

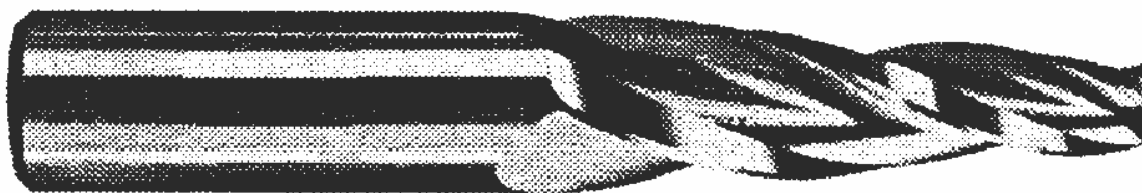
Award^{CNC}

TAPERED END MILLS

SUPER SOLID

SUB-MICROGRAIN CARBIDE

OVER 600 STOCKED STANDARD SIZES



Award Cutter Company, Inc. 5577 Crippen Ave. S.W. Grand Rapids, MI 49548

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AWARD

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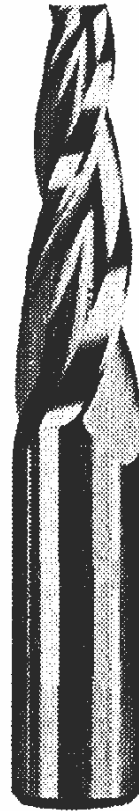
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**AWARD
TAPERED
END
MILLS**



**THE AWARD CUTTER COMPANY
WARRANTY AND LIMITATION
OF LIABILITY**

The Award Cutter Company warrants each new product manufactured and sold by it or one of its authorized dealers only against defects in workmanship and/or materials under normal service, proper installation and use. This warranty is limited to repair or replacement of verified defective products and excludes and all implied warranty or merchantability and all risks and liability whatsoever resulting from any use of said products, including incidental and consequential damages. The provisions of this warranty and limitation of liability shall not be modified in any respect except by written document signed by an officer of The Award Cutter Company.

IMPORTANT: Cutting tools can shatter/break under improper or severe use. Wear safety equipment and particularly eye protection at all times in the vicinity of their use.

Award

ALL END MILLS ARE END CUTTING

ALL END MILLS ARE GUARANTEED

**ALL TOOLS SUPER SOLID
SUBMICROGRAIN CARBIDE**

**CONSTANT SPIRAL, FREE CUTTING
LESS BREAKAGE**

LONGER CUTTING LIFE

FINEST MATERIALS AVAILABLE

IMMEDIATE SHIPMENTS

ALL TOOLS MFG IN USA

**OVER 600 SIZES AVAILABLE
STANDARD FROM STOCK**

MANUFACTURERS OF TAPERED END MILLS • COMPLETE RESHARPENING SERVICE

Award Cutter Company

AWARD CUTTER COMPANY, INC. SINCE 1959

Through the years, Award Cutter Company has been a trusted partner of major manufacturers and industrial tool distributors throughout the world in producing tapered end mills of the highest quality.

We have kept pace with industry's ever increasing demand for greater product reliability and complete technology.

Using the very latest technology in the manufacturing process, you can be assured that we are providing industry with a product that out-performs all others.

We wish to extend our sincere thanks to all of our customers, who have enabled us to grow and expand to the point we are today. Some of you have been loyal customers since our beginning in 1959, and for this, we are very grateful. You can be assured that we will continue to provide you with a quality product as well as very personalized service.

Again, we thank you.

Award Cutter Co., Inc.

AWARD TAPERED END MILL DATA

SIZES:

Standard sizes are available in a complete range all popular sizes, 1/2 degree through 45 degree in various flute lengths. All standard sizes are right hand cut, right hand spiral. The spiral is constant. Over 600 sizes available standard from stock.

MATERIAL:

All tapered end mills are produced from a premium grade of super submicrograin carbide to give you the maximum hardness and toughness. This means longer cutting life with less breakage.

GRINDING:

All flutes are hollow ground with double clearance angles. The flute face is also hollow ground and polished to assure free cutting actions with minimum of heat generation. All tools have end cutting teeth. Special grinding procedures and equipment assures a high degree on concentricity between shank and cutting flutes.

TOLERANCES:

Taper angles constant to +/- .001 per inch of flute length.
Tip diameter tolerances are held at +/- .002.
Shank diameter tolerances are -.0002 to -.0005.

AWARD TAPERED END MILL DATA

Calculating Ball End Diameters

| P/S Taper Angle | Ball End Multiplier |
|-----------------------|------------------------|
| 1/2 deg per side | 0.99131 |
| 1 deg per side | 0.98269 |
| 1-1/2 deg per side | 0.97415 |
| 2 deg per side | 0.96568 |
| 3 deg per side | 0.94896 |
| 4 deg per side | 0.93251 |
| 5 deg per side | 0.91633 |
| 6 deg per side | 0.90053 |
| 7 deg per side | 0.88472 |
| 10 deg per side | 0.83909 |
| 15 deg per side | 0.76732 |
| 20 deg per side | 0.70020 |
| 25 deg per side | 0.63707 |
| 30 deg per side | 0.57735 |
| 45 deg per side | 0.41421 |



Formula for calculating a starting tip diameter on a flat end to achieve a specific tangent Ball Diameter:
 $\text{Ball Diameter} \times \text{Multiplier} = \text{Starting Tip Diameter}$

Large Diameter Multipliers



| P/S Taper Angle | Large Diameter Multiplier |
|-----------------------|---------------------------------|
| 1/2 deg per side | 0.01745 |
| 1 deg per side | 0.03490 |
| 1-1/2 deg per side | 0.05236 |
| 2 deg per side | 0.06984 |
| 3 deg per side | 0.10482 |
| 4 deg per side | 0.13986 |
| 5 deg per side | 0.17498 |
| 6 deg per side | 0.21021 |
| 7 deg per side | 0.24556 |
| 10 deg per side | 0.35266 |
| 15 deg per side | 0.53590 |
| 20 deg per side | 0.72794 |
| 25 deg per side | 0.93262 |
| 30 deg per side | 1.15470 |
| 45 deg per side | 2.00000 |

Formula for calculating large diameters:
 $(\text{Large Diameter Multiplier} \times \text{Flute Length}) + \text{Tip Diameter} = \text{Large Diameter}$

A

MINIATURE CARBIDE Flat Ends

| Taper Per Side | Tool No. | Tip Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. | Taper Per Side | Tool No. | Tip Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------------|-------------|----------|-----------|----------|---------|------------|------------------|------------|----------|-----------|----------|---------|------------|
| 1/2 DEG | M0-0001-CB | 1/32 | 1/4 | 1/8 | 2 | 0.03561 | 2 DEG | M2-0001-CB | 1/32 | 1/4 | 1/8 | 2 | 0.04871 |
| | M0-0002-CB | 1/32 | 1/2 | 1/8 | 2 | 0.03998 | | M2-0002-CB | 1/32 | 1/2 | 1/8 | 2 | 0.06617 |
| | M0-0501-CB | 3/64 | 1/4 | 1/8 | 2 | 0.05124 | | M2-0501-CB | 3/64 | 1/4 | 1/8 | 2 | 0.06434 |
| | M0-0502-CB | 3/64 | 1/2 | 1/8 | 2 | 0.05560 | | M2-0502-CB | 3/64 | 1/2 | 1/8 | 2 | 0.08180 |
| | M0-002-CB | 1/16 | 1/2 | 1/8 | 2 | 0.07123 | | M2-002-CB | 1/16 | 1/2 | 1/8 | 2 | 0.09742 |
| | M0-003-CB | 1/16 | 3/4 | 1/8 | 2 | 0.07559 | | M2-003-CB | 1/16 | 3/4 | 1/8 | 2 | 0.11488 |
| | M0-004-CB | 1/16 | 1 | 1/8 | 3 | 0.07995 | | M2-004-CB | 1/16 | 1 | 3/16 | 3 | 0.13234 |
| | M0-052-CB | 5/64 | 1/2 | 1/8 | 2 | 0.08685 | | M2-052-CB | 5/64 | 1/2 | 1/8 | 2 | 0.11305 |
| | M0-053-CB | 5/64 | 3/4 | 1/8 | 2 | 0.09121 | | M2-053-CB | 5/64 | 3/4 | 3/16 | 2 | 0.13051 |
| M0-054-CB | 5/64 | 1 | 1/8 | 3 | 0.09558 | M2-054-CB | 5/64 | 1 | 3/16 | 3 | 0.14797 | | |
| 1 DEG | M1-0001-CB | 1/32 | 1/4 | 1/8 | 2 | 0.03998 | 3 DEG | M3-0001-CB | 1/32 | 1/4 | 1/8 | 2 | 0.05746 |
| | M1-0002-CB | 1/32 | 1/2 | 1/8 | 2 | 0.04870 | | M3-0002-CB | 1/32 | 1/2 | 1/8 | 2 | 0.08366 |
| | M1-0501-CB | 3/64 | 1/4 | 1/8 | 2 | 0.05560 | | M3-0501-CB | 3/64 | 1/4 | 1/8 | 2 | 0.07308 |
| | M1-0502-CB | 3/64 | 1/2 | 1/8 | 2 | 0.06433 | | M3-0502-CB | 3/64 | 1/2 | 1/8 | 2 | 0.09929 |
| | M1-002-CB | 1/16 | 1/2 | 1/8 | 2 | 0.07995 | | M3-002-CB | 1/16 | 1/2 | 1/8 | 2 | 0.11491 |
| | M1-003-CB | 1/16 | 3/4 | 1/8 | 2 | 0.08868 | | M3-003-CB | 1/16 | 3/4 | 3/16 | 2 | 0.14112 |
| | M1-004-CB | 1/16 | 1 | 1/8 | 3 | 0.09740 | | M3-004-CB | 1/16 | 1 | 3/16 | 3 | 0.16732 |
| | M1-052-CB | 5/64 | 1/2 | 1/8 | 2 | 0.09558 | | M3-006-CB | 1/16 | 1 1/2 | 1/4 | 3 | 0.21973 |
| | M1-053-CB | 5/64 | 3/4 | 1/8 | 2 | 0.10430 | | M3-052-CB | 5/64 | 1/2 | 3/16 | 2 | 0.13054 |
| M1-054-CB | 5/64 | 1 | 1/8 | 3 | 0.11303 | M3-053-CB | 5/64 | 3/4 | 3/16 | 2 | 0.15674 | | |
| 1-1/2 DEG | M15-0001-CB | 1/32 | 1/4 | 1/8 | 2 | 0.04434 | 5 DEG | M5-0001-CB | 1/32 | 1/4 | 1/8 | 2 | 0.07500 |
| | M15-0002-CB | 1/32 | 1/2 | 1/8 | 2 | 0.05743 | | M5-0002-CB | 1/32 | 1/2 | 3/16 | 2 | 0.11874 |
| | M15-0501-CB | 3/64 | 1/4 | 1/8 | 2 | 0.05997 | | M5-0003-CB | 1/32 | 3/4 | 3/16 | 2 1/2 | 0.16249 |
| | M15-0502-CB | 3/64 | 1/2 | 1/8 | 2 | 0.07306 | | M5-0501-CB | 3/64 | 1/4 | 1/8 | 2 | 0.09062 |
| | M15-002-CB | 1/16 | 1/2 | 1/8 | 2 | 0.08868 | | M5-0502-CB | 3/64 | 1/2 | 3/16 | 2 | 0.13437 |
| | M15-003-CB | 1/16 | 3/4 | 1/8 | 2 | 0.10177 | | M5-002-CB | 1/16 | 1/2 | 1/4 | 2 | 0.14999 |
| | M15-004-CB | 1/16 | 1 | 3/16 | 3 | 0.11486 | | M5-003-CB | 1/16 | 3/4 | 1/4 | 2 1/2 | 0.19374 |
| | M15-052-CB | 5/64 | 1/2 | 1/8 | 2 | 0.10431 | | M5-004-CB | 1/16 | 1 | 1/4 | 3 | 0.23748 |
| | M15-053-CB | 5/64 | 3/4 | 1/8 | 2 | 0.11740 | | M5-006-CB | 1/16 | 1 1/2 | 3/8 | 3 | 0.28123 |
| M15-054-CB | 5/64 | 1 | 3/16 | 3 | 0.13049 | M5-052-CB | 5/64 | 1/2 | 3/16 | 2 | 0.16562 | | |
| | | | | | | | M5-053-CB | 5/64 | 3/4 | 1/4 | 2 1/2 | 0.20936 | |
| | | | | | | | M5-054-CB | 5/64 | 1 | 3/8 | 3 | 0.25311 | |

ALL SIZES ARE AVAILABLE
CALL FOR AVAILABILITY 1-888-531-0430

Other coatings are available including: TiCN and TiAlN



• Four Flutes

STANDARD CARBIDE

Flat Ends



| Taper Per Side | Tool No. | Tip Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|------------|----------|-----------|----------|---------|------------|
| 1/2 DEG | KK-102-CB | 3/32 | 1/2 | 1/8 | 2 | 0.10248 |
| | KK-103-CB | 3/32 | 3/4 | 1/8 | 2 | 0.10684 |
| | KK-105-CB | 3/32 | 1 1/4 | 3/16 | 3 | 0.11556 |
| | KK-201-CB | 1/8 | 1/4 | 3/16 | 2 | 0.12936 |
| | KK-2015-CB | 1/8 | 3/8 | 3/16 | 2 | 0.13154 |
| | KK-202-CB | 1/8 | 1/2 | 3/16 | 2 | 0.13373 |
| | KK-203-CB | 1/8 | 3/4 | 3/16 | 2 | 0.13809 |
| | KK-204-CB | 1/8 | 1 | 3/16 | 3 | 0.14245 |
| | KK-205-CB | 1/8 | 1 1/4 | 3/16 | 3 | 0.14681 |
| | KK-206-CB | 1/8 | 1 1/2 | 3/16 | 3 | 0.15118 |
| | KK-303-CB | 3/16 | 3/4 | 1/4 | 2 1/2 | 0.20059 |
| | KK-305-CB | 3/16 | 1 1/4 | 1/4 | 3 | 0.20931 |
| | KK-307-CB | 3/16 | 1 3/4 | 1/4 | 3 1/2 | 0.21804 |
| | KK-313-CB | 3/16 | 3 1/4 | 3/8 | 5 | 0.24421 |
| | KK-403-CB | 1/4 | 3/4 | 3/8 | 2 1/2 | 0.26309 |
| | KK-405-CB | 1/4 | 1 1/4 | 3/8 | 3 | 0.27181 |
| | KK-409-CB | 1/4 | 2 1/4 | 3/8 | 4 | 0.28926 |
| | KK-413-CB | 1/4 | 3 1/4 | 3/8 | 5 | 0.30671 |
| | KK-605-CB | 3/8 | 1 1/4 | 1/2 | 3 | 0.39681 |
| | KK-609-CB | 3/8 | 2 1/4 | 1/2 | 4 | 0.41426 |
| | KK-613-CB | 3/8 | 3 1/4 | 1/2 | 5 | 0.43171 |
| | KK-805-CB | 1/2 | 1 1/4 | 9/16 | 3 | 0.52181 |
| | KK-809-CB | 1/2 | 2 1/4 | 9/16 | 4 | 0.53926 |
| | KK-813-CB | 1/2 | 3 1/4 | 5/8 | 6 | 0.55671 |
| KK-1009-CB | 5/8 | 2 1/4 | 3/4 | 5 | 0.66426 | |
| KK-1013-CB | 5/8 | 3 1/4 | 3/4 | 6 | 0.68171 | |
| KK-1017-CB | 5/8 | 4 1/4 | 3/4 | 7 | 0.69916 | |
| KK-1209-CB | 3/4 | 2 1/4 | 7/8 | 5 | 0.78926 | |
| KK-1213-CB | 3/4 | 3 1/4 | 7/8 | 6 | 0.80671 | |
| KK-1217-CB | 3/4 | 4 1/4 | 7/8 | 7 | 0.82416 | |
| KK-1221-CB | 3/4 | 5 1/4 | 7/8 | 8 | 0.84161 | |

| Taper Per Side | Tool No. | Tip Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|-----------|----------|-----------|----------|---------|------------|
| 1 DEG | K-102-CB | 3/32 | 1/2 | 1/8 | 2 | 0.11120 |
| | K-103-CB | 3/32 | 3/4 | 3/16 | 2 1/2 | 0.11993 |
| | K-104-CB | 3/32 | 1 | 3/16 | 3 | 0.12865 |
| | K-105-CB | 3/32 | 1 1/4 | 3/16 | 3 | 0.13738 |
| | K-106-CB | 3/32 | 1 1/2 | 1/4 | 3 1/2 | 0.14610 |
| | K-201-CB | 1/8 | 1/4 | 3/16 | 2 | 0.13373 |
| | K-2015-CB | 1/8 | 3/8 | 3/16 | 2 | 0.13809 |
| | K-202-CB | 1/8 | 1/2 | 3/16 | 2 | 0.14245 |
| | K-203-CB | 1/8 | 3/4 | 1/4 | 2 1/2 | 0.15118 |
| | K-204-CB | 1/8 | 1 | 1/4 | 3 | 0.15990 |
| | K-205-CB | 1/8 | 1 1/4 | 1/4 | 3 | 0.16863 |
| | K-206-CB | 1/8 | 1 1/2 | 1/4 | 3 | 0.17735 |
| | K-208-CB | 1/8 | 2 | 1/4 | 4 | 0.19480 |
| | K-303-CB | 3/16 | 3/4 | 1/4 | 2 1/2 | 0.21368 |
| | K-305-CB | 3/16 | 1 1/4 | 1/4 | 3 | 0.23113 |
| | K-307-CB | 3/16 | 1 3/4 | 1/4 | 3 1/2 | 0.24858 |
| | K-308-CB | 3/16 | 2 | 5/16 | 4 | 0.25730 |
| | K-309-CB | 3/16 | 2 1/4 | 3/8 | 4 | 0.26603 |
| | K-310-CB | 3/16 | 2 1/2 | 3/8 | 5 | 0.27475 |
| | K-313-CB | 3/16 | 3 1/4 | 3/8 | 5 | 0.30093 |
| | K-403-CB | 1/4 | 3/4 | 3/8 | 2 1/2 | 0.27618 |
| | K-405-CB | 1/4 | 1 1/4 | 3/8 | 3 | 0.29363 |
| | K-408-CB | 1/4 | 2 | 3/8 | 4 | 0.31980 |
| | K-409-CB | 1/4 | 2 1/4 | 3/8 | 4 | 0.32853 |
| K-413-CB | 1/4 | 3 1/4 | 3/8 | 5 | 0.36343 | |
| K-605-CB | 3/8 | 1 1/4 | 1/2 | 3 | 0.41863 | |
| K-609-CB | 3/8 | 2 1/4 | 1/2 | 4 | 0.45353 | |
| K-613-CB | 3/8 | 3 1/4 | 1/2 | 6 | 0.48843 | |
| K-803-CB | 1/2 | 3/4 | 5/8 | 3 | 0.52618 | |
| K-805-CB | 1/2 | 1 1/4 | 9/16 | 4 | 0.54363 | |
| K-809-CB | 1/2 | 2 1/4 | 5/8 | 4 | 0.57853 | |
| K-813-CB | 1/2 | 3 1/4 | 5/8 | 5 | 0.61343 | |
| K-1009-CB | 5/8 | 2 1/4 | 3/4 | 4 | 0.70353 | |
| K-1013-CB | 5/8 | 3 1/4 | 3/4 | 5 | 0.73843 | |
| K-1017-CB | 5/8 | 4 1/4 | 7/8 | 7 | 0.77333 | |
| K-1209-CB | 3/4 | 2 1/4 | 7/8 | 5 | 0.82853 | |
| K-1213-CB | 3/4 | 3 1/4 | 7/8 | 6 | 0.86343 | |
| K-1217-CB | 3/4 | 4 1/4 | 1 | 7 | 0.89833 | |
| K-1221-CB | 3/4 | 5 1/4 | 1 | 8 | 0.93323 | |

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Other coatings are available including: TiCN and TiAlN



• Four Flutes

A

STANDARD CARBIDE

Flat Ends

| Taper Per Side | Tool No. | Tip Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|------------|----------|-----------|----------|-------|------------|
| 1-1/2 | KX-102-CB | 3/32 | 1/2 | 3/16 | 2 | 0.11993 |
| | KX-103-CB | 3/32 | 3/4 | 3/16 | 2 1/2 | 0.13302 |
| | KX-104-CB | 3/32 | 1 | 1/4 | 3 | 0.14611 |
| | KX-105-CB | 3/32 | 1 1/4 | 3/16 | 3 | 0.15920 |
| | KX-106-CB | 3/32 | 1 1/2 | 1/4 | 3 | 0.17229 |
| | KX-154-CB | 7/64 | 1 | 3/16 | 3 | 0.16136 |
| | KX-202-CB | 1/8 | 1/2 | 3/16 | 2 1/2 | 0.15118 |
| | KX-203-CB | 1/8 | 3/4 | 1/4 | 2 1/2 | 0.16427 |
| | KX-204-CB | 1/8 | 1 | 3/16 | 3 | 0.17736 |
| | KX-205-CB | 1/8 | 1 1/4 | 1/4 | 3 | 0.19045 |
| | KX-206-CB | 1/8 | 1 1/2 | 1/4 | 3 | 0.20354 |
| | KX-208-CB | 1/8 | 2 | 1/4 | 3 1/2 | 0.22972 |
| | KX-209-CB | 1/8 | 2 1/4 | 5/16 | 4 | 0.24281 |
| | KX-212-CB | 1/8 | 3 | 5/16 | 5 | 0.28208 |
| | KX-253-CB | 5/32 | 3/4 | 1/4 | 2 1/2 | 0.19552 |
| | KX-254-CB | 5/32 | 1 | 1/4 | 3 | 0.20861 |
| | KX-255-CB | 5/32 | 1 1/4 | 1/4 | 3 | 0.22170 |
| | KX-256-CB | 5/32 | 1 1/2 | 1/4 | 3 | 0.23479 |
| | KX-258-CB | 5/32 | 2 | 5/16 | 4 | 0.26097 |
| | KX-303-CB | 3/16 | 3/4 | 3/8 | 2 1/2 | 0.22677 |
| | KX-304-CB | 3/16 | 1 | 1/4 | 3 | 0.23986 |
| | KX-305-CB | 3/16 | 1 1/4 | 3/8 | 3 | 0.25295 |
| | KX-307-CB | 3/16 | 1 3/4 | 3/8 | 3 1/2 | 0.27913 |
| | KX-309-CB | 3/16 | 2 1/4 | 3/8 | 4 | 0.30531 |
| | KX-313-CB | 3/16 | 3 1/4 | 3/8 | 5 | 0.35767 |
| | KX-403-CB | 1/4 | 3/4 | 3/8 | 2 1/2 | 0.28927 |
| | KX-405-CB | 1/4 | 1 1/4 | 3/8 | 3 | 0.31545 |
| | KX-406-CB | 1/4 | 1 1/2 | 3/8 | 3 1/2 | 0.32854 |
| | KX-409-CB | 1/4 | 2 1/4 | 3/8 | 4 | 0.36781 |
| | KX-413-CB | 1/4 | 3 1/4 | 1/2 | 5 | 0.42017 |
| | KX-605-CB | 3/8 | 1 1/4 | 1/2 | 3 | 0.44045 |
| | KX-609-CB | 3/8 | 2 1/4 | 1/2 | 4 | 0.49281 |
| | KX-613-CB | 3/8 | 3 1/4 | 9/16 | 5 | 0.54517 |
| | KX-805-CB | 1/2 | 1 1/4 | 5/8 | 3 1/2 | 0.56545 |
| | KX-806-CB | 1/2 | 1 1/2 | 5/8 | 3 1/2 | 0.52618 |
| | KX-809-CB | 1/2 | 2 1/4 | 5/8 | 4 | 0.61781 |
| | KX-813-CB | 1/2 | 3 1/4 | 3/4 | 5 | 0.67017 |
| | KX-1009-CB | 5/8 | 2 1/4 | 3/4 | 4 | 0.74281 |
| | KX-1013-CB | 5/8 | 3 1/4 | 7/8 | 6 | 0.79517 |
| | KX-1017-CB | 5/8 | 4 1/4 | 7/8 | 7 | 0.84753 |
| | KX-1209-CB | 3/4 | 2 1/4 | 7/8 | 4 | 0.86781 |
| | KX-1213-CB | 3/4 | 3 1/4 | 1 | 6 | 0.92017 |

| Taper Per Side | Tool No. | Tip Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|-----------|----------|-----------|----------|-------|------------|
| 2 | L-102-CB | 3/32 | 1/2 | 3/16 | 2 | 0.12867 |
| DEG | L-103-CB | 3/32 | 3/4 | 1/4 | 2 1/2 | 0.14613 |
| | L-104-CB | 3/32 | 1 | 1/4 | 3 | 0.16359 |
| | L-105-CB | 3/32 | 1 1/4 | 1/4 | 3 | 0.18105 |
| | L-202-CB | 1/8 | 1/2 | 3/16 | 2 | 0.15992 |
| | L-203-CB | 1/8 | 3/4 | 1/4 | 2 1/2 | 0.17738 |
| | L-204-CB | 1/8 | 1 | 1/4 | 2 1/2 | 0.19484 |
| | L-205-CB | 1/8 | 1 1/4 | 1/4 | 3 | 0.21230 |
| | L-206-CB | 1/8 | 1 1/2 | 1/4 | 3 | 0.22976 |
| | L-208-CB | 1/8 | 2 | 5/16 | 3 1/2 | 0.26468 |
| | L-210-CB | 1/8 | 2 1/2 | 5/16 | 4 | 0.29960 |
| | L-303-CB | 3/16 | 3/4 | 1/4 | 2 1/2 | 0.23988 |
| | L-305-CB | 3/16 | 1 1/4 | 3/8 | 3 | 0.27480 |
| | L-307-CB | 3/16 | 1 3/4 | 3/8 | 3 1/2 | 0.30972 |
| | L-309-CB | 3/16 | 2 1/4 | 1/2 | 4 | 0.34464 |
| | L-313-CB | 3/16 | 3 1/4 | 1/2 | 5 | 0.41448 |
| | L-403-CB | 1/4 | 3/4 | 3/8 | 2 1/2 | 0.30238 |
| | L-405-CB | 1/4 | 1 1/4 | 3/8 | 3 | 0.33730 |
| | L-408-CB | 1/4 | 2 | 1/2 | 4 | 0.38968 |
| | L-409-CB | 1/4 | 2 1/4 | 1/2 | 4 | 0.40714 |
| | L-413-CB | 1/4 | 3 1/4 | 1/2 | 5 | 0.47698 |
| | L-605-CB | 3/8 | 1 1/4 | 1/2 | 3 1/2 | 0.46230 |
| | L-609-CB | 3/8 | 2 1/4 | 9/16 | 4 | 0.53214 |
| | L-613-CB | 3/8 | 3 1/4 | 5/8 | 5 | 0.60198 |
| | L-805-CB | 1/2 | 1 1/4 | 5/8 | 3 1/2 | 0.58730 |
| | L-809-CB | 1/2 | 2 1/4 | 3/4 | 4 | 0.65714 |
| | L-813-CB | 1/2 | 3 1/4 | 3/4 | 5 | 0.72698 |
| | L-1009-CB | 5/8 | 2 1/4 | 7/8 | 5 | 0.78214 |
| | L-1013-CB | 5/8 | 3 1/4 | 7/8 | 6 | 0.85198 |
| | L-1017-CB | 5/8 | 4 1/4 | 1 | 7 | 0.92182 |
| | L-1209-CB | 3/4 | 2 1/4 | 1 | 5 | 0.90714 |
| | L-1213-CB | 3/4 | 3 1/4 | 1 | 6 | 0.97698 |

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STANDARD CARBIDE

Flat Ends



| Taper Per Side | Tool No. | Tip Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|----------|----------|-----------|----------|-------|------------|
| 3 DEG | M-103-CB | 3/32 | 3/4 | 3/16 | 2 | 0.17237 |
| | M-104-CB | 3/32 | 1 | 1/4 | 3 | 0.19857 |
| | M-105-CB | 3/32 | 1 1/4 | 1/4 | 3 | 0.22478 |
| | M-106-CB | 3/32 | 1 1/2 | 1/4 | 3 | 0.25098 |
| | M-107-CB | 3/32 | 1 3/4 | 3/8 | 3 1/2 | 0.27719 |
| | M-108-CB | 3/32 | 2 | 5/16 | 4 | 0.30339 |
| | M-110-CB | 3/32 | 2 1/2 | 3/8 | 4 | 0.35580 |
| | M-154-CB | 7/64 | 1 | 1/4 | 3 | 0.21382 |
| | M-155-CB | 7/64 | 1 1/4 | 1/4 | 3 | 0.24003 |
| | M-156-CB | 7/64 | 1 1/2 | 5/16 | 3 | 0.26623 |
| | M-158-CB | 7/64 | 2 | 3/8 | 4 | 0.31864 |
| | M-203-CB | 1/8 | 3/4 | 1/4 | 2 1/2 | 0.20362 |
| | M-204-CB | 1/8 | 1 | 1/4 | 3 | 0.22982 |
| | M-205-CB | 1/8 | 1 1/4 | 3/8 | 3 | 0.25603 |
| | M-206-CB | 1/8 | 1 1/2 | 3/8 | 3 1/2 | 0.28223 |
| | M-208-CB | 1/8 | 2 | 3/8 | 4 | 0.33464 |
| | M-209-CB | 1/8 | 2 1/4 | 3/8 | 4 | 0.36085 |
| | M-210-CB | 1/8 | 2 1/2 | 7/16 | 4 | 0.38705 |
| | M-212-CB | 1/8 | 3 | 1/2 | 5 | 0.43946 |
| | M-216-CB | 1/8 | 4 | 9/16 | 6 | 0.54428 |
| | M-253-CB | 5/32 | 3/4 | 1/4 | 2 1/2 | 0.23487 |
| | M-254-CB | 5/32 | 1 | 3/8 | 3 | 0.26107 |
| | M-255-CB | 5/32 | 1 1/4 | 3/8 | 3 | 0.28728 |
| | M-256-CB | 5/32 | 1 1/2 | 3/8 | 3 | 0.31348 |
| | M-257-CB | 5/32 | 1 3/4 | 3/8 | 3 1/2 | 0.33969 |
| | M-258-CB | 5/32 | 2 | 3/8 | 4 | 0.36589 |
| | M-303-CB | 3/16 | 3/4 | 3/8 | 2 1/2 | 0.26612 |
| | M-304-CB | 3/16 | 1 | 3/8 | 3 | 0.29232 |
| | M-305-CB | 3/16 | 1 1/4 | 3/8 | 3 | 0.31853 |
| | M-306-CB | 3/16 | 1 1/2 | 3/8 | 3 1/2 | 0.34473 |
| | M-310-CB | 3/16 | 2 1/2 | 1/2 | 4 | 0.44955 |
| | M-313-CB | 3/16 | 3 1/4 | 9/16 | 5 | 0.52817 |
| | M-316-CB | 3/16 | 4 | 5/8 | 6 | 0.60678 |
| | M-320-CB | 3/16 | 5 | 3/4 | 7 | 0.71160 |
| | M-403-CB | 1/4 | 3/4 | 3/8 | 2 1/2 | 0.32862 |
| | M-404-CB | 1/4 | 1 | 3/8 | 3 | 0.35482 |
| | M-405-CB | 1/4 | 1 1/4 | 3/8 | 3 | 0.37500 |
| | M-408-CB | 1/4 | 2 | 1/2 | 4 | 0.45964 |
| | M-409-CB | 1/4 | 2 1/4 | 1/2 | 4 | 0.48585 |
| | M-413-CB | 1/4 | 3 1/4 | 5/8 | 5 | 0.59067 |
| | M-416-CB | 1/4 | 4 | 3/4 | 6 | 0.66928 |
| | M-420-CB | 1/4 | 5 | 7/8 | 7 | 0.77410 |

| Taper Per Side | Tool No. | Tip Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|--------------|-----------|-----------|----------|---------|------------|
| 3 DEG | M-504-CB | 5/16 | 1 | 1/2 | 3 | 0.41782 |
| | M-507-CB | 5/16 | 1 3/4 | 1/2 | 3 1/2 | 0.49644 |
| | M-604-CB | 3/8 | 1 | 1/2 | 3 | 0.47982 |
| | M-605-CB | 3/8 | 1 1/4 | 1/2 | 3 | 0.50000 |
| | M-609-CB | 3/8 | 2 1/4 | 5/8 | 4 | 0.61085 |
| | M-613-CB | 3/8 | 3 1/4 | 3/4 | 5 | 0.71567 |
| | M-616-CB | 3/8 | 4 | 7/8 | 6 | 0.79428 |
| | M-620-CB | 3/8 | 5 | 1 | 8 | 0.89910 |
| | M-805-CB | 1/2 | 1 1/4 | 3/4 | 4 | 0.63103 |
| | M-809-CB | 1/2 | 2 1/4 | 3/4 | 4 | 0.73585 |
| | M-813-CB | 1/2 | 3 1/4 | 7/8 | 6 | 0.84067 |
| | M-816-CB | 1/2 | 4 | 1 | 7 | 0.91928 |
| | M-1009-CB | 5/8 | 2 1/4 | 7/8 | 5 | 0.86085 |
| | M-1013-CB | 5/8 | 3 1/4 | 1 | 6 | 0.96567 |
| | M-1209-CB | 3/4 | 2 1/4 | 1 | 5 | 0.98585 |
| | 4 DEG | N-0004-CB | 1/32 | 1 | 3/16 | 3 |
| N-004-CB | | 1/16 | 1 | 1/4 | 3 | 0.20236 |
| N-103-CB | | 3/32 | 3/4 | 1/4 | 2 1/2 | 0.19865 |
| N-104-CB | | 3/32 | 1 | 1/4 | 3 | 0.23361 |
| N-203-CB | | 1/8 | 3/4 | 1/4 | 2 1/2 | 0.22990 |
| N-204-CB | | 1/8 | 1 | 3/8 | 2 1/2 | 0.26486 |
| N-206-CB | | 1/8 | 1 1/2 | 3/8 | 3 1/2 | 0.33479 |
| N-208-CB | | 1/8 | 2 | 1/2 | 4 | 0.40472 |
| N-210-CB | | 1/8 | 2 1/2 | 1/2 | 5 | 0.47465 |
| N-303-CB | | 3/16 | 3/4 | 3/8 | 2 1/2 | 0.29240 |
| N-305-CB | | 3/16 | 1 1/4 | 3/8 | 3 | 0.36233 |
| N-313-CB | | 3/16 | 3 1/4 | 3/4 | 5 | 0.64205 |
| N-316-CB | | 3/16 | 4 | 3/4 | 6 | 0.74694 |
| N-403-CB | | 1/4 | 3/4 | 3/8 | 2 1/2 | 0.35490 |
| N-405-CB | | 1/4 | 1 1/4 | 1/2 | 3 1/2 | 0.42483 |
| N-409-CB | | 1/4 | 2 1/4 | 5/8 | 4 | 0.56469 |
| N-413-CB | | 1/4 | 3 1/4 | 3/4 | 5 | 0.70455 |
| N-416-CB | | 1/4 | 4 | 7/8 | 7 | 0.80944 |
| N-605-CB | | 3/8 | 1 1/4 | 9/16 | 3 | 0.54983 |
| N-609-CB | 3/8 | 2 1/4 | 3/4 | 4 | 0.68969 | |
| N-613-CB | 3/8 | 3 1/4 | 7/8 | 6 | 0.82955 | |
| N-616-CB | 3/8 | 4 | 1 | 7 | 0.93444 | |
| N-805-CB | 1/2 | 1 1/4 | 3/4 | 3 1/2 | 0.67483 | |
| N-809-CB | 1/2 | 2 1/4 | 7/8 | 5 | 0.81469 | |
| N-813-CB | 1/2 | 3 1/4 | 1 | 6 | 0.95455 | |

