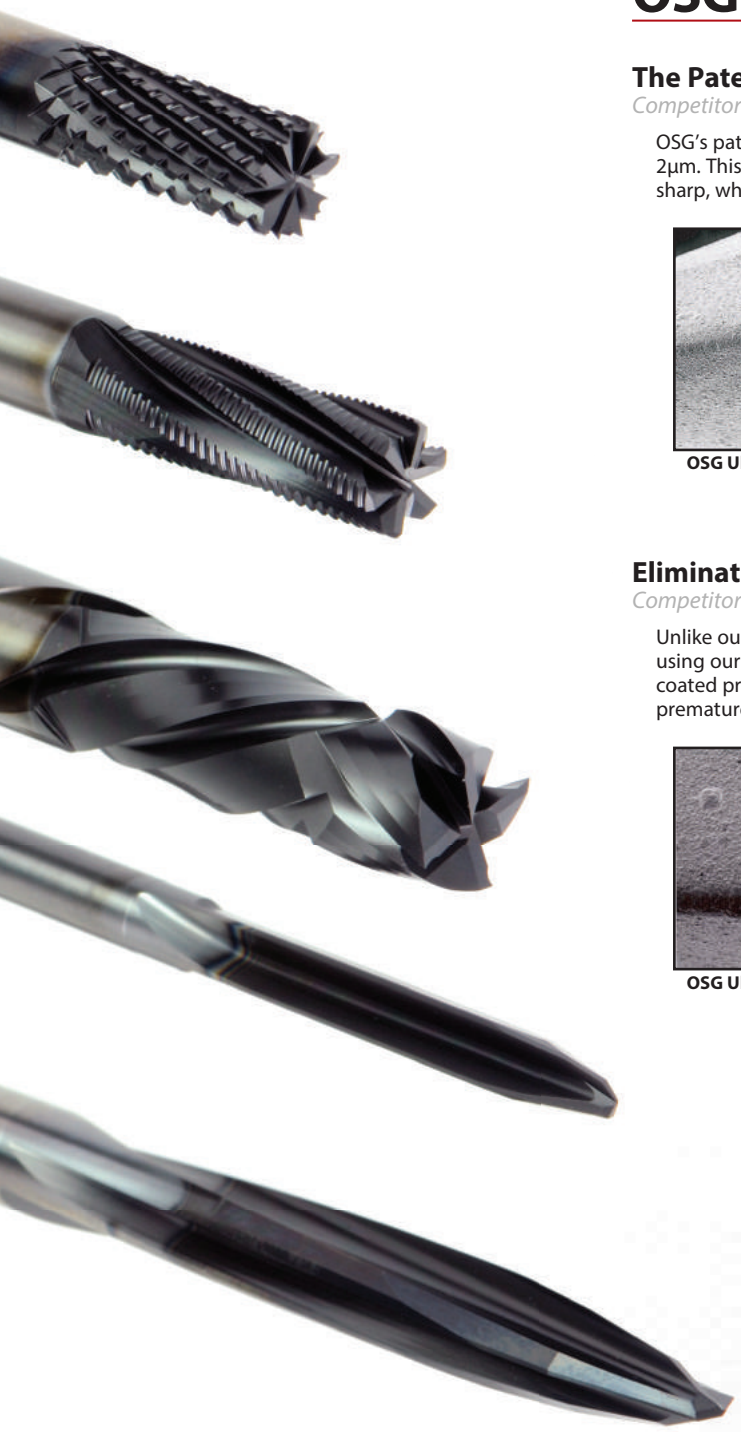
Vol 3

Cutting Tools for Modern Composite Applications

Composite Solutions

The OSG Advantage

All of OSG's composite tooling features exclusive metallurgy and cutting geometries to help increase productivity, reliability and tool life while reducing machining time and scrap. OSG also offers a patented ultra-fine diamond coating, which is a prerequisite when machining composites and provides a definitive advantage over other competitor diamond coated products.



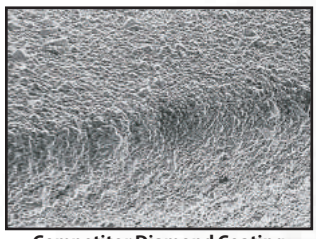
OSG's Ultra-Fine Diamond Coating

The Patented Ultra-Fine Grain Size

Competitor Comparison

OSG's patented ultra-fine diamond coating has a maximum diamond grain size diameter of 2µm. This strictly controlled diameter allows our coating to be super smooth and extremely sharp, which is visually distinguishable from our competition.

