

Milling

Pictorial Index..... M 02-03

Milling Cutters

Hushcut® Series II M 04-07
 Index-O-Cut™ M 08-11
 Excelerator® Mill M 12-31
 Powermill® M 32-34

Insert Grade Reference for Milling M 35

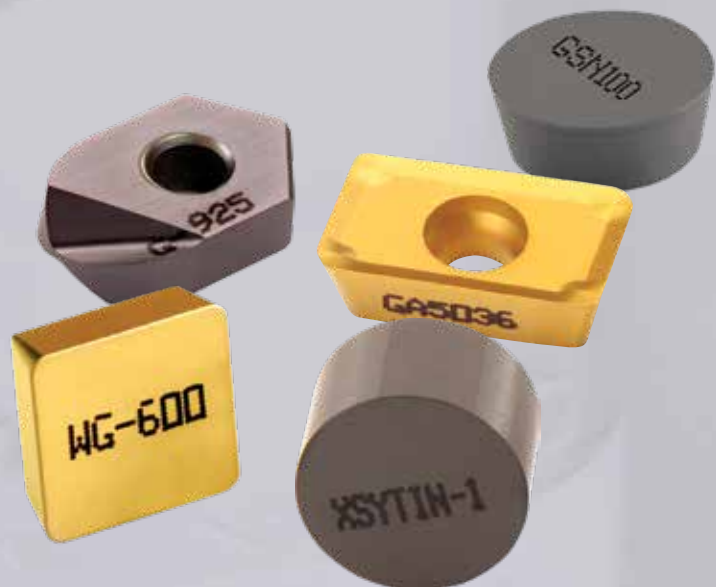
Insert Grade Descriptions..... M 36-37

Screw Torque Settings M 38

Excelerator® Mills Setup and Operational Procedures..... M 38

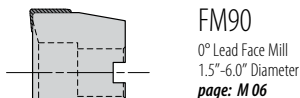
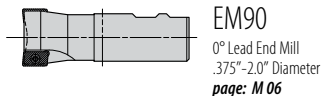
Edge Preparations..... M 39

Technical Data for Milling M 41-45

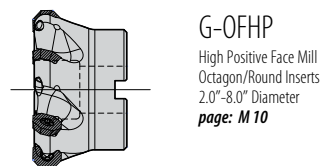


Pictorial Index

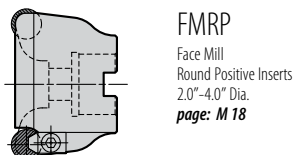
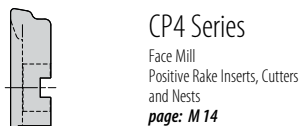
Hushcut® Series II Milling System



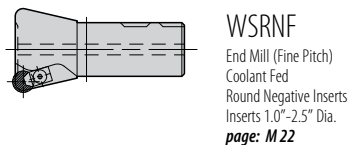
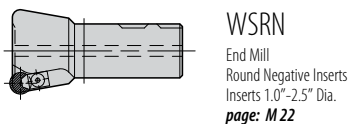
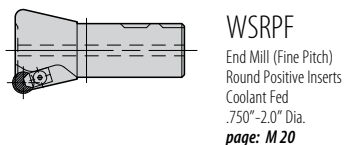
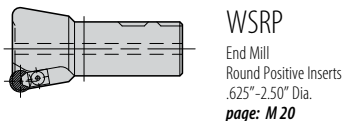
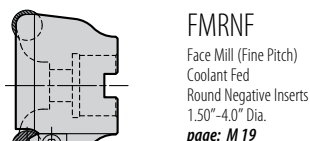
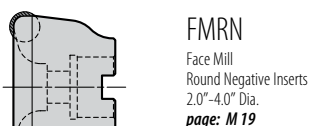
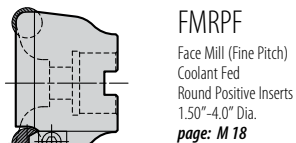
Index-O-Cut™ Milling System



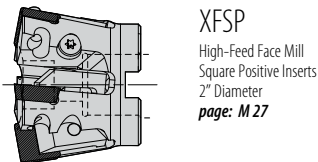
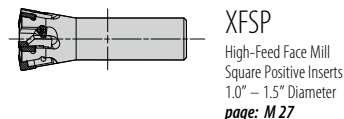
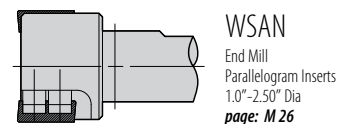
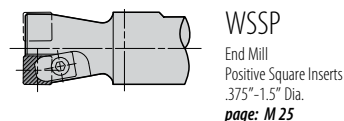
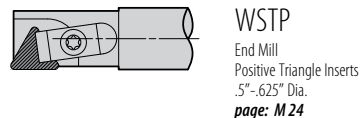
Excelerator Milling Cutters and Inserts



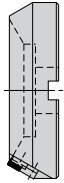
Excelerator Milling Cutters and Inserts *continued*



Excelerator Milling Cutters and Inserts *continued*



Powermill® Cutters



M430LNP-A

30° Lead Face Mill
Negative Radial
Positive Axial
4"–12" Diameter.
page: M 34



Hushcut® Series II Milling Cutters

Quiet and free-cutting mills with screw-on insert designs to make the most out of the available power. The free-cutting action results in longer tool life and improved surface finishes. Available in end mills and face mills in a wide range of small to large diameters.

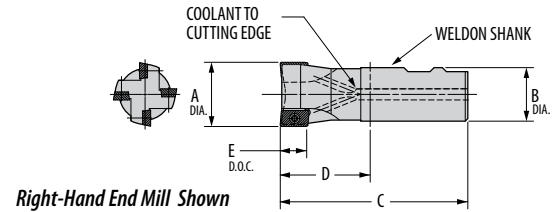
Greenleaf Tune-Up Kits

A Tune-Up Kit consists of all the standard hardware to refurbish a particular toolholder, boring bar, or milling cutter. A toolholder will have a readily visible, laser-inscribed Tune-Up Kit number on it for ease in ordering. This number will prevent any confusion created by searching a catalog for hardware, and it will help reduce downtime.



EM90S/L

0° Lead End Mill



| Part Number | Gage Insert | Dimensions (inches) | | | | | No. of Inserts | Standard Components | *Tune-Up Kit |
|------------------|------------------|---------------------|-------|-------|-------|-------|----------------|---------------------|--------------|
| | | A | B | C | D | E | | | |
| EM90S-050R-62W | ADGT-16222DFR5LD | 0.500 | 0.625 | 2.910 | 1 | 0.350 | 1 | PT-589T | TK-01002 |
| EM90S-062R-75W | ADGT-16222DFR5LD | 0.625 | 0.750 | 3.030 | 1 | 0.350 | 2 | PT-589T | TK-01003 |
| EM90S-075R-75W | ADGT-16222DFR5LD | 0.750 | 0.750 | 3.280 | 1.25 | 0.350 | 3 | PT-589T | TK-02696 |
| EM90S-088R-100W | ADGT-16222DFR5LD | 0.875 | 1.000 | 3.530 | 1.25 | 0.350 | 3 | 313631 | TK-02379 |
| EM90S-100R-75W | ADGT-16222DFR5LD | 1.000 | 0.750 | 3.530 | 1.5 | 0.350 | 4 | PT-542T | TK-00860 |
| EM90S-100R-100W | ADGT-16222DFR5LD | 1.000 | 1.000 | 3.780 | 1.5 | 0.350 | 4 | PT-542T | TK-00860 |
| EM90S-125R-125W | ADGT-16222DFR5LD | 1.250 | 1.250 | 3.780 | 1.5 | 0.350 | 5 | PT-542T | TK-00861 |
| EM90S-150R-125W | ADGT-16222DFR5LD | 1.500 | 1.250 | 3.780 | 1.5 | 0.350 | 5 | PT-542T | TK-00861 |
| EM90L-075R-75W | APHT-32.73PD2R** | 0.750 | 0.750 | 3.380 | 1.35 | 0.530 | 1 | PT-559T | TK-00758 |
| EM90L-100R-75W | APHT-32.73PD2R** | 1.000 | 0.750 | 3.880 | 1.85 | 0.530 | 2 | 312679 | TK-00780 |
| EM90L-100R-100W | APHT-32.73PD2R** | 1.000 | 1.000 | 4.130 | 1.85 | 0.530 | 2 | 312679 | TK-00780 |
| EM90L-100R-100WL | APHT-32.73PD2R** | 1.000 | 1.000 | 6.000 | 3.75 | 0.530 | 2 | 312679 | TK-00780 |
| EM90L-125R-75W | APHT-32.73PD2R** | 1.250 | 0.750 | 4.130 | 2.1 | 0.530 | 3 | 312679 | TK-00781 |
| EM90L-125R-125W | APHT-32.73PD2R** | 1.250 | 1.250 | 4.380 | 2.1 | 0.530 | 3 | 312679 | TK-00781 |
| EM90L-125R-125WM | APHT-32.73PD2R** | 1.250 | 1.250 | 5.250 | 3 | 0.530 | 3 | 312679 | TK-00781 |
| EM90L-125R-125WL | APHT-32.73PD2R** | 1.250 | 1.250 | 6.500 | 4.25 | 0.530 | 3 | 312679 | TK-00781 |
| EM90L-150R-75W | APHT-32.73PD2R** | 1.500 | 0.750 | 4.130 | 2.1 | 0.530 | 4 | 312679 | TK-00782 |
| EM90L-150R-100W | APHT-32.73PD2R** | 1.500 | 1.000 | 4.380 | 2.1 | 0.530 | 4 | 312679 | TK-00782 |
| EM90L-150R-125W | APHT-32.73PD2R** | 1.500 | 1.250 | 4.380 | 2.1 | 0.530 | 4 | 312679 | TK-00782 |
| EM90L-150R-125W3 | APHT-32.73PD2R** | 1.500 | 1.250 | 4.380 | 2.1 | 0.530 | 3 | 312679 | TK-00781 |
| EM90L-150R-125WL | APHT-32.73PD2R** | 1.500 | 1.250 | 6.500 | 4.25 | 0.530 | 3 | 312679 | TK-00781 |
| EM90L-200R-125W | APHT-32.73PD2R** | 2.000 | 1.250 | 4.380 | 2.100 | 0.530 | 5 | 312679 | TK-00783 |

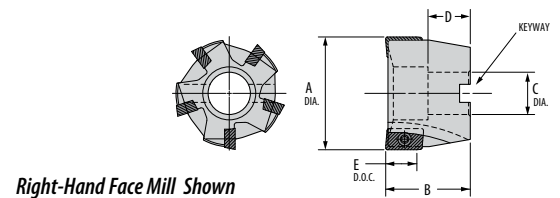
NOTE: For information on screw torque settings, please refer to the chart on page M38.

* Tune-Up Kits include all standard components and necessary wrenches to allow you to completely refurbish cutter.

** APET can be used in place of APHT.

FM90S/L

0° Lead Face Mill



| Part Number | Gage Insert | Dimensions (inches) | | | | | No. of Inserts | Keyway | Standard Components | *Tune-Up Kit |
|-------------|------------------|---------------------|-------|-------|-------|-------|----------------|-------------|---------------------|--------------|
| | | A | B | C | D | E | | | | |
| FM90S-15R | ADGT-16222DFR5LD | 1.500 | 1.500 | 0.500 | 0.620 | 0.350 | 6 | 1/4 x 5/32 | PT-542T | TK-00862 |
| FM90S-20R | ADGT-16222DFR5LD | 2.000 | 1.500 | 0.750 | 0.750 | 0.350 | 7 | 5/16 x 3/16 | PT-542T | TK-00863 |
| FM90S-25R | ADGT-16222DFR5LD | 2.500 | 1.500 | 1.000 | 0.750 | 0.350 | 8 | 3/8 x 1/4 | PT-542T | TK-00864 |
| FM90S-30R | ADGT-16222DFR5LD | 3.000 | 2.000 | 1.000 | 0.750 | 0.350 | 9 | 3/8 x 1/4 | PT-542T | TK-00913 |
| FM90L-20R | APHT-32.73PD2R** | 2.000 | 1.500 | 0.750 | 0.750 | 0.530 | 5 | 5/16 x 3/16 | 312679 | TK-00783 |
| FM90L-25R | APHT-32.73PD2R** | 2.500 | 1.500 | 1.000 | 0.750 | 0.530 | 6 | 3/8 x 1/4 | 312679 | TK-00784 |
| FM90L-30R | APHT-32.73PD2R** | 3.000 | 2.000 | 1.000 | 0.750 | 0.530 | 7 | 3/8 x 1/4 | 312679 | TK-00785 |
| FM90L-40R | APHT-32.73PD2R** | 4.000 | 2.000 | 1.500 | 1.060 | 0.530 | 8 | 5/8 x 3/8 | 312679 | TK-00786 |
| FM90L-50R | APHT-32.73PD2R** | 5.000 | 2.500 | 1.500 | 1.060 | 0.530 | 10 | 5/8 x 3/8 | 312679 | TK-01249 |
| FM90L-60R | APHT-32.73PD2R** | 6.000 | 2.500 | 1.500 | 1.060 | 0.530 | 12 | 5/8 x 3/8 | 312679 | TK-00787 |

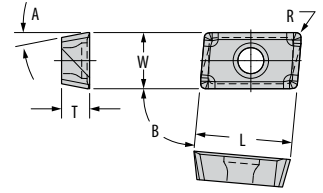
NOTE: For information on screw torque settings, please refer to the chart on page M38.


* Tune-Up Kits include all standard components and necessary wrenches to allow you to completely refurbish cutter.

** APET can be used in place of APHT.

Hushcut Inserts

ADGT, APHT, and APET



| Inserts | Part Number ANSI | Steel | | | Stainless Steel | | Cast Iron | | Heat-Resistant Super Alloys | | Part Number ISO | Dimensions (inches) | | | | | |
|---|---------------------|--------|-------|--------|-----------------|--------|-----------|--------|-----------------------------|--------|--------------------|---------------------|-------|-------|-------|-----|-----|
| | | P | | | M | | K | | S | | | L | W | T | R | A | B |
| | | GA5036 | G-915 | G-9120 | G-915 | G-9230 | G-915 | GA5023 | G-915 | G-9230 | | | | | | | |
|  | ADGT-16222DFR5LD | ◆ | ▲ | ● | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ADGT-100308DFRLD | 0.394 | 0.264 | 0.138 | 0.031 | 16° | 84° |
| | ADGT-16224DFR5LD | ◆ | ▲ | ● | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ADGT-100316DFRLD | 0.394 | 0.264 | 0.138 | 0.063 | 16° | 84° |
| | APHT-32.73PD2R | ◆ | ▲ | ● | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | APHT-160408PDR | 0.647 | 0.375 | 0.187 | 0.031 | 11° | 85° |
| | APHT-32.73PD4R | ◆ | ▲ | ● | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | APHT-160416PDR | 0.647 | 0.375 | 0.187 | 0.063 | 11° | 85° |
| | APHT-32.73PD8R | ◆ | ▲ | ● | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | APHT-160432PDR | 0.647 | 0.375 | 0.187 | 0.125 | 11° | 85° |
| | APET-32.73XD2R | ◆ | ▲ | ● | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | APET-160408PDR | 0.660 | 0.375 | 0.188 | 0.031 | 11° | 85° |
| | APET-32.73XD4R | ◆ | ▲ | ● | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | APET-160416PDR | 0.653 | 0.375 | 0.188 | 0.063 | 11° | 85° |
| | APET-32.73XD6R | ◆ | ▲ | ● | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | APET-160432PDR | 0.653 | 0.375 | 0.188 | 0.094 | 11° | 85° |

CARBIDE COATINGS: MT-CVD Coated PVD Coated Uncoated

First Choice ◆ Second Choice ● Alternative ▲

Grade descriptions — pages M 36–37



Index-0-Cut™ Milling Cutters

The Index-0-Cut™ is a high-performance milling system for all materials thanks to its high-shear cutting action and the 45° lead angle on the octagon-style insert. These mills are capable of running at higher speeds and feeds than the competition with low power consumption.

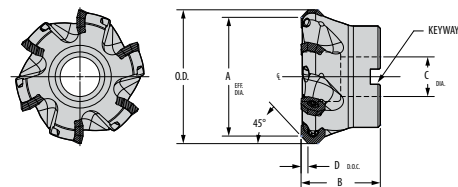
Greenleaf Tune-Up Kits

A Tune-Up Kit consists of all the standard hardware to refurbish a particular toolholder, boring bar, or milling cutter. A toolholder will have a readily visible, laser-inscribed Tune-Up Kit number on it for ease in ordering. This number will prevent any confusion created by searching a catalog for hardware, and it will help reduce downtime.



Index-O-Cut™

G-OFHP Face Mill



| Part Number | Gage Insert | Dimensions (inches) | | | | | No. of Inserts | Keyway | Standard Components | *Tune-Up Kit |
|-----------------|-------------|---------------------|-------|-------|-------|-------|----------------|--------|---------------------|--------------|
| | | A | O.D. | B | C | D** | | | | |
| G-OFHP-0545E200 | OOEW-534 | 2.000 | 2.381 | 1.500 | 0.750 | 0.173 | 4 | 5/16 | PT-546-T | TK-03249 |
| G-OFHP-0545E250 | OOEW-534 | 2.500 | 2.879 | 1.750 | 1.000 | 0.173 | 5 | 3/8 | PT-546-T | TK-03165 |
| G-OFHP-0545E300 | OOEW-534 | 3.000 | 3.378 | 2.000 | 1.000 | 0.173 | 6 | 3/8 | PT-546-T | TK-03250 |
| G-OFHP-0545E400 | OOEW-534 | 4.000 | 4.375 | 2.000 | 1.500 | 0.173 | 7 | 5/8 | PT-546-T | TK-03444 |
| G-OFHP-0545E500 | OOEW-534 | 5.000 | 5.374 | 2.000 | 1.500 | 0.173 | 8 | 5/8 | PT-546-T | TK-03445 |
| G-OFHP-0545E600 | OOEW-534 | 6.000 | 6.373 | 2.000 | 1.500 | 0.173 | 9 | 5/8 | PT-546-T | TK-03651 |
| G-OFHP-0545E800 | OOEW-534 | 8.000 | 8.372 | 2.000 | 2.500 | 0.173 | 10 | 1 | PT-546-T | TK-03437 |

* Tune-Up Kits include all standard components and necessary wrenches to allow you to completely refurbish cutter.

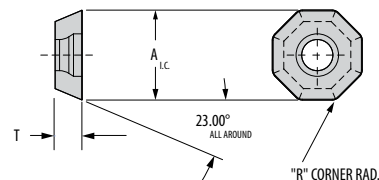
** Maximum depth of cut is 0.173".


NOTE: For information on screw torque settings, please refer to the chart on page M38.

NOTE: Index-O-Cut excelerator mills can be ordered in differential pitch for all diameters.

