



Greenleaf®
Sustainable Productivity



PRODUCTGUIDE

SOLID CERAMIC & CARBIDE END MILLS



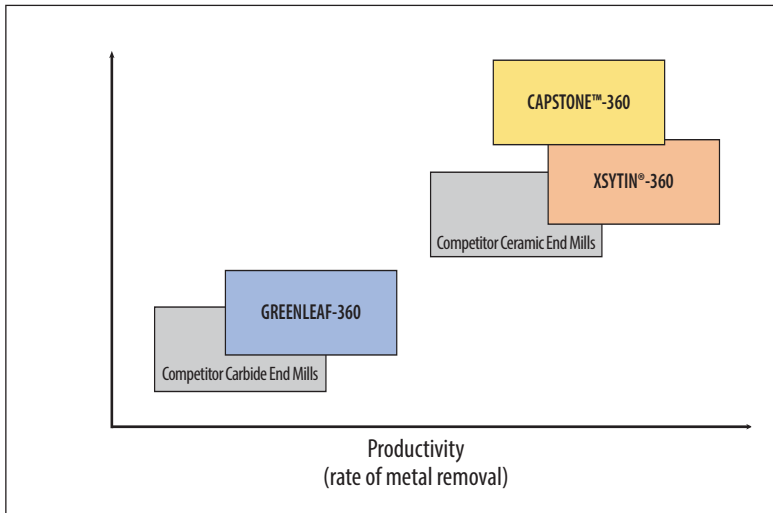


Capstone™-360 Ceramic Tipped, Carbide Shank End Mills

Speed and efficiency of solid ceramic end mills with the strength and stability of a carbide shank!

Capstone™-360, a new line of high-performance end mills featuring a ceramic tip combined with a carbide shank, offering up to 50% higher tool life compared to most commercially available solid ceramic endmills. Designed for superior performance in Heat-Resistant Super Alloys and select Cast Irons. Capstone™-360 excels in applications such as slotting, pocketing, and face milling.

Capabilities



Materials

Proven performance in machining a variety of different materials:

- Heat-Resistant Super Alloys (HRSA)
- Cast Iron

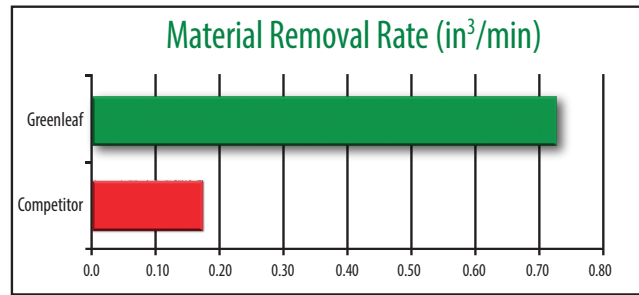
Unique Features & Benefits of Capstone™-360:

- Optimized cost vs. performance – Delivers an exceptional balance of productivity and tool life, maximizing value.
- Lower heat generation – The unique combination of geometry and chemistry optimized for Ni-base HRSA results in lower cutting forces and significantly less heat generation.
- Necked for clearance – All tools feature a neck that allows access to cavities and facilitates programming in shoulder milling while maintaining rigidity.
- Versatility – Capstone™-360 performs well at a wide range of cutting speeds in HRSA, and offers similar cycle time and cost reduction benefits in most face-milling applications in cast iron.
- Toughness and stability - the carbide shank dampens vibrations that are otherwise so detrimental to ceramic wear and allows for predictability and stability in longer-reach applications.

