hardened	90	1xø	0.4xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	Ni-Alloy hardened	90	1xø	0.4xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	Co-Alloy	9 0	1xø	0.4xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022

*** Feeds and Speeds are starting points for Overall Lengths of 4" and shorter.**
For End Mills with Overall Lengths over 4" decrease the Feeds and Speeds.

Universal - 157 (Continued)

Material Designation		SFM [ft/min]	ae max. [inch]	ap max [inch]	Chip Load per Tooth [inch] 1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
Cast Iron	Non-Alloy	755	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	Low-Alloy	541	0.04xø	0.05xø	0.0011	0.0017	0.0022	0.0041	0.0055	0.0062
	High-Alloy	377	0.04xø	0.05xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
Cast Iron with Lamellar Graphite	Non-Alloy < 180 HB	1001	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	Non-Alloy > 180 HB	853	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	Alloy	755	0.05xø	0.08xø	0.0011	0.0017	0.0022	0.0041	0.0055	0.0062
	High Alloy	541	0.05xø	0.08xø	0.0011	0.0017	0.0022	0.0041	0.0055	0.0062
Spheroidal Cast Iron	Non-Alloy < 180 HB	1001	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	Non-Alloy > 180 HB	853	0.05xø	0.08xø	0.0011	0.0017	0.0022	0.0041	0.0055	0.0062
	Alloy	705	0.05xø	0.08xø	0.0011	0.0017	0.0022	0.0041	0.0055	0.0062
White Malleable Cast Iron	< 180 HB	1001	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	> 180 HB	853	0.05xø	0.08xø	0.0011	0.0017	0.0022	0.0041	0.0055	0.0062
Black Malleable Cast Iron	< 180 HB	1001	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	> 180 HB	853	0.05xø	0.08xø	0.0011	0.0017	0.0022	0.0041	0.0055	0.0062
Copper	Non-Alloy	1394	0.1xø	0.15xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
	Wrought Alloy Non-Hardened	1181	0.1xø	0.15xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
	Wrought Alloy Hardened	968	0.1xø	0.15xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039

Universal - 190 / 191

Material Designation		SFM [ft/min]	ae max. [inch]	ap max [inch]	Chip Load per Tooth [inch] 1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
Nitriding Steel	< 1000 N/mm²	98	0.5xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	> 1000 N/mm²	74	0.5xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Quenched & Tempered Steel	Non-Alloy < 800 N/mm²	115	0.5xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	Non-Alloy 800-1000 N/mm²	98	0.5xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	Alloy < 800 N/mm²	98	0.5xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	Alloy 800-1000 N/mm²	82	0.5xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	Alloy 1000-1300 N/mm²	74	0.5xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	Alloy 1300-1600 N/mm²	66	0.5xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Stainless Steel	Ferric	82	0.5xø	0.7xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
	Martensitic	66	0.5xø	0.7xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
	Austenitic A5 < 40%	57	0.5xø	0.7xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
	Austenitic A5 > 40%	82	0.5xø	0.7xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
	Sulphured	98	0.5xø	0.7xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
High Temperature Alloy	Fe-Alloy	49	1xø	0.4xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
	Ni-Alloy not hardened	49	1xø	0.4xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
	Ni-Alloy hardened	49	1xø	0.4xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
	Co-Alloy	49	1xø	0.4xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
Cast Iron	Non-Alloy	328	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Low-Alloy	262	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	High-Alloy	197	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Stainless Cast Steel	Ferric/Martensitic	164	1xø	0.7xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
	Austenitic	164	1xø	0.7xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
Cast Iron with Lamellar Graphite	Non-Alloy < 180 HB	328	1xø	0.7xø	0.0007	0.0012	0.0019	0.0028	0.0033	0.0039
	Non-Alloy > 180 HB	295	1xø	0.7xø	0.0007	0.0012	0.0019	0.0028	0.0033	0.0039
	Alloy	262	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	High Alloy	197	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Spheroidal Cast Iron	Non-Alloy < 180 HB	312	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Non-Alloy > 180 HB	279	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloy	246	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
White Malleable Cast Iron	< 180 HB	295	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	> 180 HB	262	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Black Malleable Cast Iron	< 180 HB	295	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	> 180 HB	262	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Titanium	Non-Alloy	148	1xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloyed-Annealed	131	1xø	0.7xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
	Alloyed-Hardened	82	1xø	0.7xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025

*** Feeds and Speeds are starting points for Overall Lengths of 4" and shorter.**
For End Mills with Overall Lengths over 4" decrease the Feeds and Speeds.