Index-O-Cut™ Inserts

OOEW



| Inserts | Part Number ANSI | Steel | | | Stainless Steel | | Cast Iron | Heat-Resistant Super Alloys | | Part Number ISO | Dimensions (inches) | | | |
|---|---------------------|-------|--------|--------|-----------------|--------|-----------|-----------------------------|-------|--------------------|---------------------|-------|-------|-------|
| | | P | | | M | | K | S | | | A | T | R | |
| | | G-915 | G-9120 | G-9230 | G-915 | G-9230 | G-915 | GA5023 | G-915 | | G-9230 | | | |
|  | 00EW-534 | ● | ◆ | ▲ | ◆ | ▲ | ▲ | ◆ | ◆ | ▲ | 00EW-060416 | 0.625 | 0.188 | 0.063 |

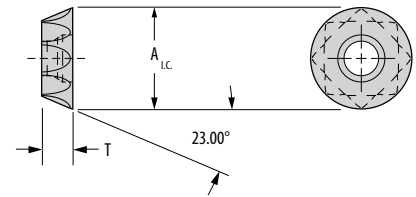
CARBIDE COATINGS: MT-CVD Coated PVD Coated Uncoated


First Choice ◆ Second Choice ● Alternative ▲

Grade descriptions — pages M 36–37

Index-O-Cut™ Inserts

ROEW



| Inserts | Part Number ANSI | Steel | | Stainless Steel | | Cast Iron | | Heat-Resistant Super Alloys | | Part Number ISO | Dimensions (inches) | |
|---|---------------------|-------|--------|-----------------|--------|-----------|--------|-----------------------------|--------|--------------------|---------------------|-------|
| | | P | | M | | K | | S | | | A | T |
| | | G-915 | G-9120 | G-915 | G-9230 | G-915 | GA5023 | G-915 | G-9230 | | | |
|  | ROEW-534 | ● | ◆ | ◆ | ▲ | ▲ | ◆ | ◆ | ▲ | ROEW-060416 | 0.625 | 0.188 |

CARBIDE COATINGS: MT-CVD Coated PVD Coated Uncoated

First Choice ◆ Second Choice ● Alternative ▲

Grade descriptions — pages M 36–37

CERAMIC CLASSIFICATION: Whisker Ceramic Phase-Toughened Silicon Nitride Alumina TiC

Performance Calculations

Starting Speeds and Feeds for Index-O-Cut™

| Work Material | Insert Grades | Hardness (HRC) | Cutting Speed (SFM) | Maximum Feed per Tooth (IPT) |
|--|---------------|----------------|---------------------|------------------------------|
| Low-Carbon Steel / Free Machining | G-9120 | <25 | 1200-1600 | 0.005-0.010 |
| Alloy Steel (4140, 4130, 6150, 8620) | G-9120 | 15-30 | 900-1400 | 0.004-0.007 |
| High-Carbon Steel (1080, 1541, Nitralloy, 52100) | G-9120 | 25-40 | 600-1000 | 0.003-0.006 |
| Tool Steel (A6, D2, P-20, H-13) | G-9120 | <30 | 800-1200 | 0.004-0.008 |
| HRSA (Inconel, Hastelloy, Waspaloy) | G-915 | <35 | 150-300 | 0.003-0.007 |
| Stainless Steel (304, 316, 17-4 PH) | G-915 | <32 | 900-1500 | 0.004-0.009 |
| Cast Iron | GA5023 | <32 | 400-1000 | 0.005-0.010 |



Excelsior[®] Milling Cutters

High-speed ceramic or standard-speed carbide milling for use in high-temp alloys, hard metals, and cast irons at high speeds and accelerated feed rates. Precision nests provide multiple insert configurations and body protection.

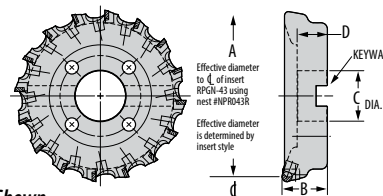
Greenleaf Tune-Up Kits

A Tune-Up Kit consists of all the standard hardware to refurbish a particular toolholder, boring bar, or milling cutter. A toolholder will have a readily visible, laser-inscribed Tune-Up Kit number on it for ease in ordering. This number will prevent any confusion created by searching a catalog for hardware, and it will help reduce downtime.



CP4 Series

Positive Rake Face Mill



Right-Hand End Mill Shown

| Part Number | | Dimensions (inches) | | | | Keyway | Bolt Circle | No. of Inserts | Standard Components | | | *Tune-Up Kit |
|-------------|-----------|---------------------|-------|-------|-------|------------|-------------|----------------|---------------------|-------------|------------|--------------|
| Right Hand | Left Hand | A | B | C | D | | | | Wedge | Wedge Screw | Nest Screw | |
| CP-403R | — | 3.000 | 2.000 | 1.250 | 0.750 | 1/2 x 9/32 | — | 6 | 425605 | 430578 | SE03-02 | TK-01141 |
| — | CP-403L | 3.000 | 2.000 | 1.250 | 0.750 | 1/2 x 9/32 | — | 6 | 425605 | 430578 | SE03-02 | TK-01141 |
| CP-404R | — | 4.000 | 2.250 | 1.500 | 1.000 | 5/8 x 3/8 | — | 8 | 425605 | 425606 | SE03-02 | TK-00841 |
| — | CP-404L | 4.000 | 2.250 | 1.500 | 1.000 | 5/8 x 3/8 | — | 8 | 425605 | 425606 | SE03-02 | TK-00841 |
| CP-405R | — | 5.000 | 2.250 | 1.500 | 1.000 | 5/8 x 3/8 | — | 10 | 425605 | 425606 | SE03-02 | TK-00845 |
| — | CP-405L | 5.000 | 2.250 | 1.500 | 1.000 | 5/8 x 3/8 | — | 10 | 425605 | 425606 | SE03-02 | TK-00845 |
| CP-406R | — | 6.000 | 2.250 | 2.000 | 1.000 | 3/4 x 7/16 | — | 12 | 425605 | 425606 | SE03-02 | TK-00842 |
| — | CP-406L | 6.000 | 2.250 | 2.000 | 1.000 | 3/4 x 7/16 | — | 12 | 425605 | 425606 | SE03-02 | TK-00842 |
| CP-408R | — | 8.000 | 2.250 | 2.500 | 1.500 | 1 x 9/16 | 4 | 16 | 425605 | 425606 | SE03-02 | TK-00843 |
| — | CP-408L | 8.000 | 2.250 | 2.500 | 1.500 | 1 x 9/16 | 4 | 16 | 425605 | 425606 | SE03-02 | TK-00843 |
| CP-410R | — | 10.000 | 2.750 | 2.500 | 1.500 | 1 x 9/16 | 4, 4-3/4 | 20 | 425605 | 425606 | SE03-02 | TK-00846 |
| — | CP-410L | 10.000 | 2.750 | 2.500 | 1.500 | 1 x 9/16 | 4, 4-3/4 | 20 | 425605 | 425606 | SE03-02 | TK-00846 |
| CP-412R | — | 12.000 | 2.750 | 2.500 | 1.500 | 1 x 9/16 | 4, 4-3/4, 7 | 24 | 425605 | 425606 | SE03-02 | TK-00847 |
| — | CP-412L | 12.000 | 2.750 | 2.500 | 1.500 | 1 x 9/16 | 4, 4-3/4, 7 | 24 | 425605 | 425606 | SE03-02 | TK-00847 |

* Tune-Up Kits include all standard components and necessary wrenches to allow you to completely refurbish cutter.

NOTE: For information on screw torque settings, please refer to the chart on page M38.

NOTE: Cutters are supplied less insert and nest. Nest must be purchased separately. Insert shape, size and quantity must be determined after choosing cutter and nest. Left-hand cutters can be built to order.

CP4 Series

Nests

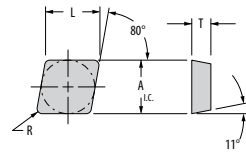
| Nests | Nest Part Number | | Gage Insert |
|-------|------------------|-----------|-------------|
| | Right Hand | Left Hand | |
| | NPC043R | — | CPGN-433 |
| | — | NPC043L | |
| | NPC1543R | — | CPGN-433 |
| | — | NPC1543L | |
| | NPR043R | — | RPGN-43 |
| | — | NPR043L | |
| | NPS143R | — | SPGN-434 |
| | — | NPS143L | |
| | NPS1543R | — | SPGN-434 |
| | — | NPS1543L | |
| | NPS4543R | — | SPGN-434 |
| | — | NPS4543L | |
| | XFNP8043R | — | SPGN-433 |
| | — | XFNP8043L | |

NOTE: For applications which will not require the maximum number of inserts, the filler block nest NPB, will act as a replacement for the inserts and insert nests. The filler block nest must be locked securely in place with the wedge to insure cutter integrity.

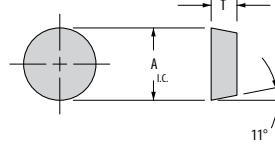
CP4 Inserts

CPGN, RPGN and SPGN

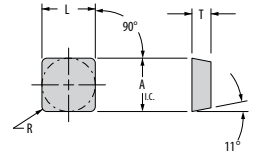
CPGN


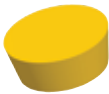



RPGN



SPGN



| Inserts | Part Number ANSI | Steel | | | Stainless Steel | | | Cast Iron | | | | Heat-Resistant Super Alloys | | | | | Hardened Steel | | | Part Number ISO | Dimensions (inches) | | | |
|---|---------------------|--------|-------|--------|-----------------|--------|---------|-----------|-------|---------|-----------|-----------------------------|--------|---------|---------|-----------|----------------|---------|-----------|--------------------|---------------------|-------|-------|-------|
| | | P | | | M | | | K | | | | S | | | | | H | | | | A | T | F | R |
| | | GA5036 | G-915 | G-9120 | G-915 | G-9230 | WG-600® | G-9230 | G-915 | GSN100™ | XSYTIN®-1 | G-915 | G-9230 | WG-600® | WG-300® | XSYTIN®-1 | WG-300® | WG-600® | XSYTIN®-1 | | | | | |
|  | CPGN-433 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | CPGN-120412 | 0.500 | 0.507 | 0.187 | 0.047 |
| | CPGN-434 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | CPGN-120416 | 0.500 | 0.507 | 0.187 | 0.062 |
| | | | | | | | | | | | | | | | | | | | | | | | | |
|  | RPGN-43 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | RPGN-120400 | 0.500 | N/A | 0.187 | N/A |
| | | | | | | | | | | | | | | | | | | | | | | | | |
|  | SPGN-433 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | SPGN-120412 | 0.500 | 0.500 | 0.187 | 0.047 |
| | SPGN-434 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | SPGN-120416 | 0.500 | 0.500 | 0.187 | 0.062 |
| | | | | | | | | | | | | | | | | | | | | | | | | |

CARBIDE COATINGS: MT-CVD Coated PVD Coated Uncoated

First Choice ◆ Second Choice ● Alternative ▲

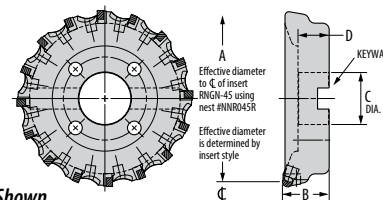
Grade descriptions — pages M 36–37

CERAMIC CLASSIFICATION: Whisker Ceramic Phase-Toughened Silicon Nitride Alumina TiC

NOTE: For additional nose radii and available edge preps, please contact Greenleaf Tech Team.

C4 Series

Negative Rake Face Mill



Right-Hand End Mill Shown

| Part Number | | Dimensions (inches) | | | | Keyway | Bolt Circle | No. of Inserts | Standard Components | | | *Tune-Up Kit |
|-------------|-----------|---------------------|-------|-------|-------|------------|-------------|----------------|---------------------|-------------|------------|--------------|
| Right Hand | Left Hand | A | B | C | D | | | | Wedge | Wedge Screw | Nest Screw | |
| C-403R | — | 3.000 | 2.000 | 1.250 | 0.750 | 1/2 x 9/32 | — | 6 | 425605 | 430578 | SE03-02 | TK-00851 |
| — | C-403L | 3.000 | 2.000 | 1.250 | 0.750 | 1/2 x 9/32 | — | 6 | 425605 | 430578 | SE03-02 | TK-00851 |
| C-404R | — | 4.000 | 2.250 | 1.500 | 1.000 | 5/8 x 3/8 | — | 8 | 425605 | 425606 | SE03-02 | TK-00841 |
| — | C-404L | 4.000 | 2.250 | 1.500 | 1.000 | 5/8 x 3/8 | — | 8 | 425605 | 425606 | SE03-02 | TK-00841 |
| C-405R | — | 5.000 | 2.250 | 1.500 | 1.000 | 5/8 x 3/8 | — | 10 | 425605 | 425606 | SE03-02 | TK-00845 |
| — | C-405L | 5.000 | 2.250 | 1.500 | 1.000 | 5/8 x 3/8 | — | 10 | 425605 | 425606 | SE03-02 | TK-00845 |
| C-406R | — | 6.000 | 2.250 | 2.000 | 1.000 | 3/4 x 7/16 | — | 12 | 425605 | 425606 | SE03-02 | TK-00842 |
| — | C-406L | 6.000 | 2.250 | 2.000 | 1.000 | 3/4 x 7/16 | — | 12 | 425605 | 425606 | SE03-02 | TK-00842 |
| C-408R | — | 8.000 | 2.250 | 2.500 | 1.500 | 1 x 9/16 | 4 | 16 | 425605 | 425606 | SE03-02 | TK-00843 |
| — | C-408L | 8.000 | 2.250 | 2.500 | 1.500 | 1 x 9/16 | 4 | 16 | 425605 | 425606 | SE03-02 | TK-00843 |
| C-410R | — | 10.000 | 2.750 | 2.500 | 1.500 | 1 x 9/16 | 4, 4-3/4 | 20 | 425605 | 425606 | SE03-02 | TK-00846 |
| — | C-410L | 10.000 | 2.750 | 2.500 | 1.500 | 1 x 9/16 | 4, 4-3/4 | 20 | 425605 | 425606 | SE03-02 | TK-00846 |
| C-412R | — | 12.000 | 2.750 | 2.500 | 1.500 | 1 x 9/16 | 4, 4-3/4, 7 | 24 | 425605 | 425606 | SE03-02 | TK-00847 |
| — | C-412L | 12.000 | 2.750 | 2.500 | 1.500 | 1 x 9/16 | 4, 4-3/4, 7 | 24 | 425605 | 425606 | SE03-02 | TK-00847 |

* Tune-Up Kits include all standard components and necessary wrenches to allow you to completely refurbish cutter.

NOTE: For information on screw torque settings, please refer to the chart on page M38.

NOTE: Cutters are supplied less insert and nest. Nest must be purchased separately. Insert shape, size and quantity must be determined after choosing cutter and nest. Left-hand cutters can be built to order.

C4 Series

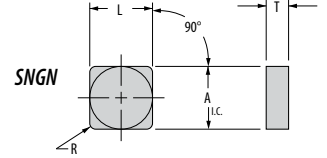
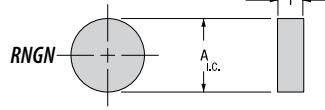
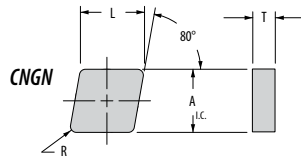
Nests



| Nests | Nest Part Number | | Gage Insert |
|-------|------------------|-----------|-------------|
| | Right Hand | Left Hand | |
| | NNC043R | — | CNGN-433 |
| | — | NNC043L | — |
| | NNC045R | — | CNGN-453 |
| | — | NNC045L | — |
| | NNC1543R | — | CNGN-433 |
| | — | NNC1543L | — |
| | NNC1545R | — | CNGN-453 |
| | — | NNC1545L | — |
| | NNR043R | — | RNGN-43 |
| | — | NNR043L | — |
| | NNR045R | — | RNGN-45 |
| | — | NNR045L | — |
| | NNS143R | — | SNGN-434 |
| | — | NNS143L | — |
| | NNS145R | — | SNGN-454 |
| | — | NNS145L | — |
| | NNS1543R | — | SNGN-434 |
| | — | NNS1543L | — |
| | NNS1545R | — | SNGN-454 |
| | — | NNS1545L | — |
| | NNS4543R | — | SNGN-434 |
| | — | NNS4543L | — |
| | NNS4545R | — | SNGN-454 |
| | — | NNS4545L | — |

NOTE: For applications which will not require the maximum number of inserts, the filler block nest NNB, will act as a replacement for the inserts and insert nests. The filler block nest must be locked securely in place with the wedge to insure cutter integrity.

C4 Inserts

CNGN, RNGN, and SNGN



| Inserts | Part Number ANSI | Steel | | | Stainless Steel | | | Cast Iron | | | Heat-Resistant Super Alloys | | | | | Hardened Steel | | | Part Number ISO | Dimensions (inches) | | | | |
|---|---------------------|--------|-------|--------|-----------------|--------|---------|-----------|-------|---------|-----------------------------|-------|--------|---------|---------|----------------|---------|---------|--------------------|---------------------|-------|-------|-------|-----------|
| | | P | | | M | | | K | | | S | | | | | H | | | | A | T | F | R | |
| | | GA5036 | G-915 | G-9120 | G-915 | G-9230 | WG-600® | G-9230 | G-915 | GSN100™ | XSYTIN®-1 | G-915 | G-9230 | WG-600® | WG-300® | XSYTIN®-1 | WG-300® | WG-600® | | | | | | XSYTIN®-1 |
|  | CNGN-433 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | CNGN-120412 | 0.500 | 0.508 | 0.187 | 0.047 |
| | CNGN-434 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | CNGN-120416 | 0.500 | 0.508 | 0.187 | 0.062 |
| | CNGN-453 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | CNGN-120712 | 0.500 | 0.508 | 0.312 | 0.047 |
| | CNGN-454 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | CNGN-120716 | 0.500 | 0.508 | 0.312 | 0.062 |
|  | RNGN-43 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | RNGN-120400 | 0.500 | — | 0.187 | — |
| | RNGN-45 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | RNGN-120700 | 0.500 | — | 0.312 | — |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
|  | SNGN-433 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | SNGN-120412 | 0.500 | 0.500 | 0.187 | 0.047 |
| | SNGN-434 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | SNGN-120416 | 0.500 | 0.500 | 0.187 | 0.062 |
| | SNGN-453 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | SNGN-120712 | 0.500 | 0.500 | 0.312 | 0.046 |
| | SNGN-454 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | SNGN-120716 | 0.500 | 0.500 | 0.312 | 0.062 |

CARBIDE COATINGS: MT-CVD Coated PVD Coated Uncoated

First Choice ◆ Second Choice ● Alternative ▲

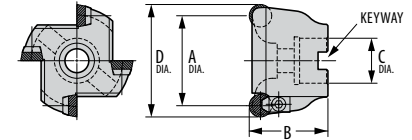
Grade descriptions — pages M 36–37

CERAMIC CLASSIFICATION: Whisker Ceramic Phase-Toughened Silicon Nitride Alumina TiC

NOTE: For additional nose radii and available edge preps, please contact Greenleaf Tech Team.

FMRP-FMRPF

Round Positive Face Mill



Right-Hand Face Mill Shown

| Part Number | | Gage Inserts | Dimensions (inches) | | | | No. of Inserts | Mounting Screw | Keyway | Standard Components | | | | *Tune-Up Kit |
|-------------|-------------|--------------|---------------------|-------|-------|-------|----------------|----------------|-----------|---------------------|----------------|--------|-----------------|--------------|
| Right Hand | Left Hand** | | A | B | C | D | | | | Anvil | Anvil Screw | Clamp | Clamp Screw | |
| FMRP-200R | | RPGN-43 | 2.000 | 1.750 | 0.750 | 2.500 | 4 | 3/8 SHCS | 5/16x3/16 | 308341 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-00649 |
| | FMRP-200L | RPGN-43 | 2.000 | 1.750 | 0.750 | 2.500 | 4 | 3/8 SHCS | 5/16x3/16 | 308341 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-00649 |
| FMRP-250R | | RPGN-43 | 2.500 | 1.750 | 1.000 | 3.000 | 4 | 1/2 SHCS | 3/8x1/4 | 308341 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-00814 |
| | FMRP-250L | RPGN-43 | 2.500 | 1.750 | 1.000 | 3.000 | 4 | 1/2 SHCS | 3/8x1/4 | 308341 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-00814 |
| FMRP-300R | | RPGN-43 | 3.000 | 2.000 | 1.250 | 3.500 | 5 | 5/8 SHCS | 1/2x 5/16 | 308341 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-00815 |
| | FMRP-300L | RPGN-43 | 3.000 | 2.000 | 1.250 | 3.500 | 5 | 5/8 SHCS | 1/2x5/16 | 308341 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-00815 |
| FMRP-400R | | RPGN-43 | 4.000 | 2.250 | 1.500 | 4.500 | 6 | 2.000 | 5/8x3/8 | 308341 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-00816 |
| | FMRP-400L | RPGN-43 | 4.000 | 2.250 | 1.500 | 4.500 | 6 | 2.000 | 5/8x3/8 | 308341 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-00816 |
| FMRPF-150R | | RPGN-43 | 1.500 | 1.750 | 0.750 | 2.000 | 5 | 3/8 SHCS | 5/16x3/16 | - | - | 3025-1 | 438919 | TK-03861 |
| | FMRPF-150L | RPGN-43 | 1.500 | 1.750 | 0.750 | 2.000 | 5 | 3/8 SHCS | 5/16x3/16 | - | - | 3025-1 | 438919 | TK-03861 |
| FMRPF-200R | | RPGN-43 | 2.000 | 1.750 | 0.750 | 2.500 | 6 | 3/8 SHCS | 5/16x3/16 | 308341 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-04689 |
| | FMRPF-200L | RPGN-43 | 2.000 | 1.750 | 0.750 | 2.500 | 6 | 3/8 SHCS | 5/16x3/16 | 308341 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-04689 |
| FMRPF-250R | | RPGN-43 | 2.500 | 1.750 | 1.000 | 3.000 | 7 | 1/2 SHCS | 3/8x1/4 | 308341 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-04195 |
| | FMRPF-250L | RPGN-43 | 2.500 | 1.750 | 1.000 | 3.000 | 7 | 1/2 SHCS | 3/8x1/4 | 308341 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-04195 |
| FMRPF-300R | | RPGN-43 | 3.000 | 2.000 | 1.250 | 3.500 | 7 | 5/8 SHCS | 1/2x 5/16 | 308341 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-00816 |
| | FMRPF-300L | RPGN-43 | 3.000 | 2.000 | 1.250 | 3.500 | 7 | 5/8 SHCS | 1/2x 5/16 | 308341 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-00816 |
| FMRPF-400R | | RPGN-43 | 4.000 | 2.250 | 1.500 | 4.500 | 10 | 15LS | 5/8x3/8 | 308341 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-04425 |
| | FMRPF-400L | RPGN-43 | 4.000 | 2.250 | 1.500 | 4.500 | 10 | 15LS | 5/8x3/8 | 308341 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-04425 |

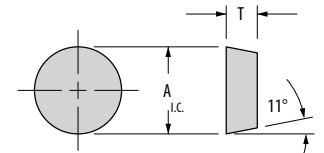
* Tune-Up Kits include all standard components and necessary wrenches to allow you to completely refurbish cutter.


