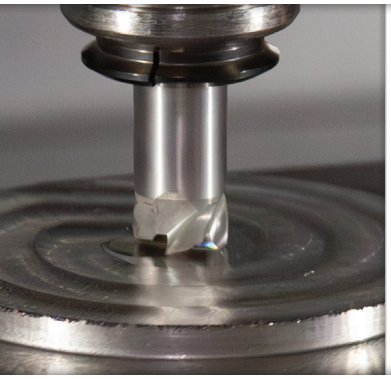
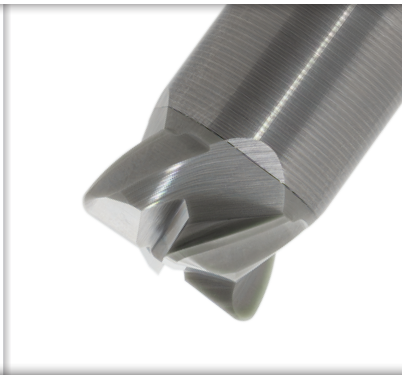
Greenleaf®

Sustainable Productivity



CERAMIC TIP END MILLS

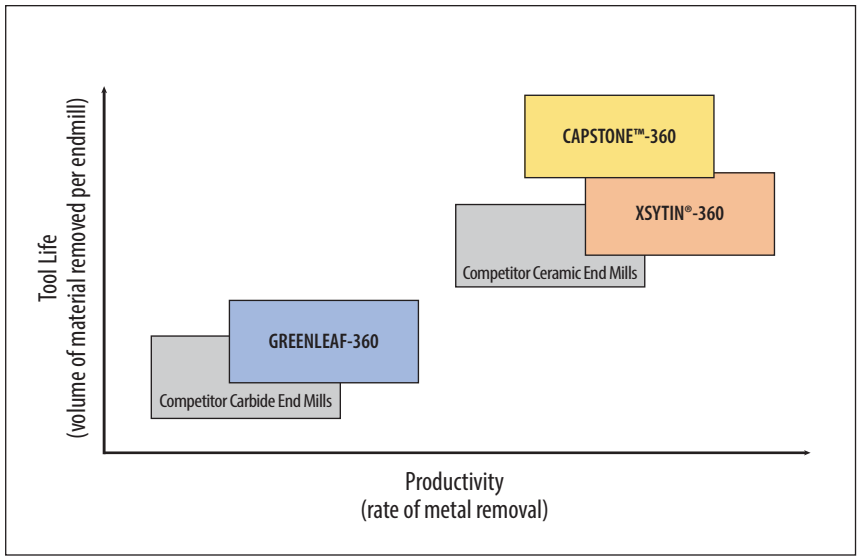
CAPSTONE™ 360 By Greenleaf

Product Highlights

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:

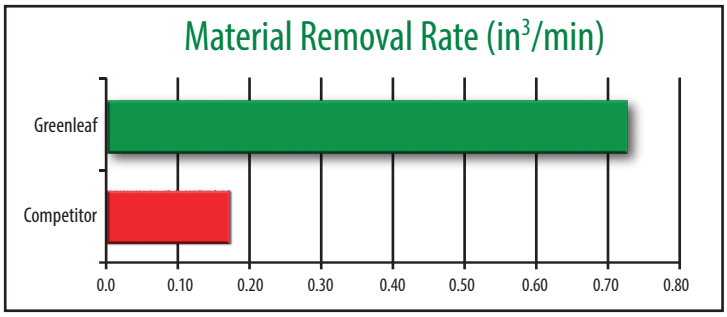
- Heat-Resistant Super Alloys (HRSA)
- Cast Iron

Unique Features & Benefits of Capstone™-360:

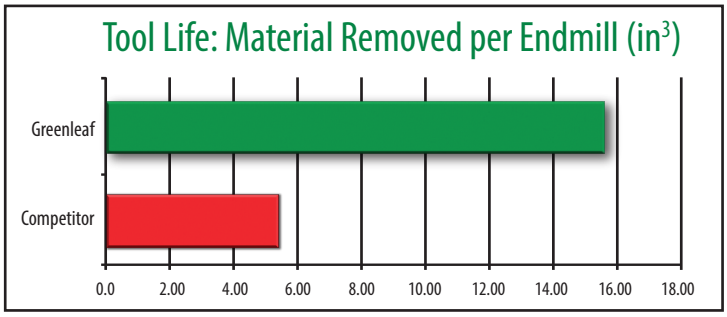
- Optimized cost vs. performance – Delivers an exceptional balance of productivity and tool life, maximizing value.
- Lower heat generation – The unique combination of geometry and chemistry optimized for Ni-base HRSAs results in lower cutting forces and significantly less heat generation.
- Necked for 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 HRSAs, 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