Universal - 120

Material Designation		SFM [ft/min]	ae max. [inch]	ap max [inch]	Chip Load per Tooth [inch] 1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
Machining Steel	< 500 N/mm²	295	1xø	0.7xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	> 500 N/mm²	213	1xø	0.7xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
Construction Steel	Non-Alloy < 500 N/mm²	295	1xø	0.7xø	0.0008	0.0012	0.0014	0.0019	0.0022	0.0025
	Non-Alloy > 500 N/mm²	213	1xø	0.7xø	0.0008	0.0012	0.0014	0.0019	0.0022	0.0025
	Alloy	180	1xø	0.7xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
Spring Steel	Annealed < 250 HB	180	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Cementation Steel	< 150 HB	279	1xø	0.7xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	150-200 HB	230	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	> 200 HB	180	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Nitriding Steel	< 1000 N/mm²	213	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	> 1000 N/mm²	164	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Quenched & Tempered Steel	Non-Alloy < 800 N/mm²	230	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	Non-Alloy 800-1000 N/mm²	213	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	Alloy < 800 N/mm²	213	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	Alloy 800-1000 N/mm²	180	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	Alloy 1000-1300 N/mm²	148	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Non-Alloy Tool Steel	General	180	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Tool Steel for Cold Processing	Low Alloy < 1000 N/mm²	164	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	Low Alloy < 1200 N/mm²	131	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	High Alloy Annealed < 1000 N/mm²	131	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Tool Steel for Warm Processing	High Alloy Annealed < 1000 N/mm²	131	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Stainless Steel	Ferric	164	1xø	0.7xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
	Martensitic	131	1xø	0.7xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
	Austenitic A5 < 40%	164	1xø	0.7xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
	Austenitic A5 > 40%	164	1xø	0.7xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
	Sulphured	180	1xø	0.7xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
High Temperature Alloy	Fe-Alloy	90	1xø	0.4xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	Ni-Alloy not hardened	90	1xø	0.4xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	Ni-Alloy hardened	90	1xø	0.4xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	Co-Alloy	90	1xø	0.4xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
Cast Iron	Non-Alloy	295	1xø	0.7xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	Low-Alloy	213	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Stainless Cast Steel	Ferric/Martensitic	131	1xø	0.7xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
	Austenitic	164	1xø	0.7xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
Cast Iron with Lamellar Graphite	Non-Alloy < 180 HB	361	1xø	0.7xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
	Non-Alloy > 180 HB	312	1xø	0.7xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
	Alloy	262	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	High Alloy	213	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Spheroidal Cast Iron	Non-Alloy < 180 HB	361	1xø	0.7xø	0.0008	0.0012	0.0014	0.0019	0.0022	0.0025
	Non-Alloy > 180 HB	312	1xø	0.7xø	0.0008	0.0012	0.0014	0.0019	0.0022	0.0025
	Alloy	262	1xø	0.7xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
White Malleable Cast Iron	< 180 HB	361	1xø	0.7xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
	> 180 HB	312	1xø	0.7xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
Black Malleable Cast Iron	< 180 HB	361	1xø	0.7xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
	> 180 HB	312	1xø	0.7xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
Titanium	Non-Alloy	197	1xø	0.4xø	0.0007	0.0012	0.0019	0.0028	0.0033	0.0039
	Alloyed-Annealed	164	1xø	0.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloyed-Hardened	131	1xø	0.4xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028

Universal - 100

Material Designation		SFM [ft/min]	ae max. [inch]	ap max [inch]	Chip Load per Tooth [inch] 1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
Machining Steel	< 500 N/mm²	295	1xø	0.7xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	> 500 N/mm²	213	1xø	0.7xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
Construction Steel	Non-Alloy < 500 N/mm²	295	1xø	0.7xø	0.0008	0.0012	0.0014	0.0019	0.0022	0.0025
	Non-Alloy > 500 N/mm²	213	1xø	0.7xø	0.0008	0.0012	0.0014	0.0019	0.0022	0.0025
	Alloy	180	1xø	0.7xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
Spring Steel	Annealed < 250 HB	180	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Cementation Steel	< 150 HB	279	1xø	0.7xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	150-200 HB	230	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	> 200 HB	180	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Nitriding Steel	< 1000 N/mm²	213	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	> 1000 N/mm²	164	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019

*** Feeds and Speeds are starting points for Overall Lengths of 4" and shorter.**
For End Mills with Overall Lengths over 4" decrease the Feeds and Speeds.