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STANDARD CARBIDE

Flat Ends

| Taper Per Side | Tool No. | Tip Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|----------|----------|-----------|----------|---------|------------|
| 5 DEG | O-102-CB | 3/32 | 1/2 | 1/4 | 2 1/2 | 0.18124 |
| | O-103-CB | 3/32 | 3/4 | 1/4 | 2 1/2 | 0.22499 |
| | O-104-CB | 3/32 | 1 | 3/8 | 3 | 0.26873 |
| | O-105-CB | 3/32 | 1 1/4 | 3/8 | 3 | 0.31248 |
| | O-106-CB | 3/32 | 1 1/2 | 3/8 | 3 1/2 | 0.35622 |
| | O-108-CB | 3/32 | 2 | 1/2 | 4 | 0.44371 |
| | O-155-CB | 7/64 | 1 1/4 | 3/8 | 3 | 0.32773 |
| | O-203-CB | 1/8 | 3/4 | 1/4 | 2 1/2 | 0.25000 |
| | O-204-CB | 1/8 | 1 | 3/8 | 3 | 0.29998 |
| | O-205-CB | 1/8 | 1 1/4 | 3/8 | 3 | 0.34373 |
| | O-206-CB | 1/8 | 1 1/2 | 3/8 | 3 1/2 | 0.37500 |
| | O-207-CB | 1/8 | 1 3/4 | 1/2 | 4 | 0.43122 |
| | O-208-CB | 1/8 | 2 | 1/2 | 4 | 0.47496 |
| | O-210-CB | 1/8 | 2 1/2 | 5/8 | 5 | 0.56245 |
| | O-212-CB | 1/8 | 3 | 3/4 | 5 | 0.64994 |
| | O-253-CB | 5/32 | 3/4 | 3/8 | 2 1/2 | 0.28749 |
| | O-254-CB | 5/32 | 1 | 3/8 | 3 | 0.33123 |
| | O-255-CB | 5/32 | 1 1/4 | 3/8 | 3 | 0.37498 |
| | O-256-CB | 5/32 | 1 1/2 | 1/2 | 3 1/2 | 0.41872 |
| | O-257-CB | 5/32 | 1 3/4 | 1/2 | 4 | 0.46247 |
| | O-258-CB | 5/32 | 2 | 1/2 | 4 | 0.50000 |
| | O-303-CB | 3/16 | 3/4 | 3/8 | 2 1/2 | 0.31874 |
| | O-304-CB | 3/16 | 1 | 3/8 | 3 | 0.36248 |
| | O-305-CB | 3/16 | 1 1/4 | 1/2 | 3 | 0.40623 |
| | O-306-CB | 3/16 | 1 1/2 | 1/2 | 3 1/2 | 0.44997 |
| | O-307-CB | 3/16 | 1 3/4 | 1/2 | 3 1/2 | 0.49372 |
| | O-308-CB | 3/16 | 2 | 9/16 | 4 | 0.53746 |
| | O-310-CB | 3/16 | 2 1/2 | 5/8 | 4 | 0.62495 |
| | O-312-CB | 3/16 | 3 | 3/4 | 5 | 0.71244 |
| | O-313-CB | 3/16 | 3 1/4 | 7/8 | 6 | 0.75619 |
| | O-316-CB | 3/16 | 4 | 1 | 7 | 0.88742 |
| | O-403-CB | 1/4 | 3/4 | 1/2 | 3 | 0.38124 |
| O-404-CB | 1/4 | 1 | 1/2 | 3 | 0.42498 | |
| O-405-CB | 1/4 | 1 1/4 | 1/2 | 3 | 0.46873 | |
| O-406-CB | 1/4 | 1 1/2 | 1/2 | 3 1/2 | 0.51247 | |
| O-407-CB | 1/4 | 1 3/4 | 5/8 | 4 | 0.55622 | |
| O-408-CB | 1/4 | 2 | 5/8 | 4 | 0.59996 | |
| O-409-CB | 1/4 | 2 1/4 | 3/4 | 5 | 0.64371 | |
| O-410-CB | 1/4 | 2 1/2 | 3/4 | 5 | 0.68745 | |
| O-413-CB | 1/4 | 3 1/4 | 7/8 | 6 | 0.81869 | |
| O-416-CB | 1/4 | 4 | 1 | 7 | 0.94992 | |
| O-504-CB | 5/16 | 1 | 1/2 | 3 | 0.48798 | |
| O-509-CB | 5/16 | 2 1/4 | 3/4 | 5 | 0.70671 | |

| Taper Per Side | Tool No. | Tip Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|-----------|----------|-----------|----------|---------|------------|
| 5 DEG | O-604-CB | 3/8 | 1 | 5/8 | 3 1/2 | 0.54998 |
| | O-605-CB | 3/8 | 1 1/4 | 5/8 | 4 | 0.59373 |
| | O-609-CB | 3/8 | 2 1/4 | 7/8 | 5 | 0.76871 |
| | O-613-CB | 3/8 | 3 1/4 | 1 | 6 | 0.94369 |
| | O-805-CB | 1/2 | 1 1/4 | 3/4 | 4 | 0.71873 |
| | O-806-CB | 1/2 | 1 1/2 | 7/8 | 4 | 0.76247 |
| O-809-CB | 1/2 | 2 1/4 | 1 | 5 | 0.89371 | |
| 6 DEG | P-004-CB | 1/16 | 1 | 5/16 | 3 | 0.27271 |
| | P-104-CB | 3/32 | 1 | 5/16 | 3 | 0.30396 |
| | P-204-CB | 1/8 | 1 | 3/8 | 3 | 0.33521 |
| 7 DEG | R-0003-CB | 1/32 | 3/4 | 1/4 | 2 1/2 | 0.21542 |
| | R-0004-CB | 1/32 | 1 | 3/8 | 3 | 0.27656 |
| | R-001-CB | 1/16 | 1/4 | 1/4 | 2 | 0.12389 |
| | R-002-CB | 1/16 | 1/2 | 1/4 | 2 | 0.18528 |
| | R-003-CB | 1/16 | 3/4 | 3/8 | 3 | 0.24667 |
| | R-004-CB | 1/16 | 1 | 3/8 | 3 | 0.30806 |
| | R-054-CB | 5/64 | 1 | 3/8 | 3 | 0.32356 |
| | R-102-CB | 3/32 | 1/2 | 1/4 | 2 1/2 | 0.21653 |
| | R-104-CB | 3/32 | 1 | 3/8 | 3 | 0.33931 |
| | R-106-CB | 3/32 | 1 1/2 | 1/2 | 3 1/2 | 0.46209 |
| | R-202-CB | 1/8 | 1/2 | 3/8 | 2 1/2 | 0.24778 |
| | R-203-CB | 1/8 | 3/4 | 3/8 | 2 1/2 | 0.30917 |
| | R-204-CB | 1/8 | 1 | 3/8 | 3 | 0.37056 |
| | R-206-CB | 1/8 | 1 1/2 | 1/2 | 3 1/2 | 0.49334 |
| | R-208-CB | 1/8 | 2 | 5/8 | 4 | 0.61612 |
| | R-212-CB | 1/8 | 3 | 7/8 | 5 | 0.86168 |
| | R-253-CB | 5/32 | 3/4 | 3/8 | 2 1/2 | 0.34042 |
| | R-305-CB | 3/16 | 1 1/4 | 1/2 | 3 1/2 | 0.49445 |
| R-403-CB | 1/4 | 3/4 | 1/2 | 3 | 0.43417 | |
| R-404-CB | 1/4 | 1 | 1/2 | 3 | 0.49556 | |
| R-405-CB | 1/4 | 1 1/4 | 5/8 | 3 1/2 | 0.55695 | |
| R-409-CB | 1/4 | 2 1/4 | 7/8 | 5 | 0.80251 | |
| R-605-CB | 3/8 | 1 1/4 | 3/4 | 4 | 0.68195 | |
| R-609-CB | 3/8 | 2 1/4 | 1 | 5 | 0.92751 | |
| R-805-CB | 1/2 | 1 1/4 | 7/8 | 4 | 0.80695 | |
| R-808-CB | 1/2 | 2 | 1 | 5 | 0.99112 | |

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Flat Ends



| Taper Per Side | Tool No. | Tip Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|-----------|----------|-----------|----------|---------|------------|
| 10 DEG | T-0002-CB | 1/32 | 1/2 | 1/4 | 2 1/2 | 0.20758 |
| | T-0003-CB | 1/32 | 3/4 | 3/8 | 2 1/2 | 0.29575 |
| | T-002-CB | 1/16 | 1/2 | 3/8 | 2 1/2 | 0.23883 |
| | T-003-CB | 1/16 | 3/4 | 3/8 | 2 1/2 | 0.32700 |
| | T-004-CB | 1/16 | 1 | 1/2 | 3 | 0.41516 |
| | T-005-CB | 1/16 | 1 1/4 | 1/2 | 3 1/2 | 0.50333 |
| | T-102-CB | 3/32 | 1/2 | 3/8 | 2 1/2 | 0.27008 |
| | T-102A-CB | 3/32 | 1/2 | 1/4 | 2 1/2 | 0.27008 |
| | T-103-CB | 3/32 | 3/4 | 3/8 | 2 1/2 | 0.35825 |
| | T-106-CB | 3/32 | 1 1/2 | 5/8 | 3 1/2 | 0.62274 |
| | T-203-CB | 1/8 | 3/4 | 3/8 | 2 1/2 | 0.38950 |
| | T-204-CB | 1/8 | 1 | 1/2 | 3 | 0.47766 |
| | T-205-CB | 1/8 | 1 1/4 | 5/8 | 3 | 0.56583 |
| | T-206-CB | 1/8 | 1 1/2 | 3/4 | 3 1/2 | 0.65399 |
| | T-254-CB | 5/32 | 1 | 1/2 | 3 | 0.50000 |
| | T-258-CB | 5/32 | 2 | 7/8 | 4 | 0.86132 |
| | T-303-CB | 3/16 | 3/4 | 1/2 | 3 | 0.45199 |
| | T-305-CB | 3/16 | 1 1/4 | 5/8 | 3 1/2 | 0.62500 |
| | T-309-CB | 3/16 | 2 1/4 | 1 | 5 | 0.98099 |
| | T-403-CB | 1/4 | 3/4 | 5/8 | 3 | 0.51450 |
| | T-404-CB | 1/4 | 1 | 5/8 | 3 | 0.60266 |
| | T-405-CB | 1/4 | 1 1/4 | 3/4 | 3 1/2 | 0.69083 |
| | T-408-CB | 1/4 | 2 | 1 | 5 | 0.95532 |
| | T-605-CB | 3/8 | 1 1/4 | 7/8 | 3 1/2 | 0.81583 |
| T-805-CB | 1/2 | 1 1/4 | 1 | 3 1/2 | 0.94083 | |
| 15 DEG | V-0001-CB | 1/32 | 1/4 | 1/4 | 2 | 0.16523 |
| | V-0003-CB | 1/32 | 3/4 | 1/2 | 2 1/2 | 0.43318 |
| | V-001-CB | 1/16 | 1/4 | 1/4 | 2 | 0.19648 |
| | V-003-CB | 1/16 | 3/4 | 1/2 | 2 1/2 | 0.46443 |
| | V-101-CB | 3/32 | 1/4 | 1/4 | 2 | 0.22773 |
| | V-102-CB | 3/32 | 1/2 | 3/8 | 2 1/2 | 0.36170 |
| | V-103-CB | 3/32 | 3/4 | 1/2 | 3 | 0.49568 |
| | V-104-CB | 3/32 | 1 | 3/4 | 3 | 0.62965 |
| | V-106-CB | 3/32 | 1 1/2 | 1 | 4 | 0.89760 |
| | V-202-CB | 1/8 | 1/2 | 1/2 | 3 | 0.39295 |
| | V-203-CB | 1/8 | 3/4 | 9/16 | 3 | 0.52693 |
| | V-204-CB | 1/8 | 1 | 3/4 | 3 | 0.66090 |
| | V-206-CB | 1/8 | 1 1/2 | 1 | 4 | 0.92885 |
| | V-304-CB | 3/16 | 1 | 3/4 | 3 | 0.72340 |
| | V-304A-CB | 3/16 | 1 | 1/2 | 3 | 0.72340 |
| | V-305-CB | 3/16 | 1 1/4 | 7/8 | 3 1/2 | 0.85738 |
| | V-404-CB | 1/4 | 1 | 3/4 | 3 | 0.78590 |
| | V-404A-CB | 1/4 | 1 | 1/2 | 3 | 0.78590 |
| | V-405-CB | 1/4 | 1 1/4 | 1 | 4 | 0.91988 |

| Taper Per Side | Tool No. | Tip Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|---------------|----------|-----------|----------|---------|------------|
| 15 DEG | V-405A-CB | 1/4 | 1 1/4 | 1/2 | 3 1/2 | 0.91988 |
| | V-504-CB | 5/16 | 1 | 7/8 | 3 1/2 | 0.84890 |
| | V-606-CB | • 3/8 | 1 1/2 | 3/4 | 4 | 1.17885 |
| | V-805-CB | • 1/2 | 1 1/4 | 3/4 | 3 1/2 | 1.16988 |
| 20 DEG | W-0001-CB | 1/32 | 1/4 | 1/4 | 2 | 0.21324 |
| | W-001-CB | 1/16 | 1/4 | 1/4 | 2 | 0.24449 |
| | W-002-CB | 1/16 | 1/2 | 1/2 | 2 1/2 | 0.42647 |
| | W-102-CB | 3/32 | 1/2 | 1/2 | 2 1/2 | 0.45772 |
| | W-103-CB | 3/32 | 3/4 | 3/4 | 3 | 0.63971 |
| | W-202-CB | 1/8 | 1/2 | 1/2 | 2 1/2 | 0.48897 |
| | W-204-CB | • 1/8 | 1 | 1/2 | 3 1/2 | 0.85294 |
| | W-304-CB | • 3/16 | 1 | 1/2 | 3 1/2 | 0.91594 |
| W-404-CB | • 1/4 | 1 | 1/2 | 3 1/2 | 0.97794 | |
| 25 DEG | X-001-CB | 1/16 | 1/4 | 3/8 | 2 1/2 | 0.35118 |
| | X-002-CB | 1/16 | 1/2 | 3/8 | 2 1/2 | 0.63985 |
| | X-101-CB | 3/32 | 1/4 | 3/8 | 2 1/2 | 0.38268 |
| | X-103-CB | 3/32 | 3/4 | 1/2 | 3 | 0.79322 |
| | X-201-CB | 1/8 | 1/4 | 1/2 | 2 1/2 | 0.41368 |
| | X-202-CB | • 1/8 | 1/2 | 1/2 | 2 1/2 | 0.70235 |
| | X-204-CB | • 1/8 | 1 | 1/2 | 3 | 1.05762 |
| | 30 DEG | Z-001-CB | 1/16 | 1/4 | 3/8 | 2 1/2 |
| Z-002-CB | | 1/16 | 1/2 | 3/8 | 2 1/2 | 0.63985 |
| Z-101-CB | | 3/32 | 1/4 | 3/8 | 2 1/2 | 0.38243 |
| Z-103-CB | | 3/32 | 3/4 | 1/2 | 2 3/4 | 0.95978 |
| Z-201-CB | | 1/8 | 1/4 | 1/2 | 2 1/2 | 0.41368 |
| Z-202-CB | | • 1/8 | 1/2 | 1/2 | 2 1/2 | 0.70235 |
| Z-204-CB | | • 1/8 | 1 | 1/2 | 3 1/8 | 1.27970 |
| Z-404-CB | • 1/4 | 1 | 3/4 | 3 | 1.40470 | |
| 45 DEG | 45-2015-CB | • 1/8 | 5/16 | 1/2 | 2 1/2 | 0.75000 |
| | 45-202-CB | • 1/8 | 1/2 | 1/2 | 2 5/8 | 1.12500 |

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MINIATURE CARBIDE Ball Ends

| Taper Per Side | Tool No. | Ball Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. | Taper Per Side | Tool No. | Ball Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|--------------|-----------|-----------|----------|---------|------------|----------------|-------------|-----------|-----------|----------|---------|------------|
| 1/2 DEG | BM0-0001-CB | 1/32 | 1/4 | 1/8 | 2 | 0.03561 | 2 DEG | BM2-0001-CB | 1/32 | 1/4 | 1/8 | 2 | 0.04871 |
| | BM0-0002-CB | 1/32 | 1/2 | 1/8 | 2 | 0.03998 | | BM2-0002-CB | 1/32 | 1/2 | 1/8 | 2 | 0.06617 |
| | BM0-0501-CB | 3/64 | 1/4 | 1/8 | 2 | 0.05124 | | BM2-0501-CB | 3/64 | 1/4 | 1/8 | 2 | 0.06434 |
| | BM0-0502-CB | 3/64 | 1/2 | 1/8 | 2 | 0.05560 | | BM2-0502-CB | 3/64 | 1/2 | 1/8 | 2 | 0.08180 |
| | BM0-002-CB | 1/16 | 1/2 | 1/8 | 2 | 0.07123 | | BM2-002-CB | 1/16 | 1/2 | 1/8 | 2 | 0.09742 |
| | BM0-003-CB | 1/16 | 3/4 | 1/8 | 2 | 0.07559 | | BM2-003-CB | 1/16 | 3/4 | 1/8 | 2 | 0.11488 |
| | BM0-004-CB | 1/16 | 1 | 1/8 | 3 | 0.07995 | | BM2-004-CB | 1/16 | 1 | 3/16 | 3 | 0.13234 |
| | BM0-052-CB | 5/64 | 1/2 | 1/8 | 2 | 0.08685 | | BM2-052-CB | 5/64 | 1/2 | 1/8 | 2 | 0.11305 |
| | BM0-053-CB | 5/64 | 3/4 | 1/8 | 2 | 0.09121 | | BM2-053-CB | 5/64 | 3/4 | 3/16 | 2 | 0.13051 |
| BM0-054-CB | 5/64 | 1 | 1/8 | 3 | 0.09558 | BM2-054-CB | 5/64 | 1 | 3/16 | 3 | 0.14797 | | |
| 1 DEG | BM1-0001-CB | 1/32 | 1/4 | 1/8 | 2 | 0.03998 | 3 DEG | BM3-0001-CB | 1/32 | 1/4 | 1/8 | 2 | 0.05746 |
| | BM1-0002-CB | 1/32 | 1/2 | 1/8 | 2 | 0.04870 | | BM3-0002-CB | 1/32 | 1/2 | 1/8 | 2 | 0.08366 |
| | BM1-0501-CB | 3/64 | 1/4 | 1/8 | 2 | 0.05560 | | BM3-0501-CB | 3/64 | 1/4 | 1/8 | 2 | 0.07308 |
| | BM1-0502-CB | 3/64 | 1/2 | 1/8 | 2 | 0.06433 | | BM3-0502-CB | 3/64 | 1/2 | 1/8 | 2 | 0.09929 |
| | BM1-002-CB | 1/16 | 1/2 | 1/8 | 2 | 0.07995 | | BM3-002-CB | 1/16 | 1/2 | 1/8 | 2 | 0.11491 |
| | BM1-003-CB | 1/16 | 3/4 | 1/8 | 2 | 0.08868 | | BM3-003-CB | 1/16 | 3/4 | 3/16 | 2 | 0.14112 |
| | BM1-004-CB | 1/16 | 1 | 1/8 | 3 | 0.09740 | | BM3-004-CB | 1/16 | 1 | 3/16 | 3 | 0.16732 |
| | BM1-052-CB | 5/64 | 1/2 | 1/8 | 2 | 0.09558 | | BM3-006-CB | 1/16 | 1 1/2 | 1/4 | 3 | 0.21973 |
| | BM1-053-CB | 5/64 | 3/4 | 1/8 | 2 | 0.10430 | | BM3-052-CB | 5/64 | 1/2 | 3/16 | 2 | 0.13054 |
| BM1-054-CB | 5/64 | 1 | 1/8 | 3 | 0.11303 | BM3-053-CB | 5/64 | 3/4 | 3/16 | 2 | 0.15674 | | |
| 1-1/2 DEG | BM15-0001-CB | 1/32 | 1/4 | 1/8 | 2 | 0.04434 | 5 DEG | BM5-0001-CB | 1/32 | 1/4 | 1/8 | 2 | 0.07500 |
| | BM15-0002-CB | 1/32 | 1/2 | 1/8 | 2 | 0.05743 | | BM5-0002-CB | 1/32 | 1/2 | 3/16 | 2 | 0.11874 |
| | BM15-0501-CB | 3/64 | 1/4 | 1/8 | 2 | 0.05997 | | BM5-0003-CB | 1/32 | 3/4 | 3/16 | 2 1/2 | 0.16249 |
| | BM15-0502-CB | 3/64 | 1/2 | 1/8 | 2 | 0.07306 | | BM5-0501-CB | 3/64 | 1/4 | 1/8 | 2 | 0.09062 |
| | BM15-002-CB | 1/16 | 1/2 | 1/8 | 2 | 0.08868 | | BM5-0502-CB | 3/64 | 1/2 | 3/16 | 2 | 0.13437 |
| | BM15-003-CB | 1/16 | 3/4 | 1/8 | 2 | 0.10177 | | BM5-002-CB | 1/16 | 1/2 | 1/4 | 2 | 0.14999 |
| | BM15-004-CB | 1/16 | 1 | 3/16 | 3 | 0.11486 | | BM5-003-CB | 1/16 | 3/4 | 1/4 | 2 1/2 | 0.19374 |
| | BM15-052-CB | 5/64 | 1/2 | 1/8 | 2 | 0.10431 | | BM5-004-CB | 1/16 | 1 | 1/4 | 3 | 0.23748 |
| | BM15-053-CB | 5/64 | 3/4 | 1/8 | 2 | 0.11740 | | BM5-006-CB | 1/16 | 1 1/2 | 3/8 | 3 | 0.28123 |
| BM15-054-CB | 5/64 | 1 | 3/16 | 3 | 0.13049 | BM5-052-CB | 5/64 | 1/2 | 3/16 | 2 | 0.16562 | | |
| | | | | | | | BM5-053-CB | 5/64 | 3/4 | 1/4 | 2 1/2 | 0.20936 | |
| | | | | | | | BM5-054-CB | 5/64 | 1 | 3/8 | 3 | 0.25311 | |

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STANDARD CARBIDE

Ball Ends



| Taper Per Side | Tool No. | Ball Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|-------------|-----------|-----------|----------|---------|------------|
| 1/2 DEG | BKK-102-CB | 3/32 | 1/2 | 1/8 | 2 | 0.10248 |
| | BKK-103-CB | 3/32 | 3/4 | 1/8 | 2 | 0.10684 |
| | BKK-105-CB | 3/32 | 1 1/4 | 3/16 | 3 | 0.11556 |
| | BKK-201-CB | 1/8 | 1/4 | 3/16 | 2 | 0.12936 |
| | BKK-2015-CB | 1/8 | 3/8 | 3/16 | 2 | 0.13154 |
| | BKK-202-CB | 1/8 | 1/2 | 3/16 | 2 | 0.13373 |
| | BKK-203-CB | 1/8 | 3/4 | 3/16 | 2 | 0.13809 |
| | BKK-204-CB | 1/8 | 1 | 3/16 | 3 | 0.14245 |
| | BKK-205-CB | 1/8 | 1 1/4 | 3/16 | 3 | 0.14681 |
| | BKK-206-CB | 1/8 | 1 1/2 | 3/16 | 3 | 0.15118 |
| | BKK-303-CB | 3/16 | 3/4 | 1/4 | 2 1/2 | 0.20059 |
| | BKK-305-CB | 3/16 | 1 1/4 | 1/4 | 3 | 0.20931 |
| | BKK-307-CB | 3/16 | 1 3/4 | 1/4 | 3 1/2 | 0.21804 |
| | BKK-313-CB | 3/16 | 3 1/4 | 3/8 | 5 | 0.24421 |
| | BKK-403-CB | 1/4 | 3/4 | 3/8 | 2 1/2 | 0.26309 |
| | BKK-405-CB | 1/4 | 1 1/4 | 3/8 | 3 | 0.27181 |
| | BKK-409-CB | 1/4 | 2 1/4 | 3/8 | 4 | 0.28926 |
| | BKK-413-CB | 1/4 | 3 1/4 | 3/8 | 5 | 0.30671 |
| | BKK-605-CB | 3/8 | 1 1/4 | 1/2 | 3 | 0.39681 |
| | BKK-609-CB | 3/8 | 2 1/4 | 1/2 | 4 | 0.41426 |
| | BKK-613-CB | 3/8 | 3 1/4 | 1/2 | 5 | 0.43171 |
| | BKK-805-CB | 1/2 | 1 1/4 | 9/16 | 3 | 0.52181 |
| | BKK-809-CB | 1/2 | 2 1/4 | 9/16 | 4 | 0.53926 |
| | BKK-813-CB | 1/2 | 3 1/4 | 5/8 | 6 | 0.55671 |
| | BKK-1009-CB | 5/8 | 2 1/4 | 3/4 | 5 | 0.66426 |
| | BKK-1013-CB | 5/8 | 3 1/4 | 3/4 | 6 | 0.68171 |
| | BKK-1017-CB | 5/8 | 4 1/4 | 3/4 | 7 | 0.69916 |
| | BKK-1209-CB | 3/4 | 2 1/4 | 7/8 | 5 | 0.78926 |
| BKK-1213-CB | 3/4 | 3 1/4 | 7/8 | 6 | 0.80671 | |
| BKK-1217-CB | 3/4 | 4 1/4 | 7/8 | 7 | 0.82416 | |
| BKK-1221-CB | 3/4 | 5 1/4 | 7/8 | 8 | 0.84161 | |

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| Taper Per Side | Tool No. | Ball Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|------------|-----------|-----------|----------|---------|------------|
| 1 DEG | BK-102-CB | 3/32 | 1/2 | 1/8 | 2 | 0.11120 |
| | BK-103-CB | 3/32 | 3/4 | 3/16 | 2 1/2 | 0.11993 |
| | BK-104-CB | 3/32 | 1 | 3/16 | 3 | 0.12865 |
| | BK-105-CB | 3/32 | 1 1/4 | 3/16 | 3 | 0.13738 |
| | BK-106-CB | 3/32 | 1 1/2 | 1/4 | 3 1/2 | 0.14610 |
| | BK-201-CB | 1/8 | 1/4 | 3/16 | 2 | 0.13373 |
| | BK-2015-CB | 1/8 | 3/8 | 3/16 | 2 | 0.13809 |
| | BK-202-CB | 1/8 | 1/2 | 3/16 | 2 | 0.14245 |
| | BK-203-CB | 1/8 | 3/4 | 1/4 | 2 1/2 | 0.15118 |
| | BK-204-CB | 1/8 | 1 | 1/4 | 3 | 0.15990 |
| | BK-205-CB | 1/8 | 1 1/4 | 1/4 | 3 | 0.16863 |
| | BK-206-CB | 1/8 | 1 1/2 | 1/4 | 3 | 0.17735 |
| | BK-208-CB | 1/8 | 2 | 1/4 | 4 | 0.19480 |
| | BK-303-CB | 3/16 | 3/4 | 1/4 | 2 1/2 | 0.21368 |
| | BK-305-CB | 3/16 | 1 1/4 | 1/4 | 3 | 0.23113 |
| | BK-307-CB | 3/16 | 1 3/4 | 1/4 | 3 1/2 | 0.24858 |
| | BK-308-CB | 3/16 | 2 | 5/16 | 4 | 0.25730 |
| | BK-309-CB | 3/16 | 2 1/4 | 3/8 | 4 | 0.26603 |
| | BK-310-CB | 3/16 | 2 1/2 | 3/8 | 5 | 0.27475 |
| | BK-313-CB | 3/16 | 3 1/4 | 3/8 | 5 | 0.30093 |
| | BK-403-CB | 1/4 | 3/4 | 3/8 | 2 1/2 | 0.27618 |
| | BK-405-CB | 1/4 | 1 1/4 | 3/8 | 3 | 0.29363 |
| | BK-408-CB | 1/4 | 2 | 3/8 | 4 | 0.31980 |
| | BK-409-CB | 1/4 | 2 1/4 | 3/8 | 4 | 0.32853 |
| | BK-413-CB | 1/4 | 3 1/4 | 3/8 | 5 | 0.36343 |
| | BK-605-CB | 3/8 | 1 1/4 | 1/2 | 3 | 0.41863 |
| | BK-609-CB | 3/8 | 2 1/4 | 1/2 | 4 | 0.45353 |
| | BK-613-CB | 3/8 | 3 1/4 | 1/2 | 6 | 0.48843 |
| | BK-803-CB | 1/2 | 3/4 | 5/8 | 3 | 0.52618 |
| | BK-805-CB | 1/2 | 1 1/4 | 9/16 | 4 | 0.54363 |
| | BK-809-CB | 1/2 | 2 1/4 | 5/8 | 4 | 0.57853 |
| | BK-813-CB | 1/2 | 3 1/4 | 5/8 | 5 | 0.61343 |
| BK-1009-CB | 5/8 | 2 1/4 | 3/4 | 4 | 0.70353 | |
| BK-1013-CB | 5/8 | 3 1/4 | 3/4 | 5 | 0.73843 | |
| BK-1017-CB | 5/8 | 4 1/4 | 7/8 | 7 | 0.77333 | |
| BK-1209-CB | 3/4 | 2 1/4 | 7/8 | 5 | 0.82853 | |
| BK-1213-CB | 3/4 | 3 1/4 | 7/8 | 6 | 0.86343 | |
| BK-1217-CB | 3/4 | 4 1/4 | 1 | 7 | 0.89833 | |
| BK-1221-CB | 3/4 | 5 1/4 | 1 | 8 | 0.93323 | |