OSG Ultra-Fine Diamond Coating

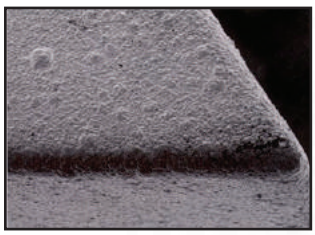


Competitor Diamond Coating
(Industry Standard)

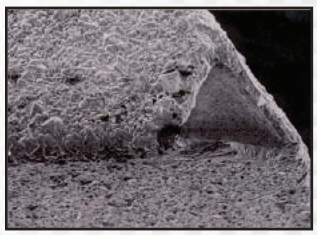
Elimination of Diamond Delamination

Competitor Comparison

Unlike our competition, OSG manufactures all diamond products in-house. This includes using our grinding techniques on our special carbide substrate. The end result is a diamond coated product in which tool life can be consistently predicted, rather than having to endure premature diamond delamination like most of our competition.



OSG Ultra-Fine Diamond Coating



Diamond Delamination
(Note: Large Grain Size)

Premium Tooling Designed for Composite Materials

EXOPRO®

OSG's top tier of high performance tooling for composite and composite/metal stack solutions. Features include our patented ultra-fine diamond coating.

EXOCARB®

Ultra-premium performance tooling solutions for composite and composite/metal drilling applications.

HY-PRO® CARB

Premium high performance tooling solutions for composite manufacturing.

CARBIDE

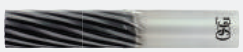
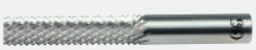
Premium uncoated tooling solutions for composite materials.

Illustrated Index

Composite Drills

List	Item	Brand/Series	Inch/ Metric	Material	Coating	Flute Length	Features	Page	Tech Page
7501		EXOPRO® AERO-STAD	Inch	Carbide	**Diamond**	Regular	Triple Angle	6	48
7520		EXOPRO® AERO-LHX	Inch	Carbide	**Diamond**	Regular	Low Helix	8	48
7500		EXOPRO® AERO-D-REAM	Inch	Carbide	**Diamond**	Regular	Tapered Reamer	10	48
7530		EXOPRO® AERO-S	Inch	Carbide	**Diamond**	Regular	High Helix, Stack Drill	12	48
7534		EXOPRO® AERO-N	Inch	Carbide	**Diamond**	Regular	Stack Drill with Nick	14	50
7532		EXOPRO® AERO-H	Inch	Carbide	**Diamond**	Regular	Stack Drill for All Stacks	16	49
5732		EXOCARB® AERO-H	Inch	Carbide	TiAlN	Regular	Stack Drill for All Stacks	18	49
HP700		HY-PRO CARB® NEPTUNE®	Inch	Carbide	TiAlN	Regular	Hand Drill	20	50

Composite Routers

List	Item	Brand/Series	Inch/ Metric	Material	Coating	Flute Length	Features	Page	Tech Page
2061		EXOPRO® AERO-BNC	Inch	Carbide	**Diamond**	Variable	Nick Router	22	51
2066		EXOPRO® AERO-HBC	Inch	Carbide	**Diamond**	Regular	Compression Router, 30˚ Helix	24	51
2064		EXOPRO® AERO-HBC 45	Inch	Carbide	**Diamond**	Regular	Compression Router, 45˚ Helix	26	51
2068		EXOPRO® AERO-HBC 60	Inch	Carbide	**Diamond**	Regular /Long	Compression Router, 60˚ Helix	28	52
2680		EXOPRO® AERO-REC	Inch	Carbide	**Diamond**	Regular	Rougher Router	30	53
2650		EXOPRO® AERO-MFR	Inch	Carbide	**Diamond**	Regular	Finishing Router	32	54
668		AERO-HBC 60	Inch	Carbide	Bright	Regular /Long	Compression Router, 60˚ Helix	34	52
641R		AERO-HFR	Inch	Carbide	Bright	Regular	Hand Router	36	55

Indexable

List	Item	Brand/Series	Inch/ Metric	Material	Coating	Features	Page	Tech Page
52100 78014		PHOENIX® PFB	Inch/ Metric	Carbide/ Steel	**Diamond**	Finishing Ball End Mill	38	45

Composite Drills

List No.	Machine Type			Composite Type				
	Hand	Pneumatic	CNC	CFRP	Honeycomb	CFRP/ Al Stack	CFRP/ Ti Stack	CFRP/ CRES Stack
7501	◎	◎	◎	◎	○	△	X	X
7520	X	○	◎	◎	○	X	X	X
7500	◎	◎	◎	◎	○	X	X	X
7530	X	◎	◎	◎	○	◎	○	X
7534	X	○	◎	△	X	X	◎	◎
7532	X	○	◎	X	X	◎	◎	◎
5732	X	○	◎	X	X	◎	◎	◎
HP700	◎	○	◎	○	○	○	○	○

X Not Recommended △ OK ○ Good ◎ Best

Composite Routers

List No.	Machine Style				Machining Efficiency	Machine Type			Composite Type	
	Slotting	Side Milling	Roughing	Finishing		Hand	CNC	5-Axis or Robot	Thin	Thick
2061	◎	◎	○	○	◎	△	◎	◎	◎	◎
2066	◎	◎	○	○	◎	△	◎	○	◎	◎
2064	◎	◎	○	◎	◎	△	◎	○	◎	◎
2068	◎	◎	○	◎	◎	△	◎	○	◎	◎
2680	◎	◎	◎	X	◎	◎	◎	◎	△	◎
2650	X	○	X	◎	△	X	◎	◎	◎	◎
668	◎	◎	○	○	○	○	◎	◎	◎	◎
641R	◎	◎	○	○	△	◎	◎	◎	◎	◎