Universal - 100 (Continued)

Material Designation		SFM [ft/min]	ae max. [inch]	ap max [inch]	Chip Load per Tooth [inch]					
					1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
Quenched & Tempered Steel	Non-Alloy < 800 N/mm²	230	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	Non-Alloy 800-1000 N/mm²	213	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	Alloy < 800 N/mm²	213	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	Alloy 800-1000 N/mm²	180	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	Alloy 1000-1300 N/mm²	148	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Non-Alloy Tool Steel	General	180	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Tool Steel for Cold Processing	Low Alloy < 1000 N/mm²	164	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	Low Alloy < 1200 N/mm²	131	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	High Alloy Annealed < 1000 N/mm²	131	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Tool Steel for Warm Processing	High Alloy Annealed < 1000 N/mm²	131	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Stainless Steel	Ferric	164	1xø	0.7xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
	Martensitic	131	1xø	0.7xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
	Austenitic A5 < 40%	164	1xø	0.7xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
	Austenitic A5 > 40%	164	1xø	0.7xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
	Sulphured	180	1xø	0.7xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
Cast Iron	Non-Alloy	295	1xø	0.7xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	Low-Alloy	213	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Stainless Cast Steel	Ferric/Martensitic	131	1xø	0.7xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
	Austenitic	164	1xø	0.7xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
Cast Iron with Lamellar Graphite	Non-Alloy < 180 HB	361	1xø	0.7xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
	Non-Alloy > 180 HB	312	1xø	0.7xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
	Alloy	262	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	High Alloy	213	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Spheroidal Cast Iron	Non-Alloy < 180 HB	361	1xø	0.7xø	0.0008	0.0012	0.0014	0.0019	0.0022	0.0025
	Non-Alloy > 180 HB	312	1xø	0.7xø	0.0008	0.0012	0.0014	0.0019	0.0022	0.0025
	Alloy	262	1xø	0.7xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
White Malleable Cast Iron	< 180 HB	361	1xø	0.7xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
	> 180 HB	312	1xø	0.7xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
Black Malleable Cast Iron	< 180 HB	361	1xø	0.7xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
	> 180 HB	312	1xø	0.7xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039

Universal - 106

Material Designation		SFM [ft/min]	ae max. [inch]	ap max [inch]	Chip Load per Tooth [inch]					
					1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
Machining Steel	< 500 N/mm²	230	1xø	0.7xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	> 500 N/mm²	164	1xø	0.7xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
Construction Steel	Non-Alloy < 500 N/mm²	230	1xø	0.7xø	0.0008	0.0012	0.0014	0.0019	0.0022	0.0025
	Non-Alloy > 500 N/mm²	164	1xø	0.7xø	0.0008	0.0012	0.0014	0.0019	0.0022	0.0025
	Alloy	131	1xø	0.7xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
Cementation Steel	< 150 HB	180	1xø	0.7xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	150-200 HB	148	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	> 200 HB	115	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Nitriding Steel	< 1000 N/mm²	131	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	> 1000 N/mm²	90	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Quenched & Tempered Steel	Non-Alloy < 800 N/mm²	148	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	Non-Alloy 800-1000 N/mm²	131	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	Alloy < 800 N/mm²	131	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	Alloy 800-1000 N/mm²	115	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	Alloy 1000-1300 N/mm²	90	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Cast Iron	Non-Alloy	197	1xø	0.7xø	0.0008	0.0012	0.0014	0.0019	0.0022	0.0025
	Low-Alloy	148	1xø	0.7xø	0.0008	0.0012	0.0014	0.0019	0.0022	0.0025
	High-Alloy	115	1xø	0.7xø	0.0008	0.0012	0.0014	0.0019	0.0022	0.0025
Stainless Cast Steel	Ferric/Martensitic	98	1xø	0.7xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
	Austenitic	98	1xø	0.7xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
Cast Iron with Lamellar Graphite	Non-Alloy < 180 HB	213	1xø	0.7xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
	Non-Alloy > 180 HB	197	1xø	0.7xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
	Alloy	148	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	High Alloy	131	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Spheroidal Cast Iron	Non-Alloy < 180 HB	213	1xø	0.7xø	0.0008	0.0012	0.0014	0.0019	0.0022	0.0025
	Non-Alloy > 180 HB	197	1xø	0.7xø	0.0008	0.0012	0.0014	0.0019	0.0022	0.0025
	Alloy	148	1xø	0.7xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
White Malleable Cast Iron	< 180 HB	213	1xø	0.7xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
	> 180 HB	197	1xø	0.7xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
Black Malleable Cast Iron	< 180 HB	213	1xø	0.7xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
	> 180 HB	197	1xø	0.7xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039