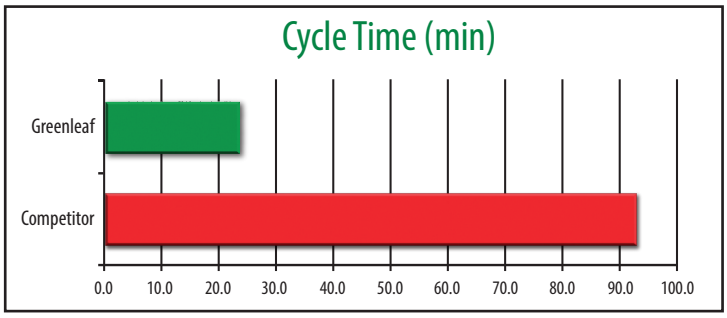
MATERIAL: INCONEL 718 (45 HRC)	COMPETITOR		GREENLEAF	
TOOLING EVALUATED	IMPERIAL	METRIC	IMPERIAL	METRIC
PRODUCT DESIGNATION:	High-Performance Carbide		GME4C08127G08530	
(Dc) END MILL DIAMETER [in|mm]:	0.630	16	0.630	16
CORNER RADIUS SIZE [in|mm]:	0.050	1.27	0.050	1.27
GRADE:			Capstone™-360	
CUTTING 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/t]:	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 [in^3/min|cm^3/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 [in^3|cm^3]:	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

Application Data

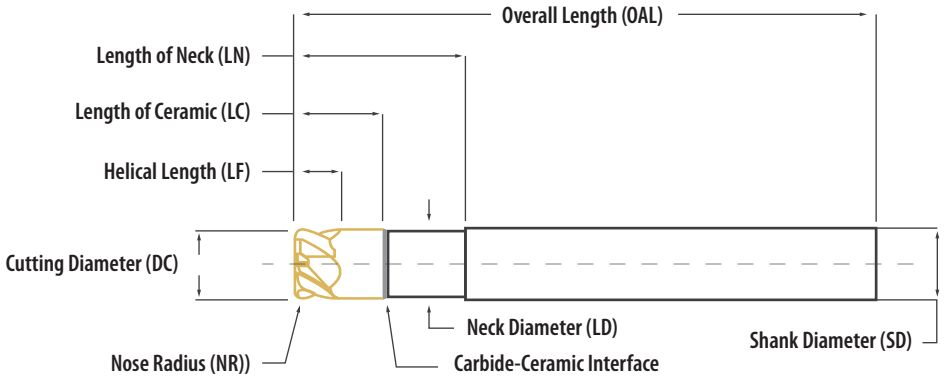
Cutting speed can be varied up or down by up to 50% from the recommended values to suit the available RPM and optimize tool life.

		Speed, Vc		Feed, Fz		DOC, Ap		WOC, Ae	Avg Chip Thickness, Hm	
Material	**Hardness (HRC)**	**SFM**	**m/min**	**IPT**	**mm/t**	**inch**	**mm**	**% of effective dia.**	**inch**	**mm**
Inconel 625, Incoloy 825, Hastelloy, Monel	as cast/rolled	1950	600	0.0014	0.034	0.030	0.75	100	0.00079	0.0200
Inconel 718, Inconel 706, Inconel 725, Inconel 713	0-20	1950	600	0.0014	0.034	0.030	0.75	100	0.00079	0.0200
	32-36	1650	500	0.0013	0.032	0.030	0.75	100	0.00073	0.0185
	40-45	1300	400	0.0012	0.030	0.030	0.75	100	0.00069	0.0175
IN100, Udimet 720, Rene 65, Rene 88, Waspaloy, C1023, N-18	0-20	1800	550	0.0013	0.032	0.030	0.75	100	0.00073	0.0185
	32-36	1500	450	0.0012	0.030	0.030	0.75	100	0.00069	0.0175
	40-45	1150	350	0.0011	0.028	0.030	0.75	100	0.00064	0.0162
Stellite, Eutalloy, Metco, Wall Colmonoy, Weartech	0-20	1300	400	0.0012	0.030	0.030	0.75	100	0.00069	0.0175
	25-35	1150	350	0.0011	0.028	0.030	0.75	100	0.00063	0.0160
	35-45	1000	300	0.0010	0.025	0.030	0.75	100	0.00057	0.0145
	45-55	800	250	0.0009	0.023	0.030	0.75	100	0.00052	0.0131
	55-62	650	200	0.0008	0.020	0.030	0.75	100	0.00046	0.0116
Lamellar (Grey) Cast Iron GG15, GG25, GG35 (EN-GJL-150, EN-GJL-250, EN-GJL-350)		2600	800	0.0016	0.040	0.030	0.75	100	0.00091	0.0232
Nodular (Ductile) Cast Iron GGG40 – GGG80 (EN-GJS-400 – EN-GJS-800)		2300	700	0.0012	0.030	0.030	0.75	100	0.00069	0.0175
Compacted Graphite Iron (CGI) EN-GJV-300 – EN-GJV-500		1950	600	0.0010	0.025	0.030	0.75	100	0.00057	0.0145
White Cast Iron Ni-Hard, EN-GJN-HV350 – EN-GJN-HV600	60	500	150	0.0008	0.020	0.030	0.75	100	0.00046	0.0116
Austempered Ductile Iron (ADI) EN-GJS-800 – EN-GJS-1400		1650	500	0.0010	0.025	0.030	0.75	100	0.00057	0.0145
Nitrided and/or Carburized Cast Iron	64	400	120	0.0008	0.020	0.030	0.75	100	0.00046	0.0116