Thin ≤ 0.100" and 0.2xD

X Not Recommended △ OK ○ Good ◎ Best

EXOPRO® AERO-STAD

Diamond Coated Triple Angle Drill for Composites

ULTRA FINE

The AERO-STAD is a diamond coated drill specifically designed to eliminate fiber breakout and delamination issues on both entry and exit of drilled holes. The drill features a patent pending triple angle geometry with OSG's patented diamond coating.

Applications

- Excels in carbon and glass composites and honeycombs
- Excellent in CFRP and Al stack applications

Features

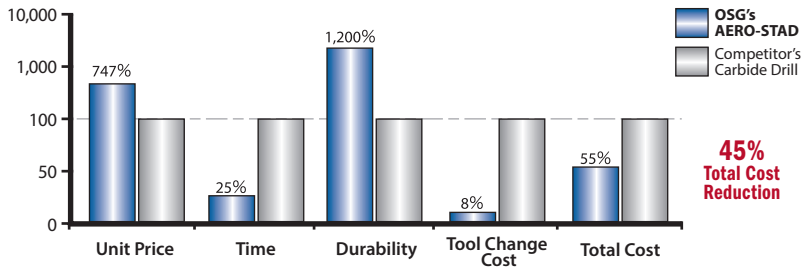
- Patent pending triple angle geometry to reduce push-out exit delamination
- Straight-fluted to eliminate the pull-up entrance delamination

Performance Highlights

OSG's AERO-STAD vs. Competitor's Carbide Tapered Drill

Overall Cost for the AERO-STAD is Less than the Competitor

Although the initial unit cost of the AERO-STAD is more than some competitors, a substantial savings can be seen after taking durability, tool change costs and reduced machining time into consideration. The graphs below illustrate the overall savings made with an investment into the AERO-STAD. ***A 45% total cost savings!***

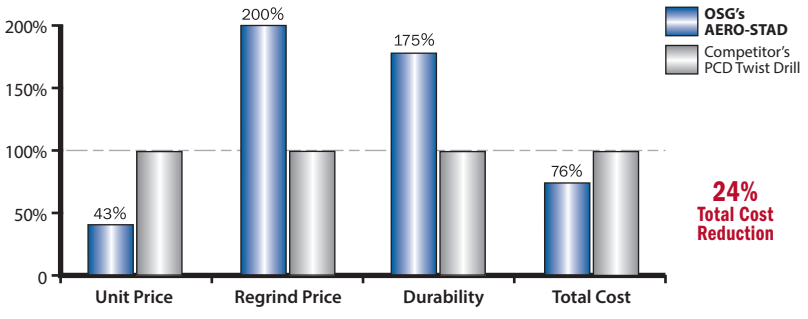


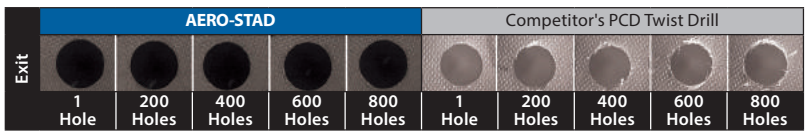
OSG's AERO-STAD vs. Competitor's PCD Twist Drill

EXOPRO® AERO-STAD Demonstrates Greater Tool Life than Competitor's Twist Drill

With a significantly greater tool life over the competitor's twist drill, the overall cost for machining with the AERO-STAD is ***24% less*** than using the competitor's drill.

Diameter: 0.251 • **Speed:** V=330 SFM • **Feed:** f=0.0025 IPR • **Thickness:** 0.750"



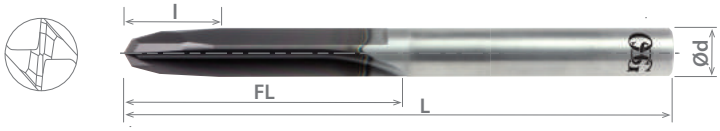


List 7501 NEW!