*** Feeds and Speeds are starting points for Overall Lengths of 4" and shorter.**
For End Mills with Overall Lengths over 4" decrease the Feeds and Speeds.

Universal - 113

Material Designation		SFM [ft/min]	ae max. [inch]	ap max [inch]	Chip Load per Tooth [inch] 1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
Machining Steel	< 500 N/mm²	968	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	> 500 N/mm²	755	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
Construction Steel	Non-Alloy < 500 N/mm²	968	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	Non-Alloy > 500 N/mm²	755	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	Alloy	640	0.05xø	0.08xø	0.0011	0.0017	0.0022	0.0041	0.0055	0.0062
Spring Steel	Annealed < 250 HB	853	0.04xø	0.05xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	Natural Hardened 250-350 HB	755	0.04xø	0.05xø	0.0011	0.0017	0.0022	0.0041	0.0055	0.0062
	Spring Hardened 1200-1600 N/mm²	509	0.04xø	0.05xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
Cementation Steel	< 150 HB	919	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	150-200 HB	853	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	> 200 HB	656	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
Nitriding Steel	< 1000 N/mm²	771	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	> 1000 N/mm²	574	0.05xø	0.08xø	0.0011	0.0017	0.0022	0.0041	0.0055	0.0062
Quenched & Tempered Steel	Non-Alloy < 800 N/mm²	853	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	Non-Alloy 800-1000 N/mm²	689	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	Alloy < 800 N/mm²	574	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	Alloy 800-1000 N/mm²	640	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	Alloy 1000-1300 N/mm²	574	0.05xø	0.08xø	0.0011	0.0017	0.0022	0.0041	0.0055	0.0062
	Alloy 1300-1600 N/mm²	476	0.04xø	0.05xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
Cast Iron	Non-Alloy	755	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	Low-Alloy	541	0.04xø	0.05xø	0.0011	0.0017	0.0022	0.0041	0.0055	0.0062
	High-Alloy	377	0.04xø	0.05xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
Cast Iron with Lamellar Graphite	Non-Alloy < 180 HB	1001	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	Non-Alloy > 180 HB	853	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	Alloy	755	0.05xø	0.08xø	0.0011	0.0017	0.0022	0.0041	0.0055	0.0062
	High Alloy	541	0.05xø	0.08xø	0.0011	0.0017	0.0022	0.0041	0.0055	0.0062
Spheroidal Cast Iron	Non-Alloy < 180 HB	1001	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	Non-Alloy > 180 HB	853	0.05xø	0.08xø	0.0011	0.0017	0.0022	0.0041	0.0055	0.0062
	Alloy	705	0.05xø	0.08xø	0.0011	0.0017	0.0022	0.0041	0.0055	0.0062
White Malleable Cast Iron	< 180 HB	1001	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	> 180 HB	853	0.05xø	0.08xø	0.0011	0.0017	0.0022	0.0041	0.0055	0.0062
Black Malleable Cast Iron	< 180 HB	1001	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055	0.0069	0.0083
	> 180 HB	853	0.05xø	0.08xø	0.0011	0.0017	0.0022	0.0041	0.0055	0.0062