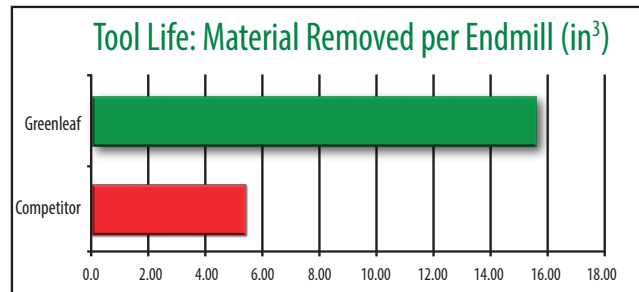


Case Study

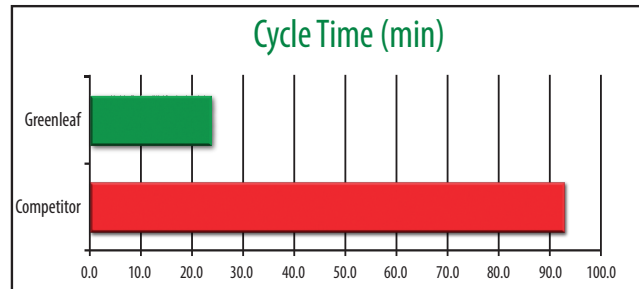
MATERIAL: INCONEL 718 (45 HRC)	COMPETITOR		GREENLEAF	
TOOLING EVALUATED	IMPERIAL	METRIC	IMPERIAL	METRIC
PRODUCT DESIGNATION:	High-Performance Carbide		GME4C08127G08530	
(Dc) END MILL DIAMETER [in/mm]:	0.630	16	0.630	16
CORNER RADIUS SIZE [in/mm]:	0.050	1.27	0.050	1.27
GRADE:			Capstone™-360	
CUTTING PARAMETERS				
(Revolutions per Minute) RPM:	849	849	10142	10142
(Deff) EFFECTIVE END MILL DIAMETER [in/mm]:	0.630	16	0.622	15.79
(Vc) SURFACE SPEED [SFM/m/min]:	140	43	1650	503
(Fz) FEED RATE [IPT/mm/ft]:	0.0024	0.0610	0.0012	0.0305
(z) NUMBER OF FLUTES [#]:	5	5	4	4
(Vf) FEED SPEED [IPM/mm/min]:	10.2	259	48.7	1236
(DOC Ap) DEPTH OF CUT [in/mm]:	0.450	11.43	0.030	0.76
(WOC Ae) WIDTH OF CUT [in/mm]:	0.040	1.0	0.500	12.7
(Hm) AVERAGE CHIP THICKNESS [in/mm]:	0.00059	0.0150	0.00079	0.0202
(MRR Q) METAL REMOVAL RATE [in³/min cm³/min]:	0.183	3.00	0.730	11.97
TOOL PERFORMANCE				
(LOC) LENGTH OF CUT PER PASS [in/mm]:	438	11132	35	891
PASSES PER PART:	2	2	30	30
(Tc) CUT TIME PER PART [min]:	86.0	86.0	21.6	21.6
MATERIAL REMOVED PER TOOL [in³ cm³]:	5.3	86.2	15.8	258.6
NUMBER OF TOOLS USED PER PART:	3	3	1	1
TIME TO CHANGE TOOLS [min]:	2	2	2	2
TOTAL LINEAR DISTANCE [in/mm]:	877	22263	1052	26716
TOTAL MACHINE TIME [min]:	92.0	92.0	23.6	23.6



75% cycle time reduction with 4X the metal removal rate!



Capstone™-360 boasts 3x tool life compared to carbide endmills!



Cycle time reduced from 1.5 hours to only 23.5 minutes in Inconel 718!