Triple Angle

SPEED FEED P 48 | CARBIDE | DIA | REG | 0°

Tolerance
+0/-0.001"



EDP Number	Approximate Hole Size			Drill Size		Flute Length	Taper Length	Overall Length	Shank Diameter
	Fractional Size	Wire Gage	Letter Size	mm	Inch	FL	l	L	d
750109816	–	#40	–	2.50	0.0985	0.6	0.150	2.0	0.0985
750112916	–	#30	–	3.28	0.1290	0.8	0.192	2.0	0.1290
750116116	–	#20	–	4.10	0.1615	1.0	0.236	3.0	0.1615
750119116	–	#11	–	4.86	0.1915	1.1	0.277	3.0	0.1915
750119216	–	#11	–	4.86	0.1915	1.9	0.277	4.0	0.1915
750122116	–	#2	–	5.63	0.2215	1.3	0.318	3.5	0.2215
750125116	1/4"	–	–	6.38	0.2510	1.5	0.358	3.5	0.2510
750125216	1/4"	–	–	6.38	0.2510	2.5	0.358	5.5	0.2510
750131316	5/16"	–	–	7.96	0.3135	1.9	0.443	4.0	0.3135
750137616	3/8"	–	–	9.55	0.3760	2.3	0.528	4.0	0.3760
750137716	3/8"	–	–	9.55	0.3760	3.8	0.528	6.0	0.3760
750143816	7/16"	–	–	11.14	0.4385	2.6	0.613	4.0	0.4385
750150116	1/2"	–	–	12.73	0.5010	3.0	0.697	5.0	0.5010

Drills are oversize over nominal.
Threaded, quick change and tri-flat brazed shanks are available upon request.

EP

Threaded Shank

Quick Change Shank

Tri-Flat Shank

Work Material												
List No.	Carbon Fiber (CFRP)	Glass Fiber (GFRP)	Aramid Fiber (AFRP)	Honeycomb					Carbon/ Carbon	Carbon Fiber/ Aluminum Stack	Carbon Fiber/ Titanium Stack	Carbon Fiber/ Al/ Ti/CRES Stack
				CFRP/Nomex	GFRP/Nomex	AFRP	CFRP/Al	Al/Al				
7501	◎	○		◎	◎		◎	○	◎	○		

○ Good ◎ Best

EXOPRO® AERO-LHX

Diamond Coated Low Helix Drill for Composites

ULTRA FINE

The AERO-LHX is a diamond coated drill specifically designed for tough laminates. It eliminates uncut fibers and delamination when other drills are unable to properly cut fibers. The drill features unique geometries combined with OSG's patented diamond coating.

Applications

- Excels in tough carbon fiber composites
- Excellent performance in unidirectional composites

Features

- Patent pending triple angle geometry to reduce push-out exit delamination
- Low helix providing a sharper cutting edge to help shear tough fibers

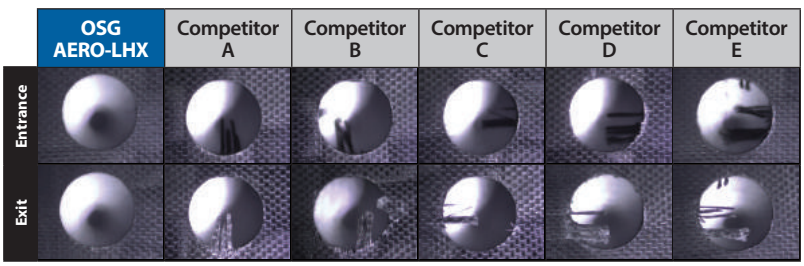
Performance Highlights

EXOPRO® AERO-LHX Provides a Quality Cut

Performance Analysis

When drilling carbon fiber composites with OSG's AERO-LHX, the hole quality can easily be seen from the first few drilled holes. The pictures below show the first hole drilled by AERO-LHX and several competitor drills. The AERO-LHX showed the cleanest cut when drilling this carbon fiber laminate.

Tool	EXOPRO® AERO-LHX
Size	0.2510"
Work Material	Carbon Fiber Composite
Drilling Speed	3000 RPM
Feed Rate	9 IPM (0.001 IPR)
Depth of Hole	0.25"
Coolant	Dry
Machine	Vertical Machining Center



List 7520 NEW!

Low Helix

SPEED FEED P 48 | CARBIDE | DIA | REG | 0°

Tolerance
+0/-0.001"

EDP Number	Approximate Hole Size			Drill Size		Flute Length	Taper Length	Overall Length	Shank Diameter
	Fractional Size	Wire Gage	Letter Size	mm	Inch	FL	l	L	d
752009816	–	#40	–	2.50	0.0985	0.6	0.276	2.0	0.0985
752012916	–	#30	–	3.28	0.1290	0.8	0.356	2.0	0.1290
752016116	–	#20	–	4.10	0.1615	1.0	0.442	3.0	0.1615
752016216	–	#11	–	4.86	0.1915	1.1	0.522	3.0	0.1915
752022116	–	#2	–	5.63	0.2215	1.3	0.601	3.5	0.2215
752025116	1/4"	–	–	6.38	0.2510	1.5	0.679	3.5	0.2510
752031316	5/16"	–	–	7.96	0.3135	1.9	0.844	4.0	0.3135
752037616	3/8"	–	–	9.55	0.3760	2.3	1.010	4.0	0.3760
752043816	7/16"	–	–	11.14	0.4385	2.6	1.175	4.0	0.4385
752050116	1/2"	–	–	12.73	0.5010	3.0	1.340	5.0	0.5010

Drills are oversize over nominal.