• Four Flutes

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STANDARD CARBIDE

Ball Ends

| Taper Per Side | Tool No. | Ball Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|------------------|------------|-----------|-----------|----------|---------|------------|
| 1-1/2 DEG | BKX-102-CB | 3/32 | 1/2 | 3/16 | 2 | 0.11993 |
| | BKX-103-CB | 3/32 | 3/4 | 3/16 | 2 1/2 | 0.13302 |
| | BKX-104-CB | 3/32 | 1 | 1/4 | 3 | 0.14611 |
| | BKX-105-CB | 3/32 | 1 1/4 | 3/16 | 3 | 0.15920 |
| | BKX-106-CB | 3/32 | 1 1/2 | 1/4 | 3 | 0.17229 |
| | BKX-154-CB | 7/64 | 1 | 3/16 | 3 | 0.16136 |
| | BKX-202-CB | 1/8 | 1/2 | 3/16 | 2 1/2 | 0.15118 |
| | BKX-203-CB | 1/8 | 3/4 | 1/4 | 2 1/2 | 0.16427 |
| | BKX-204-CB | 1/8 | 1 | 3/16 | 3 | 0.17736 |
| | BKX-205-CB | 1/8 | 1 1/4 | 1/4 | 3 | 0.19045 |
| | BKX-206-CB | 1/8 | 1 1/2 | 1/4 | 3 | 0.20354 |
| | BKX-208-CB | 1/8 | 2 | 1/4 | 3 1/2 | 0.22972 |
| | BKX-209-CB | 1/8 | 2 1/4 | 5/16 | 4 | 0.24281 |
| | BKX-212-CB | 1/8 | 3 | 5/16 | 5 | 0.28208 |
| | BKX-253-CB | 5/32 | 3/4 | 1/4 | 2 1/2 | 0.19552 |
| | BKX-254-CB | 5/32 | 1 | 1/4 | 3 | 0.20861 |
| | BKX-255-CB | 5/32 | 1 1/4 | 1/4 | 3 | 0.22170 |
| | BKX-256-CB | 5/32 | 1 1/2 | 1/4 | 3 | 0.23479 |
| | BKX-258-CB | 5/32 | 2 | 5/16 | 4 | 0.26097 |
| | BKX-303-CB | 3/16 | 3/4 | 3/8 | 2 1/2 | 0.22677 |
| | BKX-304-CB | 3/16 | 1 | 1/4 | 3 | 0.23986 |
| | BKX-305-CB | 3/16 | 1 1/4 | 3/8 | 3 | 0.25295 |
| | BKX-307-CB | 3/16 | 1 3/4 | 3/8 | 3 1/2 | 0.27913 |
| | BKX-309-CB | 3/16 | 2 1/4 | 3/8 | 4 | 0.30531 |
| | BKX-313-CB | 3/16 | 3 1/4 | 3/8 | 5 | 0.35767 |
| | BKX-403-CB | 1/4 | 3/4 | 3/8 | 2 1/2 | 0.28927 |
| | BKX-405-CB | 1/4 | 1 1/4 | 3/8 | 3 | 0.31545 |
| | BKX-406-CB | 1/4 | 1 1/2 | 3/8 | 3 1/2 | 0.32854 |
| | BKX-409-CB | 1/4 | 2 1/4 | 3/8 | 4 | 0.36781 |
| | BKX-413-CB | 1/4 | 3 1/4 | 1/2 | 5 | 0.42017 |
| | BKX-605-CB | 3/8 | 1 1/4 | 1/2 | 3 | 0.44045 |
| | BKX-609-CB | 3/8 | 2 1/4 | 1/2 | 4 | 0.49281 |
| BKX-613-CB | 3/8 | 3 1/4 | 9/16 | 5 | 0.54517 | |
| BKX-805-CB | 1/2 | 1 1/4 | 5/8 | 3 1/2 | 0.56545 | |
| BKX-806-CB | 1/2 | 1/2 | 5/8 | 3 1/2 | 0.52618 | |
| BKX-809-CB | 1/2 | 2 1/4 | 5/8 | 4 | 0.61781 | |
| BKX-813-CB | 1/2 | 3 1/4 | 3/4 | 5 | 0.67017 | |
| BKX-1009-CB | 5/8 | 2 1/4 | 3/4 | 4 | 0.74281 | |
| BKX-1013-CB | 5/8 | 3 1/4 | 7/8 | 6 | 0.79517 | |
| BKX-1017-CB | 5/8 | 4 1/4 | 7/8 | 7 | 0.84753 | |
| BKX-1209-CB | 3/4 | 2 1/4 | 7/8 | 4 | 0.86781 | |
| BKX-1213-CB | 3/4 | 3 1/4 | 1 | 6 | 0.92017 | |

| Taper Per Side | Tool No. | Ball Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|------------|-----------|-----------|----------|-------|------------|
| 2 DEG | BL-102-CB | 3/32 | 1/2 | 3/16 | 2 | 0.12867 |
| | BL-103-CB | 3/32 | 3/4 | 1/4 | 2 1/2 | 0.14613 |
| | BL-104-CB | 3/32 | 1 | 1/4 | 3 | 0.16359 |
| | BL-105-CB | 3/32 | 1 1/4 | 1/4 | 3 | 0.18105 |
| | BL-202-CB | 1/8 | 1/2 | 3/16 | 2 | 0.15992 |
| | BL-203-CB | 1/8 | 3/4 | 1/4 | 2 1/2 | 0.17738 |
| | BL-204-CB | 1/8 | 1 | 1/4 | 2 1/2 | 0.19484 |
| | BL-205-CB | 1/8 | 1 1/4 | 1/4 | 3 | 0.21230 |
| | BL-206-CB | 1/8 | 1 1/2 | 1/4 | 3 | 0.22976 |
| | BL-208-CB | 1/8 | 2 | 5/16 | 3 1/2 | 0.26468 |
| | BL-210-CB | 1/8 | 2 1/2 | 5/16 | 4 | 0.29960 |
| | BL-303-CB | 3/16 | 3/4 | 1/4 | 2 1/2 | 0.23988 |
| | BL-305-CB | 3/16 | 1 1/4 | 3/8 | 3 | 0.27480 |
| | BL-307-CB | 3/16 | 1 3/4 | 3/8 | 3 1/2 | 0.30972 |
| | BL-309-CB | 3/16 | 2 1/4 | 1/2 | 4 | 0.34464 |
| | BL-313-CB | 3/16 | 3 1/4 | 1/2 | 5 | 0.41448 |
| | BL-403-CB | 1/4 | 3/4 | 3/8 | 2 1/2 | 0.30238 |
| | BL-405-CB | 1/4 | 1 1/4 | 3/8 | 3 | 0.33730 |
| | BL-408-CB | 1/4 | 2 | 1/2 | 4 | 0.38968 |
| | BL-409-CB | 1/4 | 2 1/4 | 1/2 | 4 | 0.40714 |
| | BL-413-CB | 1/4 | 3 1/4 | 1/2 | 5 | 0.47698 |
| | BL-605-CB | 3/8 | 1 1/4 | 1/2 | 3 1/2 | 0.46230 |
| | BL-609-CB | 3/8 | 2 1/4 | 9/16 | 4 | 0.53214 |
| | BL-613-CB | 3/8 | 3 1/4 | 5/8 | 5 | 0.60198 |
| | BL-805-CB | 1/2 | 1 1/4 | 5/8 | 3 1/2 | 0.58730 |
| | BL-809-CB | 1/2 | 2 1/4 | 3/4 | 4 | 0.65714 |
| | BL-813-CB | 1/2 | 3 1/4 | 3/4 | 5 | 0.72698 |
| | BL-1009-CB | 5/8 | 2 1/4 | 7/8 | 5 | 0.78214 |
| | BL-1013-CB | 5/8 | 3 1/4 | 7/8 | 6 | 0.85198 |
| | BL-1017-CB | 5/8 | 4 1/4 | 1 | 7 | 0.92182 |
| | BL-1209-CB | 3/4 | 2 1/4 | 1 | 5 | 0.90714 |
| | BL-1213-CB | 3/4 | 3 1/4 | 1 | 6 | 0.97698 |

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STANDARD CARBIDE

Ball Ends



| Taper Per Side | Tool No. | Ball Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. | Taper Per Side | Tool No. | Ball Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. | |
|------------------|-----------|-----------|-----------|----------|-------|------------|------------------|------------------|------------|-----------|----------|-------|------------|---------|
| 3 DEG | BM-103-CB | 3/32 | 3/4 | 3/16 | 2 | 0.17237 | 3 DEG | BM-504-CB | 5/16 | 1 | 1/2 | 3 | 0.41782 | |
| | BM-104-CB | 3/32 | 1 | 1/4 | 3 | 0.19857 | | BM-507-CB | 5/16 | 1 3/4 | 1/2 | 3 1/2 | 0.49644 | |
| | BM-105-CB | 3/32 | 1 1/4 | 1/4 | 3 | 0.22478 | | BM-604-CB | 3/8 | 1 | 1/2 | 3 | 0.47982 | |
| | BM-106-CB | 3/32 | 1 1/2 | 1/4 | 3 | 0.25098 | | BM-605-CB | 3/8 | 1 1/4 | 1/2 | 3 | 0.50000 | |
| | BM-107-CB | 3/32 | 1 3/4 | 3/8 | 3 1/2 | 0.27719 | | BM-609-CB | 3/8 | 2 1/4 | 5/8 | 4 | 0.61085 | |
| | BM-108-CB | 3/32 | 2 | 5/16 | 4 | 0.30339 | | BM-613-CB | 3/8 | 3 1/4 | 3/4 | 5 | 0.71567 | |
| | BM-110-CB | 3/32 | 2 1/2 | 3/8 | 4 | 0.35580 | | BM-616-CB | 3/8 | 4 | 7/8 | 6 | 0.79428 | |
| | BM-154-CB | 7/64 | 1 | 1/4 | 3 | 0.21382 | | BM-620-CB | 3/8 | 5 | 1 | 8 | 0.89910 | |
| | BM-155-CB | 7/64 | 1 1/4 | 1/4 | 3 | 0.24003 | | BM-805-CB | 1/2 | 1 1/4 | 3/4 | 4 | 0.63103 | |
| | BM-156-CB | 7/64 | 1 1/2 | 5/16 | 3 | 0.26623 | | BM-809-CB | 1/2 | 2 1/4 | 3/4 | 4 | 0.73585 | |
| | BM-158-CB | 7/64 | 2 | 3/8 | 4 | 0.31864 | | BM-813-CB | 1/2 | 3 1/4 | 7/8 | 6 | 0.84067 | |
| | BM-203-CB | 1/8 | 3/4 | 1/4 | 2 1/2 | 0.20362 | | BM-816-CB | 1/2 | 4 | 1 | 7 | 0.91928 | |
| | BM-204-CB | 1/8 | 1 | 1/4 | 3 | 0.22982 | | BM-1009-CB | 5/8 | 2 1/4 | 7/8 | 5 | 0.86085 | |
| | BM-205-CB | 1/8 | 1 1/4 | 3/8 | 3 | 0.25603 | | BM-1013-CB | 5/8 | 3 1/4 | 1 | 6 | 0.96567 | |
| | BM-206-CB | 1/8 | 1 1/2 | 3/8 | 3 1/2 | 0.28223 | | BM-1209-CB | 3/4 | 2 1/4 | 1 | 5 | 0.98585 | |
| | BM-208-CB | 1/8 | 2 | 3/8 | 4 | 0.33464 | | 4 DEG | BN-0004-CB | 1/32 | 1 | 3/16 | 3 | 0.17111 |
| | BM-209-CB | 1/8 | 2 1/4 | 3/8 | 4 | 0.36085 | | | BN-004-CB | 1/16 | 1 | 3/16 | 3 | 0.20236 |
| | BM-210-CB | 1/8 | 2 1/2 | 7/16 | 4 | 0.38705 | | | BN-103-CB | 3/32 | 3/4 | 1/4 | 2 1/2 | 0.19865 |
| | BM-212-CB | 1/8 | 3 | 1/2 | 5 | 0.43946 | | | BN-104-CB | 3/32 | 1 | 1/4 | 3 | 0.23361 |
| | BM-216-CB | 1/8 | 4 | 9/16 | 6 | 0.54428 | | | BN-203-CB | 1/8 | 3/4 | 1/4 | 2 1/2 | 0.22990 |
| | BM-253-CB | 5/32 | 3/4 | 1/4 | 2 1/2 | 0.23487 | | | BN-204-CB | 1/8 | 1 | 3/8 | 2 1/2 | 0.26486 |
| | BM-254-CB | 5/32 | 1 | 3/8 | 3 | 0.26107 | | | BN-206-CB | 1/8 | 1 1/2 | 1/2 | 3 1/2 | 0.33479 |
| | BM-255-CB | 5/32 | 1 1/4 | 1/4 | 3 | 0.28728 | | | BN-208-CB | 1/8 | 2 | 1/2 | 4 | 0.40472 |
| | BM-256-CB | 5/32 | 1 1/2 | 5/16 | 3 | 0.31348 | | | BN-210-CB | 1/8 | 2 1/2 | 1/2 | 5 | 0.47465 |
| | BM-257-CB | 5/32 | 1 3/4 | 3/8 | 3 1/2 | 0.33969 | | | BN-303-CB | 3/16 | 3/4 | 3/8 | 2 1/2 | 0.29240 |
| | BM-258-CB | 5/32 | 2 | 3/8 | 4 | 0.36589 | | | BN-305-CB | 3/16 | 1 1/4 | 3/8 | 3 | 0.36233 |
| | BM-303-CB | 3/16 | 3/4 | 3/8 | 2 1/2 | 0.26612 | | | BN-313-CB | 3/16 | 3 1/4 | 3/4 | 5 | 0.64205 |
| | BM-304-CB | 3/16 | 1 | 3/8 | 3 | 0.29232 | | | BN-316-CB | 3/16 | 4 | 3/4 | 6 | 0.74694 |
| | BM-305-CB | 3/16 | 1 1/4 | 3/8 | 3 | 0.31853 | | | BN-403-CB | 1/4 | 3/4 | 3/8 | 2 1/2 | 0.35490 |
| | BM-306-CB | 3/16 | 1 1/2 | 3/8 | 3 1/2 | 0.34473 | | | BN-405-CB | 1/4 | 1 1/4 | 1/2 | 3 1/2 | 0.42483 |
| | BM-310-CB | 3/16 | 2 1/2 | 1/2 | 4 | 0.44955 | | | BN-409-CB | 1/4 | 2 1/4 | 5/8 | 4 | 0.56469 |
| | BM-313-CB | 3/16 | 3 1/4 | 9/16 | 5 | 0.52817 | | | BN-413-CB | 1/4 | 3 1/4 | 3/4 | 5 | 0.70455 |
| | BM-316-CB | 3/16 | 4 | 5/8 | 6 | 0.60678 | | | BN-416-CB | 1/4 | 4 | 7/8 | 7 | 0.80944 |
| | BM-320-CB | 3/16 | 5 | 3/4 | 7 | 0.71160 | | | BN-605-CB | 3/8 | 1 1/4 | 9/16 | 3 | 0.54983 |
| | BM-403-CB | 1/4 | 3/4 | 3/8 | 2 1/2 | 0.32862 | | | BN-609-CB | 3/8 | 2 1/4 | 3/4 | 4 | 0.68969 |
| | BM-404-CB | 1/4 | 1 | 3/8 | 3 | 0.35482 | | BN-613-CB | 3/8 | 3 1/4 | 7/8 | 6 | 0.82955 | |
| | BM-405-CB | 1/4 | 1 1/4 | 3/8 | 3 | 0.37500 | | BN-616-CB | 3/8 | 4 | 1 | 7 | 0.93444 | |
| | BM-408-CB | 1/4 | 2 | 1/2 | 4 | 0.45964 | | BN-805-CB | 1/4 | 1 1/4 | 3/4 | 3 1/2 | 0.67483 | |
| | BM-409-CB | 1/4 | 2 1/4 | 1/2 | 4 | 0.48585 | | BN-809-CB | 1/4 | 2 1/4 | 7/8 | 5 | 0.81469 | |
| | BM-413-CB | 1/4 | 3 1/4 | 5/8 | 5 | 0.59067 | | BN-813-CB | 1/4 | 3 1/4 | 1 | 6 | 0.95455 | |
| | BM-416-CB | 1/4 | 4 | 3/4 | 6 | 0.66928 | | | | | | | | |
| | BM-420-CB | 1/4 | 5 | 7/8 | 7 | 0.77410 | | | | | | | | |

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• Four Flutes

Other coatings are available including: TiCN and TiAlN

A

STANDARD CARBIDE

Ball Ends

| Taper Per Side | Tool No. | Ball Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|-----------|-----------|-----------|----------|---------|------------|
| 5 DEG | BO-102-CB | 3/32 | 1/2 | 1/4 | 2 1/2 | 0.18124 |
| | BO-103-CB | 3/32 | 3/4 | 1/4 | 2 1/2 | 0.22499 |
| | BO-104-CB | 3/32 | 1 | 3/8 | 3 | 0.26873 |
| | BO-105-CB | 3/32 | 1 1/4 | 3/8 | 3 | 0.31248 |
| | BO-106-CB | 3/32 | 1 1/2 | 3/8 | 3 1/2 | 0.35622 |
| | BO-108-CB | 3/32 | 2 | 1/2 | 4 | 0.44371 |
| | BO-155-CB | 7/64 | 1 1/4 | 3/8 | 3 | 0.32773 |
| | BO-203-CB | 1/8 | 3/4 | 1/4 | 2 1/2 | 0.25000 |
| | BO-204-CB | 1/8 | 1 | 3/8 | 3 | 0.29998 |
| | BO-205-CB | 1/8 | 1 1/4 | 3/8 | 3 | 0.34373 |
| | BO-206-CB | 1/8 | 1 1/2 | 3/8 | 3 1/2 | 0.37500 |
| | BO-207-CB | 1/8 | 1 3/4 | 1/2 | 4 | 0.43122 |
| | BO-208-CB | 1/8 | 2 | 1/2 | 4 | 0.47496 |
| | BO-210-CB | 1/8 | 2 1/2 | 5/8 | 5 | 0.56245 |
| | BO-212-CB | 1/8 | 3 | 3/4 | 5 | 0.64994 |
| | BO-253-CB | 5/32 | 3/4 | 3/8 | 2 1/2 | 0.28749 |
| | BO-254-CB | 5/32 | 1 | 3/8 | 3 | 0.33123 |
| | BO-255-CB | 5/32 | 1 1/4 | 3/8 | 3 | 0.37498 |
| | BO-256-CB | 5/32 | 1 1/2 | 1/2 | 3 1/2 | 0.41872 |
| | BO-257-CB | 5/32 | 1 3/4 | 1/2 | 4 | 0.46247 |
| | BO-258-CB | 5/32 | 2 | 1/2 | 4 | 0.50000 |
| | BO-303-CB | 3/16 | 3/4 | 3/8 | 2 1/2 | 0.31874 |
| | BO-304-CB | 3/16 | 1 | 3/8 | 3 | 0.36248 |
| | BO-305-CB | 3/16 | 1 1/4 | 1/2 | 3 | 0.40623 |
| | BO-306-CB | 3/16 | 1 1/2 | 1/2 | 3 1/2 | 0.44997 |
| | BO-307-CB | 3/16 | 1 3/4 | 1/2 | 3 1/2 | 0.49372 |
| | BO-308-CB | 3/16 | 2 | 9/16 | 4 | 0.53746 |
| | BO-310-CB | 3/16 | 2 1/2 | 5/8 | 4 | 0.62495 |
| | BO-312-CB | 3/16 | 3 | 3/4 | 5 | 0.71244 |
| | BO-313-CB | 3/16 | 3 1/4 | 7/8 | 6 | 0.75619 |
| | BO-316-CB | 3/16 | 4 | 1 | 7 | 0.88742 |
| | BO-403-CB | 1/4 | 3/4 | 1/2 | 3 | 0.38124 |
| BO-404-CB | 1/4 | 1 | 1/2 | 3 | 0.42498 | |
| BO-405-CB | 1/4 | 1 1/4 | 1/2 | 3 | 0.46873 | |
| BO-406-CB | 1/4 | 1 1/2 | 1/2 | 3 1/2 | 0.51247 | |
| BO-407-CB | 1/4 | 1 3/4 | 5/8 | 4 | 0.55622 | |
| BO-408-CB | 1/4 | 2 | 5/8 | 4 | 0.59996 | |
| BO-409-CB | 1/4 | 2 1/4 | 3/4 | 5 | 0.64371 | |
| BO-410-CB | 1/4 | 2 1/2 | 3/4 | 5 | 0.68745 | |
| BO-413-CB | 1/4 | 3 1/4 | 7/8 | 6 | 0.81869 | |
| BO-416-CB | 1/4 | 4 | 1 | 7 | 0.94992 | |
| BO-504-CB | 5/16 | 1 | 1/2 | 3 | 0.48798 | |
| BO-509-CB | 5/16 | 2 1/4 | 3/4 | 5 | 0.70671 | |

| Taper Per Side | Tool No. | Ball Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. | |
|----------------|------------|-----------|-----------|----------|---------|------------|---------|
| 5 DEG | BO-604-CB | 3/8 | 1 | 5/8 | 3 1/2 | 0.54998 | |
| | BO-605-CB | 3/8 | 1 1/4 | 5/8 | 4 | 0.59373 | |
| | BO-609-CB | 3/8 | 2 1/4 | 7/8 | 5 | 0.76871 | |
| | BO-613-CB | 3/8 | 3 1/4 | 1 | 6 | 0.94369 | |
| | BO-805-CB | 1/2 | 1 1/4 | 3/4 | 4 | 0.71873 | |
| | BO-806-CB | 1/2 | 1 1/2 | 7/8 | 4 | 0.76247 | |
| | BO-809-CB | 1/2 | 2 1/4 | 1 | 5 | 0.89371 | |
| | 6 DEG | BP-004-CB | 1/16 | 1 | 5/16 | 3 | 0.27271 |
| | | BP-104-CB | 3/32 | 1 | 5/16 | 3 | 0.30396 |
| BP-204-CB | | 1/8 | 1 | 3/8 | 3 | 0.33521 | |
| 7 DEG | BR-0003-CB | 1/32 | 3/4 | 1/4 | 2 1/2 | 0.21542 | |
| | BR-0004-CB | 1/32 | 1 | 3/8 | 3 | 0.27656 | |
| | BR-001-CB | 1/16 | 1/4 | 1/4 | 2 | 0.12389 | |
| | BR-002-CB | 1/16 | 1/2 | 1/4 | 2 | 0.18528 | |
| | BR-003-CB | 1/16 | 3/4 | 3/8 | 3 | 0.24667 | |
| | BR-004-CB | 1/16 | 1 | 3/8 | 3 | 0.30806 | |
| | BR-054-CB | 5/64 | 1 | 3/8 | 3 | 0.32356 | |
| | BR-102-CB | 3/32 | 1/2 | 1/4 | 2 1/2 | 0.21653 | |
| | BR-104-CB | 3/32 | 1 | 3/8 | 3 | 0.33931 | |
| | BR-106-CB | 3/32 | 1 1/2 | 1/2 | 3 1/2 | 0.46209 | |
| | BR-202-CB | 1/8 | 1/2 | 3/8 | 2 1/2 | 0.24778 | |
| | BR-203-CB | 1/8 | 3/4 | 3/8 | 2 1/2 | 0.30917 | |
| | BR-204-CB | 1/8 | 1 | 3/8 | 3 | 0.37056 | |
| | BR-206-CB | 1/8 | 1 1/2 | 1/2 | 3 1/2 | 0.49334 | |
| | BR-208-CB | 1/8 | 2 | 5/8 | 4 | 0.61612 | |
| | BR-212-CB | 1/8 | 3 | 7/8 | 5 | 0.86168 | |
| | BR-253-CB | 5/32 | 3/4 | 3/8 | 2 1/2 | 0.34042 | |
| | BR-305-CB | 3/16 | 1 1/4 | 1/2 | 3 1/2 | 0.49445 | |
| | BR-403-CB | 1/4 | 3/4 | 1/2 | 3 | 0.43417 | |
| | BR-404-CB | 1/4 | 1 | 1/2 | 3 | 0.49556 | |
| BR-405-CB | 1/4 | 1 1/4 | 5/8 | 3 1/2 | 0.55695 | | |
| BR-409-CB | 1/4 | 2 1/4 | 7/8 | 5 | 0.80251 | | |
| BR-605-CB | 3/8 | 1 1/4 | 3/4 | 4 | 0.68195 | | |
| BR-609-CB | 3/8 | 2 1/4 | 1 | 5 | 0.92751 | | |
| BR-805-CB | 1/2 | 1 1/4 | 7/8 | 4 | 0.80695 | | |
| BR-808-CB | 1/2 | 2 | 1 | 5 | 0.99112 | | |

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STANDARD CARBIDE

Ball Ends

| Taper Per Side | Tool No. | Ball Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. | Taper Per Side | Tool No. | Ball Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. | |
|----------------|------------|-----------|-----------|----------|---------|---------------|----------------|---------------|-----------|-----------|----------|---------|------------|---------|
| 10 DEG | BT-0002-CB | 1/32 | 1/2 | 1/4 | 2 1/2 | 0.20758 | 15 DEG | BV-0001-CB | 1/32 | 1/4 | 1/4 | 2 | 0.16523 | |
| | BT-0003-CB | 1/32 | 3/4 | 3/8 | 2 1/2 | 0.29575 | | BV-0003-CB | 1/32 | 3/4 | 1/2 | 2 1/2 | 0.43318 | |
| | BT-002-CB | 1/16 | 1/2 | 3/8 | 2 1/2 | 0.23883 | | BV-001-CB | 1/16 | 1/4 | 1/4 | 2 | 0.19648 | |
| | BT-003-CB | 1/16 | 3/4 | 3/8 | 2 1/2 | 0.32700 | | BV-003-CB | 1/16 | 3/4 | 1/2 | 2 1/2 | 0.46443 | |
| | BT-004-CB | 1/16 | 1 | 1/2 | 3 | 0.41516 | | BV-101-CB | 3/32 | 1/4 | 1/4 | 2 | 0.22773 | |
| | BT-005-CB | 1/16 | 1 1/4 | 1/2 | 3 1/2 | 0.50333 | | BV-102-CB | 3/32 | 1/2 | 3/8 | 2 1/2 | 0.36170 | |
| | BT-102-CB | 3/32 | 1/2 | 3/8 | 2 1/2 | 0.27008 | | BV-103-CB | 3/32 | 3/4 | 1/2 | 3 | 0.49568 | |
| | BT-102A-CB | 3/32 | 1/2 | 1/4 | 2 1/2 | 0.27008 | | BV-104-CB | 3/32 | 1 | 3/4 | 3 | 0.62965 | |
| | BT-103-CB | 3/32 | 3/4 | 3/8 | 2 1/2 | 0.35825 | | BV-106-CB | 3/32 | 1 1/2 | 1 | 4 | 0.89760 | |
| | BT-106-CB | 3/32 | 1 1/2 | 5/8 | 3 1/2 | 0.62274 | | BV-202-CB | 1/8 | 1/2 | 1/2 | 3 | 0.39295 | |
| | BT-203-CB | 1/8 | 3/4 | 3/8 | 2 1/2 | 0.38950 | | BV-203-CB | 1/8 | 3/4 | 9/16 | 3 | 0.52693 | |
| | BT-204-CB | 1/8 | 1 | 1/2 | 3 | 0.47766 | | BV-204-CB | 1/8 | 1 | 3/4 | 3 | 0.66090 | |
| | BT-205-CB | 1/8 | 1 1/4 | 5/8 | 3 | 0.56583 | | BV-206-CB | 1/8 | 1 1/2 | 1 | 4 | 0.92885 | |
| | BT-206-CB | 1/8 | 1 1/2 | 3/4 | 3 1/2 | 0.65399 | | BV-304-CB | 3/16 | 1 | 3/4 | 3 | 0.72340 | |
| | BT-254-CB | 5/32 | 1 | 1/2 | 3 | 0.50000 | | BV-304A-CB | 3/16 | 1 | 1/2 | 3 | 0.72340 | |
| | BT-258-CB | 5/32 | 2 | 7/8 | 4 | 0.86132 | | BV-305-CB | 3/16 | 1 1/4 | 7/8 | 3 1/2 | 0.85738 | |
| | BT-303-CB | 3/16 | 3/4 | 1/2 | 3 | 0.45199 | | BV-404-CB | 1/4 | 1 | 3/4 | 3 | 0.78590 | |
| | BT-305-CB | 3/16 | 1 1/4 | 5/8 | 3 1/2 | 0.62500 | | BV-404A-CB | 1/4 | 1 | 1/2 | 3 | 0.78590 | |
| | BT-309-CB | 3/16 | 2 1/4 | 1 | 5 | 0.98099 | | BV-405-CB | 1/4 | 1 1/4 | 1 | 4 | 0.91988 | |
| | BT-403-CB | 1/4 | 3/4 | 5/8 | 3 | 0.51450 | | | | | | | | |
| BT-404-CB | 1/4 | 1 | 5/8 | 3 | 0.60266 | | | | | | | | | |
| BT-405-CB | 1/4 | 1 1/4 | 3/4 | 3 1/2 | 0.69083 | | | | | | | | | |
| BT-408-CB | 1/4 | 2 | 1 | 5 | 0.95532 | | | | | | | | | |
| BT-605-CB | 3/8 | 1 1/4 | 7/8 | 3 1/2 | 0.81583 | | | | | | | | | |
| BT-805-CB | 1/2 | 1 1/4 | 1 | 3 1/2 | 0.94083 | | | | | | | | | |
| 15 DEG | BV-0001-CB | 1/32 | 1/4 | 1/4 | 2 | 0.16523 | 20 DEG | BW-0001-CB | 1/32 | 1/4 | 1/4 | 2 | 0.21324 | |
| | BV-0003-CB | 1/32 | 3/4 | 1/2 | 2 1/2 | 0.43318 | | BW-001-CB | 1/16 | 1/4 | 1/4 | 2 | 0.24449 | |
| | BV-001-CB | 1/16 | 1/4 | 1/4 | 2 | 0.19648 | | BW-002-CB | 1/16 | 1/2 | 1/2 | 2 1/2 | 0.42647 | |
| | BV-003-CB | 1/16 | 3/4 | 1/2 | 2 1/2 | 0.46443 | | BW-102-CB | 3/32 | 1/2 | 1/2 | 2 1/2 | 0.45772 | |
| | BV-101-CB | 3/32 | 1/4 | 1/4 | 2 | 0.22773 | | BW-103-CB | 3/32 | 3/4 | 3/4 | 3 | 0.63971 | |
| | BV-102-CB | 3/32 | 1/2 | 3/8 | 2 1/2 | 0.36170 | | BW-202-CB | 1/8 | 1/2 | 1/2 | 2 1/2 | 0.48897 | |
| | BV-103-CB | 3/32 | 3/4 | 1/2 | 3 | 0.49568 | | BW-204-CB | 1/8 | 1 | 1/2 | 3 1/2 | 0.85294 | |
| | BV-104-CB | 3/32 | 1 | 3/4 | 3 | 0.62965 | | BW-304-CB | 3/16 | 1 | 1/2 | 3 1/2 | 0.91594 | |
| | BV-106-CB | 3/32 | 1 1/2 | 1 | 4 | 0.89760 | | BW-404-CB | 1/4 | 1 | 1/2 | 3 1/2 | 0.97794 | |
| | BV-202-CB | 1/8 | 1/2 | 1/2 | 3 | 0.39295 | | 25 DEG | BX-001-CB | 1/16 | 1/4 | 3/8 | 2 1/2 | 0.35118 |
| BV-203-CB | 1/8 | 3/4 | 9/16 | 3 | 0.52693 | BX-002-CB | 1/16 | | 1/2 | 3/8 | 2 1/2 | 0.63985 | | |
| BV-204-CB | 1/8 | 1 | 3/4 | 3 | 0.66090 | BX-101-CB | 3/32 | | 1/4 | 3/8 | 2 1/2 | 0.38268 | | |
| BV-206-CB | 1/8 | 1 1/2 | 1 | 4 | 0.92885 | BX-103-CB | 3/32 | | 3/4 | 1/2 | 3 | 0.79322 | | |
| BV-304-CB | 3/16 | 1 | 3/4 | 3 | 0.72340 | BX-201-CB | 1/8 | | 1/4 | 1/2 | 2 1/2 | 0.41368 | | |
| BV-304A-CB | 3/16 | 1 | 1/2 | 3 | 0.72340 | BX-202-CB | 1/8 | | 1/2 | 1/2 | 2 1/2 | 0.70235 | | |
| BV-305-CB | 3/16 | 1 1/4 | 7/8 | 3 1/2 | 0.85738 | BX-204-CB | 1/8 | | 1 | 1/2 | 3 | 1.05762 | | |
| BV-404-CB | 1/4 | 1 | 3/4 | 3 | 0.78590 | 30 DEG | BZ-001-CB | | 1/16 | 1/4 | 3/8 | 2 1/2 | 0.35118 | |
| BV-404A-CB | 1/4 | 1 | 1/2 | 3 | 0.78590 | | BZ-002-CB | | 1/16 | 1/2 | 3/8 | 2 1/2 | 0.63985 | |
| BV-405-CB | 1/4 | 1 1/4 | 1 | 4 | 0.91988 | | BZ-101-CB | | 3/32 | 1/4 | 3/8 | 2 1/2 | 0.38243 | |
| | | | | | | | BZ-103-CB | 3/32 | 3/4 | 1/2 | 2 3/4 | 0.95978 | | |
| | | | | | | | BZ-201-CB | 1/8 | 1/4 | 1/2 | 2 1/2 | 0.41368 | | |
| | | | | | | | BZ-202-CB | 1/8 | 1/2 | 1/2 | 2 1/2 | 0.70235 | | |
| | | | | | | | BZ-204-CB | 1/8 | 1 | 1/2 | 3 1/8 | 1.27970 | | |
| | | | | | | | BZ-404-CB | 1/4 | 1 | 3/4 | 3 | 1.40470 | | |
| | | | | | | | 45 DEG | B45-2015-CB | 1/8 | 0.312 | 1/2 | 2 1/2 | 0.75000 | |
| | | | | | | | | B45-202-CB | 1/8 | 1/2 | 1/2 | 2 5/8 | 1.12500 | |