** Left-Hand cutters are made to order only.

NOTE: For information on screw torque settings, please refer to the chart on page M38.

FMRP-FMRPF Inserts

RPGN



| Inserts | Part Number ANSI | Steel | | | Stainless Steel | | | Cast Iron | | | Heat-Resistant Super Alloys | | | Hardened Steel | | | Part Number ISO | Dimensions (inches) | | | | |
|---|---------------------|--------|-------|--------|-----------------|--------|---------|-----------|-------|---------|-----------------------------|-------|--------|----------------|---------|-----------|--------------------|---------------------|---|-------------|---------|-----------|
| | | P | | | M | | | K | | | S | | | H | | | | A | T | | | |
| | | GA5036 | G-915 | G-9120 | G-915 | G-9230 | WG-600° | G-9230 | G-915 | GSN100™ | XSVTIN®-1 | G-915 | G-9230 | WG-600° | WG-300° | XSVTIN®-1 | | | | WG-300° | WG-600° | XSVTIN®-1 |
|  | RPGN-43 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | RPGN-120400 | 0.500 | 0.187 |
| | | | | | | | | | | | | | | | | | | | | | | |

CARBIDE COATINGS: MI-CVD Coated PVD Coated Uncoated

First Choice ◆ Second Choice ● Alternative ▲

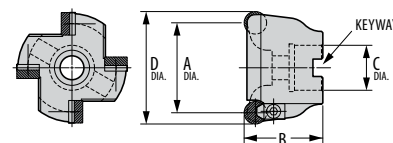
Grade descriptions — pages M36–37

CERAMIC CLASSIFICATION: Whisker Ceramic Phase-Toughened Silicon Nitride Alumina TiC

NOTE: For additional nose radii and available edge preps, please contact Greenleaf Tech Team.

FMRN—FMRNF

Round Negative Face Mill



Right-Hand Face Mill Shown

| Part Number | | Gage Inserts | Dimensions (inches) | | | | No. of Inserts | Mounting Screw | Keyway | Standard Components | | | | *Tune-Up Kit |
|-------------|-------------|--------------|---------------------|-------|-------|-------|----------------|----------------|-----------|---------------------|----------------|--------|-----------------|--------------|
| Right Hand | Left Hand** | | A | B | C | D | | | | Anvil | Anvil Screw | Clamp | Clamp Screw | |
| FMRN-200R | | RNGN-43 | 2.000 | 1.750 | 0.750 | 2.500 | 4 | 3/8 SHCS | 5/16x3/16 | 313572 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-02695 |
| | FMRN-200L | RNGN-43 | 2.000 | 1.750 | 0.750 | 2.500 | 4 | 3/8 SHCS | 5/16x3/16 | 313572 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-02695 |
| FMRN-250R | | RNGN-43 | 2.500 | 1.750 | 1.000 | 3.000 | 4 | 1/2 SHCS | 3/8x1/4 | 313572 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-02695 |
| | FMRN-250L | RNGN-43 | 2.500 | 1.750 | 1.000 | 3.000 | 4 | 1/2 SHCS | 3/8x1/4 | 313572 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-02695 |
| FMRN-300R | | RNGN-43 | 3.000 | 2.000 | 1.250 | 3.500 | 5 | 5/8 SHCS | 1/2x 5/16 | 313572 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-02697 |
| | FMRN-300L | RNGN-43 | 3.000 | 2.000 | 1.250 | 3.500 | 5 | 5/8 SHCS | 1/2x5/16 | 313572 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-02697 |
| FMRN-400R | | RNGN-43 | 4.000 | 2.250 | 1.500 | 4.500 | 6 | 2.000 | 5/8x3/8 | 313572 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-02698 |
| | FMRN-400L | RNGN-43 | 4.000 | 2.250 | 1.500 | 4.500 | 6 | 2.000 | 5/8x3/8 | 313572 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-02698 |
| FMRNF-150R† | | RNGN-43 | 1.500 | 1.750 | 0.750 | 2.000 | 5 | 3/8 SHCS | 5/16x3/16 | - | - | 3025-1 | 438919 | TK-03861 |
| | FMRNF-150L† | RNGN-43 | 1.500 | 1.750 | 0.750 | 2.000 | 5 | 3/8 SHCS | 5/16x3/16 | - | - | 3025-1 | 438919 | TK-03861 |
| FMRNF-200R | | RNGN-43 | 2.000 | 1.750 | 0.750 | 2.500 | 6 | 3/8 SHCS | 5/16x3/16 | 313572 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-02698 |
| | FMRNF-200L | RNGN-43 | 2.000 | 1.750 | 0.750 | 2.500 | 6 | 3/8 SHCS | 5/16x3/16 | 313572 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-02698 |
| FMRNF-250R | | RNGN-43 | 2.500 | 1.750 | 1.000 | 3.000 | 7 | 1/2 SHCS | 3/8x1/4 | 313572 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-04195 |
| | FMRNF-250L | RNGN-43 | 2.500 | 1.750 | 1.000 | 3.000 | 7 | 1/2 SHCS | 3/8x1/4 | 313572 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-04195 |
| FMRNF-300R | | RNGN-43 | 3.000 | 2.000 | 1.250 | 3.500 | 8 | 5/8 SHCS | 1/2x 5/16 | 313572 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-04415 |
| | FMRNF-300L | RNGN-43 | 3.000 | 2.000 | 1.250 | 3.500 | 8 | 5/8 SHCS | 1/2x 5/16 | 313572 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-04415 |
| FMRNF-400R | | RNGN-43 | 4.000 | 2.250 | 1.500 | 4.500 | 10 | 15LS | 5/8x3/8 | 313572 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-04407 |
| | FMRNF-400L | RNGN-43 | 4.000 | 2.250 | 1.500 | 4.500 | 10 | 15LS | 5/8x3/8 | 313572 | #4-40x1/4 FHCS | 3025-1 | #10-32x1/2 SHCS | TK-04407 |

* Tune-Up Kits include all standard components and necessary wrenches to allow you to completely refurbish cutter.

** Left-Hand cutters are made to order only.

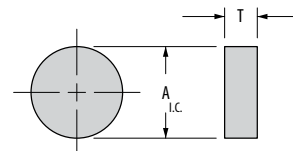
† FMRNF-150 will not accept RNGN-42 or RNGN-45.


NOTE: For information on screw torque settings, please refer to the chart on page M38.

NOTE: For Insert RNGN-42, use anvil 312780. For insert RNGN-45, use no anvil.

FMRN—FMRNF Inserts

RNGN



| Inserts | Part Number ANSI | Steel | | | Stainless Steel | | Cast Iron | | | Heat-Resistant Super Alloys | | | | | Hardened Steel | | | Part Number ISO | Dimensions (inches) | | | |
|---|---------------------|--------|-------|--------|-----------------|--------|-----------|--------|-------|-----------------------------|-----------|-------|--------|---------|----------------|-----------|---------|--------------------|---------------------|-------------|---------|-----------|
| | | P | | | M | | K | | | S | | | | | H | | | | A | T | | |
| | | GA5036 | G-915 | G-9120 | G-915 | G-9230 | WG-600® | G-9230 | G-915 | GSN100™ | XSVTIN®-1 | G-915 | G-9230 | WG-600® | WG-300® | XSVTIN®-1 | WG-300® | | | | WG-600® | XSVTIN®-1 |
|  | RNGN-42 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | RNGN-120300 | 0.500 | 0.125 |
| | RNGN-43 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | RNGN-120400 | 0.500 | 0.187 |
| | RNGN-45 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | RNGN-120700 | 0.500 | 0.312 |
| | | | | | | | | | | | | | | | | | | | | | | |

CARBIDE COATINGS: MI-CVD Coated PVD Coated Uncoated

First Choice ◆ Second Choice ● Alternative ▲

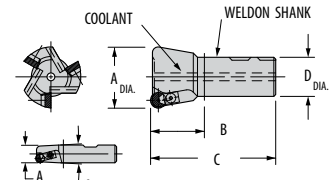
Grade descriptions — pages M36–37

CERAMIC CLASSIFICATION: Whisker Ceramic Phase-Toughened Silicon Nitride Alumina TiC

NOTE: For additional nose radii and available edge preps, please contact Greenleaf Tech Team.

WSRP-WSRPF

Round Positive End Mill



Right-Hand Cutter Shown

| Part Number | | Gage Inserts | Dimensions (inches) | | | | No. of Inserts | Standard Components | | | | *Tune-Up Kit |
|-------------------|-------------------|--------------|---------------------|-------|-------|-------|----------------|---------------------|------------------|--------|-------------------|--------------|
| Right Hand | Left Hand** | | A | B | C | D | | Anvil | Anvil Screw | Clamp | Clamp Screw | |
| WSRP-60000.6-RH † | | RPGN-21.5 | 0.625 | 1.250 | 3.160 | 0.625 | 2 | — | — | 423978 | #3-48 x 1/4 SHCS | TK-00879 |
| | WSRP-60000.6-LH † | RPGN-21.5 | 0.625 | 1.250 | 3.160 | 0.625 | 2 | — | — | 423978 | #3-48 x 1/4 SHCS | TK-00879 |
| WSRP-60000.7-RH † | | RPGN-2.52 | 0.750 | 1.250 | 3.280 | 0.750 | 2 | — | — | 429323 | SE02-01 | TK-00880 |
| | WSRP-60000.7-LH † | RPGN-2.52 | 0.750 | 1.250 | 3.280 | 0.750 | 2 | — | — | 429323 | SE02-01 | TK-00880 |
| WSRP-60001A-RH | | RPGN-2.52 | 1.000 | 1.250 | 3.280 | 0.750 | 3 | — | — | 429323 | SE02-01 | TK-00917 |
| | WSRP-60001A-LH | RPGN-2.52 | 1.000 | 1.250 | 3.280 | 0.750 | 3 | — | — | 429323 | SE02-01 | TK-00917 |
| WSRP-60001-RH | | RPGN-32 | 1.000 | 1.250 | 3.280 | 0.750 | 3 | — | — | 425716 | SE02-01 | TK-00852 |
| | WSRP-60001-LH | RPGN-32 | 1.000 | 1.250 | 3.280 | 0.750 | 3 | — | — | 425716 | SE02-01 | TK-00852 |
| WSRP-60001.2-RH | | RPGN-32 | 1.250 | 1.250 | 3.530 | 1.000 | 3 | — | — | 425716 | SE02-01 | TK-00852 |
| | WSRP-60001.2-LH | RPGN-32 | 1.250 | 1.250 | 3.530 | 1.000 | 3 | — | — | 425716 | SE02-01 | TK-00852 |
| WSRP-60001.5-RH | | RPGN-43 | 1.500 | 1.720 | 4.000 | 1.250 | 3 | — | — | 3025-1 | 438919 | TK-00645 |
| | WSRP-60001.5-LH | RPGN-43 | 1.500 | 1.720 | 4.000 | 1.250 | 3 | — | — | 3025-1 | 438919 | TK-00645 |
| WSRP-60002-RH | | RPGN-43 | 2.000 | 1.720 | 4.000 | 1.250 | 3 | 308341 | #4-40 x 1/4 FHCS | 3025-1 | 438919 | TK-00648 |
| | WSRP-60002-LH | RPGN-43 | 2.000 | 1.720 | 4.000 | 1.250 | 3 | 308341 | #4-40 x 1/4 FHCS | 3025-1 | 438919 | TK-00648 |
| WSRP-60002.5-RH | | RPGN-43 | 2.500 | 1.750 | 4.000 | 1.250 | 4 | 308341 | #4-40 x 1/4 FHCS | 3025-1 | #10-32 x 1/2 SHCS | TK-00649 |
| | WSRP-60002.5-LH | RPGN-43 | 2.500 | 1.750 | 4.000 | 1.250 | 4 | 308341 | #4-40 x 1/4 FHCS | 3025-1 | #10-32 x 1/2 SHCS | TK-00649 |
| WSRPF-60000.7-RH | | RPGN-21.5 | 0.750 | 1.250 | 3.260 | 0.750 | 3 | — | — | 423978 | #3-48 x 1/4 SHCS | TK-00879 |
| | WSRPF-60000.7-LH | RPGN-21.5 | 0.750 | 1.250 | 3.260 | 0.750 | 3 | — | — | 423978 | #3-48 x 1/4 SHCS | TK-00879 |
| WSRPF-60001A-RH | | RPGN-2.52 | 1.000 | 1.250 | 3.280 | 0.750 | 4 | — | — | 429323 | SE02-04 | TK-00880 |
| | WSRPF-60001A-LH | RPGN-2.52 | 1.000 | 1.250 | 3.280 | 0.750 | 4 | — | — | 429323 | SE02-04 | TK-00880 |
| WSRPF-60001-RH | | RPGN-32 | 1.000 | 1.250 | 3.280 | 0.750 | 4 | — | — | 429323 | SE02-04 | TK-00852 |
| | WSRPF-60001-LH | RPGN-32 | 1.000 | 1.250 | 3.280 | 0.750 | 4 | — | — | 429323 | SE02-04 | TK-00852 |
| WSRPF-60001.2-RH | | RPGN-32 | 1.250 | 1.250 | 3.530 | 1.000 | 5 | — | — | 425716 | SE02-04 | TK-00852 |
| | WSRPF-60001.2-LH | RPGN-32 | 1.250 | 1.250 | 3.530 | 1.000 | 5 | — | — | 425716 | SE02-04 | TK-00852 |
| WSRPF-60001.5-RH | | RPGN-43 | 1.500 | 1.720 | 4.000 | 1.250 | 4 | — | — | 3025 | 438919 | TK-00645 |
| | WSRPF-60001.5-LH | RPGN-43 | 1.500 | 1.720 | 4.000 | 1.250 | 4 | — | — | 3025 | 438919 | TK-00645 |
| WSRPF-60002-RH | | RPGN-43 | 2.000 | 1.720 | 4.000 | 1.250 | 4 | 308341 | #4-40 x 1/4 FHCS | 3025 | 438919 | TK-00648 |
| | WSRPF-60002-LH | RPGN-43 | 2.000 | 1.720 | 4.000 | 1.250 | 4 | 308341 | #4-40 x 1/4 FHCS | 3025 | 438919 | TK-00648 |
| WSRPF-60002.5-RH | | RPGN-43 | 2.500 | 1.750 | 4.000 | 1.250 | 5 | 308341 | #4-40 x 1/4 FHCS | 3025 | 438919 | TK-00649 |
| | WSRPF-60002.5-LH | RPGN-43 | 2.500 | 1.750 | 4.000 | 1.250 | 5 | 308341 | #4-40 x 1/4 FHCS | 3025 | 438919 | TK-00649 |

* Tune-Up Kits include all standard components and necessary wrenches to allow you to completely refurbish cutter.

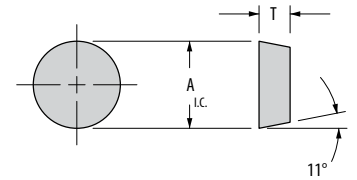
** Left-Hand cutters are made to order only.

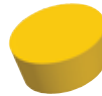
† No thru-tool coolant available

NOTE: For information on screw torque settings, please refer to the chart on page M38.

WSRP-WSRPF Inserts

RPGN



| Inserts | Part Number ANSI | Steel | | | Stainless Steel | | | Cast Iron | | | Heat-Resistant Super Alloys | | | | | Hardened Steel | | | Part Number ISO | Dimensions (inches) | | |
|---|---------------------|--------|-------|--------|-----------------|--------|---------|-----------|-------|---------|-----------------------------|-------|--------|---------|---------|----------------|---------|---------|--------------------|---------------------|-------|-----------|
| | | P | | | M | | | K | | | S | | | | | H | | | | A | T | |
| | | GA5036 | G-915 | G-9120 | G-915 | G-9230 | WG-600° | G-9230 | G-915 | GSN100™ | XSYTIN®-1 | G-915 | G-9230 | WG-600° | WG-300° | XSYTIN®-1 | WG-300° | WG-600° | | | | XSYTIN®-1 |
|  | RPGN-21.5 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | RPGN-060200 | 0.250 | 0.094 |
| | RPGN-2.52 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | RPGN-070300 | 0.312 | 0.125 |
| | RPGN-32 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | RPGN-090300 | 0.375 | 0.125 |
| | RPGN-43 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | RPGN-120400 | 0.500 | 0.187 |

CARBIDE COATINGS: **MT-CVD Coated** **PVD Coated** **Uncoated**

First Choice ◆ Second Choice ● Alternative ▲

Grade descriptions — pages M 36–37

CERAMIC CLASSIFICATION: **Whisker Ceramic** **Phase-Toughened** **Silicon Nitride** **Alumina TiC**

NOTE: For additional nose radii and available edge preps, please contact the Greenleaf Tech Team.

