

Milling

Pictorial Index..... M 02-03

Milling Cutters

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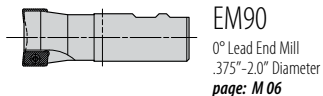
Technical Data for Milling M 41-45



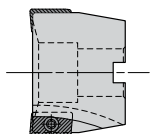
MILLING

Pictorial Index

Hushcut® Series II Milling System

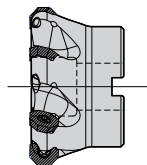


EM90
0° Lead End Mill
.375"-2.0" Diameter
page: M 06



FM90
0° Lead Face Mill
1.5"-6.0" Diameter
page: M 06

Index-O-Cut™ Milling System

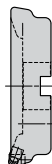


G-OFHP
High Positive Face Mill
Octagon/Round Inserts
2.0"-8.0" Diameter
page: M 10

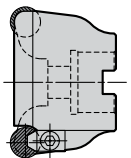
Exceleator Milling Cutters and Inserts



CP4 Series
Face Mill
Positive Rake Inserts, Cutters
and Nests
page: M 14

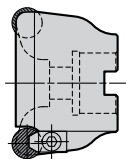


C4 Series
Face Mill
Negative Rake Inserts, Cutters
and Nests
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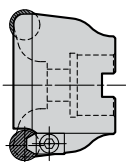


FMRP
Face Mill
Round Positive Inserts
2.0"-4.0" Dia.
page: M 18

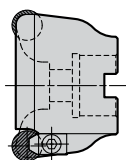
Exceleator Milling Cutters and Inserts *continued*



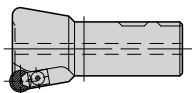
FMRPF
Face Mill (Fine Pitch)
Coolant Fed
Round Positive Inserts
1.50"-4.0" Dia.
page: M 18



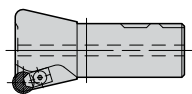
FMRN
Face Mill
Round Negative Inserts
2.0"-4.0" Dia.
page: M 19



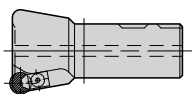
FMRNF
Face Mill (Fine Pitch)
Coolant Fed
Round Negative Inserts
1.50"-4.0" Dia.
page: M 19



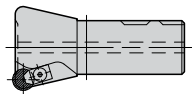
WSRP
End Mill
Round Positive Inserts
.625"-2.50" Dia.
page: M 20



WSRPF
End Mill (Fine Pitch)
Round Positive Inserts
Coolant Fed
.750"-2.0" Dia.
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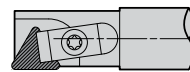


WSRN
End Mill
Round Negative Inserts
Inserts 1.0"-2.5" Dia.
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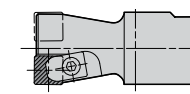


WSRNF
End Mill (Fine Pitch)
Coolant Fed
Round Negative Inserts
Inserts 1.0"-2.5" Dia.
page: M 22

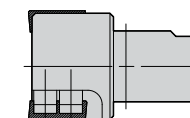
Exceleator Milling Cutters and Inserts *continued*



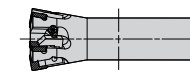
WSTP
End Mill
Positive Triangle Inserts
.5"-.625" Dia.
page: M 24



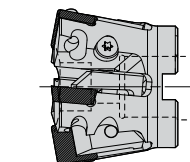
WSSP
End Mill
Positive Square Inserts
.375"-1.5" Dia.
page: M 25



WSAN
End Mill
Parallelogram Inserts
1.0"-2.50" Dia
page: M 26



XFSP
High-Feed Face Mill
Square Positive Inserts
1.0" - 1.5" Diameter
page: M 27

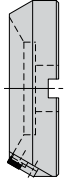


XFSP
High-Feed Face Mill
Square Positive Inserts
2" Diameter
page: M 27



SSBN
Ball Nose End Mill
Ball Nose Inserts
.375" - 1" Diameter
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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.

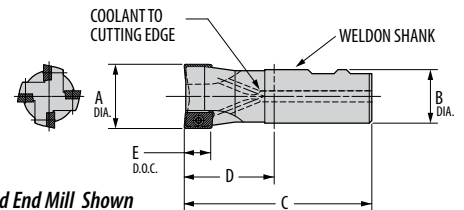
Greenleaf Tune-Up Kits

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EM90S/L

0° Lead End Mill



Right-Hand End Mill Shown

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

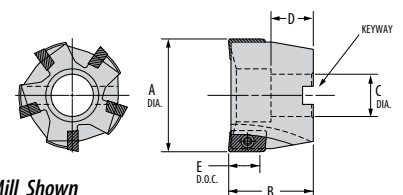
NOTE: For information on screw torque settings, please refer to the chart on page M38.

* 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



Right-Hand Face Mill Shown

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

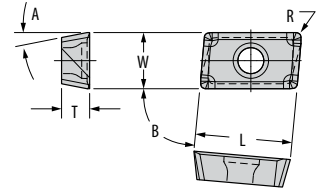
NOTE: For information on screw torque settings, please refer to the chart on page M38.

* 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

MILLING



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.

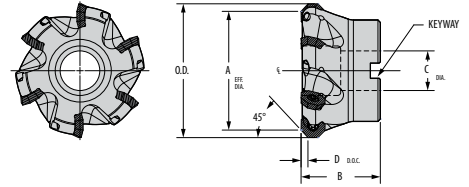
Greenleaf Tune-Up Kits

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.

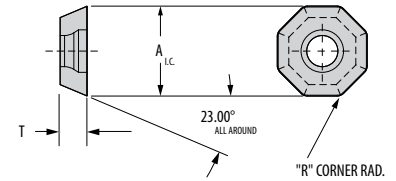
** Maximum depth of cut is 0.173".

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			
	OOEW-534	●	◆	▲	◆	▲	▲	◆	◆	▲	OOEW-060416	0.625	0.188	0.063

CARBIDE COATINGS: MT-CVD Coated PVD Coated Uncoated

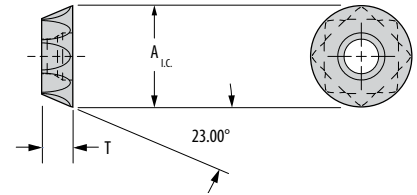
First Choice ◆ Second Choice ● Alternative ▲


Grade descriptions — pages M36–37

MILLING

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
HRSAs (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

MILLING



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.