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• Four Flutes

A

Trouble Shooting Guide For Problems With End Mills

| Problem/ Cause | Solution |
|--|--|
| Chip Packing Cut too heavy Not enough chip clearance Not enough coolant | <ul style="list-style-type: none"> • Decrease width and depth of cut • Use end mill with less flutes • Use higher coolant pressure and reposition nozzle to point of cut or use air pressure |
| Chipped Cutting Edge Feed rate too heavy Feed too heavy on first cut Lack of rigidity (machine & holder) Lack of rigidity (tool) Tool cutting corner too sharp | <ul style="list-style-type: none"> • Reduce feed rate • Reduce feed rate on first cut • Use better machine or tool holder or change parameters • Use shorter tool, hold shank deeper, try climb milling • Decrease primary relief and cutting angle, reduce radial width-of cut |
| Excessive Wear Speed is too fast Hard work material Improper feed and speed (too slow) Improper helix angle Primary relief angle is too large Recutting chips | <ul style="list-style-type: none"> • Decrease spindle speed, use another coolant • Use coatings (TiN, TiCN, TiAlN, TiAlN+, etc.) • Increase feed and speed • Change to correct helix angle • Change to smaller relief angle • Change feed & speed, Change chip size or clear chips with more coolant or air pressure |
| No Dimensional Accuracy Cut is too heavy Lack of accuracy (machine & holder) Rigidity is not enough (machine & holder) Too few flutes | <ul style="list-style-type: none"> • Decrease width and depth of cut • Repair machine or holder • Change machine or holder or change parameters • Use mult flute end mills, use end mill with higher rigidity |
| Reduced Tool Life Cutting friction is too much Hard work material Improper helix & relief angle | <ul style="list-style-type: none"> • Regrind at earlier stage • Use coatings (TiN, TiCN, TiAlN, TiAlN+, etc.) • Change to correct helix angle and primary relief |
| Rough Surface Finish Feed rate too heavy Cutting speed is too slow Wear is too much No end tooth concavity Recutting chips | <ul style="list-style-type: none"> • Reduce feed rate • Increase RPM • Regrind at earlier stage • Grind concave angle on bottom of teeth • Change feed & speed, change chip size or clear chips with coolant or air pressure |
| Side Wall Taper in Work Piece Feed rate too heavy Overhang of tool is too much Too few flutes | <ul style="list-style-type: none"> • Reduce feed rate • Hold shank deeper, use shorter end mill • Use mult flute end mills, use end mill with higher rigidity |
| Squeal and Chattering Feed and speed too fast Lack of rigidity (machine & holder) Poor set up Cut is too heavy Overhang of tool is too much Lack of relief | <ul style="list-style-type: none"> • Correct feed and speed • Use better machine or tool holder or change parameter • Improve clamping rigidity • Decrease width and depth of cut • Hold shank deeper, use shorter end mill • Decrease relief angle, make margin; hone primary with oil stone |
| Tool Breakage Feed is too heavy Cut is too heavy Overhang of tool is too much Wear is too much | <ul style="list-style-type: none"> • Reduce feed rate • Decrease width and depth-of-cut • Hold shank deeper, use shorter end mill • Regrind at earlier stage |
| Work Piece Burrs Wear on primary relief is too much Incorrect feed and speed Improper helix angle | <ul style="list-style-type: none"> • Regrind at earlier stage • Correct cutting parameters • Change to correct cutting angle |

FEEDS & SPEEDS FOR CARBIDE

A

Recommendations For Surface Feet Per Minute & Feed Per Tooth*

"UNDER" 32 HRC Hard Grade Materials

| MATERIAL | SFM | 1/8" | 3/16" | 1/4" | 3/8" | 1/2" | 5/8" | 3/4" | 1" |
|---|----------|--------|--------|--------|--------|--------|--------|--------|--------|
| NON-FERROUS MATERIALS | | | | | | | | | |
| Aluminum Alloys: 2024-T4/T6, 2014, 6061-T6/T651, 7075-T6 | 800-2000 | 0.001 | 0.002 | 0.003 | 0.004 | 0.005 | 0.006 | 0.008 | 0.010 |
| Magnesium: Die-Cast, Extruded | 800-1500 | 0.001 | 0.0015 | 0.002 | 0.003 | 0.004 | 0.006 | 0.008 | 0.009 |
| Copper: Yellow Brass, High Lead Brass, Red Brass | 800-1000 | 0.001 | 0.0012 | 0.002 | 0.0025 | 0.003 | 0.004 | 0.004 | 0.005 |
| Copper Alloys: Aluminum/Bronze, Low Silicon Bronze | 800-1000 | 0.001 | 0.0012 | 0.002 | 0.0025 | 0.003 | 0.004 | 0.004 | 0.005 |
| Plastics: Acrylics, Phenolics, Polysulfone, G10, G11 | 200-500 | 0.001 | 0.002 | 0.003 | 0.004 | 0.006 | 0.008 | 0.010 | 0.012 |
| Carbon, Graphites: Carbon, Graphites | 200-500 | 0.002 | 0.003 | 0.004 | 0.006 | 0.008 | 0.009 | 0.010 | 0.012 |
| STAINLESS STEELS | | | | | | | | | |
| Precipitation: 13/8, 15/5, AM-350/355 | 80-250 | 0.0003 | 0.0005 | 0.001 | 0.001 | 0.002 | 0.003 | 0.004 | 0.005 |
| Austenitic: 200 Series, 302, 303, 304L, 316L | 100-350 | 0.0002 | 0.0003 | 0.0005 | 0.001 | 0.002 | 0.0025 | 0.0035 | 0.0045 |
| Martensitic: 403, 410, 416 | 80-250 | 0.0002 | 0.0003 | 0.0005 | 0.001 | 0.0015 | 0.0025 | 0.003 | 0.004 |
| HIGH TEMP. ALLOYS | | | | | | | | | |
| Cobalt Base: Stellite, HS-21, Haynes 25/188, X-40, L-605 | 50-90 | 0.0003 | 0.0004 | 0.0006 | 0.0008 | 0.0012 | 0.0015 | 0.002 | 0.0025 |
| Nickel Base: Inconel 600/625, Nichel 200-270, Invar, Monel 400-405, K-Monel, PermaNechel 300, Incoly 600-800, Mar-M-246/247 | 50-95 | 0.0004 | 0.0005 | 0.0008 | 0.001 | 0.002 | 0.0025 | 0.003 | 0.004 |
| Iron Base: N-155, Timken 16-26-6, Incoloy 800-802, Multimet | 70-125 | 0.0004 | 0.0005 | 0.001 | 0.0015 | 0.002 | 0.0025 | 0.003 | 0.004 |
| STEELS | | | | | | | | | |
| High Strength Steels: 4140, 4340, 6150, 52100, H11, H13 | 100-160 | 0.0004 | 0.0006 | 0.001 | 0.0015 | 0.002 | 0.0025 | 0.003 | 0.004 |
| High Alloy Steels-Mold & Die:A-2/6/10, p20, 01, 02, 06 | 100-160 | 0.0004 | 0.0006 | 0.001 | 0.0015 | 0.0015 | 0.0025 | 0.003 | 0.004 |
| Medium Alloy Steels: 200, 250, 300 | 100-350 | 0.0005 | 0.0005 | 0.001 | 0.002 | 0.0025 | 0.0035 | 0.004 | 0.005 |
| Low Alloy Steels-Maraging: 10XX, 11XX, 13XX | 100-350 | 0.0005 | 0.0007 | 0.0012 | 0.002 | 0.003 | 0.004 | 0.005 | 0.006 |
| CAST IRONS | | | | | | | | | |
| Ductile Iron: Ductile Cast Iron | 120-350 | 0.0005 | 0.0008 | 0.0015 | 0.002 | 0.0022 | 0.003 | 0.004 | 0.006 |
| Cast Iron: Gray Cast Iron | 120-350 | 0.0005 | 0.001 | 0.002 | 0.003 | 0.004 | 0.005 | 0.006 | 0.008 |
| TITANIUM | | | | | | | | | |
| Titanium Alloys: Commercially Pure, 6AL-4V, ASTM 1/2/3, 6AL-25N-4Zr-2Mo-Si | 100-250 | 0.0003 | 0.0004 | 0.0005 | 0.001 | 0.0015 | 0.0025 | 0.003 | 0.004 |

*These are base-line recommendations. Adjust feed and speed according to individual circumstances.

RPM = SFM X 3.82/Tool Diameter Feed (in IPM's) = RPM X FPT X # of Flutes

A

FEEDS & SPEEDS FOR CARBIDE

Recommendations For Surface Feet Per Minute & Feed Per Tooth*

"OVER" 32 HRc Hard Grade Materials

| MATERIAL | SFM | 1/8" | 3/16" | 1/4" | 3/8" | 1/2" | 5/8" | 3/4" | 1" |
|--|----------|--------|--------|--------|--------|--------|--------|--------|--------|
| NON-FERROUS MATERIALS | | | | | | | | | |
| Aluminum Alloys: 440, 356, 380, C6130 | 500-1000 | 0.001 | 0.0015 | 0.002 | 0.003 | 0.004 | 0.005 | 0.006 | 0.008 |
| Copper: Naval Brass, High Silicon Bronze, A17, C-17200 | 800-1000 | 0.001 | 0.0015 | 0.002 | 0.0025 | 0.003 | 0.004 | 0.0045 | 0.005 |
| Copper Alloys: Nickel, Silver, Beryllium Copper, Oxygen-Free Copper | 800-1000 | 0.001 | 0.0015 | 0.002 | 0.0025 | 0.003 | 0.004 | 0.004 | 0.005 |
| Plastics: Polycarbonate | 200-500 | 0.001 | 0.002 | 0.003 | 0.004 | 0.006 | 0.008 | 0.010 | 0.012 |
| STAINLESS STEELS | | | | | | | | | |
| Precipitation: 17/4, 17/7, AF-17, Custom 450/635, 15/7Mo | 90-125 | 0.0003 | 0.0005 | 0.001 | 0.001 | 0.002 | 0.003 | 0.004 | 0.005 |
| Austenitic: 304, 310, 314, 316, 321, 330, 347, 348 | 90-150 | 0.0002 | 0.0003 | 0.0005 | 0.001 | 0.002 | 0.0025 | 0.0035 | 0.004 |
| Martensitic: 420, 430F, 440C, 446 | 90-170 | 0.0002 | 0.0003 | 0.0005 | 0.001 | 0.0015 | 0.0025 | 0.0025 | 0.004 |
| HIGH TEMP. ALLOYS | | | | | | | | | |
| Cobalt Base: Air-Resist 13/213/215, Haynes 21/36, Howmet 3, HS 6/51, Nasa Co-W-Re, Mar-M-302, MP-159 | 50-80 | 0.0003 | 0.0004 | 0.0006 | 0.0008 | 0.0012 | 0.0015 | 0.002 | 0.0025 |
| Nickel Base: Hastelloy-C/B/G/X, Inconel 718, Waspaloy, M252, Rene 41-95, Nimonic 75-80, Astroloy, Udimet 500-700 | 50-80 | 0.0004 | 0.0005 | 0.0008 | 0.001 | 0.002 | 0.0025 | 0.003 | 0.004 |
| Iron Base: A286, Haynes 556, Discology, V-57 | 70-110 | 0.0004 | 0.0005 | 0.001 | 0.0015 | 0.002 | 0.0025 | 0.003 | 0.004 |
| STEELS | | | | | | | | | |
| High Strength Steels: 4140, 4340M, EDT-150, HP9-430, 11-10, 300M, D6Ac, H11, H13, Armor Plate | 80-140 | 0.0004 | 0.0006 | 0.001 | 0.0015 | 0.0015 | 0.0025 | 0.003 | 0.004 |
| High Alloy Steels-Mold & Die:Hy-Tugg, Stressproof, Armor Plate | 80-140 | 0.0004 | 0.0006 | 0.001 | 0.0015 | 0.0015 | 0.0025 | 0.003 | 0.004 |
| Medium Alloy Steels: 200, 250, 300 | 80-140 | 0.0005 | 0.0005 | 0.001 | 0.002 | 0.0025 | 0.0035 | 0.004 | 0.005 |
| Low Alloy Steels-Maraging: 23XX, 31XX | 100-120 | 0.0005 | 0.0007 | 0.0012 | 0.002 | 0.003 | 0.004 | 0.005 | 0.006 |
| CAST IRONS | | | | | | | | | |
| Ductile Iron: Ductile Cast Iron | 80-140 | 0.0005 | 0.0008 | 0.0015 | 0.002 | 0.0022 | 0.003 | 0.004 | 0.006 |
| Cast Iron: Malleable, Chilled | 80-140 | 0.0005 | 0.001 | 0.002 | 0.003 | 0.004 | 0.005 | 0.006 | 0.008 |
| TITANIUM | | | | | | | | | |
| Titanium Alloys: 5Al-2 1/2-Sn-Eli 8AlMo-1V | 80-180 | 0.0003 | 0.0004 | 0.0005 | 0.001 | 0.0015 | 0.0025 | 0.003 | 0.004 |

*These are base-line recommendations. Adjust feed and speed according to individual circumstances.

$$\text{RPM} = \text{SFM} \times 3.82 / \text{Tool Diameter} \quad \text{Feed (in IPM's)} = \text{RPM} \times \text{FPT} \times \# \text{ of Flutes}$$

Award

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**MANUFACTURED FROM SUPERIOR
SUBMICROGRAIN CARBIDE**

OVER 600 STOCKED STANDARD SIZES

METRIC CONVERSION TABLE

LINEAR MEASURE

| | |
|-----------------------------------|-----------------------------------|
| 1 kilometer = 0.6214 mile | 1 mile = 1.609 kilometers |
| 39.37 inches | 1 yard = 0.9144 meter |
| 1 meter = 3.2808 feet | 1 foot = 0.3048 meter |
| 1.0936 yards | 1 foot = 304.8 millimeters |
| 1 centimeter = 0.3937 inch | 1 inch = 2.54 centimeters |
| 1 millimeter = 0.03937 inch | 1 inch = 25.4 millimeters |
| 1 micrometer (μm) | 1 microinch = 0.025 μm |
| (0.001 millimeter) = 0.00004 inch | |

SQUARE MEASURE

| |
|---|
| 1 square kilometer = 0.3861 square mile = 247.1 acres |
| 1 hectare = 2.471 acres = 107,640 square feet |
| 1 are = 0.0247 acre = 1076.4 square feet |
| 1 square meter = 10.764 square feet = 1.196 square yards |
| 1 square centimeter = 0.155 square inch |
| 1 square millimeter = 0.00155 square inch |
| 1 square mile = 2.5899 square kilometer |
| 1 acre = 0.4047 hectare = 40.47 ares |
| 1 square yard = 0.0929 square meter = 929 square centimeters |
| 1 square inch = 6.452 square centimeters = 645.2 square millimeters |

CUBIC MEASURE

| |
|--|
| 1 cubic meter = 35.31 cubic feet = 1.308 cubic yards |
| 1 cubic meter = 264.2 US gallons = 219.969 Imperial gallons |
| 1 cubic centimeter = 0.062 cubic inch |
| 1 liter (cubic decimeter) = 0.0353 cubic foot = 61.023 cubic inches |
| 1 liter = 0.2642 US gallons = 1.0567 US quarts = 0.2200 Imperial gallons |
| 1 cubic yard = 0.7646 cubic meter |
| 1 cubic foot = 0.02832 cubic meter = 28.317 liters |
| 1 cubic inch = 16.38706 cubic centimeters |
| 1 Imperial gallon = 4.546 liters |
| 1 Imperial quart = 1.136 liters |
| 1 US gallon = 3.785 liters |
| 1 US quart = 0.946 liter |

WEIGHT

| |
|--|
| 1 metric ton = 0.9842 ton (of 2240 pounds) = 2204.6 pounds |
| 1 kilogram = 2.2046 pounds = 35.274 ounces avoirdupois |
| 1 gram = 0.03215 ounces troy = 0.03527 ounces avoirdupois |
| 1 gram = 15.432 grains |
| 1 ton (of 2240 pounds) = 1.016 metric tons = 1016 kilograms |
| 1 pound = 0.4536 kilograms = 453.6 grams |
| 1 ounce avoirdupois = 28.35 grams |
| 1 ounce troy = 31.103 grams |
| 1 grain = 0.0648 gram |
| 1 kilogram per square millimeter = 1422.32 pounds per sq. in. |
| 1 kilogram per square centimeter = 14.2232 pounds per sq. in. |
| 1 kilogram/meter = 7.233 foot/pounds |
| 1 pound per square inch = 0.0703 kilogram per square centimeter |
| 1 calorie (kilogram calorie) = 3.968 Btu (British Thermal Units) |
| 1 international table calorie = 4.1868 joules |
| 1 kilojoules = 0.948 Btu |
| 1 kilo pound (kp) = 1 kilogram-force |

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AWARD

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**AWARD
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MILLS**



**THE AWARD CUTTER COMPANY
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The Award Cutter Company warrants each new product manufactured and sold by it or one of its authorized dealers only against defects in workmanship and/or materials under normal service, proper installation and use. This warranty is limited to repair or replacement of verified defective products and excludes and all implied warranty or merchantability and all risks and liability whatsoever resulting from any use of said products, including incidental and consequential damages. The provisions of this warranty and limitation of liability shall not be modified in any respect except by written document signed by an officer of The Award Cutter Company.

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Through the years, Award Cutter Company has been a trusted partner of major manufacturers and industrial tool distributors throughout the world in producing tapered end mills of the highest quality.

We have kept pace with industry's ever increasing demand for greater product reliability and complete technology.

Using the very latest technology in the manufacturing process, you can be assured that we are providing industry with a product that out-performs all others.

We wish to extend our sincere thanks to all of our customers, who have enabled us to grow and expand to the point we are today. Some of you have been loyal customers since our beginning in 1959, and for this, we are very grateful. You can be assured that we will continue to provide you with a quality product as well as very personalized service.

Again, we thank you.

Award Cutter Co., Inc.

AWARD TAPERED END MILL DATA

SIZES:

Standard sizes are available in a complete range all popular sizes, 1/2 degree through 45 degree in various flute lengths. All standard sizes are right hand cut, right hand spiral. The spiral is constant.

MATERIAL:

All tapered end mills are produced from a premium grade high speed steel capable of heat treatment throughout to obtain a combination of hardness and high wear resistance, yet remain a remarkably high impact resistance with a Rockwell of 65 and above. This means longer cutting life with less breakage.

HEAT TREATMENT:

Award tapered end mills are very carefully hardened and given a series of multiple draws, some of which are many hours duration. This process assures tools full hardness yet maximum freedom from residual stresses, which so often cause breakage. We believe our method of heat treating provides the ultimate in high hardness necessary for good cutting action and long life, coupled with maximum shock resistance to prevent breakage.

GRINDING:

All flutes are hollow ground with double clearance angles. The flute face is also hollow ground and polished to assure free cutting actions with minimum of heat generation. All tools have end cutting teeth. Special grinding procedures and equipment assures a high degree of concentricity between shank and cutting flutes.

TOLERANCES:

Taper angles constant to +/- .001 per inch of flute length.
Tip diameter tolerances are held at +/- .002.
Shank diameter tolerances are -.0002 to -.0005.

AWARD TAPERED END MILL DATA

Calculating Ball End Diameters

| P/S Taper Angle | Ball End Multiplier |
|--------------------|---------------------|
| 1/2 deg per side | 0.99131 |
| 1 deg per side | 0.98269 |
| 1-1/2 deg per side | 0.97415 |
| 2 deg per side | 0.96568 |
| 3 deg per side | 0.94896 |
| 4 deg per side | 0.93251 |
| 5 deg per side | 0.91633 |
| 6 deg per side | 0.90053 |
| 7 deg per side | 0.88472 |
| 10 deg per side | 0.83909 |
| 15 deg per side | 0.76732 |
| 20 deg per side | 0.70020 |
| 25 deg per side | 0.63707 |
| 30 deg per side | 0.57735 |
| 45 deg per side | 0.41421 |



Formula for calculating a starting tip diameter on a flat end to achieve a specific tangent Ball Diameter:
 $\text{Ball Diameter} \times \text{Multiplier} = \text{Starting Tip Diameter}$

Large Diameter Multipliers

| P/S Taper Angle | Large Diameter Multiplier |
|--------------------|---------------------------|
| 1/2 deg per side | 0.01745 |
| 1 deg per side | 0.03490 |
| 1-1/2 deg per side | 0.05236 |
| 2 deg per side | 0.06984 |
| 3 deg per side | 0.10482 |
| 4 deg per side | 0.13986 |
| 5 deg per side | 0.17498 |
| 6 deg per side | 0.21021 |
| 7 deg per side | 0.24556 |
| 10 deg per side | 0.35266 |
| 15 deg per side | 0.53590 |
| 20 deg per side | 0.72794 |
| 25 deg per side | 0.93262 |
| 30 deg per side | 1.15470 |
| 45 deg per side | 2.00000 |



Formula for calculating Large Diameters:
 $(\text{Large Diameter Multiplier} \times \text{Flute Length}) + \text{Tip Diameter} = \text{Large Diameter}$

A

MINIATURE HIGH SPEED STEEL & COBALT Flat Ends

| Taper Per Side | Tool No. | Tip Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. | |
|----------------|--------------|----------|-----------|----------|---------|------------|---------|
| 1/2 DEG | M0-002 | 1/16 | 1/2 | 3/16 | 1 3/4 | 0.07123 | |
| | M0-003 | 1/16 | 3/4 | 3/16 | 2 | 0.07559 | |
| | M0-004 | 1/16 | 1 | 3/16 | 2 1/4 | 0.07995 | |
| | M0-052 | 5/64 | 1/2 | 3/16 | 1 3/4 | 0.08685 | |
| | M0-054 | 5/64 | 1 | 3/16 | 2 1/4 | 0.09558 | |
| | M0-103 | 3/32 | 3/4 | 3/16 | 2 | 0.10684 | |
| | M0-105 | 3/32 | 1 1/4 | 3/16 | 2 1/2 | 0.11556 | |
| | M0-106 | 3/32 | 1 1/2 | 3/16 | 2 11/16 | 0.11993 | |
| | M0-201 | 1/8 | 1/4 | 3/16 | 1 1/2 | 0.12936 | |
| | M0-2015 | 1/8 | 3/8 | 3/16 | 1 5/8 | 0.13154 | |
| | M0-203 | 1/8 | 3/4 | 3/16 | 2 | 0.13809 | |
| | M0-204 | 1/8 | 1 | 3/16 | 2 1/4 | 0.14245 | |
| | 1 DEG | M1-002 | 1/16 | 1/2 | 3/16 | 1 3/4 | 0.07995 |
| | | M1-003 | 1/16 | 3/4 | 3/16 | 2 | 0.08868 |
| M1-004 | | 1/16 | 1 | 3/16 | 2 1/4 | 0.09740 | |
| M1-052 | | 5/64 | 1/2 | 3/16 | 1 3/4 | 0.09558 | |
| M1-054 | | 5/64 | 1 | 3/16 | 2 1/4 | 0.11303 | |
| M1-103 | | 3/32 | 3/4 | 3/16 | 2 | 0.11993 | |
| M1-105 | | 3/32 | 1 1/4 | 3/16 | 2 1/2 | 0.13738 | |
| M1-106 | | 3/32 | 1 1/2 | 3/16 | 2 11/16 | 0.14610 | |
| M1-201 | | 1/8 | 1/4 | 3/16 | 1 1/2 | 0.13373 | |
| M1-2015 | | 1/8 | 3/8 | 3/16 | 1 5/8 | 0.13809 | |
| M1-203 | | 1/8 | 3/4 | 3/16 | 2 | 0.15118 | |
| M1-204 | | 1/8 | 1 | 3/16 | 2 1/4 | 0.15990 | |

| Taper Per Side | Tool No. | Tip Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|------------------|----------|----------|-----------|----------|---------|------------|
| 1 1/2 DEG | M15-003 | 1/16 | 3/4 | 3/16 | 2 | 0.10177 |
| | M15-104 | 3/32 | 1 | 3/16 | 2 1/4 | 0.14611 |
| | M15-105 | 3/32 | 1 1/4 | 3/16 | 2 1/2 | 0.15920 |
| | M15-154 | 7/64 | 1 | 3/16 | 2 1/4 | 0.16174 |
| | M15-203 | 1/8 | 3/4 | 3/16 | 2 | 0.16427 |
| | M15-204 | 1/8 | 1 | 3/16 | 2 1/4 | 0.17736 |
| 2 DEG | M2-002 | 1/16 | 1/2 | 3/16 | 1 3/4 | 0.09742 |
| | M2-004 | 1/16 | 1 | 3/16 | 2 1/4 | 0.13234 |
| | M2-052 | 5/64 | 1/2 | 3/16 | 1 3/4 | 0.11305 |
| | M2-054 | 5/64 | 1 | 3/16 | 2 1/4 | 0.14797 |
| | M2-056 | 5/64 | 1 1/2 | 3/16 | 2 11/16 | 0.18289 |
| | M2-103 | 3/32 | 3/4 | 3/16 | 2 | 0.14613 |
| | M2-105 | 3/32 | 1 1/4 | 3/16 | 2 1/2 | 0.18105 |
| M2-203 | 1/8 | 3/4 | 3/16 | 2 | 0.17738 | |