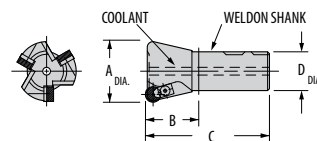
Maximum RPM

| Cutter Part Number | Max RPM Carbide | Max RPM Ceramic |
|--------------------|-----------------|-----------------|
| WSRP-60000.6 | 15,000 | 40,000 |
| WSRP-60000.7 | 12,500 | 35,000 |
| WSRP-60001A | 9,500 | 26,000 |
| WSRP-60001 | 9,500 | 26,000 |
| WSRP-60001.2 | 7,500 | 21,000 |
| WSRP-60001.5 | 6,200 | 19,500 |
| WSRP-60002 | 4,600 | 13,000 |
| WSRP-60002.5 | 3,800 | 10,000 |
| WSRPF-60000.7 | 12,500 | 35,000 |
| WSRPF-60001A | 9,500 | 26,000 |
| WSRPF-60001 | 9,500 | 26,000 |
| WSRPF-60001.2 | 7,500 | 21,000 |
| WSRPF-60001.5 | 6,200 | 19,500 |
| WSRPF-60002 | 4,600 | 13,000 |
| WSRPF-60002.5 | 3,800 | 10,000 |

MILLING

WSRN-WSRNF

Round Negative End Mill



Right-Hand Cutter Shown

| Part Number | | Gage Inserts | Dimensions (inches) | | | | No. of Inserts | Standard Components | | | | *Tune-Up Kit |
|------------------|------------------|--------------|---------------------|-------|-------|-------|----------------|---------------------|----------------|--------|-------------------|--------------|
| Right Hand | Left Hand** | | A | B | C | D | | Anvil | Anvil Screw | Clamp | Clamp Screw | |
| WSRN-60001-RH | | RNGN-32 | 1.000 | 1.250 | 3.280 | 0.750 | 2 | — | — | 425716 | SE02-01 | TK-00853 |
| | WSRN-60001-LH | RNGN-32 | 1.000 | 1.250 | 3.280 | 0.750 | 2 | — | — | 425716 | SE02-01 | TK-00853 |
| WSRN-60001.2-RH | | RNGN-32 | 1.250 | 1.250 | 3.530 | 1.000 | 3 | — | — | 425716 | SE02-01 | TK-00852 |
| | WSRN-60001.2-LH | RNGN-32 | 1.250 | 1.250 | 3.530 | 1.000 | 3 | — | — | 425716 | SE02-01 | TK-00852 |
| WSRN-60001.5-RH | | RNGN-43 | 1.500 | 1.720 | 4.000 | 1.250 | 3 | — | — | 3025-1 | 438919 | TK-00645 |
| | WSRN-60001.5-LH | RNGN-43 | 1.500 | 1.720 | 4.000 | 1.250 | 3 | — | — | 3025-1 | 438919 | TK-00645 |
| WSRN-60002-RH | | RNGN-43 | 2.000 | 1.720 | 4.000 | 1.250 | 3 | 313572 | #4-40x1/4 FHCS | 3025-1 | #10-32 x 1/2 SHCS | TK-02703 |
| | WSRN-60002-LH | RNGN-43 | 2.000 | 1.720 | 4.000 | 1.250 | 3 | 313572 | #4-40x1/4 FHCS | 3025-1 | #10-32 x 1/2 SHCS | TK-02703 |
| WSRN-60002.5-RH | | RNGN-43 | 2.500 | 1.750 | 4.000 | 1.250 | 4 | 313572 | #4-40x1/4 FHCS | 3025-1 | #10-32 x 1/2 SHCS | TK-02695 |
| | WSRN-60002.5-LH | RNGN-43 | 2.500 | 1.750 | 4.000 | 1.250 | 4 | 313572 | #4-40x1/4 FHCS | 3025-1 | #10-32 x 1/2 SHCS | TK-02695 |
| WSRNF-600001-RH | | RNGN-32 | 1.000 | 1.250 | 3.280 | 0.750 | 3 | — | — | 425716 | SE02-01 | TK-00853 |
| | WSRNF-600001-LH | RNGN-32 | 1.000 | 1.250 | 3.280 | 0.750 | 3 | — | — | 425716 | SE02-01 | TK-00853 |
| WSRNF-60001.2-RH | | RNGN-32 | 1.250 | 1.250 | 3.530 | 1.000 | 4 | — | — | 425716 | SE02-01 | TK-00853 |
| | WSRNF-60001.2-LH | RNGN-32 | 1.250 | 1.250 | 3.530 | 1.000 | 4 | — | — | 425716 | SE02-01 | TK-00853 |
| WSRNF-60001.5-RH | | RNGN-43 | 1.500 | 1.720 | 4.000 | 1.250 | 4 | — | — | 3025-1 | 438919 | TK-00645 |
| | WSRNF-60001.5-LH | RNGN-43 | 1.500 | 1.720 | 4.000 | 1.250 | 4 | — | — | 3025-1 | 438919 | TK-00645 |
| WSRNF-60002-RH | | RNGN-43 | 2.000 | 1.720 | 4.000 | 1.250 | 4 | 313572 | #4-40x1/4 FHCS | 3025-1 | #10-32 x 1/2 SHCS | TK-02703 |
| | WSRNF-60002-LH | RNGN-43 | 2.000 | 1.720 | 4.000 | 1.250 | 4 | 313572 | #4-40x1/4 FHCS | 3025-1 | #10-32 x 1/2 SHCS | TK-02703 |
| WSRNF-60002.5-RH | | RNGN-43 | 2.500 | 1.750 | 4.000 | 1.250 | 6 | 313572 | #4-40x1/4 FHCS | 3025-1 | #10-32 x 1/2 SHCS | TK-02703 |
| | WSRNF-60002.5-LH | RNGN-43 | 2.500 | 1.750 | 4.000 | 1.250 | 6 | 313572 | #4-40x1/4 FHCS | 3025-1 | #10-32 x 1/2 SHCS | TK-02703 |

* Tune-Up Kits include all standard components and necessary wrenches to allow you to completely refurbish cutter.

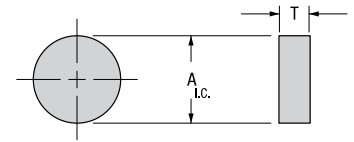
** Left-Hand cutters are made to order only.


NOTE: For information on screw torque settings, please refer to the chart on page M38.

NOTE: For Insert RNGN-42, use anvil 313596. For insert RNGN-45, use no anvil.

WSRN-WSRNF Inserts

RNGN



| Inserts | Part Number ANSI | Steel | | | Stainless Steel | | | Cast Iron | | | Heat-Resistant Super Alloys | | | | Hardened Steel | | | Part Number ISO | Dimensions (inches) | | | |
|---|---------------------|--------|-------|--------|-----------------|--------|---------|-----------|-------|---------|-----------------------------|-------|--------|---------|----------------|----------|---------|--------------------|---------------------|-------------|---------|----------|
| | | P | | | M | | | K | | | S | | | | H | | | | A | T | | |
| | | GA5036 | G-915 | G-9120 | G-915 | G-9230 | WG-600° | G-9230 | G-915 | GSN100™ | XYTIN®-1 | G-915 | G-9230 | WG-600° | WG-300° | XYTIN®-1 | WG-300° | | | | WG-600° | XYTIN®-1 |
|  | RNGN-32 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | RNGN-090300 | 0.375 | 0.125 |
| | RNGN-42 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | RNGN-120300 | 0.500 | 0.125 |
| | RNGN-43 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | RNGN-120400 | 0.500 | 0.187 |
| | RNGN-45 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | RNGN-120700 | 0.500 | 0.313 |

CARBIDE COATINGS: IMT-CVD Coated PVD Coated Uncoated

First Choice ◆ Second Choice ● Alternative ▲

Grade descriptions — pages M 36–37

CERAMIC CLASSIFICATION: Whisker Ceramic Phase-Toughened Silicon Nitride Alumina TiC

NOTE: For additional nose radii and available edge preps, please contact Greenleaf Tech Team.

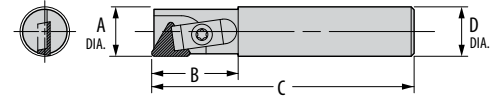
Maximum RPM

| Cutter Part Number | Max RPM Carbide | Max RPM Ceramic |
|--------------------|-----------------|-----------------|
| WSRN-60001 | 9,500 | 26,000 |
| WSRN-60001.2 | 7,500 | 21,000 |
| WSRN-60001.5 | 6,200 | 19,500 |
| WSRN-60002 | 4,600 | 13,000 |
| WSRN-60002.5 | 3,800 | 10,000 |
| WSRNF-60001 | 9,500 | 26,000 |
| WSRNF-60001.2 | 7,500 | 21,000 |
| WSRNF-60001.5 | 6,200 | 19,500 |
| WSRNF-60002 | 4,600 | 13,000 |
| WSRNF-60002.5 | 3,800 | 10,000 |

MILLING

WSTP

Triangle Positive End Mill



Right-Hand Cutter Shown

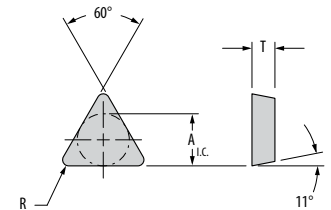
| Part Number | | Gage Inserts | Dimensions (inches) | | | | No. of Inserts | Standard Components | | *Tune-Up Kit |
|---------------|---------------|--------------|---------------------|-------|------|-------|----------------|---------------------|-------------|--------------|
| Right Hand | Left Hand | | A | B | C | D | | Clamp | Clamp Screw | |
| WSTP-70.50-RH | | TPGN-222 | 0.500 | 0.875 | 2.66 | 0.500 | 1 | 429871 | PT-317T | TK-00897 |
| | WSTP-70.50-LH | TPGN-222 | 0.500 | 0.875 | 2.66 | 0.500 | 1 | 429871 | PT-317T | TK-00897 |
| WSTP-70.56-RH | | TPGN-222 | 0.562 | 1.000 | 2.78 | 0.500 | 1 | 429871 | PT-317T | TK-00897 |
| | WSTP-70.56-LH | TPGN-222 | 0.562 | 1.000 | 2.78 | 0.500 | 1 | 429871 | PT-317T | TK-00897 |
| WSTP-70.62-RH | | TPGN-222 | 0.625 | 1.000 | 2.91 | 0.625 | 1 | 429871 | PT-317T | TK-00897 |
| | WSTP-70.62-LH | TPGN-222 | 0.625 | 1.000 | 2.91 | 0.625 | 1 | 429871 | PT-317T | TK-00897 |


* Tune-Up Kits include all standard components and necessary wrenches to allow you to completely refurbish cutter.

NOTE: For information on screw torque settings, please refer to the chart on page M38.

WSTP Inserts

TPGN



| Inserts | Part Number ANSI | Steel | | | Stainless Steel | | | Cast Iron | | | Heat-Resistant Super Alloys | | | | | Hardened Steel | | | Part Number ISO | Dimensions (inches) | | | |
|---|---------------------|--------|-------|--------|-----------------|--------|---------|-----------|-------|---------|-----------------------------|-------|--------|---------|---------|----------------|---------|---------|--------------------|---------------------|-------|-------|----------|
| | | P | | | M | | | K | | | S | | | | | H | | | | A | T | R | |
| | | GA5036 | G-915 | G-9120 | G-915 | G-9230 | WG-600® | GA5023 | G-915 | GSN100™ | XYTIN®-1 | G-915 | G-9230 | WG-600® | WG-300® | XYTIN®-1 | WG-300® | WG-600® | | | | | XYTIN®-1 |
|  | TPGN-222 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | TPGN-110308 | 0.250 | 0.125 | 0.031 |
| | | | | | | | | | | | | | | | | | | | | | | | |

CARBIDE COATINGS: MI-CVD Coated PVD Coated Uncoated

First Choice ◆ Second Choice ● Alternative ▲

Grade descriptions — pages M36–37

CERAMIC CLASSIFICATION: Whisker Ceramic Phase-Toughened Silicon Nitride Alumina TiC

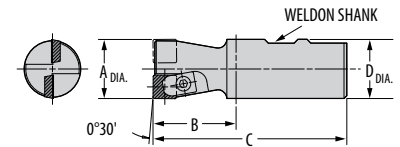
NOTE: For additional nose radii and available edge preps, please contact Greenleaf Tech Team.

Maximum RPM

| Cutter Part Number | Max RPM Carbide | Max RPM Ceramic |
|--------------------|-----------------|-----------------|
| WSTP-70.50 | 19,000 | 35,000 |
| WSTP-70.56 | 17,000 | 35,000 |
| WSTP-70.62 | 15,000 | 35,000 |

WSSP

Square Positive End Mill



Right-Hand Cutter Shown

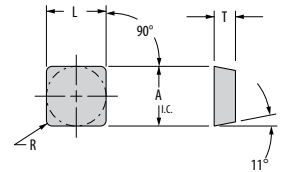
| Part Number | | Gage Inserts | Dimensions (inches) | | | | No. of Inserts | Standard Components | | *Tune-Up Kit |
|-----------------|-----------------|--------------|---------------------|-------|-------|-------|----------------|---------------------|----------------|--------------|
| Right Hand | Left Hand | | A | B | C | D | | Clamp | Screw | |
| WSSP-70000.3-RH | | SPGN-21.52 | 0.375 | 0.750 | 2.310 | 0.375 | 1 | 429871 | PT-317T | TK-00897 |
| | WSSP-70000.3-LH | SPGN-21.52 | 0.375 | 0.750 | 2.310 | 0.375 | 1 | 429871 | PT-317T | TK-00897 |
| WSSP-70000.5-RH | | SPGN-21.52 | 0.500 | 0.875 | 2.660 | 0.500 | 1 | 429871 | PT-317T | TK-00897 |
| | WSSP-70000.5-LH | SPGN-21.52 | 0.500 | 0.875 | 2.660 | 0.500 | 1 | 429871 | PT-317T | TK-00897 |
| WSSP-70000.6-RH | | SPGN-222 | 0.625 | 1.000 | 2.910 | 0.625 | 2 | 423978 | #3-48x3/16SHCS | TK-00850 |
| | WSSP-70000.6-LH | SPGN-222 | 0.625 | 1.000 | 2.910 | 0.625 | 2 | 423978 | #3-48x3/16SHCS | TK-00850 |
| WSSP-70000.7-RH | | SPGN-222 | 0.75 | 1.000 | 3.030 | 0.750 | 2 | 423978 | #3-48x1/4SHCS | TK-00879 |
| | WSSP-70000.7-LH | SPGN-222 | 0.75 | 1.000 | 3.030 | 0.750 | 2 | 423978 | #3-48x1/4SHCS | TK-00879 |
| WSSP-70001-RH | | SPGN-322 | 1.000 | 1.250 | 3.280 | 0.750 | 2 | 429706 | SE02-01 | TK-00854 |
| | WSSP-70001-LH | SPGN-322 | 1.000 | 1.250 | 3.280 | 0.750 | 2 | 429706 | SE02-01 | TK-00854 |
| WSSP-70001.2-RH | | SPGN-322 | 1.250 | 1.750 | 4.030 | 1.000 | 3 | 429706 | SE02-01 | TK-00855 |
| | WSSP-70001.2-LH | SPGN-322 | 1.250 | 1.750 | 4.030 | 1.000 | 3 | 429706 | SE02-01 | TK-00855 |
| WSSP-70001.5-RH | | SPGN-432 | 1.500 | 1.750 | 4.030 | 1.250 | 3 | 3127-C | #10-32x1/2SHCS | TK-00856 |
| | WSSP-70001.5-LH | SPGN-432 | 1.500 | 1.750 | 4.030 | 1.250 | 3 | 3127-C | #10-32x1/2SHCS | TK-00856 |


* Tune-Up Kits include all standard components and necessary wrenches to allow you to completely refurbish cutter.

NOTE: For information on screw torque settings, please refer to the chart on page M38.

WSSP Inserts

SPGN



| Inserts | Part Number ANSI | Steel | | | Stainless Steel | | | Cast Iron | | | Heat-Resistant Super Alloys | | | | Hardened Steel | | | Part Number ISO | Dimensions (inches) | | | | |
|---|---------------------|--------|-------|--------|-----------------|--------|---------|-----------|-------|---------|-----------------------------|-------|--------|---------|----------------|-----------|---------|--------------------|---------------------|-------|-------|-------|---------|
| | | P | | | M | | | K | | | S | | | | H | | | | A | L | T | R | |
| | | GA5036 | G-915 | G-9120 | G-915 | G-9230 | WG-600® | GA5023 | G-915 | GSN100™ | X5VTIN®-1 | G-915 | G-9230 | WG-600® | WG-300® | X5VTIN®-1 | WG-300® | | | | | | WG-600® |
|  | SPGN-21.52 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ◆ | ◆ | ◆ | ▲ | SPGN-060208 | 0.250 | 0.250 | 0.093 | 0.031 |
| | SPGN-222 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ◆ | ◆ | ◆ | ▲ | SPGN-060308 | 0.250 | 0.250 | 0.125 | 0.031 |
| | SPGN-322 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ◆ | ◆ | ◆ | ▲ | SPGN-090308 | 0.375 | 0.375 | 0.125 | 0.031 |
| | SPGN-432 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ▲ | SPGN-120408 | 0.500 | 0.500 | 0.187 | 0.031 |
| | SPGN-433 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ▲ | SPGN-120412 | 0.500 | 0.500 | 0.187 | 0.047 |

CARBIDE COATINGS: MT-CVD Coated PVD Coated Uncoated

First Choice ◆ Second Choice ● Alternative ▲

Grade descriptions — pages M36–37

CERAMIC CLASSIFICATION: Whisker Ceramic Phase-Toughened Silicon Nitride Alumina TiC

NOTE: For additional nose radii and available edge preps, please contact Greenleaf Tech Team.

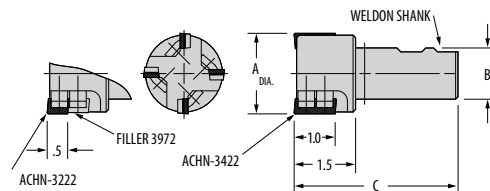
Maximum RPM

| Cutter Part Number | Max RPM Carbide | Max RPM Ceramic |
|--------------------|-----------------|-----------------|
| WSSP-70000.3 | 25,000 | 40,000 |
| WSSP-70000.5 | 19,000 | 40,000 |
| WSSP-70000.6 | 15,000 | 40,000 |
| WSSP-70000.7 | 12,500 | 35,000 |
| WSSP-70001 | 9,500 | 26,000 |
| WSSP-70001.2 | 7,500 | 21,000 |
| WSSP-70001.5 | 6,200 | 16,500 |

NOTE: For information on screw torque settings, please refer to the chart on page M38.

WSAN

Parallelogram Positive End Mill



Right-Hand Cutter Shown

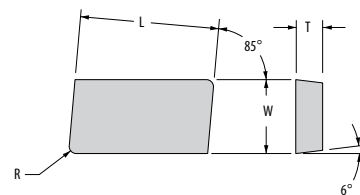
| Part Number | | Gage Inserts | Dimensions (inches) | | | No. of Inserts | Standard Components | | | | *Tune-Up Kit | Optional Components | |
|---------------|---------------|--------------|---------------------|-------|-------|----------------|---------------------|----------------|--------|-------------------|--------------|-------------------------|--------|
| Right Hand | Left Hand | | A | B | C | | Anvil | Anvil Screw | Clamp | Clamp Screw | | Max. 1/2" D.O.C. Insert | Filler |
| WSAN-1-RH | | ACHN-3422 | 0.985 | 0.750 | 3.750 | 2 | — | #4-40x1/4 FHCS | 410756 | #8-32x9/32 IPBHCS | TK-00642 | ACHN-3222 | 3972 |
| | WSAN-1-LH | ACHN-3422-LH | 0.985 | 0.750 | 3.750 | 2 | — | #4-40x1/4 FHCS | 410756 | #8-32x9/32 IPBHCS | TK-00642 | ACHN-3222-LH | 3972 |
| WSAN-1A-RH | | ACHN-3422 | 0.985 | 1.000 | 4.000 | 2 | — | #4-40x1/4 FHCS | 410756 | #8-32x9/32 IPBHCS | TK-00642 | ACHN-3222 | 3972 |
| | WSAN-1A-LH | ACHN-3422-LH | 0.985 | 1.000 | 4.000 | 2 | — | #4-40x1/4 FHCS | 410756 | #8-32x9/32 IPBHCS | TK-00642 | ACHN-3222-LH | 3972 |
| WSAN-1 1/4-RH | | ACHN-3422 | 1.215 | 1.000 | 4.000 | 2 | — | #4-40x1/4 FHCS | 410756 | #8-32x9/32 IPBHCS | TK-00642 | ACHN-3222 | 3972 |
| | WSAN-1 1/4-LH | ACHN-3422-LH | 1.215 | 1.000 | 4.000 | 2 | — | #4-40x1/4 FHCS | 410756 | #8-32x9/32 IPBHCS | TK-00642 | ACHN-3222-LH | 3972 |
| WSAN-1 1/2-RH | | ACHN-3422 | 1.465 | 1.000 | 4.000 | 3 | AAP-3224 | #4-40x1/4 FHCS | 410756 | #8-32x9/32 IPBHCS | TK-00643 | ACHN-3222 | 3972 |
| | WSAN-1 1/2-LH | ACHN-3422-LH | 1.465 | 1.000 | 4.000 | 3 | AAP-3224-LH | #4-40x1/4 FHCS | 410756 | #8-32x9/32 IPBHCS | TK-00713 | ACHN-3222-LH | 3972 |
| WSAN-2-RH | | ACHN-3422 | 1.965 | 1.250 | 4.000 | 4 | AAP-3224 | #4-40x1/4 FHCS | 410756 | #8-32x3/8 IPBHCS | TK-00644 | ACHN-3222 | 3972 |
| | WSAN-2-LH | ACHN-3422-LH | 1.965 | 1.250 | 4.000 | 4 | AAP-3224-LH | #4-40x1/4 FHCS | 410756 | #8-32x3/8 IPBHCS | TK-00821 | ACHN-3222-LH | 3972 |
| WSAN-2 1/2-RH | | ACHN-3422 | 2.465 | 1.250 | 4.000 | 4 | AAP-3224 | #4-40x1/4 FHCS | 410756 | #8-32x3/8 IPBHCS | TK-00644 | ACHN-3222 | 3972 |
| | WSAN-2 1/2-LH | ACHN-3422-LH | 2.465 | 1.250 | 4.000 | 4 | AAP-3224-LH | #4-40x1/4 FHCS | 410756 | #8-32x3/8 IPBHCS | TK-00821 | ACHN-3222-LH | 3972 |


* Tune-Up Kits include all standard components and necessary wrenches to allow you to completely refurbish cutter.