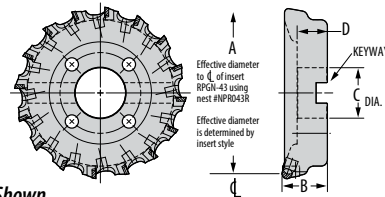
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CP4 Series

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

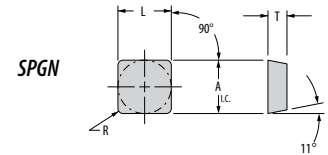
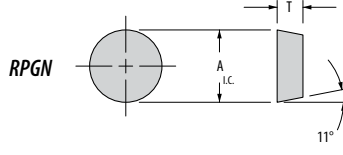
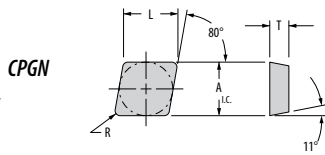
Nests

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	
	XFNS8043R	—	SPGN-433
	—	XFNS8043L	

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



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	
		GAS036	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 ▲

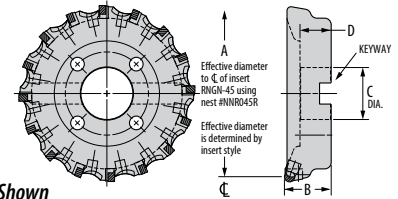
Grade descriptions — pages M 36–37

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

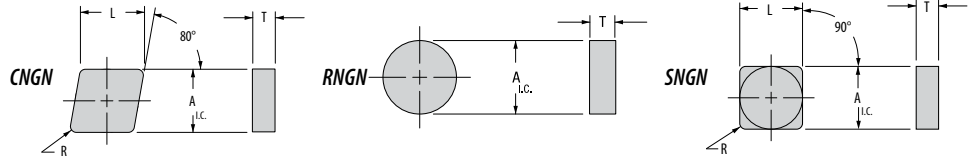
Nests

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

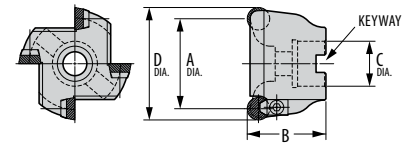
CERAMIC CLASSIFICATION: Whisker Ceramic Phase-Toughened Silicon Nitride Alumina TiC

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

MILLING

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	15L5	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	15L5	5/8x3/8	308341	#4-40x1/4 FHCS	3025-1	#10-32x1/2 SHCS	TK-04425

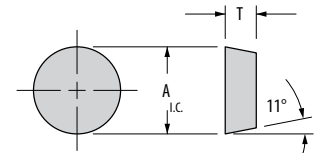
* Tune-Up Kits include all standard components and necessary wrenches to allow you to completely refurbish cutter.

** 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											
	RPGN-43	GA5036 ▲	G-915 ●	G-9120 ▲	G-915 ▲	G-9230 ◆	WG-600® ◆	G-9230 ◆	G-915 ▲	G-9230 ▲	WG-600® ●	WG-300® ▲	XSYTIN®-1 ◆	WG-300® ●	WG-600® ◆	XSYTIN®-1 ▲	RPGN-120400	0.500	0.187

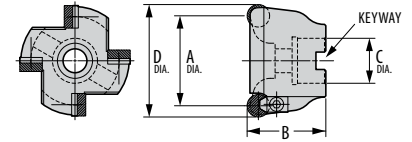
CARBIDE COATINGS: MI-CVD Coated PVD Coated Uncoated First Choice ◆ Second Choice ● Alternative ▲ Grade descriptions — pages M36-37

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	15L	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	15L	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.

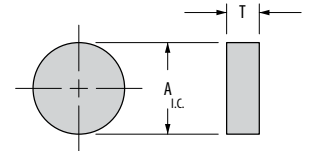
† FMRNF-150 will not accept RNGN-42 or RNGN-45.


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™	XSYTIN®-1	G-915	G-9230				WG-600®	WG-300®	XSYTIN®-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

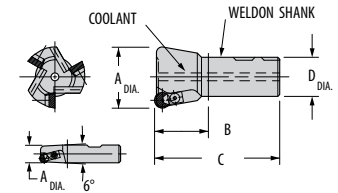
CERAMIC CLASSIFICATION: Whisker Ceramic Phase-Toughened Silicon Nitride Alumina TiC

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

MILLING

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.

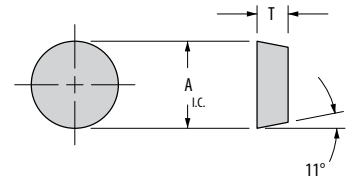
** Left-Hand cutters are made to order only.


† 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™	XYTIN®-1	G-915	G-9230	WG-600®	WG-300®	XYTIN®-1	WG-300®	WG-600®			
	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: **MI-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.

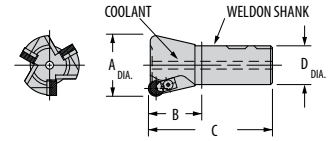
Maximum RPM

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.

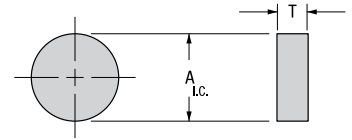
** Left-Hand cutters are made to order only.


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™	XSYTIN®-1	G-915	G-9230	WG-600®	WG-300®	XSYTIN®-1				WG-300®	WG-600®	XSYTIN®-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: IMC-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.

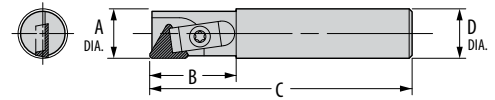
Maximum RPM

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

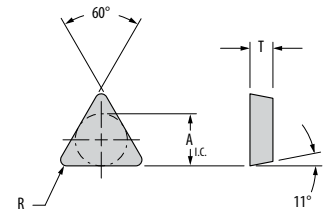
Part Number		Gage Inserts	Dimensions (inches)				No. of Inserts	Standard Components		*Tune-Up Kit
Right Hand	Left Hand		A	B	C	D		Clamp	Clamp Screw	
WSTP-70.50-RH		TPGN-222	0.500	0.875	2.66	0.500	1	429871	PT-317T	TK-00897
	WSTP-70.50-LH	TPGN-222	0.500	0.875	2.66	0.500	1	429871	PT-317T	TK-00897
WSTP-70.56-RH		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™	XSYTIN®-1	G-915	G-9230	WG-600®	WG-300®	XSYTIN®-1					WG-300®	WG-600®
	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.

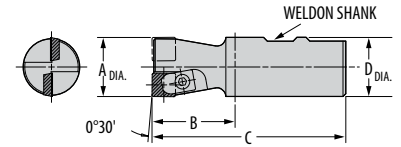
Maximum RPM

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

MILLING

WSSP

Square Positive End Mill



Right-Hand Cutter Shown

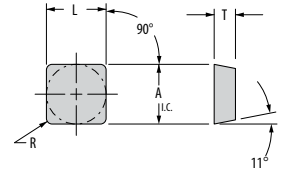
Part Number		Gage Inserts	Dimensions (inches)				No. of Inserts	Standard Components		*Tune-Up Kit
Right Hand	Left Hand		A	B	C	D		Clamp	Screw	
WSSP-70000.3-RH		SPGN-21.52	0.375	0.750	2.310	0.375	1	429871	PT-317T	TK-00897
	WSSP-70000.3-LH	SPGN-21.52	0.375	0.750	2.310	0.375	1	429871	PT-317T	TK-00897
WSSP-70000.5-RH		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	GSNT100™	XSYTIN®-1	G-915	G-9230	WG-600°	WG-300°						XSYTIN®-1	WG-300°
	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