EP

Work Material													
List No.	Carbon Fiber (CFRP)	Glass Fiber (GFRP)	Aramid Fiber (AFRP)	Honeycomb					Carbon/ Carbon	Carbon Fiber/ Aluminum Stack	Carbon Fiber/ Titanium Stack	Carbon Fiber/ Al/ Ti/CRES Stack
				CFRP/Nomex	GFRP/Nomex	AFRP	CFRP/Al	Al/Al				
7520	◎	○		◎	◎		◎		◎			

○ Good ◎ Best

EXOPRO® AERO-D-REAM

Diamond Coated Carbide Tapered Reamer for Composites

ULTRA FINE

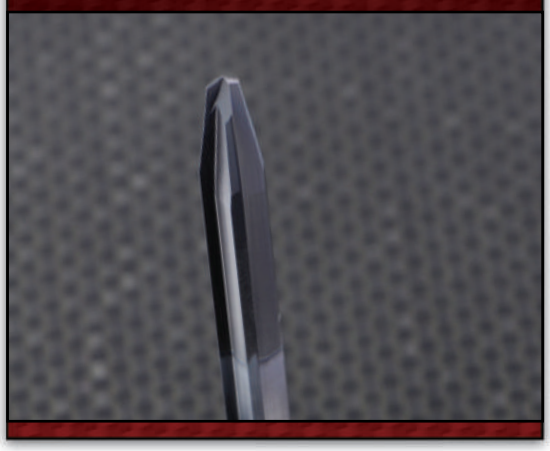
The AERO-D-REAM is a diamond coated tapered drill/reamer for composites. The tool features a tapered 4-flute design and OSG's patented diamond coating.

Applications

- Excels in carbon and glass fiber composites

Features

- Straight flute to limit peel-up at hole entrance
- Elongated double-angle geometry to reduce thrust and limit exit delamination
- Patented OSG diamond coating



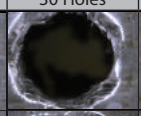
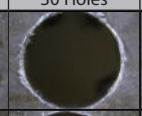
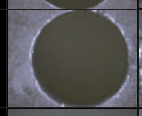
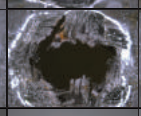
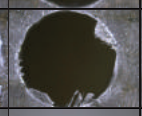
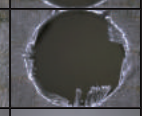
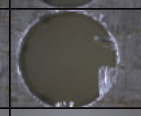
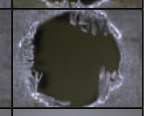
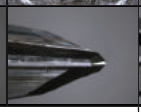
Performance Highlights

EXOPRO® AERO-D-REAM

Performance Analysis

Diamond coating significantly improves tool life and hole quality. When compared to the AERO-REAM (List 257), the EXOPRO® AERO-D-REAM was able to drill ***14 times more holes***, and at better quality, than its uncoated counterpart.

Tool	List 257 (Uncoated)	EXOPRO® AERO-D-REAM (Test 1)	EXOPRO® AERO-D-REAM (Test 2)
Size	0.251"		
Speed	3800 RPM (250 SFM)		
Feed Rate	7.6 IPM (0.002 IPR)		**11.5 IPM (0.003 IPR)**
Depth of Hole	0.450" (Through)		
Coolant	Dry		
Quality Holes	~30	~90	~180

	List 257 (Uncoated)		EXOPRO® AERO-D-REAM (Test 1)		EXOPRO® AERO-D-REAM (Test 2)	
	3 Holes	30 Holes	30 Holes	180 Holes	30 Holes	420 Holes
Entrance						
Exit						
Tool						
	At 30 holes the tool showed extreme margin wear.		At 180 holes the AERO-D-REAM showed virtually no margin wear.		At 420 holes, running at a faster feed rate, the AERO-D-REAM showed some slight margin wear.	

List 7500 NEW!

Tapered Drill

SPEED FEED P 48 | CARBIDE | DIA | REG | 0°

Tolerance
+0/-0.001"