NOTE: For information on screw torque settings, please refer to the chart on page M38.

WSAN Inserts

ACHN



| Inserts | Part Number ANSI | Steel | | | Stainless Steel | | | Cast Iron | | | Heat-Resistant Super Alloys | | | | | Hardened Steel | | | Part Number ISO | Dimensions (inches) | | | | |
|---|---------------------|--------|-------|--------|-----------------|--------|---------|-----------|-------|---------|-----------------------------|-------|--------|---------|---------|----------------|---------|---------|--------------------|---------------------|-------|-------|-------|-----------|
| | | P | | | M | | | K | | | S | | | | | H | | | | T | W | L | R | |
| | | GA5036 | G-915 | G-9120 | G-915 | G-9230 | WG-600® | GA5023 | G-915 | GSN100™ | XSVTIN®-1 | G-915 | G-9230 | WG-600® | WG-300® | XSVTIN®-1 | WG-300® | WG-600® | | | | | | XSVTIN®-1 |
|  | ACHN-3422 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | ACHN-250308 | 0.125 | 0.375 | 1.000 | 0.031 |
| | ACHN-3222 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | ACHN-120308 | 0.125 | 0.375 | 0.500 | 0.031 |
| | ACHN-3422LH | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | ACHN-250308LH | 0.125 | 0.375 | 1.000 | 0.031 |
| | ACHN-3222LH | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ● | ▲ | ◆ | ● | ◆ | ▲ | ACHN-120308LH | 0.125 | 0.375 | 0.500 | 0.031 |

CARBIDE COATINGS: MF-CVD Coated PVD Coated Uncoated

First Choice ◆ Second Choice ● Alternative ▲

Grade descriptions — pages M36–37

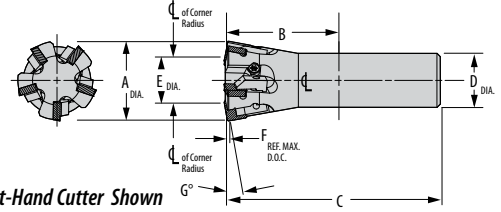
CERAMIC CLASSIFICATION: Whisker Ceramic Phase-Toughened Silicon Nitride Alumina TiC

NOTE: For additional nose radii and available edge preps, please contact Greenleaf Tech Team.

Excelerator® XF

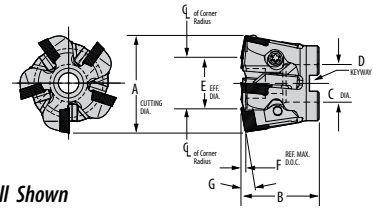
Positive High-Feed Mills

1" and 1-1/2" High-Feed End Mill / Square Positive Inserts



| Cutter Order Number | Insert | Dimensions (inches) | | | | | | | No. of Inserts | Standard Components | | *Tune-Up Kit | Max RPM Carbide | Max RPM Ceramic |
|---------------------|----------|---------------------|-------|-------|-------|-------|-------|-----|----------------|---------------------|-------------|--------------|-----------------|-----------------|
| | | A | B | C | D | E | F | G | | Clamp | Clamp Screw | | | |
| XFSP-010-EM | SPGN-222 | 1.000 | 1.250 | 3.280 | 0.750 | 0.568 | 0.031 | 10° | 4 | 431402 | PT-542T | TK-01868 | 9,500 | 26,000 |
| XFSP-015-EM | SPGN-322 | 1.500 | 1.720 | 4.000 | 1.000 | 0.822 | 0.052 | 10° | 5 | 313256 | SE02-01 | TK-01905 | 6,200 | 16,500 |

* Tune-Up Kits include all standard components and necessary wrenches to allow you to completely refurbish cutter.
NOTE: For information on screw torque settings, please refer to the chart on page M38.



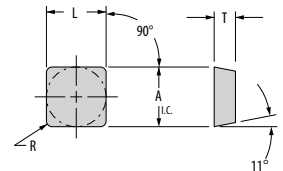
2" High-Feed Face Mill / Square Positive Inserts


| Cutter Order Number | Insert | Dimensions (inches) | | | | | | | No. of Inserts | Standard Components | | *Tune-Up Kit | Max RPM Carbide | Max RPM Ceramic |
|---------------------|----------|---------------------|-------|-------|-------|-------|-------|-----|----------------|---------------------|-------------|--------------|-----------------|-----------------|
| | | A | B | C | D | E | F | G | | Clamp | Clamp Screw | | | |
| XFSP-020-FM | SPGN-432 | 2.000 | 1.560 | 0.750 | 0.313 | 1.056 | 0.076 | 10° | 5 | 431628 | SE03-72 | TK-02167 | 4,600 | 13,300 |

* Tune-Up Kits include all standard components and necessary wrenches to allow you to completely refurbish cutter.
NOTE: For information on screw torque settings, please refer to the chart on page M38.

Excelerator XF Inserts

SPGN



| Inserts | Part Number ANSI | Steel | | | Stainless Steel | | | Cast Iron | | | Heat-Resistant Super Alloys | | | Hardened Steel | | | Part Number ISO | Dimensions (inches) | | | | |
|---|---------------------|--------|-------|--------|-----------------|--------|---------|-----------|-------|---------|--------------------------------|-------|--------|----------------|---------|-----------|--------------------|---------------------|-------|-------|-------|---------|
| | | P | | | M | | | K | | | S | | | H | | | | A | L | T | R | |
| | | GA5036 | G-915 | G-9120 | G-915 | G-9230 | WG-600° | GA5023 | G-915 | GSN100™ | XYSTIN®-1 | G-915 | G-9230 | WG-600° | WG-300° | XYSTIN®-1 | | | | | | WG-300° |
|  | SPGN-222 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ◆ | ● | ◆ | ▲ | SPGN-060308 | 0.250 | 0.250 | 0.125 | 0.031 |
| | SPGN-322 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ◆ | ● | ◆ | ▲ | SPGN-090308 | 0.375 | 0.375 | 0.125 | 0.031 |
| | SPGN-432 | ◆ | ▲ | ● | ▲ | ◆ | ◆ | ◆ | ▲ | ◆ | ▲ | ◆ | ▲ | ◆ | ● | ◆ | ▲ | SPGN-120408 | 0.500 | 0.500 | 0.187 | 0.031 |

CARBIDE COATINGS: MI-CVD Coated PVD Coated Uncoated

First Choice ◆ Second Choice ● Alternative ▲

Grade descriptions — pages M36–37

CERAMIC CLASSIFICATION: Whisker Ceramic Phase-Toughened Silicon Nitride Alumina TiC

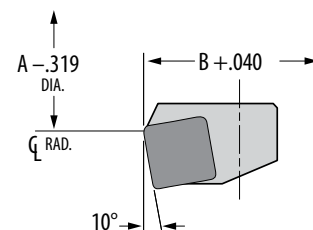
NOTE: For additional nose radii and available edge preps, please contact Greenleaf Tech Team.

XFNPS

Nest for CP4 Series

| Nest Part Number | | Gage Inserts |
|------------------|------------|--------------|
| Right Hand | Left Hand | |
| XFNPS8043R | — | |
| — | XFNPS8043L | SPGN-433 |
| | | SPGN-433 |

NOTE: For information on CP4-series nests, please refer to the chart on page M14.



Performance Calculations

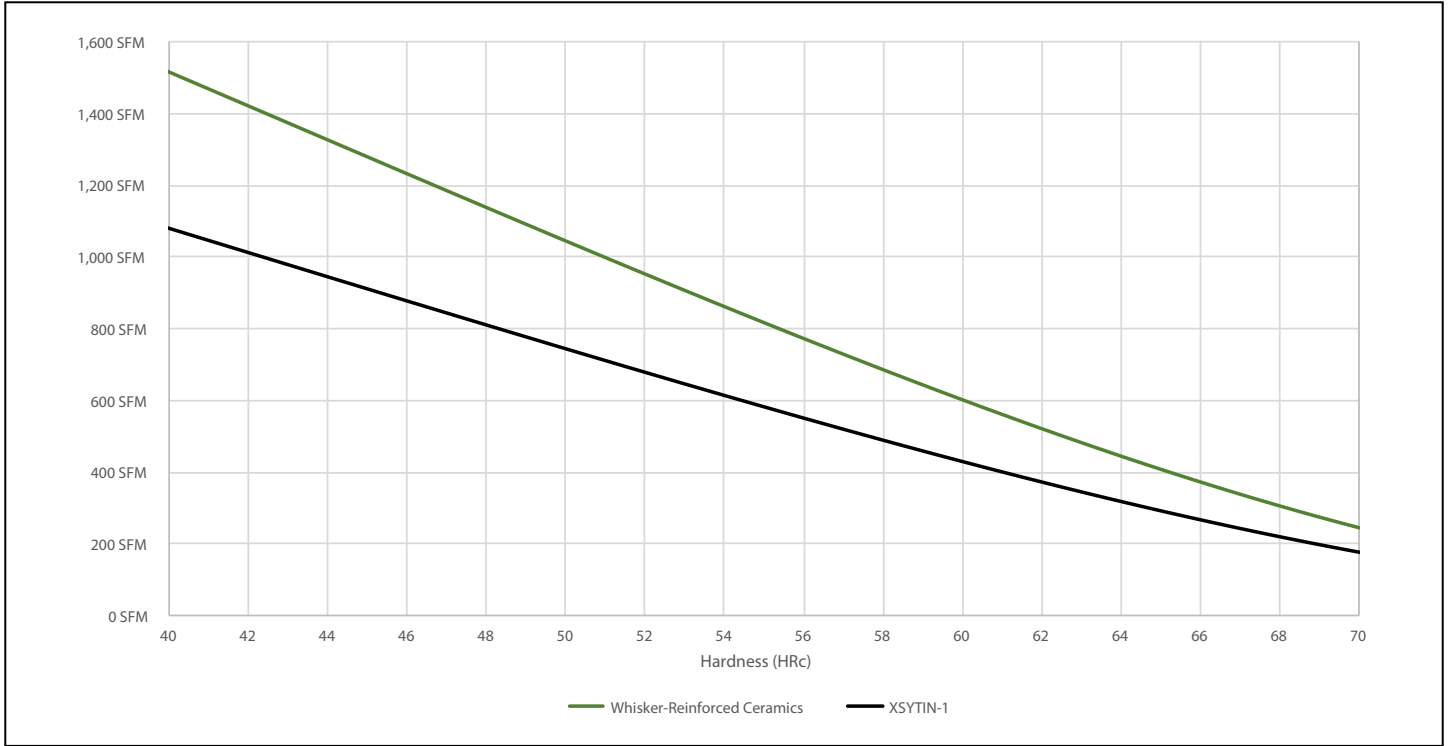
Starting Speeds and Feeds for Excelerator XF®

| Material | Hardness | Insert Grades | Cutting Speed (SFM) | Target Chip Thickness (inches) | Recommended Feed per Tooth (IPT) Width of Cut (%) of Effective Diameter | | |
|----------|-----------|---------------|---------------------|--------------------------------|--|--------|--------|
| | | | | | 15% | 30% | 45%+ |
| Steel | 60-65 HRC | WG-600® | 500 | 0.0015 | 0.0121 | 0.0094 | 0.0087 |
| | 50-59 HRC | WG-600® | 800 | 0.002 | 0.0162 | 0.0126 | 0.0116 |
| | 40-49 HRC | WG-600® | 1300 | 0.0027 | 0.0218 | 0.017 | 0.0156 |
| | 40-49 HRC | GA5036 | 405 | 0.0017 | 0.0137 | 0.0107 | 0.0098 |
| | 30-39 HRC | GA5036 | 600 | 0.003 | 0.0242 | 0.0189 | 0.0174 |
| | ≤ 30 HRC | GA5036 | 800 | 0.0041 | 0.033 | 0.026 | 0.024 |

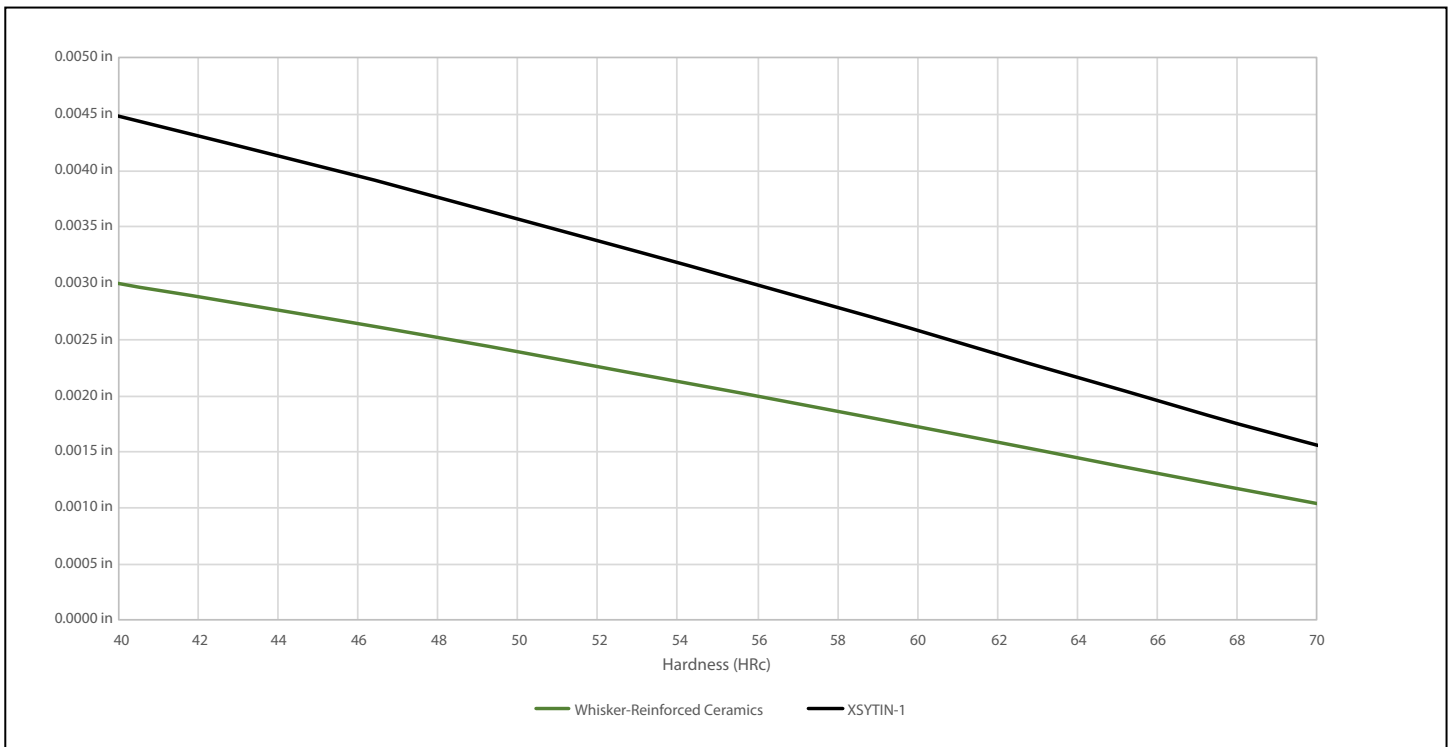
DOC vs. Effective Diameter for Excelerator® XF

| Depth of Cut | XFSP-010-EM | XFSP-015-EM | XFSP-020-EM | CP4 Series Face Mills: XFNP58043 Nest | | | | | | |
|-----------------|-------------|-------------|-------------|---------------------------------------|--------|--------|--------|--------|---------|---------|
| | 1" | 1.5" | 2" | 3" | 4" | 5" | 6" | 8" | 10" | 12" |
| 0.01 | 0.6875 | 0.9413 | 1.1832 | 2.8031 | 3.8031 | 4.8031 | 5.8031 | 7.8031 | 9.8031 | 11.8031 |
| 0.02 | 0.8014 | 1.0552 | 1.2954 | 2.9170 | 3.9170 | 4.9170 | 5.9170 | 7.9170 | 9.9170 | 11.9170 |
| 0.03 | 0.9152 | 1.1690 | 1.4076 | 3.0308 | 4.0308 | 5.0308 | 6.0308 | 8.0308 | 10.0308 | 12.0308 |
| 0.04 | X | 1.2829 | 1.5498 | 3.1447 | 4.1447 | 5.1447 | 6.1447 | 8.1447 | 10.1447 | 12.1447 |
| 0.05 | X | 1.3968 | 1.6320 | 3.2586 | 4.2586 | 5.2586 | 6.2586 | 8.2586 | 10.2586 | 12.2586 |
| 0.06 | X | 1.4742 | 1.7441 | 3.3724 | 4.3724 | 5.3724 | 6.3724 | 8.3724 | 10.3724 | 12.3724 |
| 0.07 | X | X | 1.8563 | 3.4863 | 4.4863 | 5.4863 | 6.4863 | 8.4863 | 10.4863 | 12.4863 |
| 0.08 | X | X | 1.9459 | 3.5385 | 4.5385 | 5.5385 | 6.5385 | 8.5385 | 10.5385 | 12.5385 |
| DIA OVER INSERT | 1 | 1.5 | 1.9755 | 3.575 | 4.575 | 5.575 | 6.575 | 8.575 | 10.575 | 12.575 |

Milling Hardened Steel, Cutting Speed (V_c)



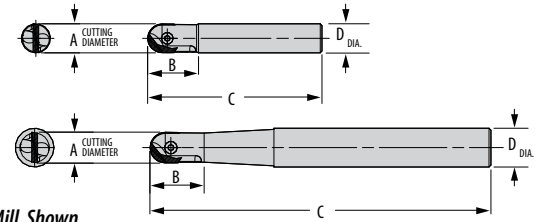
Milling Hardened Steel, Average Chip Thickness (H_m)



Ball Nose

End Mill

U.S. Patent No. 8,177,459 B2



Right-Hand End Mill Shown

| Part Number | | Gage Insert | Dimensions (inches) | | | | Standard Components | *Tune-Up Kit Includes All Standard Components | Max RPM Carbide | Max RPM Ceramic |
|--------------|-----------------|-------------|---------------------|-------|-----|-------|---------------------|---|-----------------|-----------------|
| Short Series | Extended Series | | A | B | C | D | | | | |
| SSBN-0375X | — | GBN-0375 | 0.375 | 0.75 | 4 | 0.625 | SM30-083 | TK-03466 | 40,000 | 40,000 |
| — | SSBN-0375EX | GBN-0375 | 0.375 | 0.75 | 6 | 0.75 | SM30-083 | TK-03466 | 40,000 | 40,000 |
| SSBN-0500X | — | GBN-0500 | 0.5 | 1.25 | 4 | 0.625 | SM40-106 | TK-03461 | 40,000 | 40,000 |
| — | SSBN-0500EX | GBN-0500 | 0.5 | 1.25 | 7.5 | 0.75 | SM40-106 | TK-03461 | 40,000 | 40,000 |
| SSBN-0625X | — | GBN-0625 | 0.625 | 1.375 | 5 | 0.625 | SM50-139 | TK-03175 | 40,000 | 40,000 |
| — | SSBN-0625EX | GBN-0625 | 0.625 | 1.375 | 7.5 | 0.75 | SM50-139 | TK-03175 | 40,000 | 40,000 |
| SSBN-0750X | — | GBN-0750 | 0.75 | 1.75 | 5.5 | 0.75 | SM60-167 | TK-04138 | 40,000 | 40,000 |
| — | SSBN-0750EX | GBN-0750 | 0.75 | 1.75 | 10 | 1 | SM60-167 | TK-04138 | 40,000 | 40,000 |
| SSBN-1000X | — | GBN-1000 | 1 | 1.75 | 6 | 1 | SM70-210 | TK-04142 | 40,000 | 40,000 |
| — | SSBN-1000EX | GBN-1000 | 1 | 1.75 | 11 | 1.25 | SM70-210 | TK-04142 | 40,000 | 40,000 |

NOTE: Add L to part number for left-hand cutter.