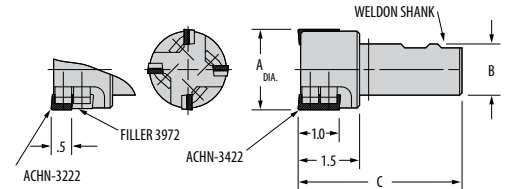
Cutter Part Number	Max RPM Carbide	Max RPM Ceramic
WSSP-70000.3	25,000	40,000
WSSP-70000.5	19,000	40,000
WSSP-70000.6	15,000	40,000
WSSP-70000.7	12,500	35,000
WSSP-70001	9,500	26,000
WSSP-70001.2	7,500	21,000
WSSP-70001.5	6,200	16,500

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

MILLING

WSAN

Parallelogram Positive End Mill



Right-Hand Cutter Shown

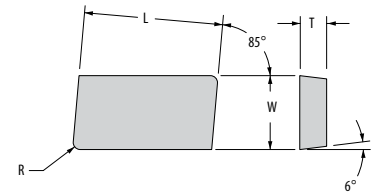
Part Number		Gage Inserts	Dimensions (inches)			No. of Inserts	Standard Components				*Tune-Up Kit	Optional Components	
Right Hand	Left Hand		A	B	C		Anvil	Anvil Screw	Clamp	Clamp Screw		Max. 1/2" D.O.C. Insert	Filler
WSAN-1-RH		ACHN-3422	0.985	0.750	3.750	2	—	#4-40x1/4 FHCS	410756	#8-32x9/32 IPBHCS	TK-00642	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														
	ACHN-3422	GA5036	G-915	G-9120	G-915	G-9230	WG-600®	GA5023	G-915	GSNT100™	XYTIN®-1	G-915	G-9230	WG-600®	WG-300®	XYTIN®-1	WG-300®	WG-600®	XYTIN®-1	ACHN-250308	0.125	0.375	1.000	0.031
	ACHN-3222	GA5036	G-915	G-9120	G-915	G-9230	WG-600®	GA5023	G-915	GSNT100™	XYTIN®-1	G-915	G-9230	WG-600®	WG-300®	XYTIN®-1	WG-300®	WG-600®	XYTIN®-1	ACHN-120308	0.125	0.375	0.500	0.031
	ACHN-3422LH	GA5036	G-915	G-9120	G-915	G-9230	WG-600®	GA5023	G-915	GSNT100™	XYTIN®-1	G-915	G-9230	WG-600®	WG-300®	XYTIN®-1	WG-300®	WG-600®	XYTIN®-1	ACHN-250308LH	0.125	0.375	1.000	0.031
	ACHN-3222LH	GA5036	G-915	G-9120	G-915	G-9230	WG-600®	GA5023	G-915	GSNT100™	XYTIN®-1	G-915	G-9230	WG-600®	WG-300®	XYTIN®-1	WG-300®	WG-600®	XYTIN®-1	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

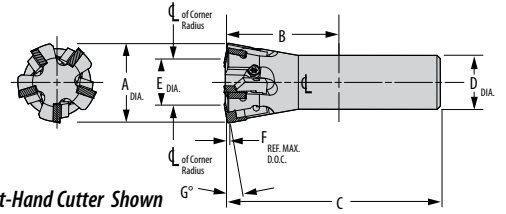
NOTE: For additional nose radii and available edge preps, please contact Greenleaf Tech Team.

MILLING

Excelerator® XF

Positive High-Feed Mills

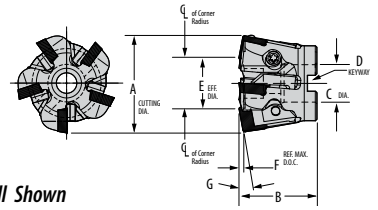
1" and 1-1/2" High-Feed End Mill / Square Positive Inserts



Right-Hand Cutter Shown

Cutter Order Number	Insert	Dimensions (inches)							No. of Inserts	Standard Components			Max RPM Carbide	Max RPM Ceramic
		A	B	C	D	E	F	G		Clamp	Clamp Screw	*Tune-Up Kit		
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.



Right-Hand Face Mill Shown

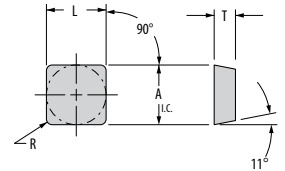
2" High-Feed Face Mill / Square Positive Inserts

Cutter Order Number	Insert	Dimensions (inches)							No. of Inserts	Standard Components			Max RPM Carbide	Max RPM Ceramic
		A	B	C	D	E	F	G		Clamp	Clamp Screw	*Tune-Up Kit		
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™	XSYTIN®-1	G-915						G-9230	WG-600®	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

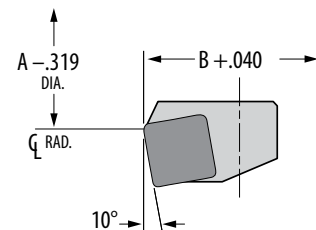
NOTE: For additional nose radii and available edge preps, please contact Greenleaf Tech Team.

XFNPS

Nest for CP4 Series

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

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



MILLING

Performance Calculations

Starting Speeds and Feeds for Excelerator XF®

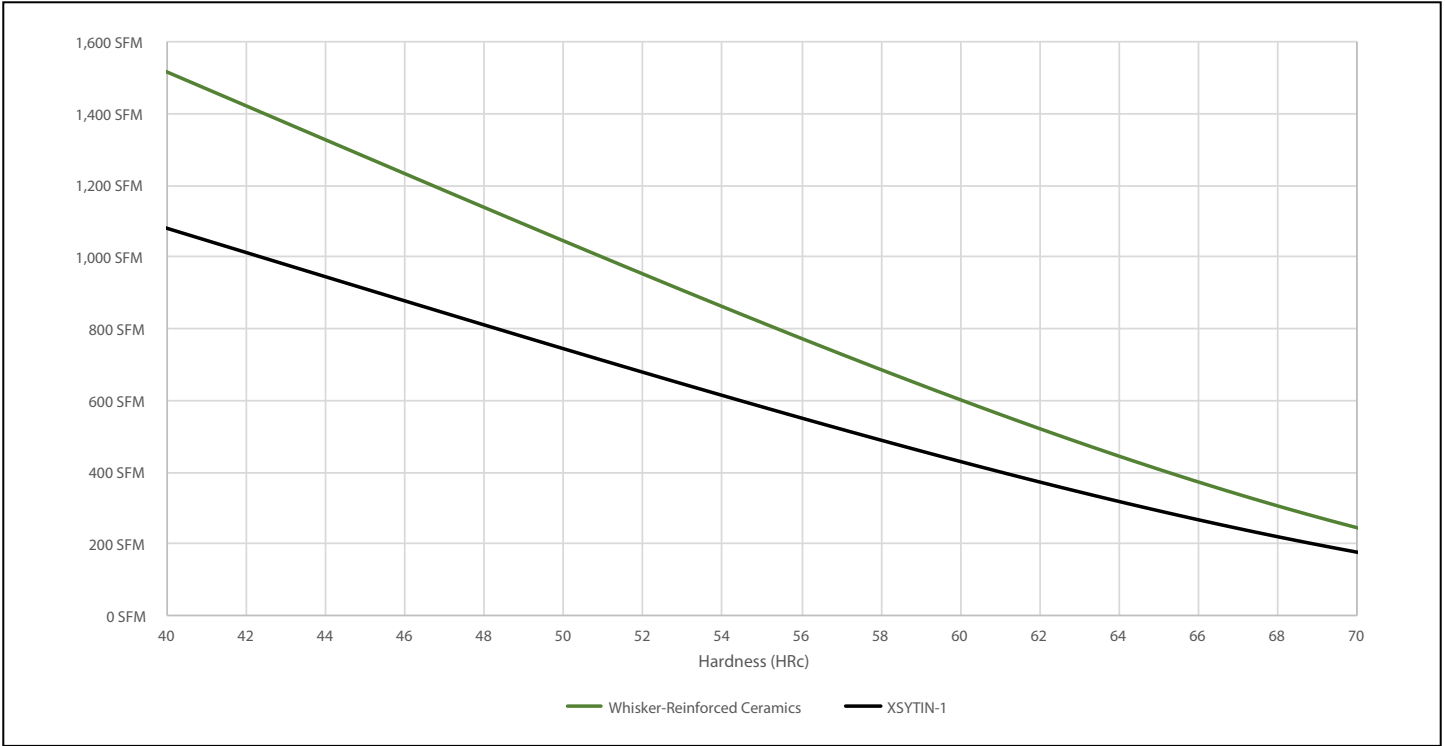
Material	Hardness	Insert Grades	Cutting Speed (SFM)	Target Chip Thickness (inches)	Recommended Feed per Tooth (IPT) Width of Cut (% of Effective Diameter)		
					15%	30%	45%+
Steel	60-65 HRC	WG-600®	500	0.0015	0.0121	0.0094	0.0087
	50-59 HRC	WG-600®	800	0.002	0.0162	0.0126	0.0116
	40-49 HRC	WG-600®	1300	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