Universal - 117

Material Designation		SFM [ft/min]	ae max. [inch]	ap max [inch]	Chip Load per Tooth [inch] 1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
Machining Steel	< 500 N/mm²	164	1xø	0.7xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	> 500 N/mm²	115	1xø	0.7xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
Construction Steel	Non-Alloy < 500 N/mm²	164	1xø	0.7xø	0.0008	0.0012	0.0014	0.0019	0.0022	0.0025
	Non-Alloy > 500 N/mm²	115	1xø	0.7xø	0.0008	0.0012	0.0014	0.0019	0.0022	0.0025
	Alloy	98	1xø	0.7xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
Spring Steel	Annealed < 250 HB	98	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Cementation Steel	< 150 HB	156	1xø	0.7xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	150-200 HB	123	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	> 200 HB	98	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Nitriding Steel	< 1000 N/mm²	115	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	> 1000 N/mm²	90	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Quenched & Tempered Steel	Non-Alloy < 800 N/mm²	131	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	Non-Alloy 800-1000 N/mm²	115	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	Alloy < 800 N/mm²	115	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	Alloy 800-1000 N/mm²	98	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	Alloy 1000-1300 N/mm²	90	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Cast Iron	Non-Alloy	328	0.8xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Low-Alloy	262	0.8xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	High-Alloy	197	0.8xø	0.7xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
Cast Iron with Lamellar Graphite	Non-Alloy < 180 HB	197	1xø	0.7xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
	Non-Alloy > 180 HB	164	1xø	0.7xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
	Alloy	131	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
	High Alloy	115	1xø	0.7xø	0.0004	0.0008	0.0011	0.0014	0.0017	0.0019
Spheroidal Cast Iron	Non-Alloy < 180 HB	197	1xø	0.7xø	0.0008	0.0012	0.0014	0.0019	0.0022	0.0025
	Non-Alloy > 180 HB	164	1xø	0.7xø	0.0008	0.0012	0.0014	0.0019	0.0022	0.0025
	Alloy	131	1xø	0.7xø	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017
White Malleable Cast Iron	< 180 HB	197	1xø	0.7xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
	> 180 HB	164	1xø	0.7xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
Black Malleable Cast Iron	< 180 HB	197	1xø	0.7xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039
	> 180 HB	164	1xø	0.7xø	0.0010	0.0017	0.0019	0.0025	0.0033	0.0039

*** Feeds and Speeds are starting points for Overall Lengths of 4" and shorter.**
For End Mills with Overall Lengths over 4" decrease the Feeds and Speeds.

Titanium - 101

Material Designation		SFM [ft/min]	ae max. [inch]	ap max [inch]	Chip Load per Tooth [inch] 1/8"	3/16" 1/4" 5/16"	3/8" 7/16"	1/2" 5/8"	3/4"	1"
Non-Alloy Tool Steel	General	303	0.8xø	0.7xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
Tool Steel for Cold Processing	Low Alloy < 1000 N/mm²	295	0.8xø	0.7xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
	Low Alloy < 1200 N/mm²	279	0.8xø	0.7xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
	Low Alloy < 1500 N/mm²	246	0.8xø	0.7xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
	High Alloy Annealed < 1000 N/mm²	262	0.8xø	0.7xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
	High Alloy Hardened < 1300 N/mm²	230	0.8xø	0.7xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
Tool Steel for Warm Processing	Low Alloy < 1200 N/mm²	328	0.8xø	0.7xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
	Low Alloy < 1500 N/mm²	295	0.8xø	0.7xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
	High Alloy Annealed < 1000 N/mm²	246	0.8xø	0.7xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
	High Alloy Hardened < 1300 N/mm²	230	0.8xø	0.7xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028
	High Alloy Hardened < 1600 N/mm²	213	0.8xø	0.7xø	0.0003	0.0007	0.0011	0.0014	0.0019	0.0025
Stainless Steel	Ferric	164	0.8xø	0.7xø	0.0004	0.0006	0.0008	0.0014	0.0017	0.0019
	Martensitic	131	0.8xø	0.7xø	0.0004	0.0006	0.0008	0.0014	0.0017	0.0019
	Austenitic A5 < 40%	164	0.8xø	0.7xø	0.0004	0.0006	0.0008	0.0014	0.0017	0.0019
	Austenitic A5 > 40%	164	0.8xø	0.7xø	0.0004	0.0006	0.0008	0.0014	0.0017	0.0019
	Sulphured	180	0.8xø	0.7xø	0.0004	0.0006	0.0008	0.0014	0.0017	0.0019
High Temperature Alloy	Fe-Alloy	90	1xø	0.4xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	Ni-Alloy not hardened	90	1xø	0.4xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	Ni-Alloy hardened	90	1xø	0.4xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
	Co-Alloy	90	1xø	0.4xø	0.0006	0.0011	0.0014	0.0017	0.0019	0.0022
Titanium	Non-Alloy	197	1xø	0.4xø	0.0007	0.0012	0.0019	0.0028	0.0033	0.0039
	Alloyed-Annealed	164	1xø	0.4xø	0.0006	0.0011	0.0017	0.0022	0.0028	0.0033
	Alloyed-Hardened	131	1xø	0.4xø	0.0004	0.0008	0.0014	0.0017	0.0022	0.0028