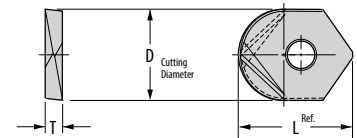
NOTE: For information on screw torque settings, please refer to the chart on page M38.


* Tune-Up Kits include all standard components and necessary wrenches to allow you to completely refurbish cutter.

Ball Nose Inserts

GBN

U.S. Patent No. 8,177,459 B2



| Inserts | Part Number ANSI | Steel | S Steel | Cast Iron | | Heat-Resistant Super Alloys | | | Hardened Steel | | Dimensions (inches) | | | |
|---|---------------------|-------|---------|-----------|---------|-----------------------------|-------|---------|----------------|-------|---------------------|-----------|-------|-------|
| | | P | M | K | | S | | | H | | | | | |
| | | G-925 | G-925 | G-925 | WC-600® | XYSTIN®-1 | G-925 | WC-600® | XYSTIN®-1 | G-925 | WC-600® | XYSTIN®-1 | L | T |
|  | GBN-0375 | ◆ | ◆ | ◆ | ▲ | ◆ | ◆ | ▲ | ◆ | ◆ | ▲ | 0.500 | 0.125 | 0.375 |
| | GBN-0500 | ◆ | ◆ | ◆ | ▲ | ◆ | ◆ | ▲ | ◆ | ◆ | ▲ | 0.670 | 0.188 | 0.500 |
| | GBN-0625 | ◆ | ◆ | ◆ | ▲ | ◆ | ◆ | ▲ | ◆ | ◆ | ▲ | 0.800 | 0.188 | 0.625 |
| | GBN-0750 | ◆ | ◆ | ◆ | ▲ | ◆ | ◆ | ▲ | ◆ | ◆ | ▲ | 0.900 | 0.188 | 0.750 |
| | GBN-1000 | ◆ | ◆ | ◆ | ▲ | ◆ | ◆ | ▲ | ◆ | ◆ | ▲ | 1.230 | 0.188 | 1.000 |

CARBIDE COATINGS: MI-CVD Coated PVD Coated Uncoated

First Choice ◆ Second Choice ● Alternative ▲

Grade descriptions — pages M36–37

CERAMIC CLASSIFICATION: Whisker Ceramic Phase-Toughened Silicon Nitride Alumina TiC

Performance Calculations

Starting Speeds and Feeds for Ball Nose

| Work Material | Hardness (HRC) | Insert Grades | Cutting Speed (SFM) | Target Chip Thickness (in.) | Recommended Feed per Tooth (IPT) Depth of Cut to Radius Ratio (Ap/r) | | |
|---------------------|----------------|---------------|---------------------|-----------------------------|---|------------|----------|
| | | | | | 0–13.4% | 13.4–29.3% | 29.3–50% |
| Steel | 40 HRC | G-925 | 500 | 0.0019 | 0.0085 | 0.0049 | 0.0038 |
| | | XYTIN®-1 | 1050 | 0.0031 | 0.0144 | 0.0081 | 0.0062 |
| | | WG-600® | 1500 | 0.0022 | 0.0100 | 0.0057 | 0.0044 |
| | 50 HRC | G-925 | 350 | 0.0013 | 0.0042 | 0.0024 | 0.0019 |
| | | XYTIN®-1 | 720 | 0.0025 | 0.0114 | 0.0065 | 0.0050 |
| | | WG-600® | 1020 | 0.0019 | 0.0085 | 0.0049 | 0.0038 |
| | 60 HRC | G-925 | 300 | 0.0006 | 0.0028 | 0.0016 | 0.0013 |
| | | XYTIN®-1 | 430 | 0.0019 | 0.0071 | 0.0041 | 0.0031 |
| | | WG-600® | 610 | 0.0013 | 0.0042 | 0.0024 | 0.0019 |
| Tool Steel | 65 HRC | G-925 | 275 | 0.0006 | 0.0028 | 0.0016 | 0.0013 |
| | | XYTIN®-1 | 280 | 0.0016 | 0.0071 | 0.0041 | 0.0031 |
| | | WG-600® | 400 | 0.0010 | 0.0042 | 0.0024 | 0.0019 |
| HRSA | 20-25 HRC | G-925 | 550 | 0.0025 | 0.0114 | 0.0065 | 0.0050 |
| | | XYTIN®-1 | 3000 | 0.0025 | 0.0114 | 0.0065 | 0.0050 |
| | | WG-600® | 3950 | 0.0016 | 0.0071 | 0.0041 | 0.0031 |
| | 40-45 HRC | G-925 | 350 | 0.0016 | 0.0071 | 0.0041 | 0.0031 |
| | | XYTIN®-1 | 2600 | 0.0016 | 0.0071 | 0.0041 | 0.0031 |
| | | WG-600® | 3450 | 0.0010 | 0.0042 | 0.0024 | 0.0019 |
| Graphitic Cast Iron | <40 HRC | G-925 | 850 | 0.0034 | 0.0156 | 0.0088 | 0.0067 |
| | | XYTIN®-1 | 2300 | 0.0028 | 0.0129 | 0.0073 | 0.0056 |
| | | WG-600® | 2950 | 0.0019 | 0.0085 | 0.0049 | 0.0038 |
| Stainless Steel | ≤40 HRC | G-925 | 450 | 0.0025 | 0.0114 | 0.0065 | 0.0050 |
| | | XYTIN®-1 | 2400 | 0.0025 | 0.0114 | 0.0065 | 0.0050 |
| | | WG-600® | 3480 | 0.0016 | 0.0071 | 0.0041 | 0.0031 |
| Titanium 6Al4V | 35-40 HRC | G-925 | 250 | 0.0010 | 0.0042 | 0.0024 | 0.0019 |
| Aluminum | | G-925 | 950 | 0.0038 | 0.0174 | 0.0097 | 0.0075 |

* Recommended Feed per Tooth values are for full slotting situations to maintain the target chip thickness value. When 3D/Profile milling, please use the Greenleaf Ball Nose Calculator to determine the appropriate cutting parameters to achieve the target chip thickness listed. For questions regarding applications and additional materials, please contact your local sales and service engineer or the Greenleaf Technical Service department.

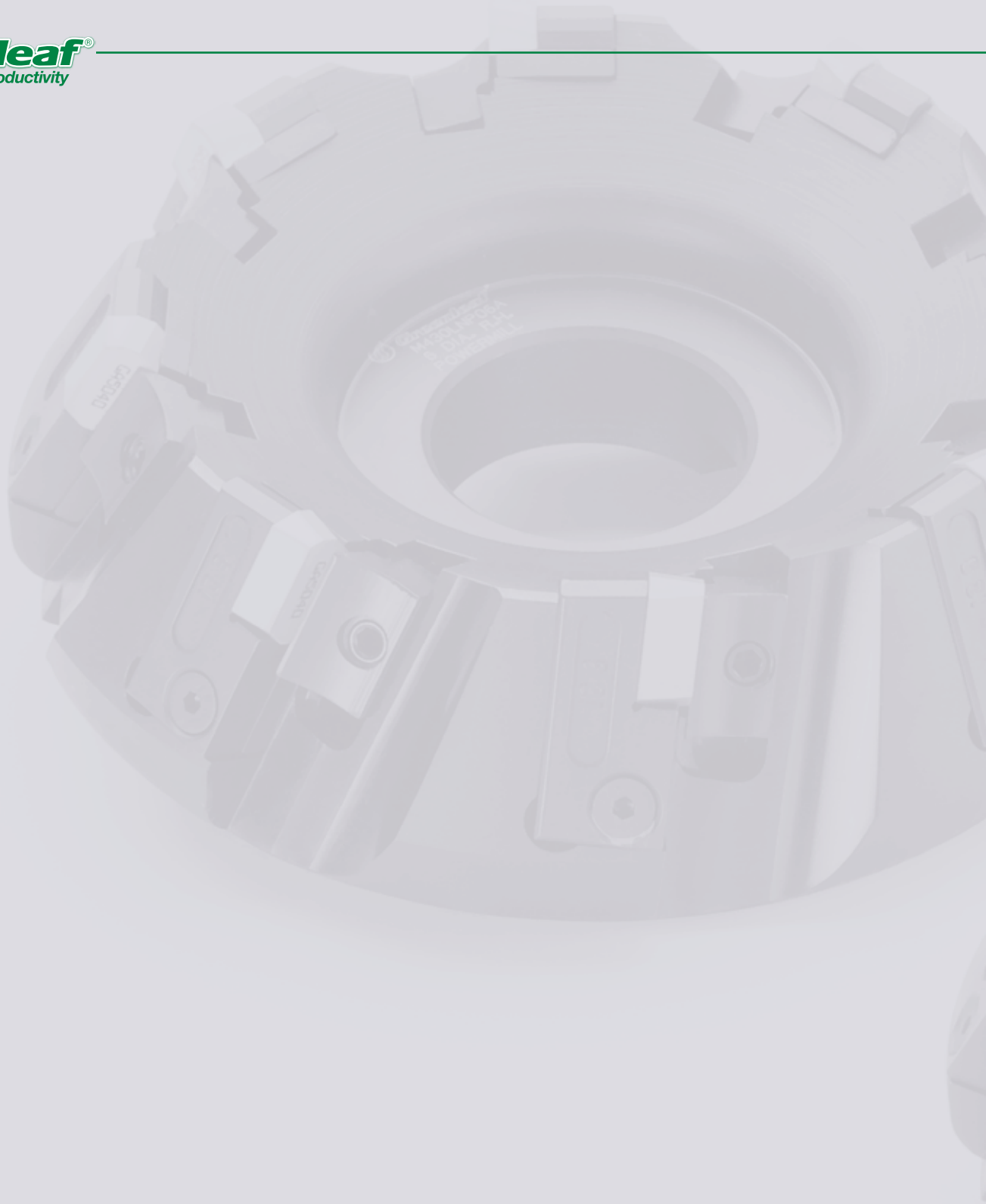
** Maximum recommended depth of cut (DOC) when using XYTIN-1 & G-925 is 20% of the insert diameter, and 15% of the insert diameter when using WG-600.

Effective Cutting Diameter

| Effective Diameter D _{eff} (in.) for a given Depth of Cut | | | | | | | | | | | | | | |
|--|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Insert Diameter (in.) | DOC | 0.005 | 0.010 | 0.015 | 0.025 | 0.035 | 0.055 | 0.075 | 0.095 | 0.100 | 0.115 | 0.125 | 0.150 | 0.200 |
| | 0.375 | 0.086 | 0.121 | 0.147 | 0.187 | 0.218 | 0.265 | 0.300 | 0.326 | 0.320 | 0.346 | 0.354 | 0.367 | — |
| | 0.500 | 0.099 | 0.140 | 0.171 | 0.218 | 0.255 | 0.313 | 0.357 | 0.392 | 0.400 | 0.421 | 0.433 | 0.458 | 0.490 |
| | 0.625 | 0.111 | 0.157 | 0.191 | 0.245 | 0.287 | 0.354 | 0.406 | 0.449 | 0.458 | 0.484 | 0.500 | 0.534 | 0.583 |
| | 0.750 | 0.122 | 0.172 | 0.210 | 0.269 | 0.316 | 0.391 | 0.450 | 0.499 | 0.510 | 0.540 | 0.559 | 0.600 | 0.663 |
| | 1.000 | 0.141 | 0.199 | 0.243 | 0.312 | 0.368 | 0.456 | 0.527 | 0.586 | 0.600 | 0.638 | 0.661 | 0.714 | 0.800 |

Maximum recommended DOC for WG-600®

Maximum recommended DOC for G-925 and XYTIN®-1



Powermill Milling Cutters

Ideal for heavy-duty cutting in severe interruptions and uneven surfaces. Replaceable components maximize cutter life while providing deep depths of cut.

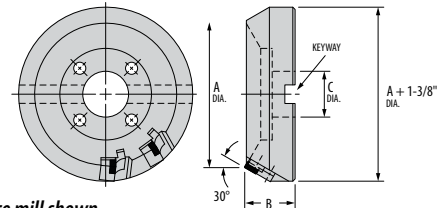
Greenleaf Tune-Up Kits

A Tune-Up Kit consists of all the standard hardware to refurbish a particular toolholder, boring bar, or milling cutter. A toolholder will have a readily visible, laser-inscribed Tune-Up Kit number on it for ease in ordering. This number will prevent any confusion created by searching a catalog for hardware, and it will help reduce downtime.



Powermill M430LNP-A

30° Lead, Neg-Pos



Right-hand face mill shown

| Part Number | | Gage Insert | No. of Inserts | Wiper Insert | Dimensions (inches) | | | | | Standard Components | | | | *Tune-Up Kit | Optional |
|-------------|---------------|-------------|----------------|--------------|---------------------|-------|-------|------------|-------------|---------------------|-------------|-------|---------------|--------------|----------|
| Right Hand | Left Hand** | | | | A | B | C | Keyway | Bolt Circle | Anvil | Wedge Screw | Anvil | Back-Up Plate | | |
| M430LNP04A | | LNP-335R | 6 | LNP-335RW | 4 | 2.250 | 1.500 | 5/8 x 3/8 | — | 412151 | XNS-58 | S-21 | 303414 | TK-00729 | S-2 |
| | M430LNP04A-LH | LNP-335L | 6 | LNP-335LW | 4 | 2.250 | 1.500 | 5/8 x 3/8 | — | 412151 | XNS-58 | S-21 | 303414 | TK-00729 | S-2 |
| M430LNP06A | | LNP-335R | 8 | LNP-335RW | 6 | 2.250 | 2.000 | 3/4 x 7/16 | — | 412151 | XNS-58 | S-21 | 303414 | TK-00633 | S-2 |
| | M430LNP06A-LH | LNP-335L | 8 | LNP-335LW | 6 | 2.250 | 2.000 | 3/4 x 7/16 | — | 412151 | XNS-58 | S-21 | 303414 | TK-00633 | S-2 |
| M430LNP08A | | LNP-335R | 10 | LNP-335RW | 8 | 2.750 | 2.500 | 1 x 17/32 | 4 | 412151 | XNS-58 | S-21 | 303414 | TK-00730 | S-2 |
| | M430LNP08A-LH | LNP-335L | 10 | LNP-335LW | 8 | 2.750 | 2.500 | 1 x 17/32 | 4 | 412151 | XNS-58 | S-21 | 303414 | TK-00730 | S-2 |
| M430LNP10A | | LNP-335R | 12 | LNP-335RW | 10 | 2.750 | 2.500 | 1 x 17/32 | 4, 4-3/4 | 412151 | XNS-58 | S-21 | 303414 | TK-00634 | S-2 |
| | M430LNP10A-LH | LNP-335L | 12 | LNP-335LW | 10 | 2.750 | 2.500 | 1 x 17/32 | 4, 4-3/4 | 412151 | XNS-58 | S-21 | 303414 | TK-00634 | S-2 |
| M430LNP12A | | LNP-335R | 16 | LNP-335RW | 12 | 2.750 | 2.500 | 1 x 17/32 | 4, 4-3/4, 7 | 412151 | XNS-58 | S-21 | 303414 | TK-00717 | S-2 |
| | M430LNP12A-LH | LNP-335L | 16 | LNP-335LW | 12 | 2.750 | 2.500 | 1 x 17/32 | 4, 4-3/4, 7 | 412151 | XNS-58 | S-21 | 303414 | TK-00717 | S-2 |

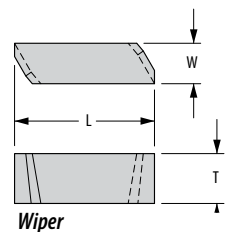
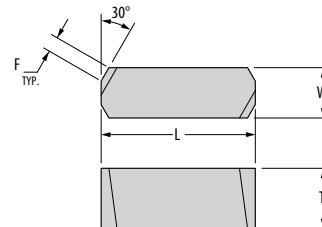
NOTE: Maximum depth of cut is .500". When using optional insert and anvil, maximum depth of cut is .880"

NOTE: The Standard and Optional Anvil both use the same Anvil Screw: #10-32 x 1 FHCS.

NOTE: For information on screw torque settings, please refer to the chart on page M38.

* Tune-Up Kits include all standard components and necessary wrenches to allow you to completely refurbish cutter.


** Left-Hand cutters are made to order only.



Wiper

Powermill Inserts

LNP

| Inserts | Part Number ANSI | Steel | | | Stainless Steel | Part Number ISO | Dimensions (inches) | | | | |
|---|---------------------|--------|-------|--------|--------------------|--------------------|---------------------|-------|-------|-------|--------|
| | | P | | | M | | W | T | L | F | |
| | | GA5036 | G-915 | G-9120 | G-910 | | | | | | G-9230 |
|  | LNP-335R | ◆ | ▲ | ● | ● | ◆ | LNP-335R | 0.312 | 0.375 | 0.750 | 0.100 |
| | LNP-335L | ◆ | ▲ | ● | ● | ◆ | LNP-335L | 0.312 | 0.375 | 0.750 | 0.100 |
| | LNP-335RW | ◆ | ▲ | ● | ● | ◆ | LNP-335RW | 0.312 | 0.355 | 0.850 | N/A |
| | LNP-335LW | ◆ | ▲ | ● | ● | ◆ | LNP-335LW | 0.312 | 0.355 | 0.850 | N/A |
| | LNP-34.57R | ◆ | ▲ | ● | ● | ◆ | LNP-34.57R | 0.437 | 0.375 | 1.125 | 0.100 |
| | LNP-34.57L | ◆ | ▲ | ● | ● | ◆ | LNP-34.57L | 0.437 | 0.375 | 1.125 | 0.100 |
| | LNP-34.57RW | ◆ | ▲ | ● | ● | ◆ | LNP-34.57RW | 0.437 | 0.355 | 1.228 | N/A |
| | LNP-34.57LW | ◆ | ▲ | ● | ● | ◆ | LNP-34.57LW | 0.437 | 0.355 | 1.228 | N/A |

CARBIDE COATINGS: MT-CVD Coated PVD Coated Uncoated

CERAMIC CLASSIFICATION: Whisker Ceramic Phase-Toughened Silicon Nitride Alumina TiC

First Choice ◆ Second Choice ● Alternative ▲

Grade descriptions — pages M36–37

Wiper Inserts (LNP-RW/LW)