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• Four Flutes

HIGH SPEED STEEL & COBALT

Flat Ends

A

| Taper Per Side | Tool No. | Tip Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|----------|----------|-----------|----------|---------|------------|
| 1/2 DEG | KK-102 | 3/32 | 1/2 | 3/8 | 2 1/2 | 0.10248 |
| | KK-103 | 3/32 | 3/4 | 3/8 | 2 5/8 | 0.10684 |
| | KK-105 | 3/32 | 1 1/4 | 3/8 | 3 1/8 | 0.11556 |
| | KK-201 | 1/8 | 1/4 | 3/8 | 2 1/2 | 0.12936 |
| | KK-202 | 1/8 | 1/2 | 3/8 | 2 1/2 | 0.13373 |
| | KK-203 | 1/8 | 3/4 | 3/8 | 2 1/2 | 0.13809 |
| | KK-204 | 1/8 | 1 | 3/8 | 2 7/8 | 0.14245 |
| | KK-205 | 1/8 | 1 1/4 | 3/8 | 3 1/8 | 0.14681 |
| | KK-206 | 1/8 | 1 1/2 | 3/8 | 3 1/4 | 0.15118 |
| | KK-303 | 3/16 | 3/4 | 3/8 | 2 1/2 | 0.20059 |
| | KK-305 | 3/16 | 1 1/4 | 3/8 | 3 1/8 | 0.20931 |
| | KK-307 | 3/16 | 1 3/4 | 3/8 | 3 7/8 | 0.21804 |
| | KK-309 | 3/16 | 2 1/4 | 3/8 | 4 1/4 | 0.22676 |
| | KK-313 | 3/16 | 3 1/4 | 3/8 | 5 1/2 | 0.24421 |
| | KK-403 | 1/4 | 3/4 | 3/8 | 2 1/2 | 0.26309 |
| | KK-405 | 1/4 | 1 1/4 | 3/8 | 3 | 0.27181 |
| | KK-409 | 1/4 | 2 1/4 | 1/2 | 4 1/4 | 0.28926 |
| | KK-409A | 1/4 | 2 1/4 | 3/8 | 4 1/4 | 0.28926 |
| | KK-413 | 1/4 | 3 1/4 | 1/2 | 5 1/2 | 0.30671 |
| | KK-605 | 3/8 | 1 1/4 | 1/2 | 3 1/8 | 0.39681 |
| | KK-609 | 3/8 | 2 1/4 | 1/2 | 4 1/4 | 0.41426 |
| | KK-613 | 3/8 | 3 1/4 | 1/2 | 5 1/2 | 0.43171 |
| | KK-805 | 1/2 | 1 1/4 | 1/2 | 3 1/4 | 0.52181 |
| | KK-809 | 1/2 | 2 1/4 | 1/2 | 4 1/4 | 0.53926 |
| | KK-813 | 1/2 | 3 1/4 | 1/2 | 5 1/2 | 0.55671 |
| | KK-1009 | 5/8 | 2 1/4 | 5/8 | 4 1/2 | 0.66426 |
| | KK-1013 | 5/8 | 3 1/4 | 5/8 | 5 1/2 | 0.68171 |
| | KK-1017 | 5/8 | 4 1/4 | 5/8 | 6 1/2 | 0.69916 |
| | KK-1209 | 3/4 | 2 1/4 | 3/4 | 4 3/4 | 0.78926 |
| | KK-1213 | 3/4 | 3 1/4 | 3/4 | 5 3/4 | 0.80671 |
| | KK-1217 | 3/4 | 4 1/4 | 3/4 | 6 3/4 | 0.82416 |
| | KK-1221 | 3/4 | 5 1/4 | 3/4 | 7 3/4 | 0.84161 |
| KK-1624 | • 1 | 6 | 1 | 8 1/2 | 1.10470 | |

| Taper Per Side | Tool No. | Tip Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|----------|----------|-----------|----------|---------|------------|
| 1 DEG | K-102 | 3/32 | 1/2 | 3/8 | 2 1/2 | 0.11120 |
| | K-103 | 3/32 | 3/4 | 3/8 | 2 1/2 | 0.11993 |
| | K-105 | 3/32 | 1 1/4 | 3/8 | 3 1/8 | 0.13738 |
| | K-201 | 1/8 | 1/4 | 3/8 | 2 1/2 | 0.13373 |
| | K-202 | 1/8 | 1/2 | 3/8 | 2 1/2 | 0.14245 |
| | K-203 | 1/8 | 3/4 | 3/8 | 2 1/2 | 0.15118 |
| | K-204 | 1/8 | 1 | 3/8 | 2 7/8 | 0.15990 |
| | K-205 | 1/8 | 1 1/4 | 3/8 | 3 1/8 | 0.16863 |
| | K-206 | 1/8 | 1 1/2 | 3/8 | 3 1/4 | 0.17735 |
| | K-208 | 1/8 | 2 | 3/8 | 3 7/8 | 0.19480 |
| | K-303 | 3/16 | 3/4 | 3/8 | 2 1/2 | 0.21368 |
| | K-305 | 3/16 | 1 1/4 | 3/8 | 3 1/8 | 0.23113 |
| | K-308 | 3/16 | 2 | 3/8 | 3 7/8 | 0.25730 |
| | K-309 | 3/16 | 2 1/4 | 3/8 | 4 1/4 | 0.26603 |
| | K-310 | 3/16 | 2 1/2 | 3/8 | 4 1/2 | 0.27475 |
| | K-313 | 3/16 | 3 1/4 | 3/8 | 5 1/2 | 0.30093 |
| | K-403 | 1/4 | 3/4 | 3/8 | 2 1/2 | 0.27618 |
| | K-405 | 1/4 | 1 1/4 | 3/8 | 3 | 0.29363 |
| | K-406 | 1/4 | 1 1/2 | 3/8 | 3 1/4 | 0.30235 |
| | K-409 | 1/4 | 2 1/4 | 1/2 | 4 1/4 | 0.32853 |
| | K-413 | 1/4 | 3 1/4 | 1/2 | 5 1/2 | 0.36343 |
| | K-605 | 3/8 | 1 1/4 | 1/2 | 3 1/4 | 0.41863 |
| | K-609 | 3/8 | 2 1/4 | 1/2 | 4 1/4 | 0.45353 |
| | K-613 | 3/8 | 3 1/4 | 1/2 | 5 1/4 | 0.48843 |
| | K-805 | 1/2 | 1 1/4 | 1/2 | 3 1/4 | 0.54363 |
| | K-809 | 1/2 | 2 1/4 | 1/2 | 4 1/4 | 0.57853 |
| | K-813 | 1/2 | 3 1/4 | 5/8 | 5 3/8 | 0.61343 |
| | K-813A | 1/2 | 3 1/4 | 1/2 | 5 3/8 | 0.61343 |
| | K-1009 | 5/8 | 2 1/4 | 5/8 | 4 1/2 | 0.70353 |
| | K-1013 | 5/8 | 3 1/4 | 5/8 | 5 1/2 | 0.73843 |
| | K-1017 | 5/8 | 4 1/4 | 5/8 | 6 1/2 | 0.77333 |
| | K-1209 | 3/4 | 2 1/4 | 3/4 | 4 3/4 | 0.82853 |
| K-1213 | 3/4 | 3 1/4 | 3/4 | 5 3/4 | 0.86343 | |
| K-1217 | 3/4 | 4 1/4 | 3/4 | 6 3/4 | 0.89833 | |
| K-1221 | 3/4 | 5 1/4 | 3/4 | 7 3/4 | 0.93323 | |
| K-1624 | • 1 | 6 | 1 | 8 1/2 | 1.20940 | |

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for Cobalt, add the suffix "CO"
for Cobalt TIN Coated, add the suffix "CO-TIN"
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• Four Flutes

A

HIGH SPEED STEEL & COBALT

Flat Ends

| Taper Per Side | Tool No. | Tip Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|----------|----------|-----------|----------|---------|------------|
| 1 1/2 DEG | KX-102 | 3/32 | 1/2 | 3/8 | 2 1/2 | 0.11993 |
| | KX-103 | 3/32 | 3/4 | 3/8 | 2 1/2 | 0.13302 |
| | KX-104 | 3/32 | 1 | 3/8 | 2 7/8 | 0.14611 |
| | KX-105 | 3/32 | 1 1/4 | 3/8 | 3 1/8 | 0.15920 |
| | KX-106 | 3/32 | 1 1/2 | 3/8 | 3 1/4 | 0.17229 |
| | KX-110 | 3/32 | 2 1/2 | 3/8 | 4 1/2 | 0.22465 |
| | KX-154 | 7/64 | 1 | 3/8 | 2 7/8 | 0.16174 |
| | KX-155 | 7/64 | 1 1/4 | 3/8 | 3 1/8 | 0.17483 |
| | KX-156 | 7/64 | 1 1/2 | 3/8 | 3 1/4 | 0.18792 |
| | KX-202 | 1/8 | 1/2 | 3/8 | 2 1/2 | 0.15118 |
| | KX-203 | 1/8 | 3/4 | 3/8 | 2 1/2 | 0.16427 |
| | KX-204 | 1/8 | 1 | 3/8 | 2 7/8 | 0.17736 |
| | KX-205 | 1/8 | 1 1/4 | 3/8 | 3 1/8 | 0.19045 |
| | KX-206 | 1/8 | 1 1/2 | 3/8 | 3 1/4 | 0.20354 |
| | KX-208 | 1/8 | 2 | 3/8 | 3 7/8 | 0.22972 |
| | KX-209 | 1/8 | 2 1/4 | 3/8 | 4 1/4 | 0.24281 |
| | KX-212 | 1/8 | 3 | 3/8 | 5 | 0.28208 |
| | KX-254 | 5/32 | 1 | 3/8 | 2 7/8 | 0.20861 |
| | KX-255 | 5/32 | 1 1/4 | 3/8 | 3 1/8 | 0.22170 |
| | KX-256 | 5/32 | 1 1/2 | 3/8 | 3 1/4 | 0.23479 |
| | KX-258 | 5/32 | 2 | 3/8 | 3 7/8 | 0.26097 |
| | KX-303 | 3/16 | 3/4 | 3/8 | 2 1/2 | 0.22677 |
| | KX-305 | 3/16 | 1 1/4 | 3/8 | 3 1/8 | 0.25295 |
| | KX-309 | 3/16 | 2 1/4 | 3/8 | 4 | 0.30531 |
| | KX-313 | 3/16 | 3 1/4 | 3/8 | 5 1/2 | 0.35767 |
| | KX-403 | 1/4 | 3/4 | 3/8 | 2 1/2 | 0.28927 |
| | KX-405 | 1/4 | 1 1/4 | 3/8 | 3 | 0.31545 |
| | KX-409 | 1/4 | 2 1/4 | 1/2 | 4 1/4 | 0.36781 |
| | KX-413 | 1/4 | 3 1/4 | 1/2 | 5 1/2 | 0.42017 |
| | KX-605 | 3/8 | 1 1/4 | 1/2 | 3 1/8 | 0.44045 |
| | KX-609 | 3/8 | 2 1/4 | 1/2 | 4 1/4 | 0.49281 |
| | KX-613 | 3/8 | 3 1/4 | 1/2 | 5 1/2 | .054517 |
| KX-805 | 1/2 | 1 1/4 | 1/2 | 3 1/4 | 0.56545 | |
| KX-809 | 1/2 | 2 1/4 | 5/8 | 4 1/2 | 0.61781 | |
| KX-813 | 1/2 | 3 1/4 | 5/8 | 5 1/2 | 0.67017 | |
| KX-1009 | 5/8 | 2 1/4 | 3/4 | 4 1/2 | 0.74281 | |
| KX-1013 | 5/8 | 3 1/4 | 3/4 | 5 1/2 | 0.79517 | |
| KX-1017 | 5/8 | 4 1/4 | 3/4 | 6 1/2 | 0.84753 | |
| KX-1209 | 3/4 | 2 1/4 | 3/4 | 4 3/4 | 0.86781 | |
| KX-1221 | 3/4 | 5 1/4 | 1 | 7 3/4 | 1.02489 | |
| KX-1624 | • 1 | 6 | 1 1/4 | 8 1/2 | 1.31416 | |

| Taper Per Side | Tool No. | Tip Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|----------|----------|-----------|----------|---------|------------|
| 2 DEG | L-002 | 1/16 | 1/2 | 3/8 | 2 5/8 | 0.09742 |
| | L-004 | 1/16 | 1 | 3/8 | 2 7/8 | 0.13234 |
| | L-102 | 3/32 | 1/2 | 3/8 | 2 1/2 | 0.12867 |
| | L-103 | 3/32 | 3/4 | 3/8 | 2 1/2 | 0.14613 |
| | L-105 | 3/32 | 1 1/4 | 3/8 | 3 1/8 | 0.18105 |
| | L-202 | 1/8 | 1/2 | 3/8 | 2 1/2 | 0.15992 |
| | L-203 | 1/8 | 3/4 | 3/8 | 2 1/2 | 0.17738 |
| | L-204 | 1/8 | 1 | 3/8 | 2 7/8 | 0.19484 |
| | L-205 | 1/8 | 1 1/4 | 3/8 | 3 1/8 | 0.21230 |
| | L-206 | 1/8 | 1 1/2 | 3/8 | 3 1/4 | 0.22976 |
| | L-208 | 1/8 | 2 | 3/8 | 3 7/8 | 0.26468 |
| | L-210 | 1/8 | 2 1/2 | 3/8 | 4 1/2 | 0.29960 |
| | L-303 | 3/16 | 3/4 | 3/8 | 2 1/2 | 0.23988 |
| | L-305 | 3/16 | 1 1/4 | 3/8 | 3 1/8 | 0.27480 |
| | L-309 | 3/16 | 2 1/4 | 1/2 | 4 1/4 | 0.34464 |
| | L-313 | 3/16 | 3 1/4 | 1/2 | 5 1/2 | 0.41448 |
| | L-403 | 1/4 | 3/4 | 3/8 | 2 1/2 | 0.30238 |
| | L-405 | 1/4 | 1 1/4 | 3/8 | 3 | 0.33730 |
| | L-409 | 1/4 | 2 1/4 | 1/2 | 4 3/8 | 0.40714 |
| | L-413 | 1/4 | 3 1/4 | 1/2 | 5 1/4 | 0.47698 |
| | L-505 | 5/16 | 1 1/4 | 1/2 | 3 1/4 | 0.39980 |
| | L-605 | 3/8 | 1 1/4 | 1/2 | 3 1/4 | 0.46230 |
| | L-609 | 3/8 | 2 1/4 | 1/2 | 4 1/4 | 0.53214 |
| | L-613 | 3/8 | 3 1/4 | 1/2 | 5 1/2 | 0.60198 |
| | L-613B | 3/8 | 3 1/4 | 5/8 | 5 1/2 | 0.60198 |
| | L-805 | 1/2 | 1 1/4 | 1/2 | 3 1/4 | 0.58730 |
| | L-809 | 1/2 | 2 1/4 | 5/8 | 4 3/8 | 0.65714 |
| | L-809A | 1/2 | 2 1/4 | 1/2 | 4 3/8 | 0.65714 |
| | L-813 | 1/2 | 3 1/4 | 3/4 | 5 1/2 | 0.72698 |
| | L-813B | 1/2 | 3 1/4 | 5/8 | 5 1/2 | 0.72698 |
| | L-1009 | 5/8 | 2 1/4 | 3/4 | 4 1/2 | 0.78214 |
| | L-1013 | 5/8 | 3 1/4 | 3/4 | 5 1/2 | 0.85198 |
| L-1017 | 5/8 | 4 1/4 | 3/4 | 6 1/2 | 0.92182 | |
| L-1209 | 3/4 | 2 1/4 | 3/4 | 4 1/2 | 0.90714 | |
| L-1213 | 3/4 | 3 1/4 | 3/4 | 5 3/4 | 0.97698 | |
| L-1221 | 3/4 | 5 1/4 | 1 | 7 3/4 | 1.11666 | |
| L-1624 | • 1 | 6 | 1 1/4 | 8 1/2 | 1.41904 | |

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HIGH SPEED STEEL & COBALT

Flat Ends



| Taper Per Side | Tool No. | Tip Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|----------|----------|-----------|----------|---------|------------|
| 3 DEG | M-002 | 1/16 | 1/2 | 3/8 | 2 5/8 | 0.11491 |
| | M-003 | 1/16 | 3/4 | 3/8 | 2 3/4 | 0.14112 |
| | M-004 | 1/16 | 1 | 3/8 | 2 7/8 | 0.16732 |
| | M-005 | 1/16 | 1 1/4 | 3/8 | 3 1/8 | 0.19353 |
| | M-006 | 1/16 | 1 1/2 | 3/8 | 3 1/4 | 0.21973 |
| | M-103 | 3/32 | 3/4 | 3/8 | 2 1/2 | 0.17237 |
| | M-104 | 3/32 | 1 | 3/8 | 2 7/8 | 0.19857 |
| | M-105 | 3/32 | 1 1/4 | 3/8 | 3 1/8 | 0.22478 |
| | M-106 | 3/32 | 1 1/2 | 3/8 | 3 1/4 | 0.25098 |
| | M-108 | 3/32 | 2 | 3/8 | 3 3/4 | 0.30339 |
| | M-110 | 3/32 | 2 1/2 | 1/2 | 4 1/2 | 0.35580 |
| | M-154 | 7/64 | 1 | 3/8 | 2 7/8 | 0.21420 |
| | M-155 | 7/64 | 1 1/4 | 3/8 | 3 1/8 | 0.24040 |
| | M-156 | 7/64 | 1 1/2 | 3/8 | 3 1/4 | 0.26661 |
| | M-158 | 7/64 | 2 | 3/8 | 3 3/4 | 0.31902 |
| | M-203 | 1/8 | 3/4 | 3/8 | 2 5/8 | 0.20362 |
| | M-204 | 1/8 | 1 | 3/8 | 2 7/8 | 0.22982 |
| | M-205 | 1/8 | 1 1/4 | 3/8 | 3 1/8 | 0.25603 |
| | M-206 | 1/8 | 1 1/2 | 3/8 | 3 1/4 | 0.28223 |
| | M-208 | 1/8 | 2 | 3/8 | 3 3/4 | 0.33464 |
| | M-210 | 1/8 | 2 1/2 | 1/2 | 4 1/2 | 0.38705 |
| | M-210A | 1/8 | 2 1/2 | 3/8 | 4 1/2 | 0.38705 |
| | M-212 | 1/8 | 3 | 1/2 | 5 | 0.43946 |
| | M-216 | 1/8 | 4 | 1/2 | 6 1/2 | 0.54428 |
| | M-2525 | 5/32 | 5/8 | 3/8 | 2 1/2 | 0.22176 |
| | M-253 | 5/32 | 3/4 | 3/8 | 2 1/2 | 0.23487 |
| | M-254 | 5/32 | 1 | 3/8 | 2 7/8 | 0.26107 |
| | M-255 | 5/32 | 1 1/4 | 3/8 | 3 1/8 | 0.28728 |
| | M-256 | 5/32 | 1 1/2 | 3/8 | 3 1/4 | 0.31348 |
| | M-258 | 5/32 | 2 | 3/8 | 3 7/8 | 0.36589 |
| | M-303 | 3/16 | 3/4 | 3/8 | 2 5/8 | 0.26612 |
| | M-304 | 3/16 | 1 | 3/8 | 2 7/8 | 0.29232 |
| M-305 | 3/16 | 1 1/4 | 3/8 | 3 1/8 | 0.31853 | |
| M-306 | 3/16 | 1 1/2 | 3/8 | 3 1/8 | 0.34473 | |
| M-308 | 3/16 | 2 | 1/2 | 4 | 0.39714 | |
| M-310 | 3/16 | 2 1/2 | 1/2 | 4 1/2 | 0.44955 | |
| M-312 | 3/16 | 3 | 1/2 | 5 | 0.50196 | |
| M-313 | 3/16 | 3 1/4 | 1/2 | 5 1/2 | 0.52817 | |
| M-316 | 3/16 | 4 | 5/8 | 6 1/8 | 0.60678 | |
| M-320 | 3/16 | 5 | 3/4 | 7 1/4 | 0.71160 | |
| M-322 | 3/16 | 5 1/2 | 3/4 | 7 3/4 | 0.76401 | |

| Taper Per Side | Tool No. | Tip Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|----------|----------|-----------|----------|---------|------------|
| 3 DEG | M-403 | 1/4 | 3/4 | 3/8 | 2 1/2 | 0.32862 |
| | M-404 | 1/4 | 1 | 3/8 | 2 3/4 | 0.35482 |
| | M-405 | 1/4 | 1 1/4 | 3/8 | 3 1/8 | 0.37500 |
| | M-406 | 1/4 | 1 1/2 | 3/8 | 3 1/4 | 0.40723 |
| | M-409 | 1/4 | 2 1/4 | 1/2 | 4 1/4 | 0.48585 |
| | M-410 | 1/4 | 2 1/2 | 1/2 | 4 1/2 | 0.51205 |
| | M-413 | 1/4 | 3 1/4 | 1/2 | 5 1/2 | 0.59067 |
| | M-416 | 1/4 | 4 | 3/4 | 6 1/4 | 0.66928 |
| | M-416A | 1/4 | 4 | 5/8 | 6 1/4 | 0.66928 |
| | M-420 | 1/4 | 5 | 3/4 | 7 3/8 | 0.77410 |
| | M-504 | 5/16 | 1 | 1/2 | 3 1/8 | 0.41732 |
| | M-507 | 5/16 | 1 3/4 | 1/2 | 3 7/8 | 0.49594 |
| | M-605 | 3/8 | 1 1/4 | 1/2 | 3 1/4 | 0.50000 |
| | M-609 | 3/8 | 2 1/4 | 5/8 | 4 3/8 | 0.61085 |
| | M-609A | 3/8 | 2 1/4 | 1/2 | 4 3/8 | 0.61085 |
| | M-613 | 3/8 | 3 1/4 | 5/8 | 5 3/8 | 0.71567 |
| | M-613A | 3/8 | 3 1/4 | 3/4 | 5 3/8 | 0.71567 |
| | M-616 | 3/8 | 4 | 3/4 | 6 1/2 | 0.79428 |
| | M-620 | 3/8 | 5 | 3/4 | 7 1/2 | 0.89910 |
| | M-624 | 3/8 | 6 | 1 | 8 1/2 | 1.00392 |
| | M-805 | 1/2 | 1 1/4 | 1/2 | 3 1/4 | 0.63103 |
| | M-809 | 1/2 | 2 1/4 | 3/4 | 4 1/2 | 0.73585 |
| | M-809A | 1/2 | 2 1/4 | 1/2 | 4 1/8 | 0.73585 |
| | M-809B | 1/2 | 2 1/4 | 5/8 | 4 1/4 | 0.73585 |
| | M-813 | 1/2 | 3 1/4 | 3/4 | 5 1/2 | 0.84067 |
| | M-816 | 1/2 | 4 | 3/4 | 6 3/8 | 0.91928 |
| | M-820 | 1/2 | 5 | 1 | 7 1/2 | 1.02410 |
| | M-824 | 1/2 | 6 | 1 | 8 1/2 | 1.12892 |
| | M-1009 | 5/8 | 2 1/4 | 3/4 | 4 1/2 | 0.86085 |
| | M-1013 | 5/8 | 3 1/4 | 3/4 | 5 1/2 | 0.96567 |
| | M-1016 | 5/8 | 4 | 1 | 6 1/2 | 1.04428 |
| | M-1020 | 5/8 | 5 | 1 | 7 1/2 | 1.14910 |
| M-1209 | 3/4 | 2 1/4 | 1 | 4 3/4 | 0.98585 | |
| M-1213 | 3/4 | 3 1/4 | 1 | 5 3/4 | 1.09067 | |
| M-1216 | • 3/4 | 4 | 1 | 6 1/2 | 1.16928 | |
| M-1220 | • 3/4 | 5 | 1 | 7 1/2 | 1.27410 | |
| M-1224 | • 3/4 | 6 | 1 1/4 | 8 1/2 | 1.37892 | |
| M-1624 | • 1 | 6 | 1 1/4 | 8 1/2 | 1.62892 | |

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for Cobalt, add the suffix "CO"
for Cobalt TIN Coated, add the suffix "CO-TIN"
If no suffix is given High Speed Steel will ship.

A

HIGH SPEED STEEL & COBALT Flat Ends

| Taper Per Side | Tool No. | Tip Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|----------|----------|-----------|----------|---------|------------|
| 4 DEG | N-004 | 1/16 | 1 | 3/8 | 2 7/8 | 0.20236 |
| | N-006 | 1/16 | 1 1/2 | 3/8 | 3 1/4 | 0.27229 |
| | N-103 | 3/32 | 3/4 | 3/8 | 2 5/8 | 0.19865 |
| | N-104 | 3/32 | 1 | 3/8 | 2 7/8 | 0.23361 |
| | N-203 | 1/8 | 3/4 | 3/8 | 2 5/8 | 0.22990 |
| | N-204 | 1/8 | 1 | 3/8 | 2 7/8 | 0.26486 |
| | N-206 | 1/8 | 1 1/2 | 3/8 | 3 1/4 | 0.33479 |
| | N-208 | 1/8 | 2 | 1/2 | 3 7/8 | 0.40472 |
| | N-210 | 1/8 | 2 1/2 | 1/2 | 4 1/2 | 0.47465 |
| | N-303 | 3/16 | 3/4 | 3/8 | 2 5/8 | 0.29240 |
| | N-305 | 3/16 | 1 1/4 | 3/8 | 3 1/8 | 0.36233 |
| | N-310 | 3/16 | 2 1/2 | 1/2 | 4 1/2 | 0.53715 |
| | N-313 | 3/16 | 3 1/4 | 5/8 | 5 1/2 | 0.64205 |
| | N-316 | 3/16 | 4 | 3/4 | 6 1/2 | 0.74694 |
| | N-403 | 1/4 | 3/4 | 3/8 | 2 1/2 | 0.35490 |
| | N-405 | 1/4 | 1 1/4 | 1/2 | 3 1/4 | 0.42483 |
| | N-409 | 1/4 | 2 1/4 | 5/8 | 4 3/8 | 0.56469 |
| | N-413 | 1/4 | 3 1/4 | 3/4 | 5 1/2 | 0.70455 |
| | N-416 | 1/4 | 4 | 3/4 | 6 1/2 | 0.80944 |
| | N-605 | 3/8 | 1 1/4 | 1/2 | 3 1/4 | 0.54983 |
| | N-609 | 3/8 | 2 1/4 | 5/8 | 4 3/8 | 0.68969 |
| | N-613 | 3/8 | 3 1/4 | 3/4 | 5 1/2 | 0.82955 |
| | N-616 | 3/8 | 4 | 3/4 | 6 1/2 | 0.93444 |
| | N-805 | 1/2 | 1 1/4 | 1/2 | 3 1/4 | 0.67483 |
| N-809 | 1/2 | 2 1/4 | 3/4 | 4 1/2 | 0.81469 | |
| N-813 | 1/2 | 3 1/4 | 3/4 | 6 1/2 | 0.95455 | |
| N-816 | 1/2 | 4 | 1 | 6 1/2 | 1.05944 | |
| N-820 | 1/2 | 5 | 1 | 7 1/2 | 1.19930 | |

| Taper Per Side | Tool No. | Tip Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|----------|----------|-----------|----------|--------|------------|
| 5 DEG | O-0002 | 1/32 | 1/2 | 3/16 | 2 5/8 | 0.11874 |
| | O-0003 | 1/32 | 3/4 | 3/16 | 2 5/8 | 0.16249 |
| | O-002 | 1/16 | 1/2 | 3/8 | 2 5/8 | 0.14999 |
| | O-003 | 1/16 | 3/4 | 3/8 | 2 5/8 | 0.19374 |
| | O-004 | 1/16 | 1 | 3/8 | 2 7/8 | 0.23748 |
| | O-005 | 1/16 | 1 1/4 | 3/8 | 3 1/8 | 0.28123 |
| | O-006 | 1/16 | 1 1/2 | 3/8 | 3 1/4 | 0.32497 |
| | O-102 | 3/32 | 1/2 | 3/8 | 2 5/8 | 0.18124 |
| | O-103 | 3/32 | 3/4 | 3/8 | 2 5/8 | 0.22499 |
| | O-104 | 3/32 | 1 | 3/8 | 2 7/8 | 0.26873 |
| | O-105 | 3/32 | 1 1/4 | 3/8 | 3 1/8 | 0.31248 |
| | O-106 | 3/32 | 1 1/2 | 3/8 | 3 1/4 | 0.35622 |
| | O-108 | 3/32 | 2 | 1/2 | 4 | 0.44371 |
| | O-108A | 3/32 | 2 | 3/8 | 3 7/8 | 0.44371 |
| | O-110 | 3/32 | 2 1/2 | 1/2 | 4 1/2 | 0.53120 |
| | O-114 | 3/32 | 3 1/2 | 3/4 | 5 7/8 | 0.66244 |
| | O-154 | 7/64 | 1 | 3/8 | 2 7/8 | 0.28436 |
| | O-155 | 7/64 | 1 1/4 | 3/8 | 3 1/8 | 0.32810 |
| | O-156 | 7/64 | 1 1/2 | 3/8 | 3 5/16 | 0.37185 |
| | O-158 | 7/64 | 2 | 1/2 | 4 | 0.45934 |
| | O-203 | 1/8 | 3/4 | 3/8 | 2 5/8 | 0.25000 |
| | O-204 | 1/8 | 1 | 3/8 | 2 7/8 | 0.29998 |
| | O-205 | 1/8 | 1 1/4 | 3/8 | 3 1/8 | 0.34373 |
| | O-206 | 1/8 | 1 1/2 | 3/8 | 3 1/4 | 0.37500 |
| | O-208 | 1/8 | 2 | 1/2 | 4 | 0.47496 |
| | O-208A | 1/8 | 2 | 3/8 | 3 7/8 | 0.47496 |
| | O-210 | 1/8 | 2 1/2 | 5/8 | 4 1/2 | 0.56245 |
| | O-210A | 1/8 | 2 1/2 | 1/2 | 4 1/2 | 0.56245 |
| | O-212 | 1/8 | 3 | 3/4 | 5 1/4 | 0.64994 |
| | O-212A | 1/8 | 3 | 1/2 | 5 1/4 | 0.64994 |
| | O-222 | 1/8 | 5 1/2 | 1/2 | 7 1/2 | 1.08739 |
| | O-254 | 5/32 | 1 | 3/8 | 2 7/8 | 0.33123 |
| | O-255 | 5/32 | 1 1/4 | 3/8 | 3 1/8 | 0.37498 |
| | O-256 | 5/32 | 1 1/2 | 1/2 | 3 5/8 | 0.41872 |
| | O-258 | 5/32 | 2 | 1/2 | 3 7/8 | 0.50000 |
| | O-303 | 3/16 | 3/4 | 3/8 | 2 9/16 | 0.31874 |
| | O-304 | 3/16 | 1 | 1/2 | 3 | 0.36248 |
| | O-305 | 3/16 | 1 1/4 | 1/2 | 3 3/8 | 0.40623 |
| | O-305S | 7/32 | 1 1/4 | 1/2 | 3 3/8 | 0.43748 |
| | O-306 | 3/16 | 1 1/2 | 1/2 | 3 1/2 | 0.44997 |
| | O-308 | 3/16 | 2 | 1/2 | 4 1/8 | 0.53746 |
| | O-310 | 3/16 | 2 1/2 | 5/8 | 4 5/8 | 0.62495 |
| | O-310A | 3/16 | 2 1/2 | 1/2 | 4 1/2 | 0.62495 |
| | O-312 | 3/16 | 3 | 3/4 | 5 1/4 | 0.71244 |
| | O-312A | 3/16 | 3 | 1/2 | 5 1/4 | 0.71244 |
| | O-313 | 3/16 | 3 1/4 | 3/4 | 5 1/2 | 0.75619 |
| | O-313A | 3/16 | 3 1/4 | 1/2 | 5 1/2 | 0.74619 |

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for Cobalt, add the suffix "CO"
for Cobalt TIN Coated, add the suffix "CO-TIN"
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• Four Flutes