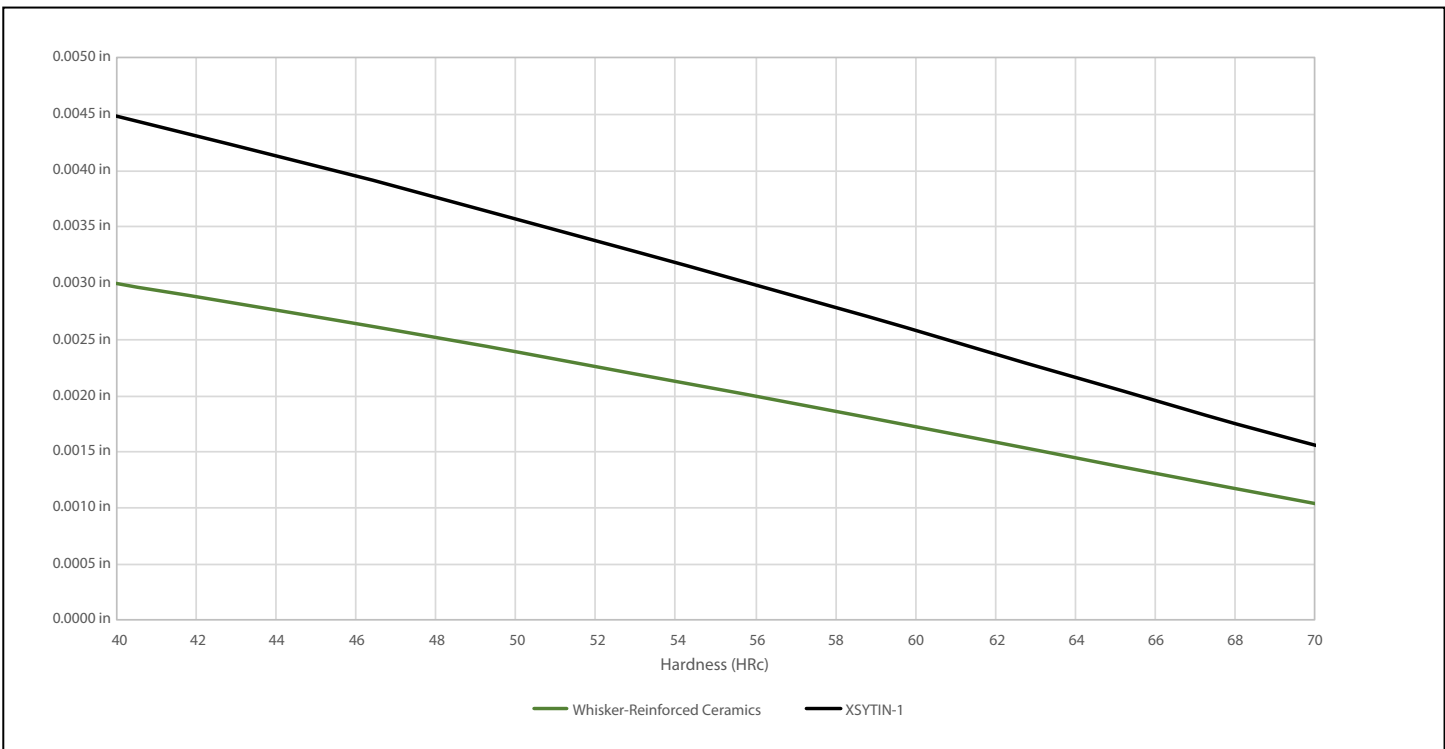
Depth of Cut	XFSP-010-EM	XFSP-015-EM	XFSP-020-EM	CP4 Series Face Mills: XFNPS8043 Nest						
	1"	1.5"	2"	3"	4"	5"	6"	8"	10"	12"
0.01	0.6875	0.9413	1.1832	2.8031	3.8031	4.8031	5.8031	7.8031	9.8031	11.8031
0.02	0.8014	1.0552	1.2954	2.9170	3.9170	4.9170	5.9170	7.9170	9.9170	11.9170
0.03	0.9152	1.1690	1.4076	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

Milling Hardened Steel, Cutting Speed (Vc)



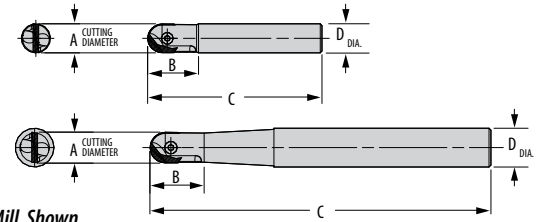
Milling Hardened Steel, Average Chip Thickness (Hm)



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.

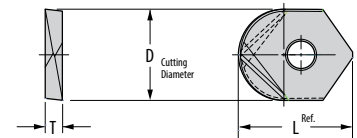
NOTE: For information on screw torque settings, please refer to the chart on page M38.

* 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	Material						Dimensions (inches)							
		Steel		Cast Iron		Heat-Resistant Super Alloys		Hardened Steel		L	T	D			
		P	M	K	S	H									
		G-925	G-925	G-925	WG-600®	XYTIN®-1	G-925	WG-600®	XYTIN®-1	G-925	WG-600®	XYTIN®-1			
	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

MILLING

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
		XSYTIN®-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
		XSYTIN®-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
		XSYTIN®-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
		XSYTIN®-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
		XSYTIN®-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
		XSYTIN®-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
		XSYTIN®-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
		XSYTIN®-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.