Recommendations for Best Performance

- Continue to use the tool until the sound of machining changes or there's a spike in spindle load – this is end of life. As long as chips remain the same color and the sound of machining does not suddenly change – wear is regular. Do not judge the wear of this tool by carbide endmill standards – as the ceramic material is used up new cutting edges are exposed and machining continues in a predictable, reliable manner. The effective diameter will continue to decrease as the tool wears – account for this by programming a draft angle (0.5° for every 30mins in cut) on vertical surfaces or using 80% of the effective diameter for WOC (Ae) in face-milling operations.
- In HRSA - intended for roughing only. Leave at least .010" (0.25mm) stock for finishing. Recommend leaving .020-.025" stock for finishing.
- Workpiece fixturing must be rigid to reduce vibrations
- Use of precision milling chucks (press-fit/hydraulic/shrink-fit) required. The lower the runout the better, and they must be rated for high rpm.
- Reduce tool overhang as much as the application allows

	Imperial (inch)	Metric (mm)
Diameter	0.2500 - 0.7500	6 - 20
Overall Length	3.150	80
Corner Radius	0.050	1.



XYTIN®-360

Substrate

XYTIN®-360 ceramic end mills combine Greenleaf's phase-toughened XYTIN®-1 substrate with a unique cutting geometry that offers ten times higher productivity and tremendous cost savings. The strength of the material allows the user to apply chip loads similar to solid carbide end mills with higher speeds common to ceramic machining. These new ceramic end mills provide customers with significant increases in productivity over current solid carbide or ceramic products.

Speeds and Feeds

- Capable of slotting, pocketing with ramping, and profiling applications maintaining heavy chip loads
- A very broad application range means numerous machining centers are capable of running these end mills
- Extremely versatile end mills with twice the feed rate capability and a much broader speed range!

Materials

Proven performance in machining a variety of different materials:

- High-temperature alloys
- Hardened steels
- Ductile cast irons
- Compacted graphite iron (CGI)
- 3D-printed sintered high-temperature alloys



4-Flute

4-flute end mills allow for maximum material removal in all applications. Unique flute design minimizes cutting forces, which reduces vibrations and optimizes tool life.

	Imperial (inch)	Metric (mm)
Diameter	0.3125 - 0.7500	8 - 20
Overall Length	2.250- 3.250	60 - 80
Corner Radius	0.031 - 0.094	1.00 - 2.00



Greenleaf-360 Carbide End Mills

Substrate

As with building anything, a solid foundation is required to have the strongest structure. Greenleaf-360 carbide end mills are no exception! Extensive testing of various substrates allowed us to select a substrate that has proven capability in a wide variety of materials- from low carbon steel alloys to heat-resistant special alloys. This sub-micron grade carbide provides toughness and wearability to offer customers one grade to be applied in many applications.

Coating

A uniquely applied PVD coating is standard on all Greenleaf-360 products to provide added productivity and performance. This coating offers a very low coefficient of friction with an extremely high service temperature range. This combination offers high wear resistance and allows for higher speed capabilities, especially in heat-resistant alloys.

Performance

Greenleaf-360 carbide end mills offer an excellent combination of strength, toughness, and heat resistance that enables machining capabilities from roughing to finishing with extended tool life and predictability. Greenleaf-360 high-performance end mills have shown speed and feed performance 25-50% higher than the competition with extended tool life.



SCAN TO VIEW
FULL CATALOG

4-Flute

4-flute end mills excel in any application where heavy material removal rates are required. Primarily targeted for full slotting, the 4-flute geometry may also be used for profiling at any stepover.

	Imperial (inch)	Metric (mm)
Diameter	0.1250 - 0.7500	4 - 20
Overall Length	1.500 - 5.000	50 - 100
Corner Radius	SQ - 0.120	SQ - 3.00

5-Flute

5-flute end mills are an excellent all-around shop tool for various profiling applications with stepovers ranging from light to heavy at an axial cutting depth up to two times the tool diameter.

	Imperial (inch)	Metric (mm)
Diameter	0.2500 - 0.7500	6 - 20
Overall Length	2.000 - 6.000	50 - 100
Corner Radius	SQ - 0.120	SQ - 2.00

7-Flute

7-flute end mills are the best choice for high-speed machining or high-efficiency milling and in profiling applications with up to 20% radial engagement at an axial cutting depth up to two times the tool diameter.