HIGH SPEED STEEL & COBALT

Flat Ends



| Taper Per Side | Tool No. | Tip Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|----------|----------|-----------|----------|---------|------------|
| 5 | O-316 | 3/16 | 4 | 3/4 | 6 1/4 | 0.88742 |
| | O-320 | 3/16 | 5 | 1 | 7 1/2 | 1.06240 |
| | O-324 | 3/16 | 6 | 1 | 8 1/2 | 1.23738 |
| | O-403 | 1/4 | 3/4 | 3/8 | 2 1/2 | 0.38124 |
| | O-404 | 1/4 | 1 | 1/2 | 3 | 0.42498 |
| | O-405 | 1/4 | 1 1/4 | 1/2 | 3 1/4 | 0.46873 |
| | O-406 | 1/4 | 1 1/2 | 1/2 | 3 1/2 | 0.51247 |
| | O-409 | 1/4 | 2 1/4 | 5/8 | 4 3/8 | 0.64371 |
| | O-409A | 1/4 | 2 1/4 | 1/2 | 4 1/4 | 0.64371 |
| | O-410 | 1/4 | 2 1/2 | 5/8 | 4 1/2 | 0.68745 |
| | O-413 | 1/4 | 3 1/4 | 3/4 | 5 1/2 | 0.81869 |
| | O-416 | 1/4 | 4 | 3/4 | 6 1/4 | 0.94992 |
| | O-424 | 1/4 | 6 | 1 | 8 1/2 | 1.29988 |
| | O-509 | 5/16 | 2 1/4 | 5/8 | 4 1/4 | 0.70621 |
| | O-605 | 3/8 | 1 1/4 | 1/2 | 3 1/4 | 0.59373 |
| | O-609 | 3/8 | 2 1/4 | 3/4 | 4 1/2 | 0.76871 |
| | O-613 | 3/8 | 3 1/4 | 3/4 | 5 1/2 | 0.94369 |
| | O-616 | 3/8 | 4 | 1 | 6 1/2 | 1.07492 |
| | O-620 | 3/8 | 5 | 1 1/4 | 7 1/2 | 1.24990 |
| | O-624 | 3/8 | 6 | 1 1/4 | 8 1/2 | 1.42488 |
| | O-805 | 1/2 | 1 1/4 | 1/2 | 3 1/4 | 0.71873 |
| | O-809 | 1/2 | 2 1/4 | 3/4 | 4 1/2 | 0.89371 |
| | O-813 | 1/2 | 3 1/4 | 3/4 | 5 5/8 | 1.06869 |
| | O-816 | 1/2 | 4 | 1 | 6 1/2 | 1.19992 |
| | O-820 | 1/2 | 5 | 1 1/4 | 7 1/2 | 1.37490 |
| | O-824 | 1/2 | 6 | 1 1/4 | 8 1/2 | 1.54988 |
| | O-1009 | 5/8 | 2 1/4 | 3/4 | 4 1/4 | 1.01871 |
| | O-1020 | • 5/8 | 5 | 1 1/4 | 7 1/2 | 1.49990 |
| | O-1209 | 3/4 | 2 1/4 | 3/4 | 4 3/4 | 1.14371 |
| | O-1216 | • 3/4 | 4 | 1 1/4 | 6 1/2 | 1.44992 |
| | O-1220 | • 3/4 | 5 | 1 1/4 | 7 1/2 | 1.62490 |
| | O-1224 | • 3/4 | 6 | 1 1/4 | 8 1/2 | 1.79988 |
| O-1620 | • 1 | 5 | 1 1/4 | 7 1/2 | 1.87490 | |
| O-1624 | • 1 | 6 | 2 | 9 1/2 | 2.04988 | |
| 6 DEG | P-004 | 1/16 | 1 | 3/8 | 2 7/8 | 0.27271 |
| | P-104 | 3/32 | 1 | 3/8 | 2 7/8 | 0.30396 |
| | P-204 | 1/8 | 1 | 3/8 | 2 7/8 | 0.33521 |
| | P-206 | 1/8 | 1 1/2 | | 3 1/4 | 0.44032 |
| | P-306 | 3/16 | 1 1/2 | 1/2 | 3 1/4 | 0.50282 |
| | P-406 | 1/4 | 1 1/2 | 5/8 | 3 1/2 | 0.56532 |
| | P-605 | 3/8 | 1 1/4 | 5/8 | 3 1/4 | 0.63776 |
| | P-805 | 1/2 | 1 1/4 | 3/4 | 3 1/4 | 0.76276 |

| Taper Per Side | Tool No. | Tip Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|----------|----------|-----------|----------|---------|------------|
| 7 DEG | R-0004 | 1/32 | 1 | 3/8 | 2 3/4 | 0.27681 |
| | R-003 | 1/16 | 3/4 | 3/8 | 2 5/8 | 0.24667 |
| | R-004 | 1/16 | 1 | 3/8 | 2 7/8 | 0.30806 |
| | R-006 | 1/16 | 1 1/2 | 1/2 | 3 1/4 | 0.43084 |
| | R-0254 | .070 | 1 | 3/8 | 2 7/8 | 0.31556 |
| | R-054 | 5/64 | 1 | 3/8 | 2 7/8 | 0.32369 |
| | R-103 | 3/32 | 3/4 | 3/8 | 2 1/2 | 0.27792 |
| | R-104 | 3/32 | 1 | 3/8 | 2 3/4 | 0.33931 |
| | R-105 | 3/32 | 1 1/4 | 1/2 | 3 1/8 | 0.40070 |
| | R-106 | 3/32 | 1 1/2 | 1/2 | 3 1/2 | 0.46209 |
| | R-203 | 1/8 | 3/4 | 3/8 | 2 9/16 | 0.30917 |
| | R-204 | 1/8 | 1 | 3/8 | 2 3/4 | 0.37056 |
| | R-206 | 1/8 | 1 1/2 | 1/2 | 3 1/2 | 0.49334 |
| | R-208 | 1/8 | 2 | 5/8 | 3 7/8 | 0.61612 |
| | R-212 | 1/8 | 3 | 3/4 | 5 1/4 | 0.86168 |
| | R-305 | 3/16 | 1 1/4 | 1/2 | 3 1/4 | 0.49445 |
| | R-312 | 3/16 | 3 | 3/4 | 5 3/8 | 0.92418 |
| | R-403 | 1/4 | 3/4 | 1/2 | 2 1/2 | 0.43417 |
| | R-405 | 1/4 | 1 1/4 | 1/2 | 3 1/4 | 0.55695 |
| | R-409 | 1/4 | 2 1/4 | 3/4 | 4 1/2 | 0.80251 |
| | R-413 | 1/4 | 3 1/4 | 1 | 5 3/8 | 1.04807 |
| | R-416 | 1/4 | 4 | 1 | 6 1/2 | 1.23224 |
| | R-513 | 5/16 | 3 1/4 | 1 | 5 3/4 | 1.11057 |
| | R-605 | 3/8 | 1 1/4 | 5/8 | 3 1/4 | 0.68195 |
| | R-609 | 3/8 | 2 1/4 | 3/4 | 4 1/2 | 0.92751 |
| | R-613 | 3/8 | 3 1/4 | 1 | 5 5/8 | 1.17307 |
| | R-616 | 3/8 | 4 | 1 1/4 | 6 1/2 | 1.35724 |
| | R-624 | • 3/8 | 6 | 1 1/4 | 8 1/2 | 1.84836 |
| | R-805 | 1/2 | 1 1/4 | 3/4 | 3 1/2 | 0.80695 |
| | R-805A | 1/2 | 1 1/4 | 5/8 | 3 3/8 | 0.80695 |
| | R-809 | 1/2 | 2 1/4 | 1 | 4 5/8 | 1.05251 |
| | R-813 | • 1/2 | 3 1/4 | 1 1/4 | 5 3/4 | 1.29807 |
| R-816 | • 1/2 | 4 | 1 1/4 | 6 1/2 | 1.48224 | |
| R-824 | • 1/2 | 6 | 1 1/4 | 8 1/2 | 1.97336 | |
| R-1016 | • 5/8 | 4 | 1 1/4 | 6 1/2 | 1.60724 | |
| R-1020 | • 5/8 | 5 | 1 1/4 | 7 1/2 | 1.85280 | |
| R-1213 | • 3/4 | 3 1/4 | 1 1/4 | 5 3/4 | 1.54807 | |
| R-1216 | • 3/4 | 4 | 1 1/4 | 6 1/2 | 1.73224 | |
| R-1224 | • 3/4 | 6 | 2 | 9 1/2 | 2.22336 | |
| R-1624 | • 1 | 6 | 2 | 9 1/2 | 2.47336 | |

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A

HIGH SPEED STEEL & COBALT

Flat Ends

| Taper Per Side | Tool No. | Tip Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|----------|----------|-----------|----------|---------|------------|
| 10 DEG | T-0003 | 1/32 | 3/4 | 3/8 | 2 3/4 | 0.29575 |
| | T-002 | 1/16 | 1/2 | 3/8 | 2 3/8 | 0.23883 |
| | T-003 | 1/16 | 3/4 | 3/8 | 2 5/8 | 0.32700 |
| | T-004 | 1/16 | 1 | 1/2 | 2 7/8 | 0.41516 |
| | T-102 | 3/32 | 1/2 | 3/8 | 2 3/8 | 0.27008 |
| | T-103 | 3/32 | 3/4 | 3/8 | 2 5/8 | 0.35825 |
| | T-106 | 3/32 | 1 1/2 | 1/2 | 3 1/2 | 0.62274 |
| | T-203 | 1/8 | 3/4 | 3/8 | 2 5/8 | 0.38950 |
| | T-205 | 1/8 | 1 1/4 | 1/2 | 3 1/4 | 0.56583 |
| | T-206 | 1/8 | 1 1/2 | 1/2 | 3 1/2 | 0.65399 |
| | T-254 | 5/32 | 1 | 1/2 | 3 | 0.50000 |
| | T-258 | 5/32 | 2 | 3/4 | 4 1/4 | 0.86157 |
| | T-305 | 3/16 | 1 1/4 | 1/2 | 3 3/8 | 0.62500 |
| | T-309 | 3/16 | 2 1/4 | 3/4 | 4 1/2 | 0.98099 |
| | T-403 | 1/4 | 3/4 | 1/2 | 2 3/4 | 0.51450 |
| | T-405 | 1/4 | 1 1/4 | 1/2 | 3 1/4 | 0.69083 |
| | T-409 | 1/4 | 2 1/4 | 3/4 | 4 1/2 | 1.04349 |
| | T-409A | 1/4 | 2 1/4 | 1/2 | 4 1/2 | 1.04349 |
| | T-413 | 1/4 | 3 1/4 | 1 | 5 5/8 | 1.39615 |
| | T-605 | 3/8 | 1 1/4 | 5/8 | 3 1/2 | 0.81583 |
| | T-609 | 3/8 | 2 1/4 | 1 | 4 5/8 | 1.16849 |
| T-613 | • 3/8 | 3 1/4 | 1 1/4 | 5 3/4 | 1.52115 | |
| T-805 | 1/2 | 1 1/4 | 3/4 | 3 1/2 | 0.94083 | |
| T-809 | 1/2 | 2 1/4 | 1 | 4 3/4 | 1.29349 | |
| T-813 | • 1/2 | 3 1/4 | 1 1/4 | 5 3/4 | 1.64615 | |
| T-816 | • 1/2 | 4 | 1 1/4 | 6 3/8 | 1.91064 | |

| Taper Per Side | Tool No. | Tip Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|----------|----------|-----------|----------|---------|------------|
| 15 DEG | V-0003 | 1/32 | 3/4 | 1/2 | 2 3/4 | 0.43318 |
| | V-003 | 1/16 | 3/4 | 1/2 | 2 3/4 | 0.46443 |
| | V-102 | 3/32 | 1/2 | 3/8 | 2 3/8 | 0.36170 |
| | V-103 | 3/32 | 3/4 | 1/2 | 2 7/8 | 0.49568 |
| | V-104 | 3/32 | 1 | 1/2 | 3 | 0.62965 |
| | V-106 | 3/32 | 1 1/2 | 3/4 | 3 3/4 | 0.89760 |
| | V-106A | 3/32 | 1 1/2 | 1/2 | 3 3/4 | 0.89760 |
| | V-202 | 1/8 | 1/2 | 1/2 | 2 5/8 | 0.39295 |
| | V-202A | 1/8 | 1/2 | 3/8 | 2 5/8 | 0.39295 |
| | V-203 | 1/8 | 3/4 | 1/2 | 2 7/8 | 0.52693 |
| | V-204 | 1/8 | 1 | 1/2 | 3 1/8 | 0.66090 |
| | V-205 | 1/8 | 1 1/4 | 5/8 | 3 1/2 | 0.79488 |
| | V-205A | 1/8 | 1 1/4 | 1/2 | 3 1/2 | 0.79488 |
| | V-206A | 1/8 | 1 1/2 | 1/2 | 3 5/8 | 0.92885 |
| | V-304 | 3/16 | 1 | 1/2 | 3 1/8 | 0.72340 |
| | V-305 | 3/16 | 1 1/4 | 3/4 | 3 1/2 | 0.85738 |
| | V-305A | 3/16 | 1 1/4 | 1/2 | 3 1/2 | 0.85738 |
| | V-308 | 3/16 | 2 | 1 | 4 1/2 | 1.25930 |
| | V-404 | 1/4 | 1 | 1/2 | 3 1/8 | 0.78590 |
| | V-405 | 1/4 | 1 1/4 | 3/4 | 3 1/2 | 0.91988 |
| | V-405A | 1/4 | 1 1/4 | 1/2 | 3 1/2 | 0.91988 |
| | V-406 | 1/4 | 1 1/2 | 3/4 | 3 3/4 | 1.05385 |
| | V-408 | 1/4 | 2 | 3/4 | 4 1/2 | 1.32180 |
| | V-409 | 1/4 | 2 1/4 | 1 | 4 3/4 | 1.45578 |
| | V-413 | • 1/4 | 3 1/4 | 1 1/4 | 5 3/4 | 1.99168 |
| | V-504 | 5/16 | 1 | 3/4 | 3 1/4 | 0.84840 |
| | V-506 | 5/16 | 1 1/2 | 3/4 | 3 7/8 | 1.11635 |
| | V-509 | • 5/16 | 2 1/4 | 1 | 4 7/8 | 1.51828 |
| | V-605 | 3/8 | 1 1/4 | 3/4 | 3 5/8 | 1.04488 |
| | V-609 | • 3/8 | 2 1/4 | 1 1/4 | 4 3/4 | 1.51828 |
| | V-613 | • 3/8 | 3 1/4 | 1 1/4 | 5 3/4 | 2.05418 |
| | V-804 | 1/2 | 1 | 3/4 | 3 1/4 | 1.03590 |
| V-805 | 1/2 | 1 1/4 | 3/4 | 3 5/8 | 1.16988 | |
| V-807 | • 1/2 | 1 3/4 | 1 | 4 1/4 | 1.43783 | |
| V-809 | • 1/2 | 2 1/4 | 1 1/4 | 4 7/8 | 1.70578 | |
| V-812 | • 1/2 | 3 | 1 1/4 | 5 1/2 | 2.10770 | |
| V-813 | • 1/2 | 3 1/4 | 1 1/4 | 6 | 2.24168 | |



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HIGH SPEED STEEL & COBALT

Flat Ends

A

| Taper Per Side | Tool No. | Tip Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. | |
|----------------|----------|----------|-----------|----------|-------|------------|---------|
| 20 DEG | W-002 | 1/16 | 1/2 | 3/8 | 2 1/2 | 0.42647 | |
| | W-103 | 3/32 | 3/4 | 1/2 | 2 3/4 | 0.63971 | |
| | W-202 | 1/8 | 1/2 | 3/8 | 2 1/2 | 0.48897 | |
| | W-204 | • 1/8 | 1 | 1/2 | 3 1/8 | 0.85294 | |
| | W-304 | • 3/16 | 1 | 1/2 | 4 | 0.91544 | |
| | W-306 | • 3/16 | 1 1/2 | 3/4 | 3 1/4 | 1.27941 | |
| | W-404 | • 1/4 | 1 | 1/2 | 3 1/8 | 0.97794 | |
| | W-406 | • 1/4 | 1 1/2 | 3/4 | 4 | 1.34191 | |
| | W-504 | • 5/16 | 1 | 3/4 | 3 1/4 | 1.04044 | |
| | W-506 | • 5/16 | 1 1/2 | 3/4 | 3 7/8 | 1.40441 | |
| | W-606 | • 3/8 | 1 1/2 | 3/4 | 3 7/8 | 1.46691 | |
| | W-608 | • 3/8 | 2 | 1 | 4 1/2 | 1.83088 | |
| | W-809 | • 1/2 | 2 1/4 | 1 1/4 | 4 7/8 | 2.13787 | |
| 25 DEG | X-103 | 3/32 | 3/4 | 1/2 | 3 | 0.79322 | |
| | X-202 | 1/8 | 1/2 | 1/2 | 2 1/2 | 0.59131 | |
| | X-204A | 1/8 | 1 | 1/2 | 3 1/8 | 1.05762 | |
| | X-204B | 1/8 | 1 | 5/8 | 3 1/8 | 1.05762 | |
| | X-204C | 1/8 | 1 | 3/4 | 3 1/8 | 1.05762 | |
| | X-404 | • 1/4 | 1 | 5/8 | 3 1/4 | 1.18262 | |
| | X-406 | • 1/4 | 1 1/2 | 3/4 | 4 1/8 | 1.64893 | |
| | X-503 | • 5/16 | 3/4 | 5/8 | 3 | 1.01197 | |
| | X-504 | • 5/16 | 1 | 3/4 | 3 3/8 | 1.24512 | |
| | X-506 | • 5/16 | 1 1/2 | 1 | 4 1/8 | 1.71143 | |
| | X-603 | • 3/8 | 3/4 | 5/8 | 3 | 1.07447 | |
| | X-604 | • 3/8 | 1 | 3/4 | 3 1/4 | 1.30762 | |
| | X-606 | • 3/8 | 1 1/2 | 1 | 4 1/8 | 1.77393 | |
| | X-805 | • 1/2 | 1 1/4 | 1 | 3 3/4 | 1.66578 | |
| | 30 DEG | Z-002 | 1/16 | 1/2 | 1/2 | 2 1/2 | 0.63985 |
| | | Z-103 | 3/32 | 3/4 | 1/2 | 3 | 0.95978 |
| Z-202 | | • 1/8 | 1/2 | 1/2 | 2 5/8 | 0.70235 | |
| Z-204 | | • 1/8 | 1 | 1/2 | 3 1/8 | 1.27970 | |
| Z-404 | | • 1/4 | 1 | 3/4 | 3 3/8 | 1.40470 | |
| Z-406 | | • 1/4 | 1 1/2 | 1 | 4 1/8 | 1.98205 | |
| Z-605 | | • 3/8 | 1 1/4 | 1 | 3 7/8 | 1.81838 | |
| Z-606 | | • 3/8 | 1 1/2 | 1 | 4 1/4 | 2.10705 | |
| Z-805 | | • 1/2 | 1 1/4 | 1 | 3 3/4 | 1.94338 | |
| Z-806 | | • 1/2 | 1 1/2 | 1 | 4 1/4 | 2.23205 | |

| Taper Per Side | Tool No. | Tip Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|----------|----------|-----------|----------|-------|------------|
| 45 DEG | 45-2015 | • 1/8 | 5/16 | 1/2 | 2 1/2 | 0.75000 |
| | 45-202 | • 1/8 | 1/2 | 1/2 | 2 5/8 | 1.12500 |
| | 45-203 | • 1/8 | 3/4 | 5/8 | 3 1/4 | 1.62500 |
| | 45-204 | • 1/8 | 1 | 1 | 3 3/4 | 2.12500 |
| | 45-303 | • 3/16 | 3/4 | 3/4 | 3 1/4 | 1.68750 |
| | 45-304 | • 3/16 | 1 | 1 | 4 | 2.17850 |
| | 45-305 | • 3/16 | 1 1/4 | 1 1/4 | 4 1/4 | 2.68750 |
| | 45-403 | • 1/4 | 3/4 | 3/4 | 3 1/4 | 1.75000 |
| | 45-404 | • 1/4 | 1 | 1 | 4 | 2.25000 |
| | 45-405 | • 1/4 | 1 1/4 | 1 1/4 | 4 1/4 | 2.75000 |
| | 45-406 | • 1/4 | 1 1/2 | 1 1/4 | 4 1/2 | 3.25000 |
| | 45-603 | • 3/8 | 3/4 | 3/4 | 3 1/4 | 1.87500 |
| | 45-604 | • 3/8 | 1 | 1 | 4 | 2.37500 |
| | 45-605 | • 3/8 | 1 1/4 | 1 1/4 | 4 1/4 | 2.87500 |
| | 45-606 | • 3/8 | 1 1/2 | 1 1/4 | 4 1/2 | 3.37500 |
| | 45-803 | • 1/2 | 3/4 | 3/4 | 3 1/4 | 2.00000 |
| | 45-804 | • 1/2 | 1 | 1 | 4 | 2.50000 |
| | 45-805 | • 1/2 | 1 1/4 | 1 1/4 | 4 1/4 | 3.00000 |
| | 45-806 | • 1/2 | 1 1/2 | 1 1/4 | 4 5/8 | 3.50000 |



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for Cobalt TIN Coated, add the suffix "CO-TIN"
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• Four Flutes

A

MINIATURE HIGH SPEED STEEL & COBALT Ball Ends

| Taper Per Side | Tool No. | Ball Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|--------------|-----------|-----------|----------|---------|------------|
| 1/2 DEG | BM0-002 | 1/16 | 1/2 | 3/16 | 1 3/4 | 0.07123 |
| | BM0-003 | 1/16 | 3/4 | 3/16 | 2 | 0.07559 |
| | BM0-004 | 1/16 | 1 | 3/16 | 2 1/4 | 0.07995 |
| | BM0-052 | 5/64 | 1/2 | 3/16 | 1 3/4 | 0.08685 |
| | BM0-054 | 5/64 | 1 | 3/16 | 2 1/4 | 0.09558 |
| | BM0-103 | 3/32 | 3/4 | 3/16 | 2 | 0.10684 |
| | BM0-105 | 3/32 | 1 1/4 | 3/16 | 2 1/2 | 0.11556 |
| | BM0-106 | 3/32 | 1 1/2 | 3/16 | 2 | 0.11993 |
| | BM0-201 | 1/8 | 1/4 | 3/16 | 1 1/2 | 0.12936 |
| | BM0-2015 | 1/8 | 3/8 | 3/16 | 1 5/8 | 0.13154 |
| | BM0-203 | 1/8 | 3/4 | 3/16 | 2 | 0.13809 |
| | BM0-204 | 1/8 | 1 | 3/16 | 2 1/4 | 0.14245 |
| | 1 DEG | BM1-002 | 1/16 | 1/2 | 3/16 | 1 3/4 |
| BM1-003 | | 1/16 | 3/4 | 3/16 | 2 | 0.08868 |
| BM1-003 | | 1/16 | 1 | 3/16 | 2 1/4 | 0.09740 |
| BM1-052 | | 5/64 | 1/2 | 3/16 | 1 3/4 | 0.09558 |
| BM1-054 | | 5/64 | 1 | 3/16 | 2 1/4 | 0.11303 |
| BM1-103 | | 3/32 | 3/4 | 3/16 | 2 | 0.11993 |
| BM1-105 | | 3/32 | 1 1/4 | 3/16 | 2 1/2 | 0.13738 |
| BM1-106 | | 3/32 | 1 1/2 | 3/16 | 2 11/16 | 0.14610 |
| BM1-201 | | 1/8 | 1/4 | 3/16 | 1 1/2 | 0.13373 |
| BM1-2015 | | 1/8 | 3/8 | 3/16 | 1 5/8 | 0.13809 |
| BM1-203 | | 1/8 | 3/4 | 3/16 | 2 | 0.15118 |
| BM1-204 | | 1/8 | 1 | 3/16 | 2 1/4 | 0.15990 |

| Taper Per Side | Tool No. | Ball Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|------------------|----------|-----------|-----------|----------|---------|------------|
| 1 1/2 DEG | BM15-003 | 1/16 | 3/4 | 3/16 | 2 | 0.10177 |
| | BM15-104 | 3/32 | 1 | 3/16 | 2 1/4 | 0.14611 |
| | BM15-105 | 3/32 | 1 1/4 | 3/16 | 2 1/2 | 0.15920 |
| | BM15-154 | 7/64 | 1 | 3/16 | 2 1/4 | 0.16174 |
| | BM15-203 | 1/8 | 3/4 | 3/16 | 2 | 0.16427 |
| | BM15-204 | 1/8 | 1 | 3/16 | 2 1/4 | 0.17736 |
| 2 DEG | BM2-002 | 1/16 | 1/2 | 3/16 | 1 3/4 | 0.09742 |
| | BM2-004 | 1/16 | 1 | 3/16 | 2 1/4 | 0.13234 |
| | BM2-052 | 5/64 | 1/2 | 3/16 | 1 3/4 | 0.11305 |
| | BM2-054 | 5/64 | 1 | 3/16 | 2 1/4 | 0.14797 |
| | BM2-056 | 5/64 | 1 1/2 | 3/16 | 2 11/16 | 0.18289 |
| | BM2-103 | 3/32 | 3/4 | 3/16 | 2 | 0.14613 |
| | BM2-105 | 3/32 | 1 1/4 | 3/16 | 2 1/2 | 0.18105 |
| BM2-203 | 1/8 | 3/4 | 3/16 | 2 | 0.17738 | |

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for Cobalt, add the suffix "CO"
for Cobalt TIN Coated, add the suffix "CO-TIN"
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• Four Flutes

HIGH SPEED STEEL & COBALT

Ball Ends

A

| Taper Per Side | Tool No. | Ball Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|----------|-----------|-----------|----------|---------|------------|
| 1/2 DEG | BKK-102 | 3/32 | 1/2 | 3/8 | 2 1/2 | 0.10248 |
| | BKK-103 | 3/32 | 3/4 | 3/8 | 2 5/8 | 0.10684 |
| | BKK-105 | 3/32 | 1 1/4 | 3/8 | 3 1/8 | 0.11556 |
| | BKK-201 | 1/8 | 1/4 | 3/8 | 2 1/2 | 0.12936 |
| | BKK-202 | 1/8 | 1/2 | 3/8 | 2 1/2 | 0.13373 |
| | BKK-203 | 1/8 | 3/4 | 3/8 | 2 1/2 | 0.13809 |
| | BKK-204 | 1/8 | 1 | 3/8 | 2 7/8 | 0.14245 |
| | BKK-205 | 1/8 | 1 1/4 | 3/8 | 3 1/8 | 0.14681 |
| | BKK-206 | 1/8 | 1 1/2 | 3/8 | 3 1/4 | 0.15118 |
| | BKK-303 | 3/16 | 3/4 | 3/8 | 2 1/2 | 0.20059 |
| | BKK-305 | 3/16 | 1 1/4 | 3/8 | 3 1/8 | 0.20931 |
| | BKK-307 | 3/16 | 1 1/4 | 3/8 | 3 7/8 | 0.21804 |
| | BKK-309 | 3/16 | 2 1/4 | 3/8 | 4 1/4 | 0.22676 |
| | BKK-313 | 3/16 | 3 1/4 | 3/8 | 5 1/2 | 0.24421 |
| | BKK-403 | 1/4 | 3/4 | 3/8 | 2 1/2 | 0.26309 |
| | BKK-405 | 1/4 | 1 1/4 | 3/8 | 3 | 0.27181 |
| | BKK-409 | 1/4 | 2 1/4 | 1/2 | 4 1/4 | 0.28926 |
| | BKK-409A | 1/4 | 2 1/4 | 3/8 | 4 1/4 | 0.28926 |
| | BKK-413 | 1/4 | 3 1/4 | 1/2 | 5 1/2 | 0.30671 |
| | BKK-605 | 3/8 | 1 1/4 | 1/2 | 3 1/8 | 0.39681 |
| | BKK-609 | 3/8 | 2 1/4 | 1/2 | 4 1/4 | 0.41426 |
| | BKK-613 | 3/8 | 3 1/4 | 1/2 | 5 1/2 | 0.43171 |
| | BKK-805 | 1/2 | 1 1/4 | 1/2 | 3 1/4 | 0.52181 |
| | BKK-809 | 1/2 | 2 1/4 | 1/2 | 4 1/4 | 0.53926 |
| | BKK-813 | 1/2 | 3 1/4 | 1/2 | 5 1/2 | 0.55671 |
| | BKK-1009 | 5/8 | 2 1/4 | 5/8 | 4 1/2 | 0.66426 |
| | BKK-1013 | 5/8 | 3 1/4 | 5/8 | 5 1/2 | 0.68171 |
| | BKK-1017 | 5/8 | 4 1/4 | 5/8 | 6 1/2 | 0.69916 |
| | BKK-1209 | 3/4 | 2 1/4 | 3/4 | 4 3/4 | 0.78926 |
| | BKK-1213 | 3/4 | 3 1/4 | 3/4 | 5 3/4 | 0.80671 |
| | BKK-1217 | 3/4 | 4 1/4 | 3/4 | 6 3/4 | 0.82416 |
| | BKK-1221 | 3/4 | 5 1/4 | 3/4 | 7 3/4 | 0.84161 |
| BKK-1624 | • 1 | 6 | 1 | 8 1/2 | 1.10470 | |

| Taper Per Side | Tool No. | Ball Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|----------|-----------|-----------|----------|---------|------------|
| 1 DEG | BK-102 | 3/32 | 1/2 | 3/8 | 2 1/2 | 0.11120 |
| | BK-103 | 3/32 | 3/4 | 3/8 | 2 1/2 | 0.11993 |
| | BK-105 | 3/32 | 1 1/4 | 3/8 | 3 1/8 | 0.13738 |
| | BK-201 | 1/8 | 1/4 | 3/8 | 2 1/2 | 0.13373 |
| | BK-202 | 1/8 | 1/2 | 3/8 | 2 1/2 | 0.14245 |
| | BK-203 | 1/8 | 3/4 | 3/8 | 2 1/2 | 0.15118 |
| | BK-204 | 1/8 | 1 | 3/8 | 2 7/8 | 0.15990 |
| | BK-205 | 1/8 | 1 1/4 | 3/8 | 3 1/8 | 0.16863 |
| | BK-206 | 1/8 | 1 1/2 | 3/8 | 3 1/4 | 0.17735 |
| | BK-208 | 1/8 | 2 | 3/8 | 3 7/8 | 0.19480 |
| | BK-303 | 3/16 | 3/4 | 3/8 | 2 1/2 | 0.21368 |
| | BK-305 | 3/16 | 1 1/4 | 3/8 | 3 1/8 | 0.23113 |
| | BK-308 | 3/16 | 2 | 3/8 | 3 7/8 | 0.25730 |
| | BK-309 | 3/16 | 2 1/4 | 3/8 | 4 1/4 | 0.26603 |
| | BK-310 | 3/16 | 2 1/2 | 3/8 | 4 1/2 | 0.27475 |
| | BK-313 | 3/16 | 3 1/4 | 3/8 | 5 1/2 | 0.30093 |
| | BK-403 | 1/4 | 3/4 | 3/8 | 2 1/2 | 0.27618 |
| | BK-405 | 1/4 | 1 1/4 | 3/8 | 3 | 0.29363 |
| | BK-406 | 1/4 | 1 1/2 | 3/8 | 3 1/4 | 0.30235 |
| | BK-409 | 1/4 | 2 1/4 | 1/2 | 4 1/4 | 0.32853 |
| | BK-413 | 1/4 | 3 1/4 | 1/2 | 5 1/2 | 0.36343 |
| | BK-605 | 3/8 | 1 1/4 | 1/2 | 3 1/4 | 0.41863 |
| | BK-609 | 3/8 | 2 1/4 | 1/2 | 4 1/4 | 0.45353 |
| | BK-613 | 3/8 | 3 1/4 | 1/2 | 5 1/4 | 0.48843 |
| | BK-805 | 1/2 | 1 1/4 | 1/2 | 3 1/4 | 0.54363 |
| | BK-809 | 1/2 | 2 1/4 | 1/2 | 4 1/4 | 0.57853 |
| | BK-813 | 1/2 | 3 1/4 | 5/8 | 5 3/8 | 0.61343 |
| | BK-813A | 1/2 | 3 1/4 | 1/2 | 5 3/8 | 0.61343 |
| | BK-1009 | 5/8 | 2 1/4 | 5/8 | 4 1/2 | 0.70353 |
| | BK-1013 | 5/8 | 3 1/4 | 5/8 | 5 1/2 | 0.73843 |
| | BK-1017 | 5/8 | 4 1/4 | 5/8 | 6 1/2 | 0.77333 |
| | BK-1209 | 3/4 | 2 1/4 | 3/4 | 4 3/4 | 0.82853 |
| BK-1213 | 3/4 | 3 1/4 | 3/4 | 5 3/4 | 0.86343 | |
| BK-1217 | 3/4 | 4 1/4 | 3/4 | 6 3/4 | 0.89833 | |
| BK-1221 | 3/4 | 5 1/4 | 3/4 | 7 3/4 | 0.93323 | |
| BK-1624 | • 1 | 6 | 1 | 8 1/2 | 1.20940 | |