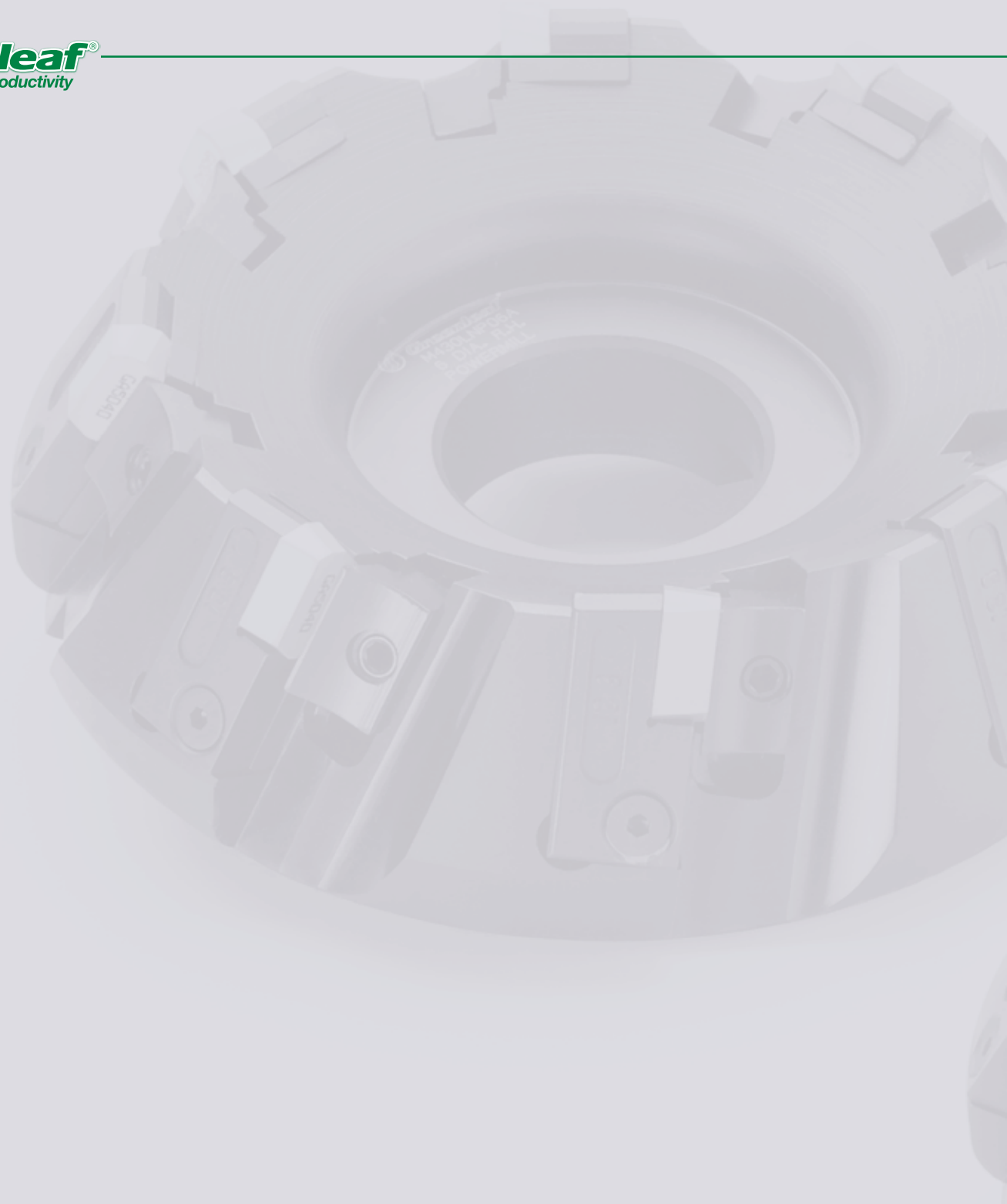
** Maximum recommended depth of cut (DOC) when using XSYTIN-1 & G-925 is 20% of the insert diameter, and 15% of the insert diameter when using WG-600.

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 XSYTIN®-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.

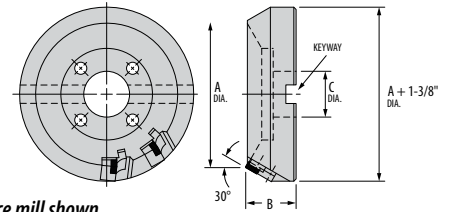
Greenleaf Tune-Up Kits

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

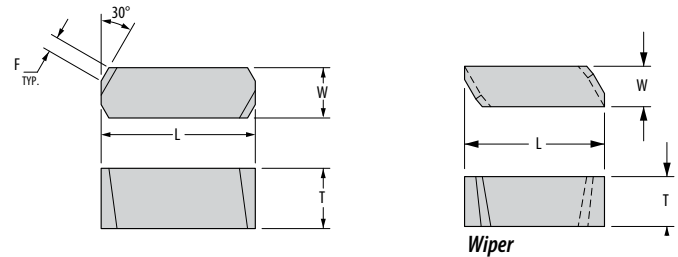
30° Lead, Neg-Pos



Right-hand face mill shown

Part Number		Gage Insert	No. of Inserts	Wiper Insert	Dimensions (inches)					Standard Components				*Tune-Up Kit	Optional †Anvil
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.



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					
	LNP-335R	◆	▲	●	●	◆	0.312	0.375	0.750	0.100
	LNP-335L	◆	▲	●	●	◆	0.312	0.375	0.750	0.100
	LNP-335RW	◆	▲	●	●	◆	0.312	0.355	0.850	N/A
	LNP-335LW	◆	▲	●	●	◆	0.312	0.355	0.850	N/A
	LNP-34.57R	◆	▲	●	●	◆	0.437	0.375	1.125	0.100
	LNP-34.57L	◆	▲	●	●	◆	0.437	0.375	1.125	0.100
	LNP-34.57RW	◆	▲	●	●	◆	0.437	0.355	1.228	N/A
	LNP-34.57LW	◆	▲	●	●	◆	0.437	0.355	1.228	N/A

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

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.