	Imperial (inch)	Metric (mm)
Diameter	0.2500 - 0.7500	6 - 20
Overall Length	2.000 - 5.000	50 - 100
Corner Radius	SQ - 0.120	SQ - 2.00



Special Tooling

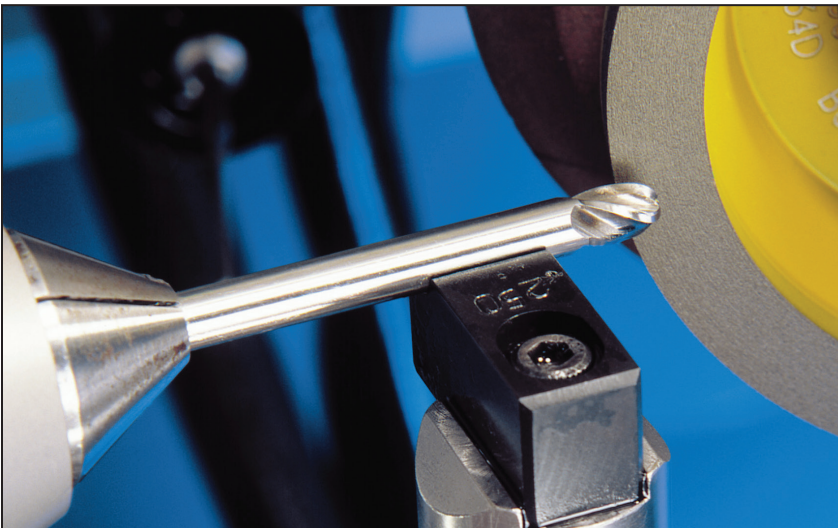
XSYTIN®-360 and Greenleaf-360

We recognize that many customers have special applications that may require tools that are not offered in our catalog. From special corner radii and chamfer end mills to added neck relief for straight or tapered shanks to ball end mills or complete custom tools - Greenleaf has the capability to quote and manufacture all forms of specials. Special tools can be produced from ceramic or carbide blanks to provide customers with options for the highest level of productivity.

For special applications or tool styles that are not shown in our standard catalog, please contact your local Greenleaf Sales & Service Engineer or Greenleaf Customer Service.



Regrind Services



XSYTIN®-360

XSYTIN®-360 ceramic end mills are not reground in the traditional manner of carbide end mills. The shorter flute length allows for the capability to re-manufacture XSYTIN-360 end mills with new flutes. The entire used flute geometry is removed from the end of the tool, and new flutes are ground to the original specifications for diameter, length of flute, and corner radius. Performance of the re-manufactured tool matches that of brand new tools with the only difference being the overall length.

Greenleaf-360

All Greenleaf-360 carbide end mills can be resharpened and re-coated to match the same quality specifications of new product. Please note that the diameter and overall length could be reduced during the regrind process. Matching the geometry, edge preparation, and coating to original specifications will offer customers the maximum performance for a reground product. This service provides customers with added cost savings by providing more useful life from the same tools at a fraction of the cost of new product.

For more information about our regrind services, please contact your local Greenleaf Sales & Service Engineer or Greenleaf Customer Service.



Greenleaf Corporation is a world leader in ceramic cutting tools!

Greenleaf Corporation

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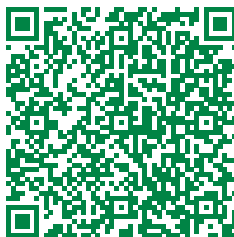


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Greenleaf Corporation is a leading supplier of industrial cutting tools, specializing in the manufacture of high-performance tungsten carbide and ceramic grade inserts and innovative tool-holding systems. Greenleaf continues to build on nearly 80 years of innovation and the legacy established by its founder Walter J. Greenleaf, Sr., which centers on supplying customers with productive solutions to every metal-cutting situation.

Discover more at: <https://greenleafcorporation.com>



MADE IN THE USA

*Greenleaf Corporation
is ISO 9001 Certified.*