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A

HIGH SPEED STEEL & COBALT Ball Ends

| Taper Per Side | Tool No. | Ball Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. | Taper Per Side | Tool No. | Ball Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|----------|-----------|-----------|----------|---------|------------|----------------|----------|-----------|-----------|----------|-------|------------|
| 1 1/2 DEG | BKX-102 | 3/32 | 1/2 | 3/8 | 2 1/2 | 0.11993 | 2 DEG | BL-002 | 1/16 | 1/2 | 3/8 | 2 5/8 | 0.09742 |
| | BKX-103 | 3/32 | 3/4 | 3/8 | 2 1/2 | 0.13302 | | BL-004 | 1/16 | 1 | 3/8 | 2 7/8 | 0.13234 |
| | BKX-104 | 3/32 | 1 | 3/8 | 2 7/8 | 0.14611 | | BL-102 | 3/32 | 1/2 | 3/8 | 2 1/2 | 0.12867 |
| | BKX-105 | 3/32 | 1 1/4 | 3/8 | 3 1/8 | 0.15920 | | BL-103 | 3/32 | 3/4 | 3/8 | 2 1/2 | 0.14613 |
| | BKX-106 | 3/32 | 1 1/2 | 3/8 | 3 1/4 | 0.17229 | | BL-105 | 3/32 | 1 1/4 | 3/8 | 3 1/8 | 0.18105 |
| | BKX-110 | 3/32 | 2 1/2 | 3/8 | 4 1/2 | 0.22465 | | BL-202 | 1/8 | 1/2 | 3/8 | 2 1/2 | 0.15992 |
| | BKX-154 | 7/64 | 1 | 3/8 | 2 7/8 | 0.16174 | | BL-203 | 1/8 | 3/4 | 3/8 | 2 1/2 | 0.17738 |
| | BKX-155 | 7/64 | 1 1/4 | 3/8 | 3 1/8 | 0.17483 | | BL-204 | 1/8 | 1 | 3/8 | 2 7/8 | 0.19484 |
| | BKX-156 | 7/64 | 1 1/2 | 3/8 | 3 1/4 | 0.18792 | | BL-205 | 1/8 | 1 1/4 | 3/8 | 3 1/8 | 0.21230 |
| | BKX-202 | 1/8 | 1/2 | 3/8 | 2 1/2 | 0.15118 | | BL-206 | 1/8 | 1 1/2 | 3/8 | 3 1/4 | 0.22976 |
| | BKX-203 | 1/8 | 3/4 | 3/8 | 2 1/2 | 0.16427 | | BL-208 | 1/8 | 2 | 3/8 | 3 7/8 | 0.26468 |
| | BKX-204 | 1/8 | 1 | 3/8 | 2 7/8 | 0.17736 | | BL-210 | 1/8 | 2 1/2 | 3/8 | 4 1/2 | 0.29960 |
| | BKX-205 | 1/8 | 1 1/4 | 3/8 | 3 1/8 | 0.19045 | | BL-303 | 3/16 | 3/4 | 3/8 | 2 1/2 | 0.23988 |
| | BKX-206 | 1/8 | 1 1/2 | 3/8 | 3 1/4 | 0.20354 | | BL-305 | 3/16 | 1 1/4 | 3/8 | 3 1/8 | 0.27480 |
| | BKX-208 | 1/8 | 2 | 3/8 | 3 7/8 | 0.22972 | | BL-309 | 3/16 | 2 1/4 | 1/2 | 4 1/4 | 0.34464 |
| | BKX-209 | 1/8 | 2 1/4 | 3/8 | 4 1/4 | 0.24281 | | BL-313 | 3/16 | 3 1/4 | 1/2 | 5 1/2 | 0.41448 |
| | BKX-212 | 1/8 | 3 | 3/8 | 5 | 0.28208 | | BL-403 | 1/4 | 3/4 | 3/8 | 2 1/2 | 0.30238 |
| | BKX-254 | 5/32 | 1 | 3/8 | 2 7/8 | 0.20861 | | BL-405 | 1/4 | 1 1/4 | 3/8 | 3 | 0.33730 |
| | BKX-255 | 5/32 | 1 1/4 | 3/8 | 3 1/8 | 0.22170 | | BL-409 | 1/4 | 2 1/4 | 1/2 | 4 3/8 | 0.40714 |
| | BKX-256 | 5/32 | 1 1/2 | 3/8 | 3 1/4 | 0.23479 | | BL-413 | 1/4 | 3 1/4 | 1/2 | 5 1/4 | 0.47698 |
| | BKX-258 | 5/32 | 2 | 3/8 | 3 7/8 | 0.26097 | | BL-505 | 5/16 | 1 1/4 | 1/2 | 3 1/4 | 0.39980 |
| | BKX-303 | 3/16 | 3/4 | 3/8 | 2.125 | 0.22677 | | BL-605 | 3/8 | 1 1/4 | 1/2 | 3 1/4 | 0.46230 |
| | BKX-305 | 3/16 | 1 1/4 | 3/8 | 3 1/8 | 0.25295 | | BL-609 | 3/8 | 2 1/4 | 1/2 | 4 1/4 | 0.53214 |
| | BKX-309 | 3/16 | 2 1/4 | 3/8 | 4 | 0.30531 | | BL-613 | 3/8 | 3 1/4 | 1/2 | 5 1/2 | 0.60198 |
| | BKX-313 | 3/16 | 3 1/4 | 3/8 | 5 1/2 | 0.35767 | | BL-613B | 3/8 | 3 1/4 | 5/8 | 5 1/2 | 0.60198 |
| | BKX-403 | 1/4 | 3/4 | 3/8 | 2 1/2 | 0.28927 | | BL-805 | 1/2 | 1 1/4 | 1/2 | 3 1/4 | 0.58730 |
| | BKX-405 | 1/4 | 1 1/4 | 3/8 | 3 | 0.31545 | | BL-809 | 1/2 | 2 1/4 | 5/8 | 4 3/8 | 0.65714 |
| | BKX-409 | 1/4 | 2 1/4 | 1/2 | 4 1/4 | 0.36781 | | BL-809A | 1/2 | 2 1/4 | 1/2 | 4 3/8 | 0.65714 |
| | BKX-413 | 1/4 | 3 1/4 | 1/2 | 5 1/2 | 0.42017 | | BL-813 | 1/2 | 3 1/4 | 3/4 | 5 1/2 | 0.72698 |
| | BKX-605 | 3/8 | 1 1/4 | 1/2 | 3 1/8 | 0.44045 | | BL-813B | 1/2 | 3 1/4 | 5/8 | 5 1/2 | 0.72698 |
| | BKX-609 | 3/8 | 2 1/4 | 1/2 | 4 1/4 | 0.49281 | | BL-1009 | 5/8 | 2 1/4 | 3/4 | 4 1/2 | 0.78214 |
| | BKX-613 | 3/8 | 3 1/4 | 1/2 | 5 1/2 | .054517 | | BL-1013 | 5/8 | 3 1/4 | 3/4 | 5 1/2 | 0.85198 |
| | BKX-805 | 1/2 | 1 1/4 | 1/2 | 3 1/4 | 0.56545 | | BL-1017 | 5/8 | 4 1/4 | 3/4 | 6 1/2 | 0.92182 |
| BKX-809 | 1/2 | 2 1/4 | 0 | 4 1/2 | 0.61781 | BL-1209 | 3/4 | 2 1/4 | 3/4 | 4 1/2 | 0.90714 | | |
| BKX-813 | 1/2 | 3 1/4 | 0 | 5 1/2 | 0.67017 | BL-1213 | 3/4 | 3 1/4 | 3/4 | 5 3/4 | 0.97698 | | |
| BKX-1009 | 5/8 | 2 1/4 | 0 | 4 1/2 | 0.74281 | BL-1221 | 3/4 | 5 1/4 | 1 | 7 3/4 | 1.11666 | | |
| BKX-1013 | 5/8 | 3 1/4 | 0 | 5 1/2 | 0.79517 | BL-1624 | • 1 | 6 | 1 1/4 | 8 1/2 | 1.41904 | | |
| BKX-1017 | 5/8 | 4 1/4 | 0 | 6 1/2 | 0.84753 | | | | | | | | |
| BKX-1209 | 3/4 | 2 1/4 | 0 | 4 3/4 | 0.86781 | | | | | | | | |
| BKX-1221 | 3/4 | 5 1/4 | 1 | 7 3/4 | 1.02489 | | | | | | | | |
| BKX-1624 | • 1 | 6 | 1 1/4 | 8 1/2 | 1.31416 | | | | | | | | |

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for Cobalt, add the suffix "CO"
for Cobalt TIN Coated, add the suffix "CO-TIN"
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HIGH SPEED STEEL & COBALT

Ball Ends



| Taper Per Side | Tool No. | Ball Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|----------|-----------|-----------|----------|---------|------------|
| 3 DEG | BM-002 | 1/16 | 1/2 | 3/8 | 2 5/8 | 0.11491 |
| | BM-003 | 1/16 | 3/4 | 3/8 | 2 3/4 | 0.14112 |
| | BM-004 | 1/16 | 1 | 3/8 | 2 7/8 | 0.16732 |
| | BM-005 | 1/16 | 1 1/4 | 3/8 | 3 1/8 | 0.19353 |
| | BM-006 | 1/16 | 1 1/2 | 3/8 | 3 1/4 | 0.21973 |
| | BM-103 | 3/32 | 3/4 | 3/8 | 2 1/2 | 0.17237 |
| | BM-104 | 3/32 | 1 | 3/8 | 2 7/8 | 0.19857 |
| | BM-105 | 3/32 | 1 1/4 | 3/8 | 3 1/8 | 0.22478 |
| | BM-106 | 3/32 | 1 1/2 | 3/8 | 3 1/4 | 0.25098 |
| | BM-108 | 3/32 | 2 | 3/8 | 3 3/4 | 0.30339 |
| | BM-110 | 3/32 | 2 1/2 | 1/2 | 4 1/2 | 0.35580 |
| | BM-154 | 7/64 | 1 | 3/8 | 2 7/8 | 0.21420 |
| | BM-155 | 7/64 | 1 1/4 | 3/8 | 3 1/8 | 0.24040 |
| | BM-156 | 7/64 | 1 1/2 | 3/8 | 3 1/4 | 0.26661 |
| | BM-158 | 7/64 | 2 | 3/8 | 3 3/4 | 0.31902 |
| | BM-203 | 1/8 | 3/4 | 3/8 | 2 5/8 | 0.20362 |
| | BM-204 | 1/8 | 1 | 3/8 | 2 7/8 | 0.22982 |
| | BM-205 | 1/8 | 1 1/4 | 3/8 | 3 1/8 | 0.25603 |
| | BM-206 | 1/8 | 1 1/2 | 3/8 | 3 1/4 | 0.28223 |
| | BM-208 | 1/8 | 2 | 3/8 | 3 3/4 | 0.33464 |
| | BM-210 | 1/8 | 2 1/2 | 1/2 | 4 1/2 | 0.38705 |
| | BM-210A | 1/8 | 2 1/2 | 3/8 | 4 1/2 | 0.38705 |
| | BM-212 | 1/8 | 3 | 1/2 | 5 | 0.43946 |
| | BM-216 | 1/8 | 4 | 1/2 | 6 1/2 | 0.54428 |
| | BM-2525 | 5/32 | 5/8 | 3/8 | 2 1/2 | 0.22176 |
| | BM-253 | 5/32 | 3/4 | 3/8 | 2 1/2 | 0.23487 |
| | BM-254 | 5/32 | 1 | 3/8 | 2 7/8 | 0.26107 |
| | BM-255 | 5/32 | 1 1/4 | 3/8 | 3 1/8 | 0.28728 |
| | BM-256 | 5/32 | 1 1/2 | 3/8 | 3 1/4 | 0.31348 |
| | BM-258 | 5/32 | 2 | 3/8 | 3 7/8 | 0.36589 |
| | BM-303 | 3/16 | 3/4 | 3/8 | 2 5/8 | 0.26612 |
| | BM-304 | 3/16 | 1 | 3/8 | 2 7/8 | 0.29232 |
| BM-305 | 3/16 | 1 1/4 | 3/8 | 3 1/8 | 0.31853 | |
| BM-306 | 3/16 | 1 1/2 | 3/8 | 3 1/8 | 0.34473 | |
| BM-308 | 3/16 | 2 | 1/2 | 4 | 0.39714 | |
| BM-310 | 3/16 | 2 1/2 | 1/2 | 4 1/2 | 0.44955 | |
| BM-312 | 3/16 | 3 | 1/2 | 5 | 0.50196 | |
| BM-313 | 3/16 | 3 1/4 | 1/2 | 5 1/2 | 0.52817 | |
| BM-316 | 3/16 | 4 | 5/8 | 6 1/8 | 0.60678 | |
| BM-320 | 3/16 | 5 | 3/4 | 7 1/4 | 0.71160 | |
| BM-322 | 3/16 | 5 1/2 | 3/4 | 7 3/4 | 0.76401 | |

| Taper Per Side | Tool No. | Ball Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|----------|-----------|-----------|----------|---------|------------|
| 3 DEG | BM-403 | 1/4 | 3/4 | 3/8 | 2 1/2 | 0.32862 |
| | BM-404 | 1/4 | 1 | 3/8 | 2 3/4 | 0.35482 |
| | BM-405 | 1/4 | 1 1/4 | 3/8 | 3 1/8 | 0.37500 |
| | BM-406 | 1/4 | 1 1/2 | 3/8 | 3 1/4 | 0.40723 |
| | BM-409 | 1/4 | 2 1/4 | 1/2 | 4 1/4 | 0.48585 |
| | BM-410 | 1/4 | 2 1/2 | 1/2 | 4 1/2 | 0.51205 |
| | BM-413 | 1/4 | 3 1/4 | 1/2 | 5 1/2 | 0.59067 |
| | BM-416 | 1/4 | 4 | 3/4 | 6 1/4 | 0.66928 |
| | BM-416A | 1/4 | 4 | 5/8 | 6 1/4 | 0.66928 |
| | BM-420 | 1/4 | 5 | 3/4 | 7 3/8 | 0.77410 |
| | BM-504 | 5/16 | 1 | 1/2 | 3 1/8 | 0.41732 |
| | BM-507 | 5/16 | 1 3/4 | 1/2 | 3 7/8 | 0.49594 |
| | BM-605 | 3/8 | 1 1/4 | 1/2 | 3 1/4 | 0.50000 |
| | BM-609 | 3/8 | 2 1/4 | 5/8 | 4 3/8 | 0.61085 |
| | BM-609A | 3/8 | 2 1/4 | 1/2 | 4 3/8 | 0.61085 |
| | BM-613 | 3/8 | 3 1/4 | 5/8 | 5 3/8 | 0.71567 |
| | BM-613A | 3/8 | 3 1/4 | 3/4 | 5 3/8 | 0.71567 |
| | BM-616 | 3/8 | 4 | 3/4 | 6 1/2 | 0.79428 |
| | BM-620 | 3/8 | 5 | 3/4 | 7 1/2 | 0.89910 |
| | BM-624 | 3/8 | 6 | 1 | 8 1/2 | 1.00392 |
| | BM-805 | 1/2 | 1 1/4 | 1/2 | 3 1/4 | 0.63103 |
| | BM-809 | 1/2 | 2 1/4 | 3/4 | 4 1/2 | 0.73585 |
| | BM-809A | 1/2 | 2 1/4 | 1/2 | 4 1/8 | 0.73585 |
| | BM-809B | 1/2 | 2 1/4 | 5/8 | 4 1/4 | 0.73585 |
| | BM-813 | 1/2 | 3 1/4 | 3/4 | 5 1/2 | 0.84067 |
| | BM-816 | 1/2 | 4 | 3/4 | 6 3/8 | 0.91928 |
| | BM-820 | 1/2 | 5 | 1 | 7 1/2 | 1.02410 |
| | BM-824 | 1/2 | 6 | 1 | 8 1/2 | 1.12892 |
| | BM-1009 | 5/8 | 2 1/4 | 3/4 | 4 1/2 | 0.86085 |
| | BM-1013 | 5/8 | 3 1/4 | 3/4 | 5 1/2 | 0.96567 |
| | BM-1016 | 5/8 | 4 | 1 | 6 1/2 | 1.04428 |
| | BM-1020 | 5/8 | 5 | 1 | 7 1/2 | 1.14910 |
| BM-1209 | 3/4 | 2 1/4 | 1 | 4 3/4 | 0.98585 | |
| BM-1213 | 3/4 | 3 1/4 | 1 | 5 3/4 | 1.09067 | |
| BM-1216 | • 3/4 | 4 | 1 | 6 1/2 | 1.16928 | |
| BM-1220 | • 3/4 | 5 | 1 | 7 1/2 | 1.27410 | |
| BM-1224 | • 3/4 | 6 | 1 1/4 | 8 1/2 | 1.37892 | |
| BM-1624 | • 1 | 6 | 1 1/4 | 8 1/2 | 1.62892 | |

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for Cobalt, add the suffix "CO"
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If no suffix is given High Speed Steel will ship.

A

HIGH SPEED STEEL & COBALT Ball Ends

| Taper Per Side | Tool No. | Ball Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|----------|-----------|-----------|----------|-------|------------|
| 4 DEG | BN-004 | 1/16 | 1 | 3/8 | 2 7/8 | 0.20236 |
| | BN-006 | 1/16 | 1 1/2 | 3/8 | 3 1/4 | 0.27229 |
| | BN-103 | 3/32 | 3/4 | 3/8 | 2 5/8 | 0.19865 |
| | BN-104 | 3/32 | 1 | 3/8 | 2 7/8 | 0.23361 |
| | BN-203 | 1/8 | 3/4 | 3/8 | 2 5/8 | 0.22990 |
| | BN-204 | 1/8 | 1 | 3/8 | 2 7/8 | 0.26486 |
| | BN-206 | 1/8 | 1 1/2 | 3/8 | 3 1/4 | 0.33479 |
| | BN-208 | 1/8 | 2 | 1/2 | 3 7/8 | 0.40472 |
| | BN-210 | 1/8 | 2 1/2 | 1/2 | 4 1/2 | 0.47465 |
| | BN-303 | 3/16 | 3/4 | 3/8 | 2 5/8 | 0.29240 |
| | BN-305 | 3/16 | 1 1/4 | 3/8 | 3 1/8 | 0.36233 |
| | BN-310 | 3/16 | 2 1/2 | 1/2 | 4 1/2 | 0.53715 |
| | BN-313 | 3/16 | 3 1/4 | 5/8 | 5 1/2 | 0.64205 |
| | BN-316 | 3/16 | 4 | 3/4 | 6 1/2 | 0.74694 |
| | BN-403 | 1/4 | 3/4 | 3/8 | 2 1/2 | 0.35490 |
| | BN-405 | 1/4 | 1 1/4 | 1/2 | 3 1/4 | 0.42483 |
| | BN-409 | 1/4 | 2 1/4 | 5/8 | 4 3/8 | 0.56469 |
| | BN-413 | 1/4 | 3 1/4 | 3/4 | 5 1/2 | 0.70455 |
| | BN-416 | 1/4 | 4 | 3/4 | 6 1/2 | 0.80944 |
| | BN-605 | 3/8 | 1 1/4 | 1/2 | 3 1/4 | 0.54983 |
| | BN-609 | 3/8 | 2 1/4 | 5/8 | 4 3/8 | 0.68969 |
| | BN-613 | 3/8 | 3 1/4 | 3/4 | 5 1/2 | 0.82955 |
| | BN-616 | 3/8 | 4 | 3/4 | 6 1/2 | 0.93444 |
| | BN-805 | 1/2 | 1 1/4 | 1/2 | 3 1/4 | 0.67483 |
| | BN-809 | 1/2 | 2 1/4 | 3/4 | 4 1/2 | 0.81469 |
| | BN-813 | 1/2 | 3 1/4 | 3/4 | 6 1/2 | 0.95455 |
| | BN-816 | 1/2 | 4 | 1 | 6 1/2 | 1.05944 |
| | BN-820 | 1/2 | 5 | 1 | 7 1/2 | 1.19930 |

| Taper Per Side | Tool No. | Ball Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|----------|-----------|-----------|----------|--------|------------|
| 5 DEG | BO-002 | 1/32 | 1/2 | 3/16 | 2 5/8 | 0.11874 |
| | BO-003 | 1/32 | 3/4 | 3/16 | 2 5/8 | 0.16249 |
| | BO-002 | 1/16 | 1/2 | 3/8 | 2 5/8 | 0.14999 |
| | BO-003 | 1/16 | 3/4 | 3/8 | 2 5/8 | 0.19374 |
| | BO-004 | 1/16 | 1 | 3/8 | 2 7/8 | 0.23748 |
| | BO-005 | 1/16 | 1 1/4 | 3/8 | 3 1/8 | 0.28123 |
| | BO-006 | 1/16 | 1 1/2 | 3/8 | 3 1/4 | 0.32497 |
| | BO-102 | 3/32 | 1/2 | 3/8 | 2 5/8 | 0.18124 |
| | BO-103 | 3/32 | 3/4 | 3/8 | 2 5/8 | 0.22499 |
| | BO-104 | 3/32 | 1 | 3/8 | 2 7/8 | 0.26873 |
| | BO-105 | 3/32 | 1 1/4 | 3/8 | 3 1/8 | 0.31248 |
| | BO-106 | 3/32 | 1 1/2 | 3/8 | 3 1/4 | 0.35622 |
| | BO-108 | 3/32 | 2 | 1/2 | 4 | 0.44371 |
| | BO-108A | 3/32 | 2 | 3/8 | 3 7/8 | 0.44371 |
| | BO-110 | 3/32 | 2 1/2 | 1/2 | 4 1/2 | 0.53120 |
| | BO-114 | 3/32 | 3 1/2 | 3/4 | 5 7/8 | 0.66244 |
| | BO-154 | 7/64 | 1 | 3/8 | 2 7/8 | 0.28436 |
| | BO-155 | 7/64 | 1 1/4 | 3/8 | 3 1/8 | 0.32810 |
| | BO-156 | 7/64 | 1 1/2 | 3/8 | 3 5/16 | 0.37185 |
| | BO-158 | 7/64 | 2 | 1/2 | 4 | 0.45934 |
| | BO-203 | 1/8 | 3/4 | 3/8 | 2 5/8 | 0.25000 |
| | BO-204 | 1/8 | 1 | 3/8 | 2 7/8 | 0.29998 |
| | BO-205 | 1/8 | 1 1/4 | 3/8 | 3 1/8 | 0.34373 |
| | BO-206 | 1/8 | 1 1/2 | 3/8 | 3 1/4 | 0.37500 |
| | BO-208 | 1/8 | 2 | 1/2 | 4 | 0.47496 |
| | BO-208A | 1/8 | 2 | 3/8 | 3 7/8 | 0.47496 |
| | BO-210 | 1/8 | 2 1/2 | 5/8 | 4 1/2 | 0.56245 |
| | BO-210A | 1/8 | 2 1/2 | 1/2 | 4 1/2 | 0.56245 |
| | BO-212 | 1/8 | 3 | 3/4 | 5 1/4 | 0.64994 |
| | BO-212A | 1/8 | 3 | 1/2 | 5 1/4 | 0.64994 |
| | BO-222 | 1/8 | 5 1/2 | 1/2 | 7 1/2 | 1.08739 |
| | BO-254 | 5/32 | 1 | 3/8 | 2 7/8 | 0.33123 |
| | BO-255 | 5/32 | 1 1/4 | 3/8 | 3 1/8 | 0.37498 |
| | BO-256 | 5/32 | 1 1/2 | 1/2 | 3 5/8 | 0.41872 |
| | BO-258 | 5/32 | 2 | 1/2 | 3 7/8 | 0.50000 |
| | BO-303 | 3/16 | 3/4 | 3/8 | 2 9/16 | 0.31874 |
| | BO-304 | 3/16 | 1 | 1/2 | 3 | 0.36248 |
| | BO-305 | 3/16 | 1 1/4 | 1/2 | 3 3/8 | 0.40623 |
| | BO-305S | 7/32 | 1 1/4 | 1/2 | 3 3/8 | 0.43748 |
| | BO-306 | 3/16 | 1 1/2 | 1/2 | 3 1/2 | 0.44997 |
| | BO-308 | 3/16 | 2 | 1/2 | 4 1/8 | 0.53746 |
| | BO-310 | 3/16 | 2 1/2 | 5/8 | 4 5/8 | 0.62495 |
| | BO-310A | 3/16 | 2 1/2 | 1/2 | 4 1/2 | 0.62495 |
| | BO-312 | 3/16 | 3 | 3/4 | 5 1/4 | 0.71244 |
| | BO-312A | 3/16 | 3 | 1/2 | 5 1/4 | 0.71244 |
| | BO-313 | 3/16 | 3 1/4 | 3/4 | 5 1/2 | 0.75619 |
| | BO-313A | 3/16 | 3 1/4 | 1/2 | 5 1/2 | 0.74619 |

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HIGH SPEED STEEL & COBALT

Ball Ends



| Taper Per Side | Tool No. | Ball Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. | Taper Per Side | Tool No. | Ball Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|----------|-----------|-----------|----------|---------|------------|----------------|----------|-----------|-----------|----------|---------|------------|
| 5 | BO-316 | 3/16 | 4 | 3/4 | 6 1/4 | 0.88742 | 7 DEG | BR-0004 | 1/32 | 1 | 3/8 | 2 3/4 | 0.27681 |
| | BO-320 | 3/16 | 5 | 1 | 7 1/2 | 1.06240 | | BR-003 | 1/16 | 3/4 | 3/8 | 2 5/8 | 0.24667 |
| | BO-324 | 3/16 | 6 | 1 | 8 1/2 | 1.23738 | | BR-004 | 1/16 | 1 | 3/8 | 2 7/8 | 0.30806 |
| | BO-403 | 1/4 | 3/4 | 3/8 | 2 1/2 | 0.38124 | | BR-006 | 1/16 | 1 1/2 | 1/2 | 3 1/4 | 0.43084 |
| | BO-404 | 1/4 | 1 | 1/2 | 3 | 0.42498 | | BR-0254 | .070 | 1 | 3/8 | 2 7/8 | 0.31556 |
| | BO-405 | 1/4 | 1 1/4 | 1/2 | 3 1/4 | 0.46873 | | BR-054 | 5/64 | 1 | 3/8 | 2 7/8 | 0.32369 |
| | BO-406 | 1/4 | 1 1/2 | 1/2 | 3 1/2 | 0.51247 | | BR-103 | 3/32 | 3/4 | 3/8 | 2 1/2 | 0.27792 |
| | BO-409 | 1/4 | 2 1/4 | 5/8 | 4 3/8 | 0.64371 | | BR-104 | 3/32 | 1 | 3/8 | 2 3/4 | 0.33931 |
| | BO-409A | 1/4 | 2 1/4 | 1/2 | 4 1/4 | 0.64371 | | BR-105 | 3/32 | 1 1/4 | 1/2 | 3 1/8 | 0.40070 |
| | BO-410 | 1/4 | 2 1/2 | 5/8 | 4 1/2 | 0.68745 | | BR-106 | 3/32 | 1 1/2 | 1/2 | 3 1/2 | 0.46209 |
| | BO-413 | 1/4 | 3 1/4 | 3/4 | 5 1/2 | 0.81869 | | BR-203 | 1/8 | 3/4 | 3/8 | 2 9/16 | 0.30917 |
| | BO-416 | 1/4 | 4 | 3/4 | 6 1/4 | 0.94992 | | BR-204 | 1/8 | 1 | 3/8 | 2 3/4 | 0.37056 |
| | BO-424 | 1/4 | 6 | 1 | 8 1/2 | 1.29988 | | BR-206 | 1/8 | 1 1/2 | 1/2 | 3 1/2 | 0.49334 |
| | BO-509 | 5/16 | 2 1/4 | 5/8 | 4 1/4 | 0.70621 | | BR-208 | 1/8 | 2 | 5/8 | 3 7/8 | 0.61612 |
| | BO-605 | 3/8 | 1 1/4 | 1/2 | 3 1/4 | 0.59373 | | BR-212 | 1/8 | 3 | 3/4 | 5 1/4 | 0.86168 |
| | BO-609 | 3/8 | 2 1/4 | 3/4 | 4 1/2 | 0.76871 | | BR-305 | 3/16 | 1 1/4 | 1/2 | 3 1/4 | 0.49445 |
| | BO-613 | 3/8 | 3 1/4 | 3/4 | 5 1/2 | 0.94369 | | BR-312 | 3/16 | 3 | 3/4 | 5 3/8 | 0.92418 |
| | BO-616 | 3/8 | 4 | 1 | 6 1/2 | 1.07492 | | BR-403 | 1/4 | 3/4 | 1/2 | 2 1/2 | 0.43417 |
| | BO-620 | 3/8 | 5 | 1 1/4 | 7 1/2 | 1.24990 | | BR-405 | 1/4 | 1 1/4 | 1/2 | 3 1/4 | 0.55695 |
| | BO-624 | 3/8 | 6 | 1 1/4 | 8 1/2 | 1.42488 | | BR-409 | 1/4 | 2 1/4 | 3/4 | 4 1/2 | 0.80251 |
| | BO-805 | 1/2 | 1 1/4 | 1/2 | 3 1/4 | 0.71873 | | BR-413 | 1/4 | 3 1/4 | 1 | 5 3/8 | 1.04807 |
| | BO-809 | 1/2 | 2 1/4 | 3/4 | 4 1/2 | 0.89371 | | BR-416 | 1/4 | 4 | 1 | 6 1/2 | 1.23224 |
| | BO-813 | 1/2 | 3 1/4 | 3/4 | 5 5/8 | 1.06869 | | BR-513 | 5/16 | 3 1/4 | 1 | 5 3/4 | 1.11057 |
| | BO-816 | 1/2 | 4 | 1 | 6 1/2 | 1.19992 | | BR-605 | 3/8 | 1 1/4 | 5/8 | 3 1/4 | 0.68195 |
| | BO-820 | 1/2 | 5 | 1 1/4 | 7 1/2 | 1.37490 | | BR-609 | 3/8 | 2 1/4 | 3/4 | 4 1/2 | 0.92751 |
| | BO-824 | 1/2 | 6 | 1 1/4 | 8 1/2 | 1.54988 | | BR-613 | 3/8 | 3 1/4 | 1 | 5 5/8 | 1.17307 |
| | BO-1009 | 5/8 | 2 1/4 | 3/4 | 4 1/4 | 1.01871 | | BR-616 | 3/8 | 4 | 1 1/4 | 6 1/2 | 1.35724 |
| | BO-1020 | • 5/8 | 5 | 1 1/4 | 7 1/2 | 1.49990 | | BR-624 | • 3/8 | 6 | 1 1/4 | 8 1/2 | 1.84836 |
| | BO-1209 | 3/4 | 2 1/4 | 3/4 | 4 3/4 | 1.14371 | | BR-805 | 1/2 | 1 1/4 | 3/4 | 3 1/2 | 0.80695 |
| | BO-1216 | • 3/4 | 4 | 1 1/4 | 6 1/2 | 1.44992 | | BR-805A | 1/2 | 1 1/4 | 5/8 | 3 3/8 | 0.80695 |
| | BO-1220 | • 3/4 | 5 | 1 1/4 | 7 1/2 | 1.62490 | | BR-809 | 1/2 | 2 1/4 | 1 | 4 5/8 | 1.05251 |
| | BO-1224 | • 3/4 | 6 | 1 1/4 | 8 1/2 | 1.79988 | | BR-813 | • 1/2 | 3 1/4 | 1 1/4 | 5 3/4 | 1.29807 |
| BO-1620 | • 1 | 5 | 1 1/4 | 7 1/2 | 1.87490 | BR-816 | • 1/2 | 4 | 1 1/4 | 6 1/2 | 1.48224 | | |
| BO-1624 | • 1 | 6 | 2 | 9 1/2 | 2.04988 | BR-824 | • 1/2 | 6 | 1 1/4 | 8 1/2 | 1.97336 | | |
| 6 DEG | BP-004 | 1/16 | 1 | 3/8 | 2 7/8 | 0.27271 | BR-1016 | • 5/8 | 4 | 1 1/4 | 6 1/2 | 1.60724 | |
| | BP-104 | 3/32 | 1 | 3/8 | 2 7/8 | 0.30396 | BR-1020 | • 5/8 | 5 | 1 1/4 | 7 1/2 | 1.85280 | |
| | BP-204 | 1/8 | 1 | 3/8 | 2 7/8 | 0.33521 | BR-1213 | • 3/4 | 3 1/4 | 1 1/4 | 5 3/4 | 1.54807 | |
| | BP-206 | 1/8 | 1 1/2 | 1/2 | 3 1/4 | 0.44032 | BR-1216 | • 3/4 | 4 | 1 1/4 | 6 1/2 | 1.73224 | |
| | BP-306 | 3/16 | 1 1/2 | 1/2 | 3 1/4 | 0.50282 | BR-1224 | • 3/4 | 6 | 2 | 9 1/2 | 2.22336 | |
| | BP-406 | 1/4 | 1 1/2 | 5/8 | 3 1/2 | 0.56532 | BR-1624 | • 1 | 6 | 2 | 9 1/2 | 2.47336 | |
| | BP-605 | 3/8 | 1 1/4 | 5/8 | 3 1/4 | 0.63776 | | | | | | | |
| | BP-805 | 1/2 | 1 1/4 | 3/4 | 3 1/4 | 0.76276 | | | | | | | |