Steel - 250

Material Designation		SFM [ft/min]	ae max. [inch]	ap max [inch]	Chip Load per Tooth [inch] 1/8"	3/16" 1/4"	3/8"	1/2"
Machining Steel	< 500 N/mm²	968	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055
	> 500 N/mm²	755	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055
Construction Steel	Non-Alloy < 500 N/mm²	968	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055
	Non-Alloy > 500 N/mm²	755	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055
	Alloy	640	0.05xø	0.08xø	0.0011	0.0017	0.0022	0.0041
Spring Steel	Annealed < 250 HB	853	0.04xø	0.05xø	0.0011	0.0022	0.0033	0.0055
	Natural Hardened 250-350 HB	755	0.04xø	0.05xø	0.0011	0.0017	0.0022	0.0041
	Spring Hardened 1200-1600 N/mm²	509	0.04xø	0.05xø	0.0010	0.0017	0.0019	0.0025
Cementation Steel	< 150 HB	919	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055
	150-200 HB	853	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055
	> 200 HB	656	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055
Nitriding Steel	< 1000 N/mm²	771	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055
	> 1000 N/mm²	574	0.05xø	0.08xø	0.0011	0.0017	0.0022	0.0041
Quenched & Tempered Steel	Non-Alloy < 800 N/mm²	853	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055
	Non-Alloy 800-1000 N/mm²	689	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055
	Alloy < 800 N/mm²	574	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055
	Alloy 800-1000 N/mm²	640	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055
	Alloy 1000-1300 N/mm²	574	0.05xø	0.08xø	0.0011	0.0017	0.0022	0.0041
	Alloy 1300-1600 N/mm²	476	0.04xø	0.05xø	0.0010	0.0017	0.0019	0.0025
Non-Alloy Tool Steel	General	755	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055
Tool Steel for Cold Processing	Low Alloy < 1000 N/mm²	640	0.05xø	0.08xø	0.0011	0.0022	0.0033	0.0055
	Low Alloy < 1200 N/mm²	541	0.04xø	0.05xø	0.0011	0.0017	0.0022	0.0041
	Low Alloy < 1500 N/mm²	427	0.04xø	0.05xø	0.0010	0.0017	0.0019	0.0025
	High Alloy Annealed < 1000 N/mm²	541	0.05xø	0.08xø	0.0011	0.0017	0.0022	0.0041
	High Alloy Hardened < 1300 N/mm²	377	0.04xø	0.05xø	0.0010	0.0017	0.0019	0.0025
Tool Steel for Warm Processing	Low Alloy < 1200 N/mm²	541	0.04xø	0.05xø	0.0011	0.0022	0.0033	0.0055
	Low Alloy < 1500 N/mm²	427	0.04xø	0.05xø	0.0011	0.0017	0.0022	0.0041
	High Alloy Annealed < 1000 N/mm²	541	0.05xø	0.08xø	0.0011	0.0017	0.0022	0.0041
	High Alloy Hardened < 1300 N/mm²	377	0.04xø	0.05xø	0.0010	0.0017	0.0019	0.0025
	High Alloy Hardened < 1600 N/mm²	344	0.04xø	0.05xø	0.0010	0.0017	0.0019	0.0025
Stainless Steel	Ferric	82	0.05xø	0.08xø	0.0003	0.0006	0.0008	0.0011
	Martensitic	66	0.05xø	0.08xø	0.0003	0.0006	0.0008	0.0011
	Austenitic A5 < 40%	82	0.05xø	0.08xø	0.0003	0.0006	0.0008	0.0011
	Austenitic A5 > 40%	66	0.05xø	0.08xø	0.0003	0.0006	0.0008	0.0011
	Sulphured	98	0.05xø	0.08xø	0.0003	0.0006	0.0008	0.0011

*** Feeds and Speeds are starting points for Overall Lengths of 4" and shorter.**
For End Mills with Overall Lengths over 4" decrease the Feeds and Speeds.