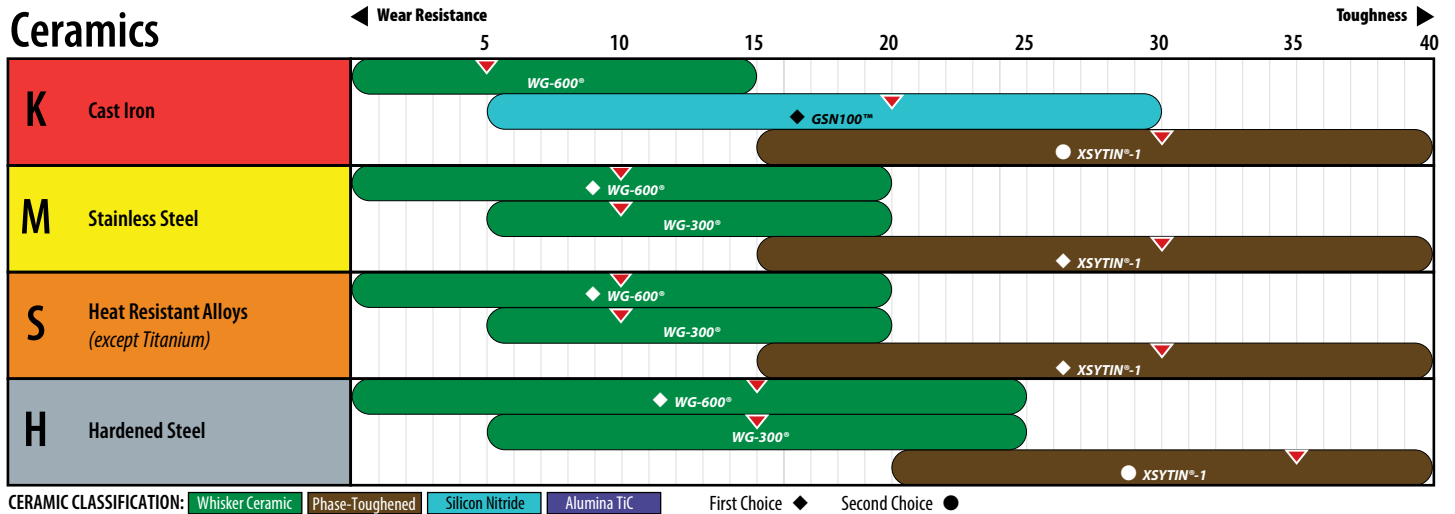
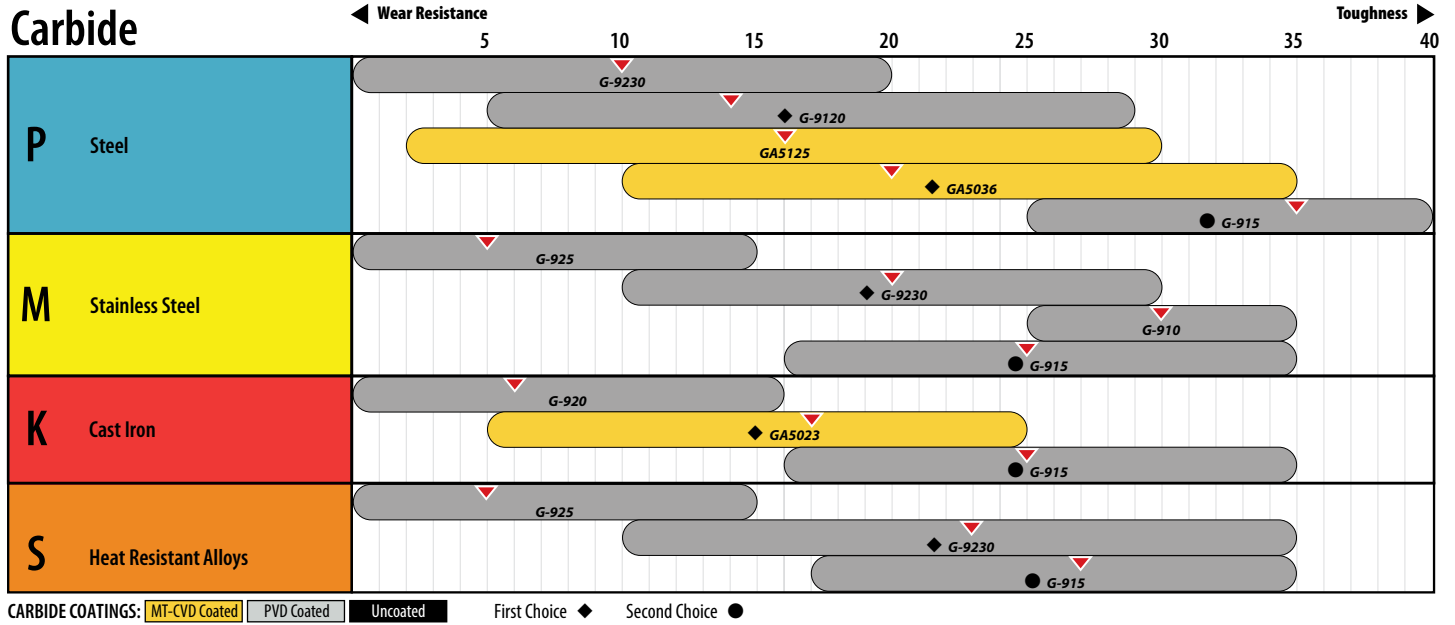
A wiper insert is designed to be higher above the face of the cutter compared to standard inserts and has a broader wiping flat or radius to effectively wipe out any tool marks produced by the tolerance differences in the standard inserts.

Wiper inserts can be used effectively in a single pocket in smaller diameter cutters and in multiples of two or three in larger cutters to produce a superior finish.

The grades selected for wiper inserts will generally be harder (higher 'C' classification) to combat the trend toward more rapid wear caused by the increased surface contact. Wiper inserts should only be used when the required RMS value is very low.

Always bear in mind that the majority of finish problems in milling come from lack of rigidity of the set-up, deflection of the part piece or machine spindle, excessive overhangs, and poor cleanliness and assembly practices in the cutter body. Wiper inserts cannot be expected to resolve these problems.

Insert Grade Reference for Milling



Insert Grades

Carbide

Greenleaf offers a comprehensive line of carbide inserts ranging from sub-micron C-1 through C-8 classifications in uncoated, MT-CVD coated and PVD coated options. Carbide inserts are available in ANSI standard geometries that support the various milling products that are offered.

CVD Coated

GA5023

A high-performance grade designed for the turning and milling of various grades of cast iron, GA5023 features an advanced MT-CVD coating specifically developed to withstand the abrasiveness of cast iron in machining. Applications range from roughing to finishing in most grades of cast iron, including gray, nodular, and others. The high wear resistance and toughness of GA5023 enable high-speed machining in a wide range of feed rates.

GA5036

A high-speed MT-CVD coated milling grade, GA5036 should be used when milling forged and cast steels and select ductile irons. GA5036 constitutes a unique combination of toughness and heat resistance, making it suitable for heavy and light-duty milling at high cutting speeds. It is a great first choice for all steel milling.

GA5125

A high-performance MT-CVD coated carbide used primarily for the milling and turning of manganese steel. GA5125 can also be applied in Cr-Mo steels, tool steels, and other alloyed steels in continuous and interrupted turning. GA5125 provides excellent resistance to abrasion, crater wear, thermal shock, deformation, and built-up edge. It performs best when applied at high speeds and moderate feed rates.

PVD Coated

G-910

A PVD-coated grade for milling high-temp alloys, stainless steel, and low carbon steels, G-910 is a medium-speed grade and should be applied at moderate to high feed rates.

PVD Coated *continued*

G-915

A multi-layer PVD-coated grade, G-915 is exceptional for milling and interrupted turning of heat-resistant alloys, stainless steels, and low-carbon steels. The coating adds heat and abrasion resistance to the tough substrate. G-915 should be used at moderate speeds and moderate to high feeds. It is a versatile grade that performs well in a variety of materials and operations outside its primary application range, making it a great choice for general machining.

G-9120

This multi-layer PVD-coated carbide grade excels at milling and turning steel castings and forgings. G-9120 was engineered specifically to maximize productivity at moderate to heavy feed rates and high depths of cut, making it ideal for heavy-turning applications in steel.

G-9230

A PVD-coated grade designed for the machining of heat-resistant alloys, titanium, and hardened and stainless steels. G-9230 works particularly well in stainless steel turning, interrupted turning of HRSA, and interrupted turning of titanium. G-9230 has superior wear resistance and toughness and is excellent for casting and forging scale conditions.

G-925

A high-performance multi-layer PVD-coated grade, G-925 is specifically designed for turning abrasive and difficult-to-machine materials. Typical applications include turning of HRSA, titanium and other refractory metals, stainless steels, and ductile cast irons. G-925 exhibits excellent resistance to notching and deformation. Apply at moderate to high speeds and moderate feeds.

G-935

A multi-layer PVD-coated grade for steel milling and turning applications requiring additional resistance to mechanical and thermal shock. The multi-layered PVD coating raises the speed envelope and wear resistance in tough milling, indexable drilling, and interrupted turning applications.

Uncoated

G-01

Developed for milling heat-resistant alloys, stainless steel, and low-carbon steels at low speeds and moderate to high feeds, G-01 can also be used for turning in the same range of materials with severe interruption or old machinery.

G-01M

A tough sub-micron grade, G01M is used for milling and rough turning stainless steels— even when rolling or casting skin is present. The edge strength of G-01M allows the use of sharp edges and high positive rakes in continuous or interrupted cuts.

G-02

An excellent general-purpose cast-iron grade, G-02 can be used for milling and turning cast iron at moderately high speeds and medium feeds. G-02 is also a good choice for machining aluminum with positive rakes and light roughing of some heat-resistant alloys and stainless steels.

G-53

An excellent general-purpose milling grade for steels at moderate speeds and feeds. G-53 has a good combination of toughness and wear resistance for milling, or can be used as an all-around grade for mixed-production applications.

G-60

Used for the milling of steel, steel castings, and steel forgings. Apply G-60 at moderate speeds and heavy feed rates and depths of cut. G-60 is more wear-resistant than G-50 but is lower in toughness.

Ceramic

Greenleaf is the leader in the development and manufacture of ceramic and coated ceramic inserts. ANSI standard geometries are offered to fit in many of the milling lines offered.



WG-300®

A SiC whisker-reinforced Al_2O_3 ceramic that is very effective at machining nickel- and cobalt-based super alloys, alloyed cast iron, and hardened steels at metal removal rates up to 10 times higher than carbide. Excellent chemical stability and wear resistance at very high cutting speeds make WG-300® the first choice worldwide for grooving and turning difficult materials.



WG-600®

A coated SiC whisker-reinforced Al_2O_3 ceramic that offers higher tool life and speed capabilities than uncoated whisker-reinforced ceramics due to the additional barrier to heat and mechanical abrasion. Application areas for WG-600® include rough and finish turning of alloys in the M, K, S, and H ISO material classes, as well as milling of hardened steels and select stainless steels. WG-600® is particularly well-suited for finish-turning and grooving of heat-resistant super alloys and is unmatched in both turning and milling of steels with a hardness above 60 HRC.



WG-700™

A SiC whisker-reinforced Al_2O_3 ceramic featuring improved toughness and a unique low-friction coating. WG-700™ is ideal for turning, grooving, and profiling nickel- and cobalt-based super alloys that other ceramics may struggle in. WG-700™ exhibits exceptional tool life and productivity in next-generation formulations or novel heat treatments of heat-resistant super alloys, and long-reach or thin-walled applications with lower rigidity.



XSYTIN®-1

A phase-toughened ceramic grade capable of sustaining extreme cutting forces. The unprecedented strength, impact toughness, and resistance to thermal shock of XSYTIN®-1 make it ideal for use in interrupted cuts, forging scale removal, and milling. In continuous cuts, the strength of XSYTIN®-1 allows the use of significantly higher feed rates or depths of cut. In machining environments with severe interruptions and scale, the edge strength of XSYTIN®-1 allows the use of very light edge preparations, minimizing the force of impact and making for a much smoother cut.



GSN100™

An engineered blend of hot-pressed silicon nitride and proprietary toughening agents that excels in the machining of cast iron. GSN100™ delivers superior wear and toughness for turning, grooving, and milling applications. It is available in all standard geometries and engineered specials.



Screw Torque Settings

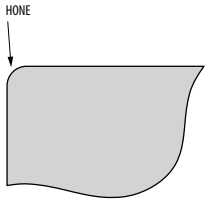
| Screw Type | Part Number | Screw Torque (in-lbs) | Wrench |
|---------------------|--------------------|-----------------------|--------|
| Insert Screw | PT-589T | 8 | T7 |
| | 313631 | 8 | T7 |
| | PT-542T | 8 | T7 |
| | PT-559T | 23 | T15 |
| | 312679 | 23 | T15 |
| | PT-546T | 45 | T20 |
| | SM30-083 | 17 | T10+ |
| | SM40-106 | 26 | T15+ |
| | SM50-1139 | 52 | T20 |
| | SM60-167 | 77 | T25 |
| | SM70-210 | 95 | T20 |
| Wedge Screw | 430578 | 85 | 3/16 |
| | 425606 | 85 | 3/16 |
| | XNS-58 | 95 | 5/32 |
| Nest Screw | SE03-02 | 70 | T15 |
| Anvil Screw | #4-40x1/4 FHCS | 9 | 1/16 |
| | #10-32x7/8 FHCS | 60 | 1/8 |
| Clamp Screw | #10-32x1/2 SHCS | 68 | 5/32 |
| | 438919 | 68 | T25 |
| | #3-48x1/4 SHCS | 9 | 5/64 |
| | SE02-01 | 22 | T15 |
| | SE02-04 | 22 | T15 |
| | PT-317T | 15 | T10 |
| | #3-48x3/16 SHCS | 9 | 5/64 |
| | #8-32x9/32 IPBHCCS | 30 | T15 |
| | #8-32x3/8 IPBHCS | 30 | T15 |
| | PT-542T | 8 | T7 |
| | SE03-72 | 70 | T20 |
| Back-Up Plate Screw | #5-40x3/8 FHCS | 13 | 5/64 |

Excelerator® Mills

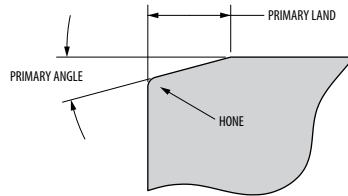
Setup and Operational Procedures

1. Thoroughly clean all insert pockets.
2. Install the inserts, making sure that they are properly seated in the pocket, and torque the insert clamp screws to the correct torque as indicated on the body of the Excelerator Milling Cutter.
3. Use Greenleaf Excelerator Mills only on machines that have adequate shield guards.
4. Run the Greenleaf Excelerator Mills using cutting parameters as recommended by Greenleaf Tech Team. Contact the Greenleaf Tech Team at: 814-763-2915 or by email: techteam@greenleafcorporation.com
5. For safety purposes, do not exceed the maximum RPMs etched on the Excelerator Mill. Note: There are two max RPM numbers. One (the lower RPM number) is for using the mill with carbide inserts and the other is for usage with ceramic inserts.

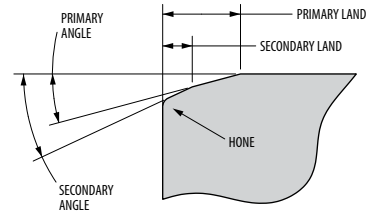
Ceramic Edge Preparations



HONE



PRIMARY ANGLE



SECONDARY ANGLE

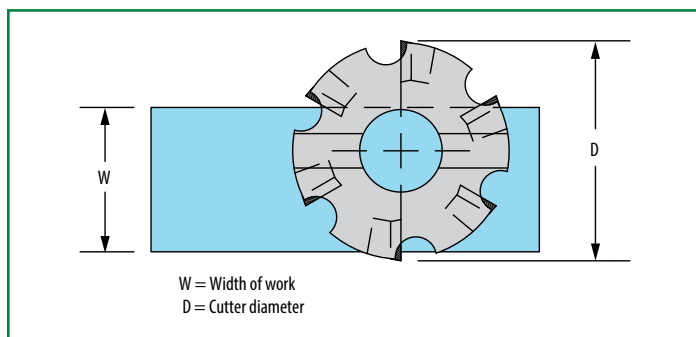
| Edge Prep | Hone | Primary Land | Primary Angle | Application |
|------------|------------------|--------------|---------------|---|
| A | .0005 - .001" R. | | | Light hone added to designated lands and chipforms • XSYTIN®-1 – General-purpose milling of HRSA, hardened steel, and maraging steel |
| T1 | | .002 - .004" | 20° | • XSYTIN®-1 – General-purpose milling of high-hardness HRSA, and hardened steel |
| T1A | .0005 - .001" R. | .002 - .004" | 20° | • WG-300®/600/700 – Light-medium milling of hardened steel, milling HRSA, general-purpose turning and milling of stainless steel • XSYTIN®-1 – Same applications as T1 where the interruption or hardness gradient and size of hard particles are greater - particularly in HRSA forging scale |
| T2 | | .006 - .008" | 20° | Used in the same applications as T1 but at heavier depths of cut and/or heavier feed rates • GSN100™ – General purpose grey, nodular, and CGI cast iron milling • XSYTIN®-1 – General purpose grey, nodular, and CGI cast iron milling |
| T2A | .0005 - .001" R. | .006 - .008" | 20° | • WG-300®/600/700 – Milling of grey and nodular cast iron, and hardened steel • GSN100™ – Same applications as T2 where more edge strength and protection from irregular wear is required • XSYTIN®-1 – General-purpose cast iron (including white cast iron, ADI, CGI) milling |

Technical Data

Selection of Correct Cutter Diameter

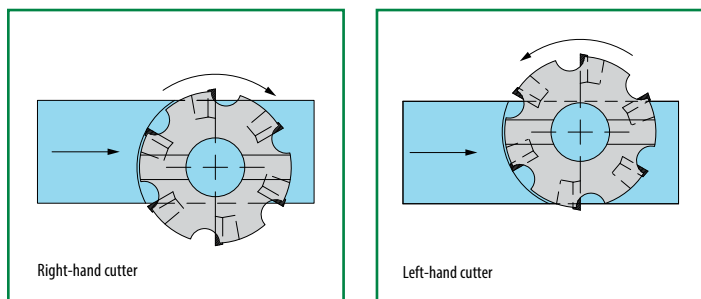
Select a cutter diameter greater than the workpiece width by a ratio of approximately 1.5 to 1. This will ensure that each insert enters the cut without the frictional, no-chip phase which occurs when attempting to cut the full cutter diameter. Also, the insert leaves the part without reducing the chip down to zero. These benefits can greatly extend the insert life.

With smaller, low horsepower machines it will be better to select a smaller cutter and take two passes rather than a large diameter cutter forced to operate at low tooth loads (feed rates) to avoid stalling of the spindle.



Choose a cutter diameter approximately 1.5 times the workpiece width.

Hand of Cutters



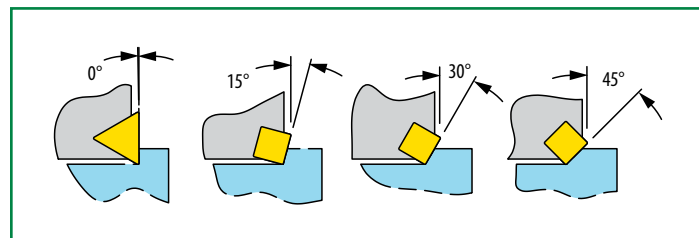
A *right-hand cutter* is one which, when viewed from above, rotates clockwise relative to the workpiece.

A *left-hand cutter* is one which, when viewed from above, rotates counterclockwise relative to the workpiece.

Lead Angles

The lead angle of a milling cutter is not intended for producing a specific angle on the work. In fact, because of compound angles, a given lead angle will not produce that angle exactly.

The purpose of lead angle is to thin the chip while absorbing a given depth of cut over a greater portion of the insert edge. This results in improved tool life and, for a given horsepower, a greater depth potential.



For example, 30° lead angle is a good choice for face milling in general purpose applications.

The exception to the previous statement is the 0° lead cutter, sometimes called a 90° cutter, which is designed for milling to square shoulders and producing a 90° corner.

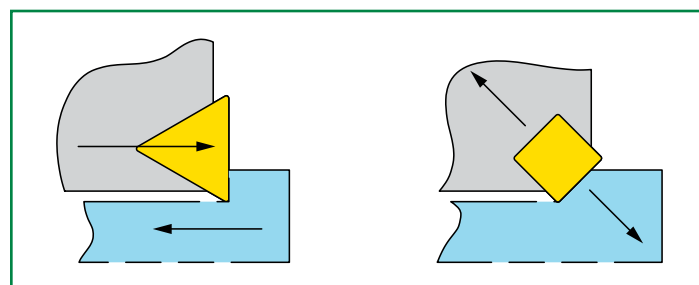
Lead Angles and Cutting Forces

The lead angle of a milling cutter has a direct effect upon the cutting forces being presented to the workpiece, cutting tool, and machine.

The resultant force is always directly perpendicular to the cutting edge. A lead angle may, therefore, be a major consideration in how we want to direct the forces.