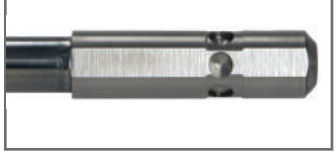
EDP Number	Approximate Hole Size			Drill Size		Flute Length	Taper Length	Overall Length	Shank Diameter
	Fractional Size	Wire Gage	Letter Size	mm	Inch	FL	l	L	d
750009816	–	#40	–	2.50	0.0985	0.573	0.199	3	0.0985
750012816	–	#30	–	3.26	0.1285	0.748	0.257	3	0.1285
750012916	–	#30	–	3.26	0.1285	1.257	0.257	6	0.1285
750016116	–	#20	–	4.10	0.1615	0.940	0.321	3	0.1615
750016216	–	#20	–	4.10	0.1615	1.581	0.321	6	0.1615
750018716	3/16"	–	–	4.76	0.1875	1.841	0.371	6	0.1875
750019016	–	#11	–	4.83	0.1900	1.866	0.376	4	0.1900
750019116	–	#11	–	4.83	0.1900	1.866	0.376	6	0.1900
750019216	–	#11	–	4.85	0.1910	1.866	0.378	4	0.1910
750019316	–	#11	–	4.85	0.1910	1.866	0.378	6	0.1910
750019416	–	#11	–	4.86	0.1920	1.115	0.380	3	0.1920
750019516	–	#11	–	4.86	0.1920	1.881	0.380	4	0.1920
750019716	–	#11	–	4.86	0.1920	1.881	0.380	6	0.1920
750021816	7/32"	–	–	5.54	0.2180	2.141	0.431	6	0.2180
750022116	–	#2	–	5.63	0.2215	2.175	0.437	4	0.2215
750025016	1/4"	–	–	6.35	0.2500	2.455	0.493	4	0.2500
750025116	1/4"	–	–	6.35	0.2500	2.455	0.493	6	0.2500
750025316	1/4"	–	–	6.38	0.2510	1.461	0.494	3	0.2510
750025416	1/4"	–	–	6.38	0.2510	2.465	0.494	4	0.2510
750025516	1/4"	–	–	6.38	0.2510	2.465	0.494	6	0.2510
750031216	5/16"	–	–	7.94	0.3125	1.819	0.614	4	0.3125
750031316	5/16"	–	–	7.94	0.3125	2.444	0.614	6	0.3125
750031416	5/16"	–	–	7.96	0.3135	1.824	0.616	4	0.3135
750031516	5/16"	–	–	7.96	0.3135	2.452	0.616	6	0.3135
750037516	3/8"	–	–	9.53	0.3750	2.183	0.735	4	0.3750
750037616	3/8"	–	–	9.53	0.3750	2.933	0.735	6	0.3750
750037716	3/8"	–	–	9.55	0.3760	2.188	0.737	4	0.3760
750037816	3/8"	–	–	9.55	0.3760	2.940	0.737	6	0.3760
750043816	7/16"	–	–	11.14	0.4385	2.552	0.858	4	0.4385
750050116	1/2"	–	–	12.73	0.5010	3.918	0.979	6	0.5010

Drills are oversize over nominal.
Threaded, quick change, and tri-flat brazed shanks are available upon request.

EP

Threaded Shank

Quick Change Shank



Tri-Flat Shank

Work Material												
List No.	Carbon Fiber (CFRP)	Glass Fiber (GFRP)	Aramid Fiber (AFRP)	Honeycomb					Carbon/ Carbon	Carbon Fiber/ Aluminum Stack	Carbon Fiber/ Titanium Stack	Carbon Fiber/ Al/ Ti/CRES Stack
				CFRP/Nomex	GFRP/Nomex	AFRP	CFRP/Al	Al/Al				
7500	◎	○		◎	◎		◎		◎			

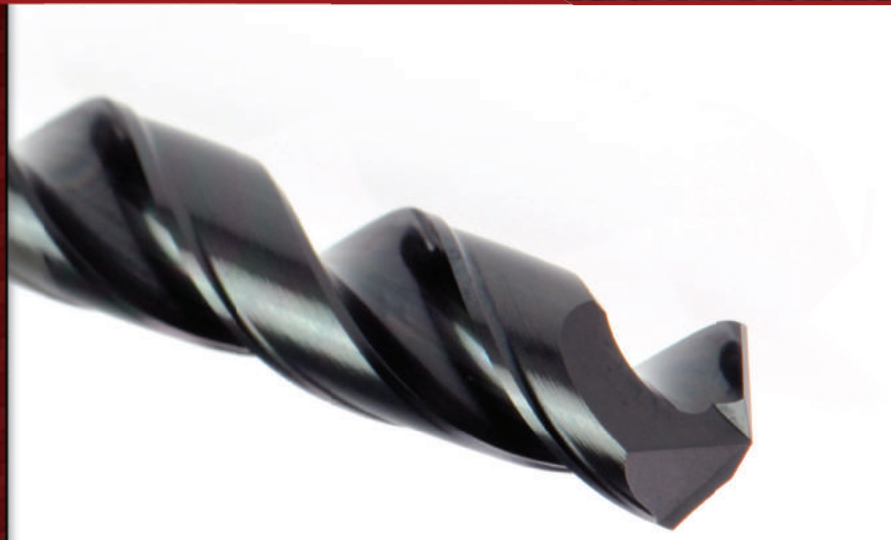
○ Good ◎ Best

EXOPRO® AERO-S

Diamond Coated High Helix Drill for Composites

ULTRA FINE

The AERO-S is a high helix diamond coated drill designed for composites and metal stack materials. It features OSG's patented diamond coating and unique geometries such as a high helix to assist in chip evacuation.