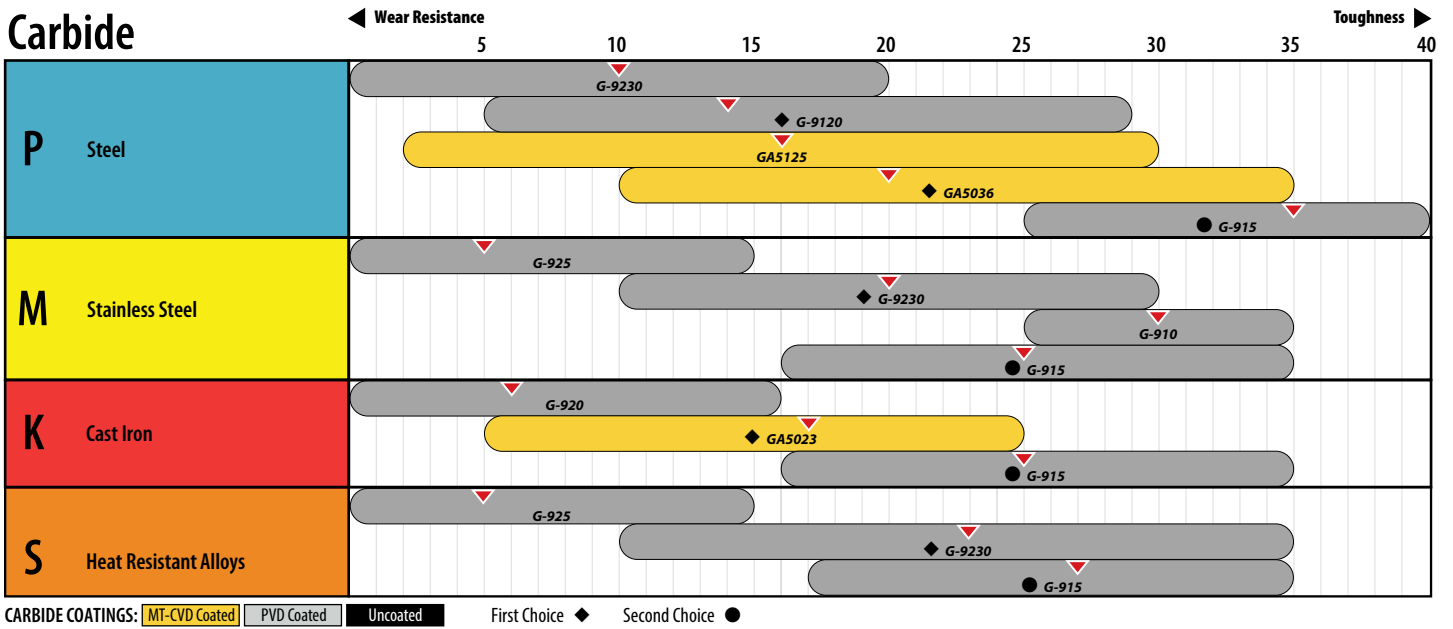
Wiper inserts can be used effectively in a single pocket in smaller diameter cutters and in multiples of two or three in larger cutters to produce a superior finish.

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.

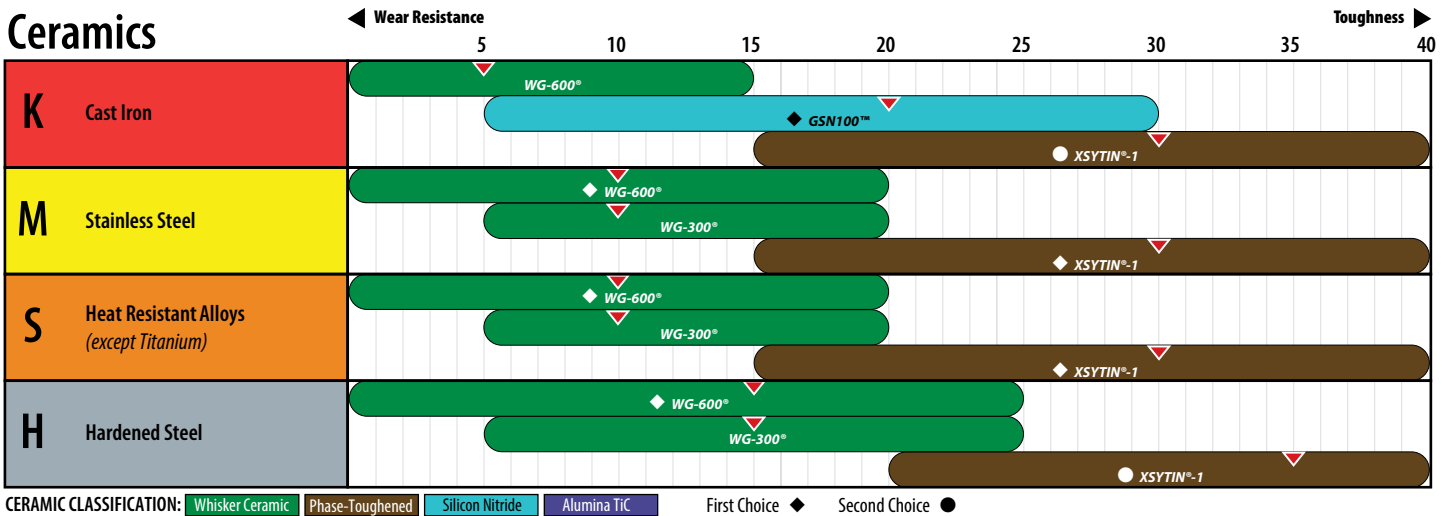
Always bear in mind that the majority of finish problems in milling come from lack of rigidity of the set-up, deflection of the part piece or machine spindle, excessive overhangs, and poor cleanliness and assembly practices in the cutter body. Wiper inserts cannot be expected to resolve these problems.

Insert Grade Reference for Milling

Carbide



Ceramics



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.



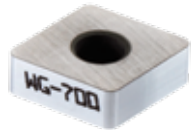
WG-300®

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

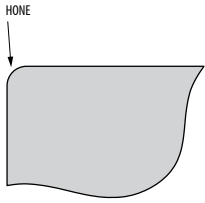
Screw Type	Part Number	Screw Torque (in-lbs)	Wrench
Insert Screw	PT-589T	8	T7
	313631	8	T7
	PT-542T	8	T7
	PT-559T	23	T15
	312679	23	T15
	PT-546T	45	T20
	SM30-083	17	T10+
	SM40-106	26	T15+
	SM50-1139	52	T20
	SM60-167	77	T25
SM70-210	95	T20	
Wedge Screw	430578	85	3/16
	425606	85	3/16
	XNS-58	95	5/32
Nest 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

Excelsator[®] Mills

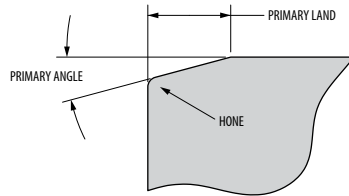
Setup and Operational Procedures

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 Excelsator Milling Cutter.
3. Use Greenleaf Excelsator Mills only on machines that have adequate shield guards.
4. Run the Greenleaf Excelsator 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 Excelsator 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.