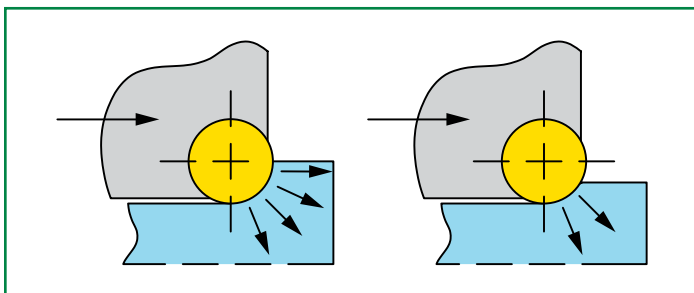
For example, in a thin section workpiece, a high lead angle may cause deflection since there is more tendency to "push" the part away from the cutter. On the other hand, a 0° lead cutter has more deflective force on the machine spindle.

For example, in a thin section workpiece, a high lead angle may cause deflection since there is more tendency to "push" the part away from the cutter. On the other hand, a 0° lead cutter has more deflective force on the machine spindle.



The Round Insert Cutter

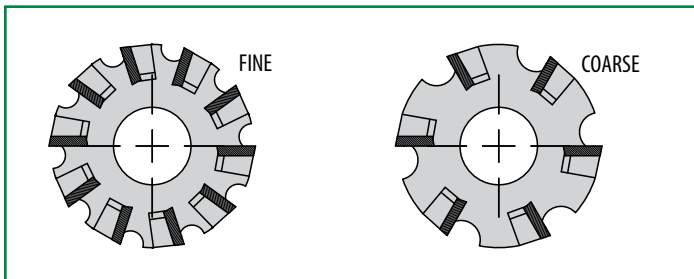
The exception to the rule in lead angle cutting forces is the round insert. With a round insert, the lead angle is entirely dependent upon the depth of cut. As the depth increases, the lead angle decreases. If cutting half the diameter deep, there is effectively 0° lead angle.



In the milling of work hardening materials such as Inconel, and using a round insert cutter, there will be a direct relationship between depth of cut and speed of development of notch wear. The shallower the cut, the slower the notch wear.

Pitch

The pitch of a milling cutter refers to the numbers of inserts placed into a given diameter.



Cutters for cast iron are often closer pitch to allow the maximum number of teeth to be engaged at one time for smoother cutting, and because cast iron does not need large gullet for the discontinuous chips produced.

For general use, choose a fairly coarse pitch. A guide would be diameter plus 2, i.e., a 6" cutter with 8 inserts, etc.

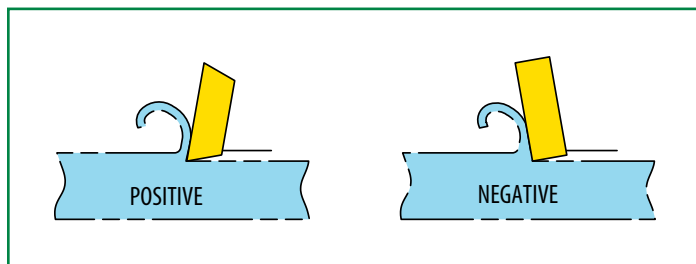
Negative Versus Positive Geometry

In an indexable cutter, the negative insert is the only one which permits the insert to be turned over and used on both sides. It is the most economical style. Also, it is the strongest insert because all edges are 90° to the faces.

On the minus side, the negative rake tool produces higher cutting forces when compared to the positive rake.

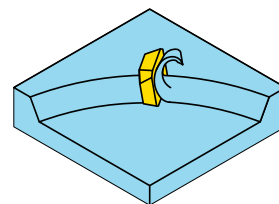
In general, use negative rakes for cast iron, interrupted cuts, and on rigid high horsepower machining for steels.

Use positive rakes for aluminum, titanium, copper, most stainless steels, thin or easily deflected parts, steels, and nickel alloys.



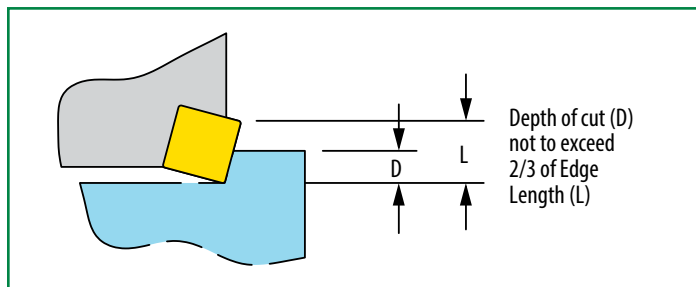
There are many milling cutters with a combination of positive and negative rakes often called shear-angle design. These cutters offer some of both worlds, although inserts are essentially like positive inserts and cannot be turned over. Shear angle cutters do provide continuous chip ejection since the axial rake behaves much like a helix in a flute and takes the chip up and away from the finished surface.

These cutters work well in heavy duty operations with wide widths of cut — especially if combined with a 30° lead angle.



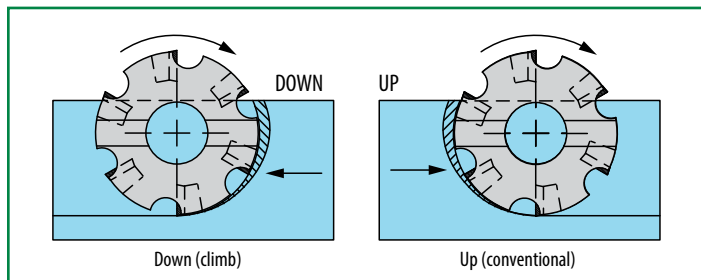
Depth of Cut

It is a good general rule not to allow depth of cut to exceed 2/3 of the cutting edge length. Remember that in lead angle cutters the cutting edge length in use is not the same as the depth of cut.



Up Milling and Down Milling

This refers to direction of rotation relative to the feed.

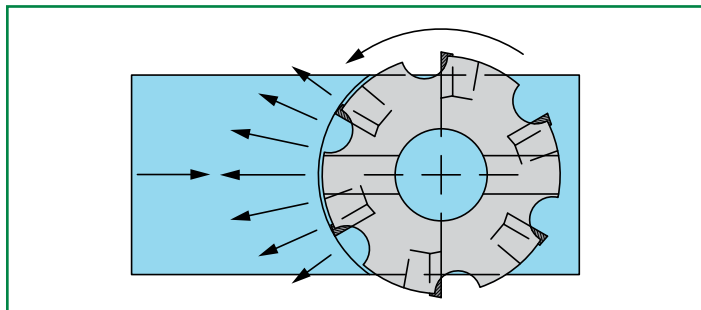


With a modern machine in good condition, down milling will give the best results. This is because the thickest section of the chip is against the insert to avoid welding, and pressure is progressively relieved towards the finished surface.

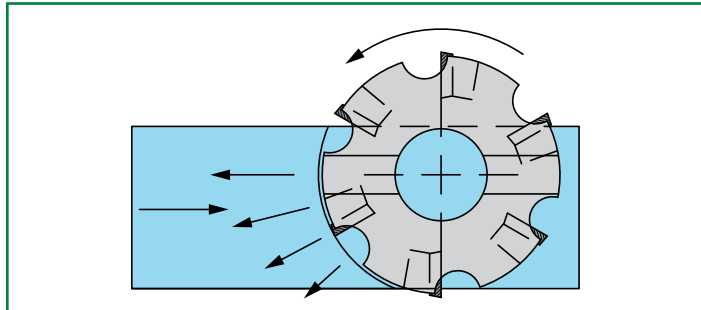
In up milling, friction and pressure build up before the chip starts to form, causing premature edge wear. It should be in rare cases that up milling is needed. This could be, for example, on an older machine with backlash in the table feed.

Cutter Positioning

Central positioning of the cutter can give rise to vibration if any spindle play is present. This is because of an alternating radial force pushing against the spindle.



Placing the cutter off center will always be a better situation to avoid chatter and vibration and also to improve tool life.

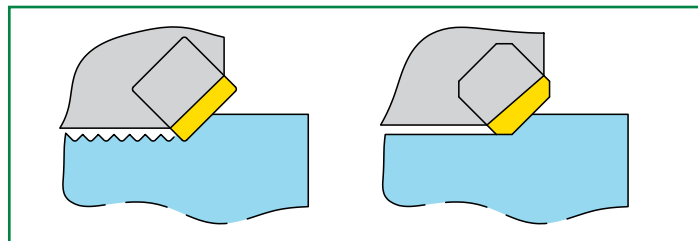


When moving off center, the path of cut is longer since each insert now sweeps a longer arc with each revolution. This may have a measureable impact on tool life, and cutting temperature will tend to increase.

Seek a happy medium by moving off center in small increments until vibration is controlled.

Surface Finish

In a milling cutter the finish is produced by the highest insert. Since variations exist in the body and the inserts, it is inevitable that some inserts will be higher than others. If the inserts have small corner radii, for example, the highest insert will cut the track and this will determine the finish.



For this reason, most inserts designed especially for milling, use flats on the insert rather than a radius. In this way, the highest insert produces a wiping effect removing the variances of the other inserts and leaving a much improved finish. "Wiper" inserts installed in a few stations can be used for this purpose as well as "finishing" inserts which are available for certain cutters in the Greenleaf line.

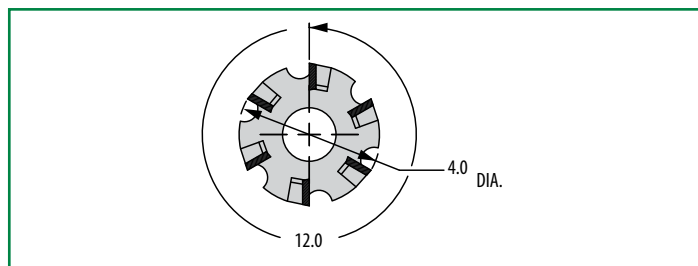
The 4" Reference for Speed Calculations

Recommended cutting speeds are usually given in surface feet per minute (SFM). Sometimes a problem exists in converting SFM to the correct RPM (revolutions per minute) for a given cutter diameter.

A very easy way to make a quick approximate calculation is to use a 4" cutter as a base of reference. Since a 4" cutter has a circumference of approximately 12" or 1 foot

$$\frac{(\pi \times D'')}{12} = \text{Cft}$$

the correct RPM for a 4" cutter is the same as required speed in SFM, i.e., 100 RPM = 100 SFM.



This makes it easy to make a mental calculation for most popular cutter diameters

For Example:

An 8" cutter has 2x the circumference. Therefore, 100 RPM=200 SFM.

A 2" cutter has half the circumference. Therefore, 100 RPM=50 SFM and so forth.

If you want to make an accurate calculation, the formula is:

$$\text{SFM} = \frac{(\pi \times d \times \text{RPM})}{12}$$

Speed rate recommendations are based upon the material to be machined and the cutting tool material which will be used, i.e., carbide, coated carbide, ceramic, silicon nitride, etc.

Feed Rate Calculation

One problem encountered in milling cutter feed rate considerations is that while most milling cutter manufacturers make recommendations in load per tooth or feed per tooth, the machine is calibrated in inches per minute. It is, therefore, necessary to do a little simple math to get the answers required.

In turning, these problems do not exist since only one insert is involved, and the machine is calibrated in feed per revolution. Feed per revolution is the same as feed per tooth when there is only one insert, so we simply plug in the recommended feed.

With a milling cutter, the feed per tooth is controlled by three factors. These are:

1. The feed rate or table advance in inches per minute.
2. The spindle speed in revolutions per minute.
3. The number of inserts in the milling cutter.

We must make a calculation in order to find out the really critical information needed, i.e., what is the feed per tooth or how much work are we asking each insert to perform? Too little work is more often a problem than too much.

If the feed per tooth is very small, let us say less than .003", then abrasive wear is accelerated. No real chip is produced to take away the heat.

On the other hand, if high feed rates are used and the cutter has many teeth, then horsepower available may be insufficient. This is an important consideration in selecting a cutter, specially larger diameter cutters with fine pitch.

Here are the equations you will need to make your calculations:

T = Number of teeth

FPT = Feed per tooth

IPM = Inches per minute

RPM = Revolutions per minute

$\pi = 3.1416$

$$\text{Feed per tooth} = \frac{\text{IPM}}{\text{T} \times \text{RPM}}$$

$$\text{Feed per revolution} = \frac{\text{IPM}}{\text{RPM}}$$

$$\text{Inches per minute} = \text{FPT} \times \text{T} \times \text{RPM}$$

$$\text{Revolutions per minute} = \frac{12 \times \text{SFM}}{\pi \times d}$$

These calculations can also be readily made using the Greenleaf milling calculator available free of charge upon request from your local representative or directly from Greenleaf Corporation (800-458-1850). This calculator also displays horsepower needed at the spindle for a given cut. This takes into account width and depth as well as speed and feed for a given cutter together with the machinability of the material to be machined, often referred to as the "K" factor.

It is a good starting point to know that a mild steel (150BHN) requires about 1 HP per cubic inch of material to be removed per minute.

The formula for cubic inches removed is:

$$\text{Cu. ins.} = \text{D} \times \text{W} \times \text{IPM}$$

$$\text{Depth} = .060$$

$$\text{Width} = 6 \text{ inches}$$

$$\text{IPM} = 22 \text{ inches per minute}$$

$$.060 \times 6 \times 22 = 7.92 \text{ cubic inches per minute}$$

(or)

$$\text{Approximately 8HP needed for steel 150 BHN}$$

For any other material we can divide our answer by the "K" factor which is a machinability rating relative to 150BHN steel.

"K" Factors

| Material | "K" Factor |
|---------------------------|------------|
| Aluminum | 4.00 |
| Brass—soft | 3.00 |
| Brass—hard | 2.00 |
| Bronze—hard | 1.40 |
| Cast iron to 200 BHN | 1.75 |
| Cast iron to over 200 BHN | 1.20 |
| Malleable iron | 1.50 |
| Steel—100 BHN | 1.40 |
| Steel—150 BHN | 1.00 |
| Steel—200 BHN | 0.85 |
| Steel—250 BHN | 0.83 |
| Steel—300 BHN | 0.80 |
| Steel—400 BHN | 0.65 |

HPc = Horsepower needed at spindle

D = Depth of cut

W = Width of cut

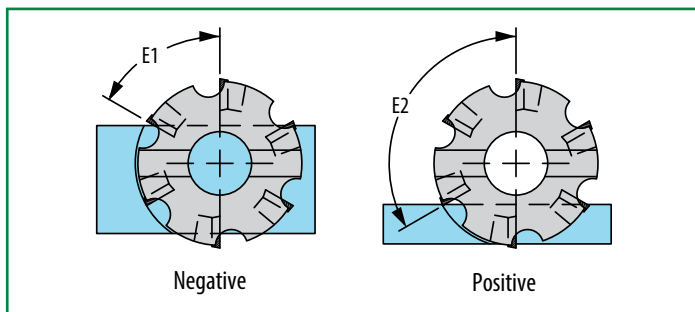
IPM = Inches per minute feed rate

K = K Factor

$$\text{HPc} = \frac{\text{D} \times \text{W} \times \text{IPM}}{\text{K}}$$

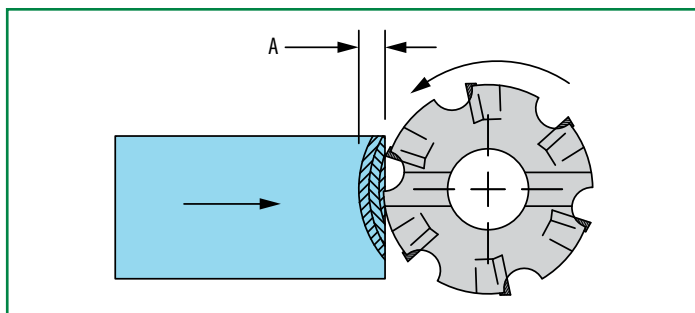
Angle of Entry

In face milling operations, the angle of entry can have a significant impact upon insert performance. A positive angle of entry can cause breakage or chipping, especially when using positive inserts. Positive angle of entry will occur when the path of cut is narrow relative to cutter diameter.

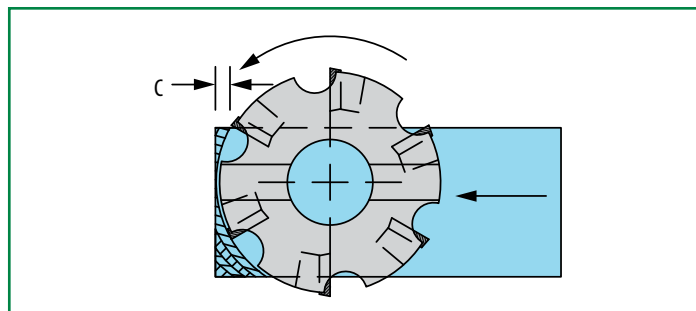


1. When the angle of entry (E1) is less than 90° , the initial impact occurs at a position behind the point of the tool. The insert has a greater section and is stronger here and better able to withstand the impacts.
2. When the angle of entry (E2) is greater than 90° , the initial impact between the insert and the part piece occurs at the point of the tool, which, especially in a positive rake milling cutter, is the weakest section of the insert. This can lead to insert failure.

Entering and Exiting the Cut



The angle of entry is always adverse as the cut commences. In the illustration, we can see that as the cutter travels through zone A, the angle of entry is changing. It starts out positive as the inserts first start to cut. As the cut progresses, it becomes less and less positive and eventually negative.



With a CNC machine, it is a worthwhile exercise to slow down the feed rate in zone A, especially with positive rake tools and hard to cut materials. As the cutter starts to break through at the end of the cut, another problem area is created in zone C.

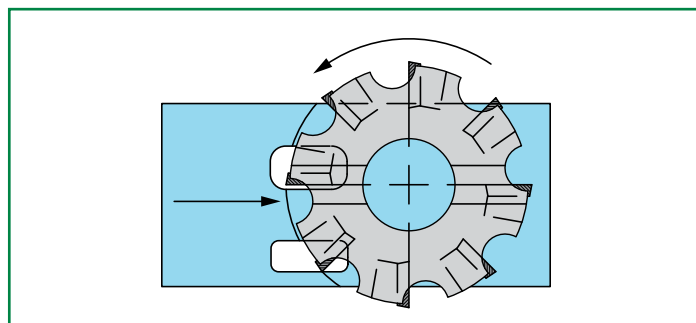
At this point, the cutter breaks through in the center, leaving two islands of material. Changes of entry angle occur which can result in insert problems. As in entry into the part, a reduction of feed rate can help alleviate chipping or breakage problems if they arise.

Interruptions

Milling is by definition an interrupted operation. In addition, as the cutter crosses voids in the part, changes of entry angle occur. This situation is usually too complex to define in absolute terms relative to a targeted solution.

Recognizing this in interrupted parts, try to include some of the following features in the set-up to reduce impact:

1. Negative or negative/positive geometry
2. Use a lead-angle cutter (30° or 45°) if possible
3. Use an impact-resistant carbide grade
4. Use a cutter with medium or fine pitch
5. Keep the load per tooth on the low end.



A Milling Cutter is a Series of Single-Point Tools

It is easy to lose sight of the fact that a milling cutter is nothing more than a series of single-point tools clamped into a rotating holder. If you always keep this in mind, you will be constantly reminded that what is most important to know is what is happening to each tool or insert.

The feed rate in inches per minute of machine table travel does not tell you anything important unless or until you calculate the feed per tooth. You cannot calculate the feed per tooth until you know the speed in revolutions per minute and how many teeth are in the cutter. Therefore, it should become second nature to ask, know, and consider the three “golden” variables:

1. How many inserts?
2. How many RPM?
3. What feed in inches per minute?

Use this formula to find feed per tooth:

$$\text{FPT} = \frac{\text{IPM}}{\text{No. of Teeth} \times \text{RPM}}$$

Once you know the feed per tooth, as a very broad general guide, try to keep the feed above .003” per tooth and remember that horsepower limitations usually come into play long before most cutters reach the upper limit.

Some heavy-duty cutters can be used as high as .030” or more per tooth, but this will need a machine in the 50+ horsepower class – and a larger cutter could well use over 100 horsepower!

For Additional Information about Milling with Ceramics

For additional information about milling with ceramics, go to the Application and Technical Information (ATI) section of the catalog.