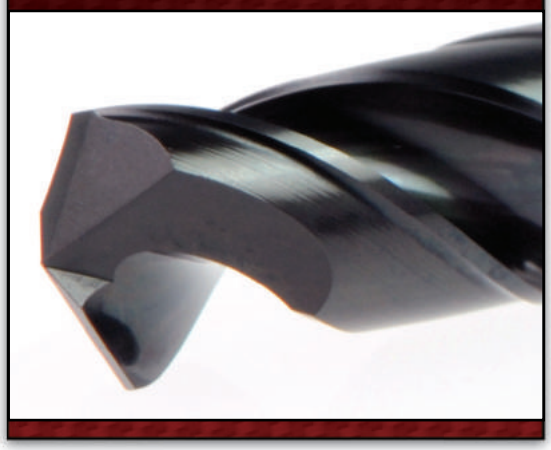


Applications

- Designed to shear through tough fibers
- Excellent for CFRP/Al stack applications

Features

- High helix angles for shearing fibers
- Drill point designed for cutting stacks
- Thin web and wide flutes to reduce thrust and improve chip evacuation



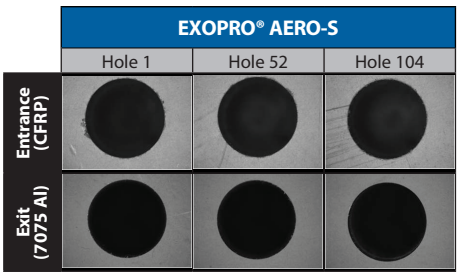
Performance Highlights

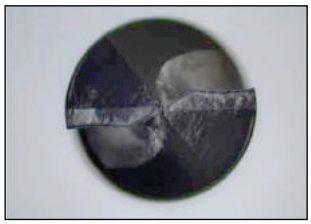
EXOPRO® AERO-S in CFRP/Al Stack Applications

Performance Analysis

Positive geometry and diamond coating allow for high quality holes in CFRP/Al stacks.

Tool	EXOPRO® AERO-S
Size	0.251"
Work Material	CFRP/Al
Drilling Speed	3000 RPM
Feed Rate	(0.003 IPR) • 0.015 Peck
Depth of Hole	0.25" (CFRP) 0.25" (Al)
Coolant	Dry
Machine	Vertical Machining Center





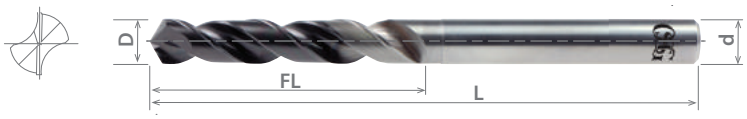
Drill wear after 104 holes.

List 7530 NEW!

High Helix

SPEED FEED P 48 | CARBIDE | DIA | REG | 40°

Tolerance
+0/-0.001"



EDP Number	Approximate Hole Size			Drill Size		Flute Length	Overall Length	Shank Diameter
	Fractional Size	Wire Gage	Letter Size	mm	Inch	FL	L	d
753009816	–	#40	–	2.50	0.0985	0.6	2	0.0985
753012916	–	#30	–	3.28	0.1290	0.8	3	0.1290
753016116	–	#20	–	4.10	0.1615	1.0	4	0.1615
753019116	–	#11	–	4.86	0.1915	1.1	4	0.1915
753022116	–	#2	–	5.63	0.2215	1.3	4	0.2215
753025116	1/4	–	–	6.38	0.2510	1.5	4	0.2510
753031316	5/16	–	–	7.96	0.3135	1.9	4	0.3135
753037616	3/8	–	–	9.55	0.3760	2.3	6	0.3760
753043816	7/16	–	–	11.14	0.4385	2.6	6	0.4385
753050116	1/2	–	–	12.73	0.5010	3.0	6	0.5010

Drills are oversize over nominal.

EP

Work Material												
List No.	Carbon Fiber (CFRP)	Glass Fiber (GFRP)	Aramid Fiber (AFRP)	Honeycomb					Carbon/ Carbon	Carbon Fiber/ Aluminum Stack	Carbon Fiber/ Titanium Stack	Carbon Fiber/ Al/ Ti/CRES Stack
				CFRP/Nomex	GFRP/Nomex	AFRP	CFRP/Al	Al/Al				
7530	◎	◎		○	○		◎	◎		◎		

○ Good ◎ Best

EXOPRO® AERO-N

Diamond Coated Nicked Drill for Titanium Stack Drilling

ULTRA FINE

The AERO-N is a diamond coated carbide drill specifically designed for drilling carbon fiber/titanium stack applications. It features a special point geometry with enhanced flute form for optimal chip evacuation to minimize "washout" or "reverse countersink" effect.