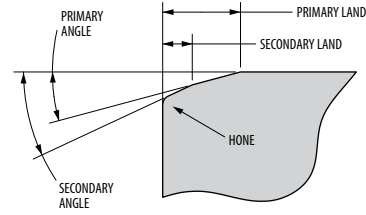
Ceramic Edge Preparations



HONE



PRIMARY ANGLE



SECONDARY ANGLE

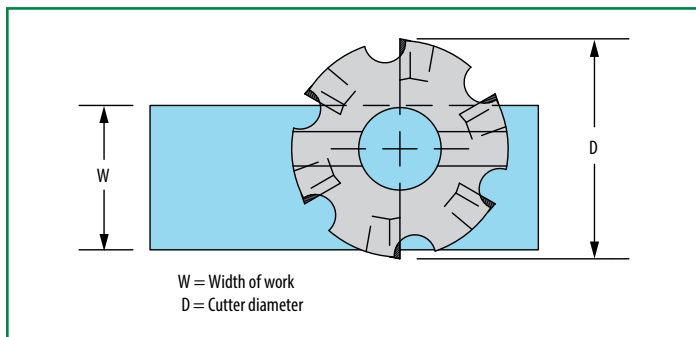
Edge Prep	Hone	Primary Land	Primary Angle	Application
A	.0005 - .001" R.			Light hone added to designated lands and chipforms • XSYTIN®-1 – General-purpose milling of HRSA, hardened steel, and maraging steel
T1		.002 - .004"	20°	• XSYTIN®-1 – General-purpose milling of high-hardness HRSA, and hardened 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

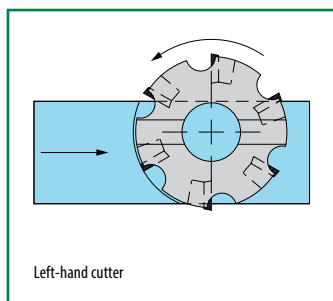
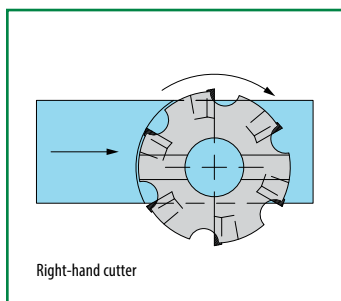
Select a cutter diameter greater than the workpiece width by a ratio of approximately 1.5 to 1. This will ensure that each insert enters the cut without the frictional, no-chip phase which occurs when attempting to cut the full cutter diameter. Also, the insert leaves the part without reducing the chip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



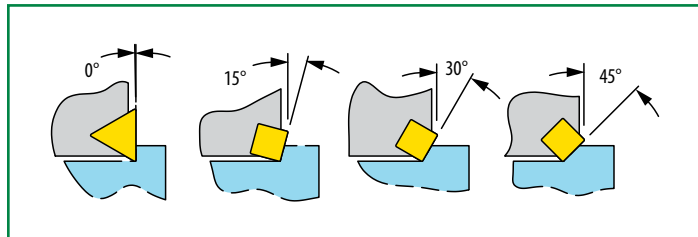
A *right-hand cutter* is one which, when viewed from above, rotates clockwise relative to the workpiece.

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.

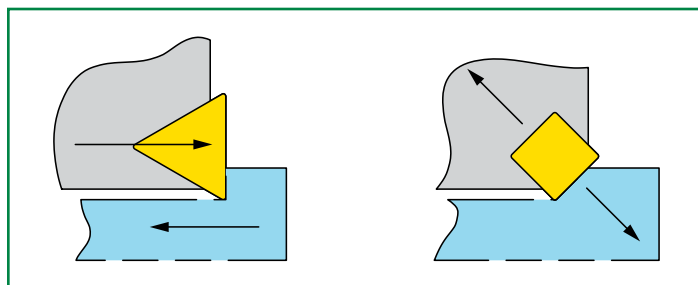
Lead Angles and Cutting Forces

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.

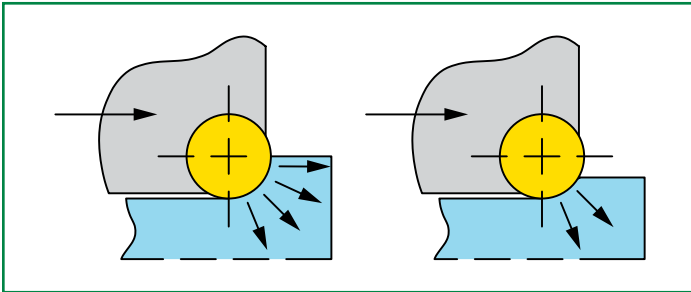
For example, in a thin section workpiece, a high lead angle may cause deflection since there is more tendency to “push” the part away from the cutter. On the other hand, a 0° lead cutter has more deflective force on the machine spindle.

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

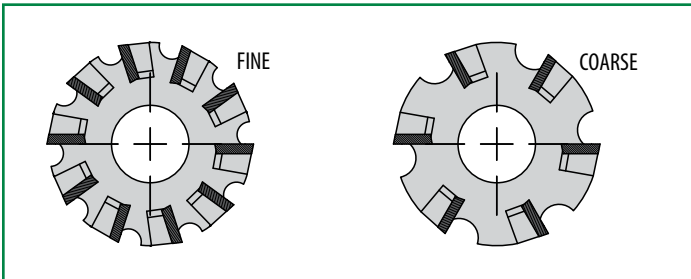
The exception to the rule in lead angle cutting forces is the round insert. With a round insert, the lead angle is entirely dependent upon the depth of cut. As the depth increases, the lead angle decreases. If cutting half the diameter deep, there is effectively 0° lead angle.



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.

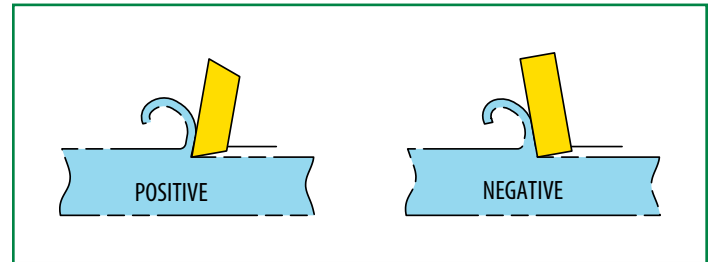
Negative Versus Positive Geometry

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.

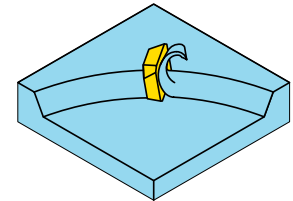
In general, use negative rakes for cast iron, interrupted cuts, and on rigid high horsepower machining for steels.

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



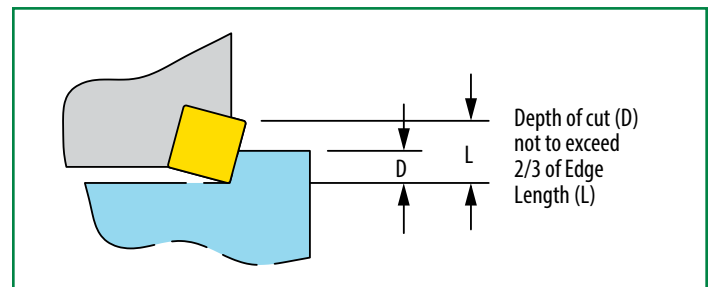
There are many milling cutters with a combination of positive and negative rakes often called shear-angle design. These cutters offer some of both worlds, although inserts are essentially like positive inserts and cannot be turned over. Shear angle cutters do provide continuous chip ejection since the 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.



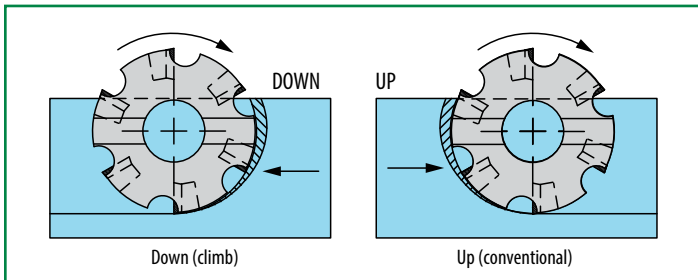
Depth of Cut

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.