- Face-milling with a max DOC (Ap) of .050" (1.25mm) only. Not designed for high-DOC (Ap) side-milling. For optimal performance, keep DOC (Ap) at .020"-.030" (0.5-0.75mm)
- Ramping process for pocketing may be applied with angle of inclination less than 3° and reduction of feed by 50%
- Reduce feed by 50% when entering, enter on an arc, keep the tool in contact with the material as much as possible, program large radii to connect tool path segments, and make the tool path as smooth as possible.
- Do NOT use coolant
- Use of air blast directed at and positioned as close as possible to the cutting zone is beneficial to extending tool life
- Do NOT remove built-up edge from tooling when machining
- Higher cutting speed reduces built-up edge but may reduce tool life

Product Information

Ceramic tip delivers productivity while the carbide shank handles the mechanical loads and heat dissipation.



CAPSTONE™-360: Imperial

Part Number	Cutting Dia. DC (inch)	Flute Count	Neck Dia. LD (inch)	Helical Length LF (inch)	Nose Radius RE (inch)	Shank Dia. SD (inch)	OAL (inch)	Length of Neck LN (inch)	Length of Ceramic Tip (inch)
25E4A14325315059	0.25	4	0.24	0.145	0.05	0.25	3.15	0.59	0.2
31E4A21331315059	0.312	4	0.302	0.216	0.05	0.312	3.15	0.59	0.2
37E4A23337315098	0.375	4	0.365	0.236	0.05	0.375	3.15	0.984	0.4
50E4A28350315098	0.5	4	0.49	0.282	0.05	0.5	3.15	0.984	0.4
62E4A31362315118	0.625	4	0.615	0.315	0.05	0.625	3.15	1.181	0.4
75E4D31375315157	0.75	4	0.708	0.315	0.05	0.75	3.15	1.574	0.4

CAPSTONE™-360: Metric

Part Number	Cutting Dia. DC (mm)	Flute Count	Neck Dia. LD (mm)	Helical Length LF (mm)	Nose Radius RE (mm)	Shank Dia. SD (mm)	OAL (mm)	Length of Neck LN (mm)	Length of Ceramic Tip LC (mm)
CME4A03127C08015	6	4	5.8	3.7	1.27	6	80	15	5
ZME4A04127Z08015	7	4	6.8	4.5	1.27	7	80	15	5
DME4A05127D08015	8	4	7.8	5	1.27	8	80	15	5
EME4B06127E08025	10	4	9.7	6	1.27	10	80	25	10
FME4B07127F08025	12	4	11.7	7	1.27	12	80	25	10
GME4C08127G08030	16	4	15.6	8	1.27	16	80	30	10
HME4I08127H08040	20	4	19	8	1.27	20	80	40	10

Greenleaf®
Sustainable Productivity

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 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**

Greenleaf Corporation
18695 Greenleaf Drive
Saegertown, PA 16433 USA
800-458-1850 • 814-763-2915
sales@greenleafcorporation.com

Greenleaf Europe BV
De Steeg 2
6333 AP Schimmert
The Netherlands
+31-45-404-1774
eurooffice@greenleafcorporation.com

Greenleaf (Hunan) High-Tech Materials Co., Ltd.
Changsha, Hunan 410205, China
+86-731-89954796
info@greenleafcorporation.com.cn

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