Steel - 251 / 252 / 253 / 254

Material Designation		SFM [ft/min]	ae max. [inch]	ap max [inch]	Chip Load per Tooth [inch] 1/32" 3/32" 1/8"	Chip Load per Tooth [inch] 3/16"
Machining Steel	< 500 N/mm²	213	1xø	0.04xø	0.0011	0.0017
	> 500 N/mm²	189	1xø	0.04xø	0.0011	0.0017
Construction Steel	Non-Alloy < 500 N/mm²	213	1xø	0.04xø	0.0011	0.0017
	Non-Alloy > 500 N/mm²	189	1xø	0.04xø	0.0011	0.0017
	Alloy	148	1xø	0.04xø	0.0011	0.0017
Spring Steel	Annealed < 250 HB	189	1xø	0.04xø	0.0011	0.0017
	Natural Hardened 250-350 HB	148	1xø	0.04xø	0.0011	0.0017
	Spring Hardened 1200-1600 N/mm²	115	1xø	0.03xø	0.0010	0.0017
Cementation Steel	< 150 HB	213	1xø	0.04xø	0.0011	0.0017
	150-200 HB	189	1xø	0.04xø	0.0011	0.0017
	> 200 HB	148	1xø	0.04xø	0.0011	0.0017
Nitriding Steel	< 1000 N/mm²	148	1xø	0.04xø	0.0011	0.0017
	> 1000 N/mm²	148	1xø	0.04xø	0.0011	0.0017
Quenched & Tempered Steel	Non-Alloy < 800 N/mm²	189	1xø	0.04xø	0.0011	0.0017
	Non-Alloy 800-1000 N/mm²	148	1xø	0.04xø	0.0011	0.0017
	Alloy < 800 N/mm²	189	1xø	0.04xø	0.0011	0.0017
	Alloy 800-1000 N/mm²	148	1xø	0.04xø	0.0011	0.0017
	Alloy 1000-1300 N/mm²	115	1xø	0.03xø	0.0010	0.0017
	Alloy 1300-1600 N/mm²	98	1xø	0.03xø	0.0010	0.0017
Non-Alloy Tool Steel	General	148	1xø	0.04xø	0.0011	0.0017
Tool Steel for Cold Processing	Low Alloy < 1000 N/mm²	148	1xø	0.04xø	0.0011	0.0017
	Low Alloy < 1200 N/mm²	115	1xø	0.03xø	0.0010	0.0017
	Low Alloy < 1500 N/mm²	98	1xø	0.03xø	0.0010	0.0017
	High Alloy Annealed < 1000 N/mm²	148	1xø	0.04xø	0.0011	0.0017
	High Alloy Hardened < 1300 N/mm²	115	1xø	0.03xø	0.0010	0.0017
Tool Steel for Warm Processing	Low Alloy < 1200 N/mm²	115	1xø	0.03xø	0.0010	0.0017
	Low Alloy < 1500 N/mm²	98	1xø	0.03xø	0.0010	0.0017
	High Alloy Annealed < 1000 N/mm²	148	1xø	0.04xø	0.0011	0.0017
	High Alloy Hardened < 1300 N/mm²	115	1xø	0.03xø	0.0010	0.0017
	High Alloy Hardened < 1600 N/mm²	98	1xø	0.03xø	0.0010	0.0017
Stainless Steel	Ferric	82	0.05xø	0.08xø	0.0003	0.0006
	Martensitic	66	0.05xø	0.08xø	0.0003	0.0006
	Austenitic A5 < 40%	82	0.05xø	0.08xø	0.0003	0.0006
	Austenitic A5 > 40%	66	0.05xø	0.08xø	0.0003	0.0006
	Sulphured	98	0.05xø	0.08xø	0.0003	0.0006

*** Feeds and Speeds are starting points for Overall Lengths of 4" and shorter.**
For End Mills with Overall Lengths over 4" decrease the Feeds and Speeds.

Notes

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