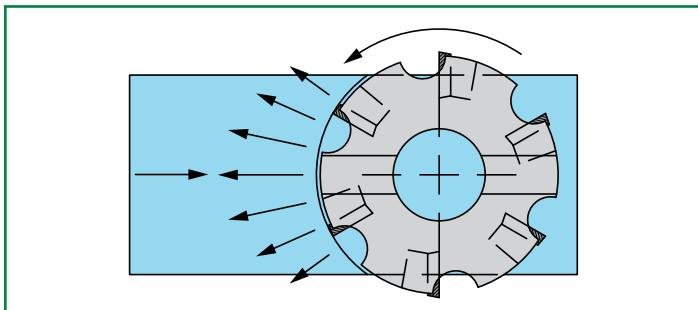


With a modern machine in good condition, down milling will give the best results. This is because the thickest section of the chip is against the insert to avoid welding, and pressure is progressively relieved towards the finished surface.

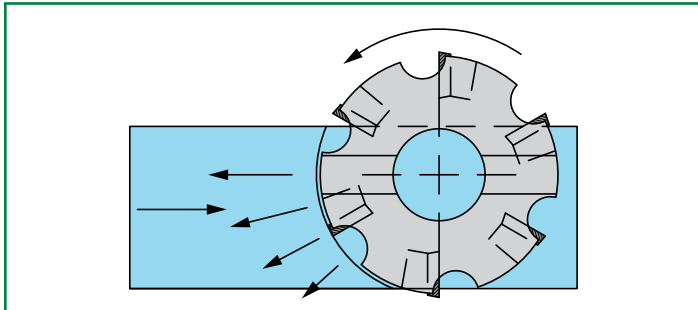
In up milling, friction and pressure build up before the chip starts to form, causing premature edge wear. It should be in rare cases that up milling is needed. This could be, for example, on an older machine with backlash in the table feed.

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.

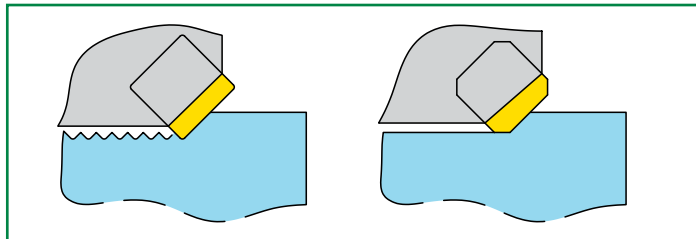


When moving off center, the path of cut is longer since each insert now sweeps a longer arc with each revolution. This may have a measureable impact on tool life, and cutting temperature will tend to increase.

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.

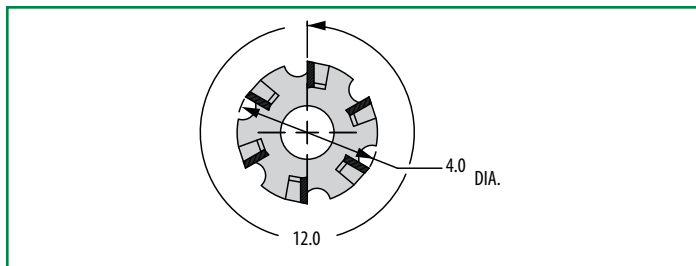
The 4" Reference for Speed Calculations

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

π = 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)

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

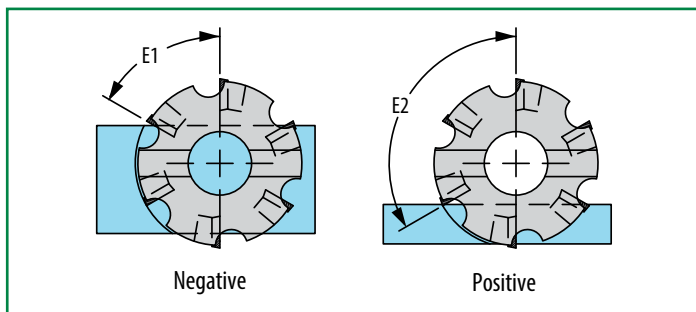
IPM = Inches per minute feed rate

K = K Factor

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

Angle of Entry

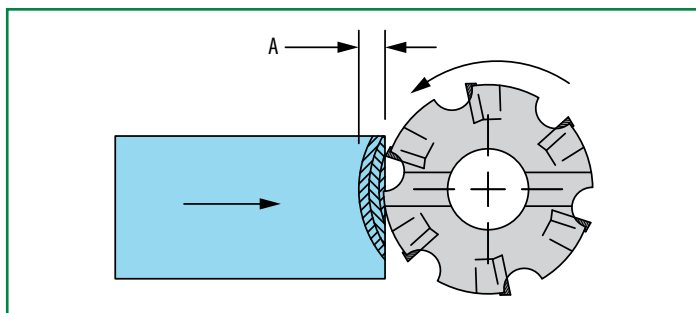
In face milling operations, the angle of entry can have a significant impact upon insert performance. A positive angle of entry can cause breakage or chipping, especially when using positive inserts. Positive angle of entry will occur when the path of cut is narrow relative to cutter diameter.



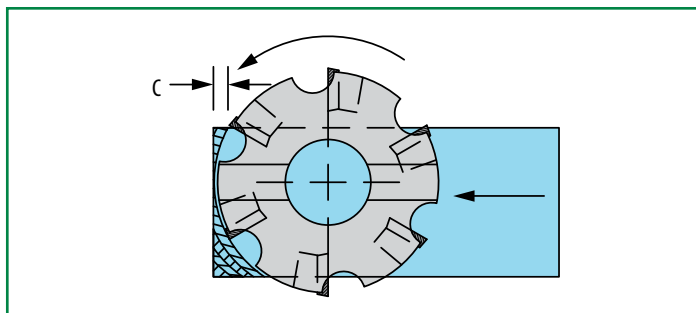
1. When the angle of entry (E1) is less than 90° , the initial impact occurs at a position behind the point of the tool. The insert has a greater section and is stronger here and better able to withstand the impacts.

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.

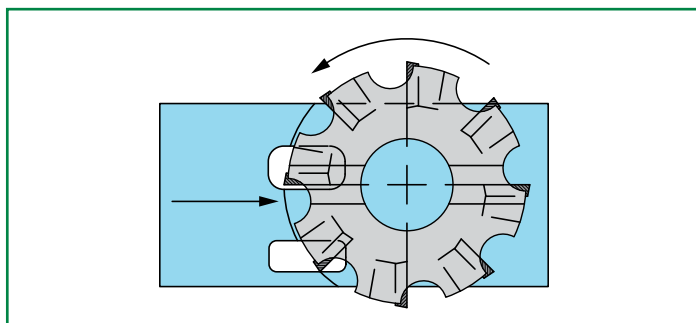
At this point, the cutter breaks through in the center, leaving two islands of material. Changes of entry angle occur which can result in insert problems. As in entry into the part, a reduction of feed rate can help alleviate chipping or breakage problems if they arise.

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.