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HIGH SPEED STEEL & COBALT Ball Ends

| Taper Per Side | Tool No. | Ball Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|----------|-----------|-----------|----------|---------|------------|
| 10 DEG | BT-0003 | 1/32 | 3/4 | 3/8 | 2 3/4 | 0.29575 |
| | BT-002 | 1/16 | 1/2 | 3/8 | 2 3/8 | 0.23883 |
| | BT-003 | 1/16 | 3/4 | 3/8 | 2 5/8 | 0.32700 |
| | BT-004 | 1/16 | 1 | 1/2 | 2 7/8 | 0.41516 |
| | BT-102 | 3/32 | 1/2 | 3/8 | 2 3/8 | 0.27008 |
| | BT-103 | 3/32 | 3/4 | 3/8 | 2 5/8 | 0.35825 |
| | BT-106 | 3/32 | 1 1/2 | 1/2 | 3 1/2 | 0.62274 |
| | BT-203 | 1/8 | 3/4 | 3/8 | 2 5/8 | 0.38950 |
| | BT-205 | 1/8 | 1 1/4 | 1/2 | 3 1/4 | 0.56583 |
| | BT-206 | 1/8 | 1 1/2 | 1/2 | 3 1/2 | 0.65399 |
| | BT-254 | 5/32 | 1 | 1/2 | 3 | 0.50000 |
| | BT-258 | 5/32 | 2 | 3/4 | 4 1/4 | 0.86157 |
| | BT-305 | 3/16 | 1 1/4 | 1/2 | 3 3/8 | 0.62500 |
| | BT-309 | 3/16 | 2 1/4 | 3/4 | 4 1/2 | 0.98099 |
| | BT-403 | 1/4 | 3/4 | 1/2 | 2 3/4 | 0.51450 |
| | BT-405 | 1/4 | 1 1/4 | 1/2 | 3 1/4 | 0.69083 |
| | BT-409 | 1/4 | 2 1/4 | 3/4 | 4 1/2 | 1.04349 |
| | BT-409A | 1/4 | 2 1/4 | 1/2 | 4 1/2 | 1.04349 |
| | BT-413 | 1/4 | 3 1/4 | 1 | 5 5/8 | 1.39615 |
| | BT-605 | 3/8 | 1 1/4 | 5/8 | 3 1/2 | 0.81583 |
| | BT-609 | 3/8 | 2 1/4 | 1 | 4 5/8 | 1.16849 |
| | BT-613 | • 3/8 | 3 1/4 | 1 1/4 | 5 3/4 | 1.52115 |
| | BT-805 | 1/2 | 1 1/4 | 3/4 | 3 1/2 | 0.94083 |
| | BT-809 | 1/2 | 2 1/4 | 1 | 4 3/4 | 1.29349 |
| BT-813 | • 1/2 | 3 1/4 | 1 1/4 | 5 3/4 | 1.64615 | |
| BT-816 | • 1/2 | 4 | 1 1/4 | 6 3/8 | 1.91064 | |

| Taper Per Side | Tool No. | Ball Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|----------|-----------|-----------|----------|---------|------------|
| 15 DEG | BV-0003 | 1/32 | 3/4 | 1/2 | 2 3/4 | 0.43318 |
| | BV-003 | 1/16 | 3/4 | 1/2 | 2 3/4 | 0.46443 |
| | BV-102 | 3/32 | 1/2 | 3/8 | 2 3/8 | 0.36170 |
| | BV-103 | 3/32 | 3/4 | 1/2 | 2 7/8 | 0.49568 |
| | BV-104 | 3/32 | 1 | 1/2 | 3 | 0.62965 |
| | BV-106 | 3/32 | 1 1/2 | 3/4 | 3 3/4 | 0.89760 |
| | BV-106A | 3/32 | 1 1/2 | 1/2 | 3 3/4 | 0.89760 |
| | BV-202 | 1/8 | 1/2 | 1/2 | 2 5/8 | 0.39295 |
| | BV-202A | 1/8 | 1/2 | 3/8 | 2 5/8 | 0.39295 |
| | BV-203 | 1/8 | 3/4 | 1/2 | 2 7/8 | 0.52693 |
| | BV-204 | 1/8 | 1 | 1/2 | 3 1/8 | 0.66090 |
| | BV-205 | 1/8 | 1 1/4 | 5/8 | 3 1/2 | 0.79488 |
| | BV-205A | 1/8 | 1 1/4 | 1/2 | 3 1/2 | 0.79488 |
| | BV-206A | 1/8 | 1 1/2 | 1/2 | 3 5/8 | 0.92885 |
| | BV-304 | 3/16 | 1 | 1/2 | 3 1/8 | 0.72340 |
| | BV-305 | 3/16 | 1 1/4 | 3/4 | 3 1/2 | 0.85738 |
| | BV-305A | 3/16 | 1 1/4 | 1/2 | 3 1/2 | 0.85738 |
| | BV-308 | 3/16 | 2 | 1 | 4 1/2 | 1.25930 |
| | BV-404 | 1/4 | 1 | 1/2 | 3 1/8 | 0.78590 |
| | BV-405 | 1/4 | 1 1/4 | 3/4 | 3 1/2 | 0.91988 |
| | BV-405A | 1/4 | 1 1/4 | 1/2 | 3 1/2 | 0.91988 |
| | BV-406 | 1/4 | 1 1/2 | 3/4 | 3 3/4 | 1.05385 |
| | BV-408 | 1/4 | 2 | 3/4 | 4 1/2 | 1.32180 |
| | BV-409 | 1/4 | 2 1/4 | 1 | 4 3/4 | 1.45578 |
| | BV-413 | • 1/4 | 3 1/4 | 1 1/4 | 5 3/4 | 1.99168 |
| | BV-504 | 5/16 | 1 | 3/4 | 3 1/4 | 0.84840 |
| | BV-506 | 5/16 | 1 1/2 | 3/4 | 3 7/8 | 1.11635 |
| | BV-509 | • 5/16 | 2 1/4 | 1 | 4 7/8 | 1.51828 |
| | BV-605 | 3/8 | 1 1/4 | 3/4 | 3 5/8 | 1.04488 |
| | BV-609 | • 3/8 | 2 1/4 | 1 1/4 | 4 3/4 | 1.51828 |
| | BV-613 | • 3/8 | 3 1/4 | 1 1/4 | 5 3/4 | 2.05418 |
| | BV-804 | 1/2 | 1 | 3/4 | 3 1/4 | 1.03590 |
| | BV-805 | 1/2 | 1 1/4 | 3/4 | 3 5/8 | 1.16988 |
| | BV-807 | • 1/2 | 1 3/4 | 1 | 4 1/4 | 1.43783 |
| BV-809 | • 1/2 | 2 1/4 | 1 1/4 | 4 7/8 | 1.70578 | |
| BV-812 | • 1/2 | 3 | 1 1/4 | 5 1/2 | 2.10770 | |
| BV-813 | • 1/2 | 3 1/4 | 1 1/4 | 6 | 2.24168 | |



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Ball Ends

A

| Taper Per Side | Tool No. | Ball Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|----------|-----------|-----------|----------|-------|------------|
| 20 DEG | BW-002 | 1/16 | 1/2 | 3/8 | 2 1/2 | 0.42647 |
| | BW-103 | 3/32 | 3/4 | 1/2 | 2 3/4 | 0.63971 |
| | BW-202 | 1/8 | 1/2 | 3/8 | 2 1/2 | 0.48897 |
| | BW-204 | • 1/8 | 1 | 1/2 | 3 1/8 | 0.85294 |
| | BW-304 | • 3/16 | 1 | 1/2 | 4 | 0.91544 |
| | BW-306 | • 3/16 | 1 1/2 | 3/4 | 3 1/4 | 1.27941 |
| | BW-404 | • 1/4 | 1 | 1/2 | 3 1/8 | 0.97794 |
| | BW-406 | • 1/4 | 1 1/2 | 3/4 | 4 | 1.34191 |
| | BW-504 | • 5/16 | 1 | 3/4 | 3 1/4 | 1.04044 |
| | BW-506 | • 5/16 | 1 1/2 | 3/4 | 3 7/8 | 1.40441 |
| | BW-606 | • 3/8 | 1 1/2 | 3/4 | 3 7/8 | 1.46691 |
| | BW-608 | • 3/8 | 2 | 1 | 4 1/2 | 1.83088 |
| | BW-809 | • 1/2 | 2 1/4 | 1 1/4 | 4 7/8 | 2.13787 |
| | 25 DEG | BX-103 | 3/32 | 3/4 | 1/2 | 3 |
| BX-202 | | 1/8 | 1/2 | 1/2 | 2 1/2 | 0.59131 |
| BX-204A | | 1/8 | 1 | 1/2 | 3 1/8 | 1.05762 |
| BX-204B | | 1/8 | 1 | 5/8 | 3 1/8 | 1.05762 |
| BX-204C | | 1/8 | 1 | 3/4 | 3 1/8 | 1.05762 |
| BX-404 | | • 1/4 | 1 | 5/8 | 3 1/4 | 1.18262 |
| BX-406 | | • 1/4 | 1 1/2 | 3/4 | 4 1/8 | 1.64893 |
| BX-503 | | • 5/16 | 3/4 | 5/8 | 3 | 1.01197 |
| BX-504 | | • 5/16 | 1 | 3/4 | 3 3/8 | 1.24512 |
| BX-506 | | • 5/16 | 1 1/2 | 1 | 4 1/8 | 1.71143 |
| BX-603 | | • 3/8 | 3/4 | 5/8 | 3 | 1.07447 |
| BX-604 | | • 3/8 | 1 | 3/4 | 3 1/4 | 1.30762 |
| BX-606 | | • 3/8 | 1 1/2 | 1 | 4 1/8 | 1.77393 |
| BX-805 | | • 1/2 | 1 1/4 | 1 | 3 3/4 | 1.66578 |
| 30 DEG | BZ-002 | 1/16 | 1/2 | 1/2 | 2 1/2 | 0.63985 |
| | BZ-103 | 3/32 | 3/4 | 1/2 | 3 | 0.95978 |
| | BZ-202 | • 1/8 | 1/2 | 1/2 | 2 5/8 | 0.70235 |
| | BZ-204 | • 1/8 | 1 | 1/2 | 3 1/8 | 1.27970 |
| | BZ-404 | • 1/4 | 1 | 3/4 | 3 3/8 | 1.40470 |
| | BZ-406 | • 1/4 | 1 1/2 | 1 | 4 1/8 | 1.98205 |
| | BZ-605 | • 3/8 | 1 1/4 | 1 | 3 7/8 | 1.81838 |
| | BZ-606 | • 3/8 | 1 1/2 | 1 | 4 1/4 | 2.10705 |
| | BZ-805 | • 1/2 | 1 1/4 | 1 | 3 3/4 | 1.94338 |
| | BZ-806 | • 1/2 | 1 1/2 | 1 | 4 1/4 | 2.23205 |

| Taper Per Side | Tool No. | Ball Dia. | Flt. Lgth | Shk Dia. | OAL | Large Dia. |
|----------------|----------|-----------|-----------|----------|---------|------------|
| 45 DEG | B45-2015 | • 1/8 | 5/16 | 1/2 | 2 1/2 | 0.75000 |
| | B45-202 | • 1/8 | 1/2 | 1/2 | 2 5/8 | 1.12500 |
| | B45-203 | • 1/8 | 3/4 | 5/8 | 3 1/4 | 1.62500 |
| | B45-204 | • 1/8 | 1 | 1 | 3 3/4 | 2.12500 |
| | B45-303 | • 3/16 | 3/4 | 3/4 | 3 1/4 | 1.68750 |
| | B45-304 | • 3/16 | 1 | 1 | 4 | 2.17850 |
| | B45-305 | • 3/16 | 1 1/4 | 1 1/4 | 4 1/4 | 2.68750 |
| | B45-403 | • 1/4 | 3/4 | 3/4 | 3 1/4 | 1.75000 |
| | B45-404 | • 1/4 | 1 | 1 | 4 | 2.25000 |
| | B45-405 | • 1/4 | 1 1/4 | 1 1/4 | 4 1/4 | 2.75000 |
| | B45-406 | • 1/4 | 1 1/2 | 1 1/4 | 4 1/2 | 3.25000 |
| | B45-603 | • 3/8 | 3/4 | 3/4 | 3 1/4 | 1.87500 |
| | B45-604 | • 3/8 | 1 | 1 | 4 | 2.37500 |
| | B45-605 | • 3/8 | 1 1/4 | 1 1/4 | 4 1/4 | 2.87500 |
| | B45-606 | • 3/8 | 1 1/2 | 1 1/4 | 4 1/2 | 3.37500 |
| | B45-803 | • 1/2 | 3/4 | 3/4 | 3 1/4 | 2.00000 |
| | B45-804 | • 1/2 | 1 | 1 | 4 | 2.50000 |
| | B45-805 | • 1/2 | 1 1/4 | 1 1/4 | 4 1/4 | 3.00000 |
| B45-806 | • 1/2 | 1 1/2 | 1 1/4 | 4 5/8 | 3.50000 | |



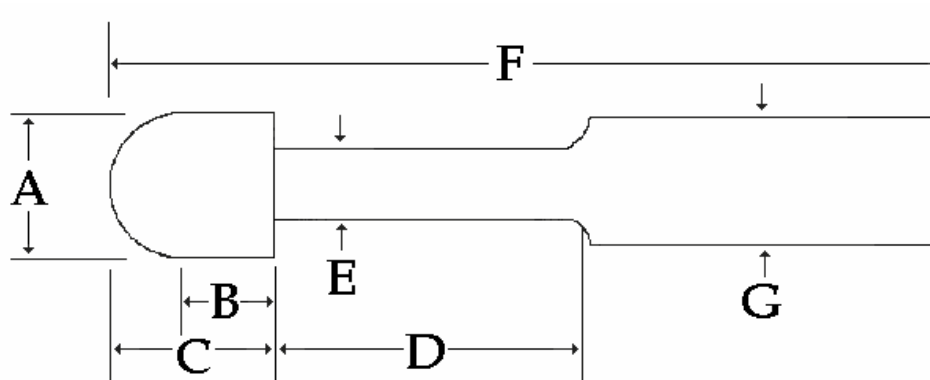
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TO ORDER COBALT OR COATINGS,
Add a suffix to the part number given above.
for TIN Coated, add the suffix "TIN"
for Cobalt, add the suffix "CO"
for Cobalt TIN Coated, add the suffix "CO-TIN"
If no suffix is given High Speed Steel will ship.

• Four Flutes

A

UNDERCUTTING TOOLS



HIGH SPEED STEEL & COBALT

| ORDER NO. | A | B | C | D | E | F | G |
|-----------|-----|-----|-----|-------|-------|-------|-----|
| SE-61S | 3/8 | 1/4 | 3/8 | 1-1/8 | 0.250 | 3-1/2 | 3/8 |
| SE-61L | 3/8 | 1/4 | 3/8 | 1-5/8 | 0.250 | 4 | 3/8 |
| SE-81S | 1/2 | 1/4 | 1/2 | 1-1/4 | 0.310 | 3-5/8 | 1/2 |
| SE-81L | 1/2 | 1/4 | 1/2 | 1-3/4 | 0.310 | 4-1/2 | 1/2 |
| SE-101S | 5/8 | 1/4 | 1/2 | 1-1/8 | 0.400 | 3-3/4 | 5/8 |
| SE-101L | 5/8 | 1/4 | 1/2 | 2-1/8 | 0.400 | 5-1/8 | 5/8 |
| SE-121S | 3/4 | 1/4 | 5/8 | 1-1/4 | 0.490 | 4-1/8 | 3/4 |
| SE-121L | 3/4 | 1/4 | 5/8 | 2-1/8 | 0.490 | 5-1/2 | 3/4 |

TO ORDER COBALT OR COATINGS,
 Add a suffix to the part number given above.
 for TIN Coated, add the suffix "TIN"
 for Cobalt, add the suffix "CO"
 for Cobalt TIN Coated, add the suffix "CO-TIN"
 If no suffix is given High Speed Steel will ship.

Trouble Shooting Guide For Problems With End Mills



| Problem/ Cause | Solution |
|--|--|
| Chip Packing Cut too heavy Not enough chip clearance Not enough coolant | <ul style="list-style-type: none"> • Decrease width and depth of cut • Use end mill with less flutes • Use higher coolant pressure and reposition nozzle to point of cut or use air pressure |
| Chipped Cutting Edge Feed rate too heavy Feed too heavy on first cut Lack of rigidity (machine & holder) Lack of rigidity (tool) Tool cutting corner too sharp | <ul style="list-style-type: none"> • Reduce feed rate • Reduce feed rate on first cut • Use better machine or tool holder or change parameters • Use shorter tool, hold shank deeper, try climb milling • Decrease primary relief and cutting angle, reduce radial width-of cut |
| Excessive Wear Speed is too fast Hard work material Improper feed and speed (too slow) Improper helix angle Primary relief angle is too large Recutting chips | <ul style="list-style-type: none"> • Decrease spindle speed, use another coolant • Use coatings (TiN, TiCN, TiAlN, TiAlN+, etc.) • Increase feed and speed • Change to correct helix angle • Change to smaller relief angle • Change feed & speed, Change chip size or clear chips with more coolant or air pressure |
| No Dimensional Accuracy Cut is too heavy Lack of accuracy (machine & holder) Rigidity is not enough (machine & holder) Too few flutes | <ul style="list-style-type: none"> • Decrease width and depth of cut • Repair machine or holder • Change machine or holder or change parameters • Use mult flute end mills, use end mill with higher rigidity |
| Reduced Tool Life Cutting friction is too much Hard work material Improper helix & relief angle | <ul style="list-style-type: none"> • Regrind at earlier stage • Use coatings (TiN, TiCN, TiAlN, TiAlN+, etc.) • Change to correct helix angle and primary relief |
| Rough Surface Finish Feed rate too heavy Cutting speed is too slow Wear is too much No end tooth concavity Recutting chips | <ul style="list-style-type: none"> • Reduce feed rate • Increase RPM • Regrind at earlier stage • Grind concave angle on bottom of teeth • Change feed & speed, change chip size or clear chips with coolant or air pressure |
| Side Wall Taper in Work Piece Feed rate too heavy Overhang of tool is too much Too few flutes | <ul style="list-style-type: none"> • Reduce feed rate • Hold shank deeper, use shorter end mill • Use mult flute end mills, use end mill with higher rigidity |
| Squeal and Chattering Feed and speed too fast Lack of rigidity (machine & holder) Poor set up Cut is too heavy Overhang of tool is too much Lack of relief | <ul style="list-style-type: none"> • Correct feed and speed • Use better machine or tool holder or change parameter • Improve clamping rigidity • Decrease width and depth of cut • Hold shank deeper, use shorter end mill • Decrease relief angle, make margin; hone primary with oil stone |
| Tool Breakage Feed is too heavy Cut is too heavy Overhang of tool is too much Wear is too much | <ul style="list-style-type: none"> • Reduce feed rate • Decrease width and depth-of-cut • Hold shank deeper, use shorter end mill • Regrind at earlier stage |
| Work Piece Burrs Wear on primary relief is too much Incorrect feed and speed Improper helix angle | <ul style="list-style-type: none"> • Regrind at earlier stage • Correct cutting parameters • Change to correct cutting angle |

A

FINISHING & ROUGHING FEEDS & SPEEDS FOR HIGH SPEED STEEL

Instructions

1. Locate SFM & FPT for material, (Table A)
2. Find RPM at Intersection of SFM line & Diameter Column, (Table B)
3. Calculate Feed IPM = FPT X (No. of Flutes) X RPM

Explanation of Symbols:

SFM = Surface Feet Per Minute (Cutting Speed)
 RPM = Revolutions Per Minute (Spindle Speed)
 FPT = Feed Per Tooth
 IPM = Inches Per Minute

| HIGH SPEED STEEL | | | | | | | | |
|---------------------------|-----------|----------------|-------|-------|-------|-------|-------|----------|
| MATERIAL TO BE CUT | CONDITION | FEED PER TOOTH | | | | | | SFM |
| | | 1/8" & under | 1/4" | 3/8" | 1/2" | 3/4" | 1" | |
| Aluminum 2024, 6061, 7075 | 150 Bhn | .0006 | .0012 | .0020 | .0040 | .0064 | .0080 | 400-800 |
| Magnesium AM60A | 90 Bhn | .0007 | .0014 | .0023 | .0045 | .0072 | .0090 | 500-1000 |
| Bronze / Brass | 81RF | .0004 | .0008 | .0013 | .0025 | .0040 | .0050 | 75-120 |
| Copper 834, 934, 978 | 150 Bhn | .0005 | .0009 | .0015 | .0030 | .0048 | .0060 | 275-450 |
| Inconel 625, 718 | 300 Bhn | .0002 | .0005 | .0008 | .0015 | .0024 | .0030 | 10-20 |
| Hastelloy Alloy B | 220 Bhn | .0002 | .0005 | .0008 | .0015 | .0024 | .0030 | 15-30 |
| Stainless Steel 304 | 185 Bhn | .0004 | .0008 | .0013 | .0025 | .0040 | .0050 | 60-110 |
| Stainless Steel 17-4PH | 375 Bhn | .0002 | .0003 | .0005 | .0010 | .0016 | .0020 | 45-80 |
| Steel 4140 / 4340 | 350 Bhn | .0003 | .0006 | .0010 | .0020 | .0032 | .0040 | 40-70 |
| Steel 1020 | 150 Bhn | .0004 | .0008 | .0013 | .0025 | .0040 | .0050 | 100-165 |
| Tool Steel A2 | 250 Bhn | .0002 | .0005 | .0008 | .0015 | .0024 | .0030 | 50-90 |
| Tool Steel D2 | 250 Bhn | .0002 | .0005 | .0008 | .0015 | .0024 | .0030 | 35-65 |
| Tool Steel H13 | 200 Bhn | .0002 | .0005 | .0008 | .0015 | .0024 | .0030 | 60-100 |
| Titanium 6Al-4V | 325 Bhn | .0002 | .0005 | .0008 | .0015 | .0024 | .0030 | 30-90 |
| Titanium 6Al-6V-2Sn | 370 Bhn | .0002 | .0005 | .0008 | .0015 | .0024 | .0030 | 30-90 |
| Cast Iron (Ductile) | 190 Bhn | .0005 | .0009 | .0015 | .0030 | .0048 | .0060 | 75-125 |
| Cast Iron (Gray) | 220 Bhn | .0003 | .0006 | .0010 | .0020 | .0032 | .0040 | 75-125 |

These are based on a RADIAL Depth of Cut equal to the Tool Diameter divided by 4.

These Starting Points are Based on Maximum Axial Depth of 1.5 X the Cutting Diameter.

Speeds May be Increased When Using: TiN +25% TiCN +30% TiAlN +35%.

When Slotting Reduce Feed per Tooth 20% and if the Slot Depth is Greater than 1/2 of the Tool Diameter Reduce by 50%

Roughing End Mills Increase Feed per Tooth by 20%.

| RPM SELECTOR | | | | | | | | | | | | | | | | | | | B |
|-------------------------------|------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|---|
| Surface Feet Per Minute (SFM) | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 125 | 150 | 200 | 300 | 400 | 500 | 600 | 800 | 1000 | |
| Diameter Inches | REVOLUTIONS PER MINUTE (RPM) | | | | | | | | | | | | | | | | | | |
| 1/16 | 122 | 1833 | 2445 | 3056 | 3667 | 4278 | 4889 | 5500 | 6112 | 7639 | 9167 | | | | | | | | |
| 1/8 | 611 | 917 | 1222 | 1528 | 1833 | 2139 | 2445 | 2750 | 3056 | 3820 | 4584 | 6112 | 9167 | | | | | | |
| 3/16 | 407 | 611 | 815 | 1019 | 1222 | 1426 | 1630 | 1833 | 2037 | 2546 | 3056 | 4074 | 6112 | 8149 | | | | | |
| 1/4 | 306 | 458 | 611 | 764 | 917 | 1070 | 1222 | 1375 | 1528 | 1910 | 2292 | 3056 | 4584 | 6112 | 7639 | 9167 | | | |
| 5/16 | 244 | 367 | 489 | 611 | 733 | 856 | 978 | 1100 | 1222 | 1528 | 1833 | 2445 | 3667 | 4889 | 6112 | 7334 | 9778 | | |
| 3/8 | 204 | 306 | 407 | 509 | 611 | 713 | 815 | 917 | 1019 | 1273 | 1528 | 2037 | 3056 | 4074 | 5093 | 6112 | 8149 | | |
| 7/16 | 175 | 262 | 349 | 437 | 524 | 611 | 698 | 786 | 873 | 1091 | 1310 | 1746 | 2619 | 3492 | 4365 | 5238 | 6985 | 8731 | |
| 1/2 | 153 | 229 | 306 | 382 | 458 | 535 | 611 | 688 | 764 | 955 | 1146 | 1528 | 2292 | 3056 | 3820 | 4584 | 6112 | 7639 | |
| 5/8 | 122 | 183 | 244 | 306 | 367 | 428 | 489 | 550 | 611 | 764 | 917 | 1222 | 1833 | 2445 | 3056 | 3667 | 4889 | 6112 | |
| 3/4 | 102 | 153 | 204 | 255 | 306 | 257 | 407 | 458 | 509 | 637 | 764 | 1019 | 1528 | 2037 | 2546 | 3056 | 4074 | 5093 | |
| 7/8 | 87 | 131 | 175 | 218 | 262 | 306 | 349 | 393 | 437 | 546 | 655 | 873 | 1310 | 1746 | 2183 | 2619 | 3492 | 4365 | |
| 1 | 76 | 115 | 153 | 191 | 229 | 267 | 306 | 344 | 382 | 477 | 573 | 764 | 1146 | 1528 | 1910 | 2292 | 3056 | 3820 | |
| 1-1/8 | 68 | 102 | 136 | 170 | 204 | 238 | 272 | 306 | 340 | 424 | 509 | 679 | 1019 | 1358 | 1698 | 2037 | 2716 | 3395 | |
| 1-1/4 | 61 | 92 | 122 | 153 | 183 | 214 | 244 | 275 | 306 | 382 | 458 | 611 | 917 | 1222 | 1528 | 1833 | 2445 | 3056 | |
| 1-3/8 | 56 | 83 | 111 | 139 | 167 | 194 | 222 | 250 | 278 | 347 | 417 | 556 | 833 | 1111 | 1389 | 1667 | 2222 | 2778 | |
| 1-1/2 | 51 | 76 | 102 | 127 | 153 | 178 | 204 | 229 | 255 | 318 | 382 | 509 | 764 | 1019 | 1273 | 1528 | 2037 | 2546 | |
| 1-5/8 | 47 | 71 | 94 | 118 | 141 | 165 | 188 | 212 | 235 | 294 | 353 | 470 | 705 | 940 | 1175 | 1410 | 1880 | 2351 | |
| 1-3/4 | 44 | 66 | 87 | 109 | 131 | 153 | 175 | 196 | 218 | 273 | 327 | 437 | 655 | 873 | 1091 | 1310 | 1746 | 2183 | |
| 1-7/8 | 41 | 61 | 82 | 102 | 122 | 143 | 163 | 183 | 204 | 255 | 306 | 407 | 611 | 815 | 1019 | 1222 | 1630 | 2037 | |
| 2 | 38 | 57 | 76 | 96 | 115 | 134 | 153 | 172 | 191 | 239 | 286 | 382 | 573 | 764 | 955 | 1446 | 1528 | 1910 | |
| 2-1/2 | 31 | 46 | 61 | 76 | 92 | 107 | 122 | 138 | 153 | 191 | 229 | 306 | 458 | 611 | 764 | 917 | 1222 | 1528 | |

Award

TAPERED END MILLS™

SUPERIOR SERVICE SINCE 1959

**HEAT TREATED FOR MAXIMUM CUTTING
SPEED AND ABRASION RESISTANCE**

**HIGHLY ACCURATE - TOOL AFTER TOOL
LATEST MANUFACTURING TECHNOLOGY
KNOWN WORLDWIDE FOR PRODUCT RELIABILITY**

**FEWER CHANGES, LASTS MANY
TIMES LONGER THAN ORDINARY
HIGH SPEED STEEL END MILLS**

**MANUFACTURED FROM SUPERIOR
HIGH SPEED STEELS**

METRIC CONVERSION TABLE

LINEAR MEASURE

| | |
|-----------------------------------|----------------------------------|
| 1 kilometer = 0.6214 mile | 1 mile = 1.609 kilometers |
| 39.37 inches | 1 yard = 0.9144 meter |
| 1 meter = 3.2808 feet | 1 foot = 0.3048 meter |
| 1.0936 yards | 1 foot = 304.8 millimeters |
| 1 centimeter = 0.3937 inch | 1 inch = 2.54 centimeters |
| 1 millimeter = 0.03937 inch | 1 inch = 25.4 millimeters |
| 1 micrometer (μm) | 1 micromin = 0.025 μm |
| (0.001 millimeter) = 0.00004 inch | |

SQUARE MEASURE

| |
|---|
| 1 square kilometer = 0.3861 square mile = 247.1 acres |
| 1 hectare = 2.471 acres = 107,640 square feet |
| 1 are = 0.0247 acre = 1076.4 square feet |
| 1 square meter = 10.764 square feet = 1.196 square yards |
| 1 square centimeter = 0.155 square inch |
| 1 square millimeter = 0.00155 square inch |
| 1 square mile = 2.5899 square kilometer |
| 1 acre = 0.4047 hectare = 40.47 ares |
| 1 square yard = 0.0929 square meter = 929 square centimeters |
| 1 square inch = 6.452 square centimeters = 645.2 square millimeters |

CUBIC MEASURE

| |
|--|
| 1 cubic meter = 35.31 cubic feet = 1.308 cubic yards |
| 1 cubic meter = 264.2 US gallons = 219.969 Imperial gallons |
| 1 cubic centimeter = 0.062 cubic inch |
| 1 liter (cubic decimeter) = 0.0353 cubic foot = 61.023 cubic inches |
| 1 liter = 0.2642 US gallons = 1.0567 US quarts = 0.2200 Imperial gallons |
| 1 cubic yard = 0.7646 cubic meter |
| 1 cubic foot = 0.02832 cubic meter = 28.317 liters |
| 1 cubic inch = 16.38706 cubic centimeters |
| 1 Imperial gallon = 4.546 liters |
| 1 Imperial quart = 1.136 liters |
| 1 US gallon = 3.785 liters |
| 1 US quart = 0.946 liter |

WEIGHT

| |
|--|
| 1 metric ton = 0.9842 ton (of 2240 pounds) = 2204.6 pounds |
| 1 kilogram = 2.2046 pounds = 35.274 ounces avoirdupois |
| 1 gram = 0.03215 ounces troy = 0.03527 ounces avoirdupois |
| 1 gram = 15.432 grains |
| 1 ton (of 2240 pounds) = 1.016 metric tons = 1016 kilograms |
| 1 pound = 0.4536 kilograms = 453.6 grams |
| 1 ounce avoirdupois = 28.35 grams |
| 1 ounce troy = 31.103 grams |
| 1 grain = 0.0648 gram |
| 1 kilogram per square millimeter = 1422.32 pounds per sq. in. |
| 1 kilogram per square centimeter = 14.2232 pounds per sq. in. |
| 1 kilogram/meter = 7.233 foot/pounds |
| 1 pound per square inch = 0.0703 kilogram per square centimeter |
| 1 calorie (kilogram calorie) = 3.968 Btu (British Thermal Units) |
| 1 international table calorie = 4.1868 joules |
| 1 kilojoules = 0.948 Btu |
| 1 kilo pound (kp) = 1 kilogram-force |