Applications

- Excels in CFRP/Ti stacks
- Low thrust requirements

Features

- Nick geometry for lower thrust and reduced chip size
- Unique flute form for enhanced chip evacuation
- Coolant-through for cooling and improved chip evacuation

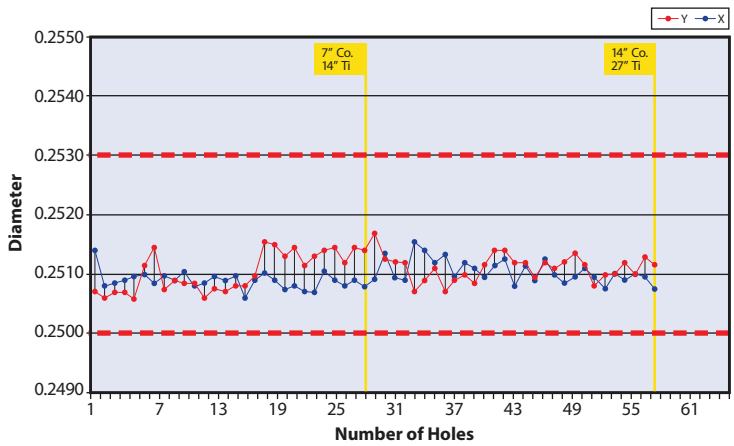
Performance Highlights

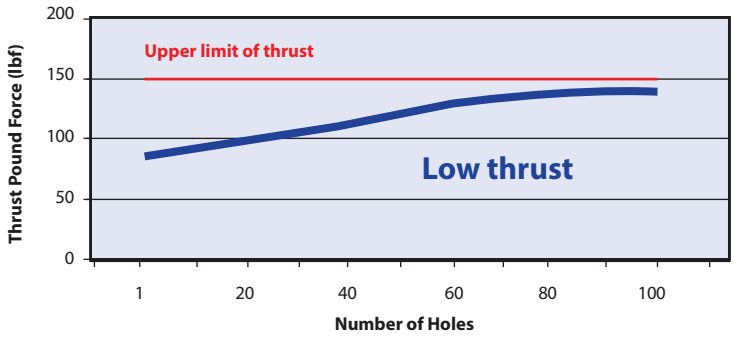
EXOPRO® AERO-N for Low Thrust Force and Stable Hole Size

Performance Analysis

OSG's AERO-N's unique nick geometry reduces thrust force and keeps hole sizes stable in carbon fiber/titanium stack applications.

Co. (0.250") - 3,000 RPM @ 12 IPM
Ti. (0.500") - 750 RPM @ 1.4 (Pecking every 0.040)





List 7534 NEW!

Nicked Stack Drill

SPEED FEED P 50 | CARBIDE | DIA | REG | 12°

Tolerance
+0/-0.001"

EDP Number	Approximate Hole Size			Drill Size		Flute Length	Overall Length	Shank Diameter
	Fractional Size	Wire Gage	Letter Size	mm	Inch	FL	L	d
753419116	–	#11	–	4.86	0.1915	2	4	0.1915
753425116	1/4	–	–	6.38	0.2510	2	4	0.2510
753437616	3/8	–	–	9.55	0.3760	2	4	0.3760

Drills are oversize over nominal.

EP

Work Material												
List No.	Carbon Fiber (CFRP)	Glass Fiber (GFRP)	Aramid Fiber (AFRP)	Honeycomb					Carbon/ Carbon	Carbon Fiber/ Aluminum Stack	Carbon Fiber/ Titanium Stack	Carbon Fiber/ Al/ Ti/CRES Stack
				CFRP/Nomex	GFRP/Nomex	AFRP	CFRP/Al	Al/Al				
7534	◎										◎	○

○ Good ◎ Best

EXOPRO® AERO-H

Diamond Coated Stack Drill for All Stack Applications

ULTRA FINE

The EXOPRO® AERO-H is a diamond coated carbide drill specifically designed for drilling composite/metal stack applications. It features a high helix and parabolic flute form for improved chip evacuation as well as corner radius and end gash to resist chipping.

Applications

- Designed for difficult metal alloys such as Titanium, PH Stainless and Nickel Alloys
- For general purpose stacks

Features

- Parabolic flute form for improved chip evacuation
- Corner radius and end gash to resist chipping
- OSG's diamond coating makes it suitable for all materials and longer tool life

Performance Highlights

EXOPRO® AERO-H

Performance Analysis

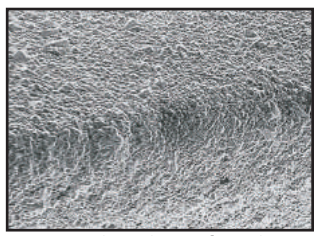
The AERO-H is designed to excel in difficult metal alloys such as Titanium, PH Stainless and Nickel Alloys with a cutting edge gash to reduce chipping and burr height. The AERO-H comes standard with either OSG's diamond coating (EXOPRO® AERO-H) or TiAlN coating (EXOCARB® AERO-H - Page 18). Diamond coating makes the AERO-H suitable for all materials.

The Patented Ultra-Fine Grain Size

Competitor Comparison

OSG's patented ultra-fine diamond coating has a maximum diamond grain size diameter of 2µm. This strictly controlled diamter allows our coating to be super smooth and extremely sharp, which visually is distinguishable from our competition.

OSG Ultra-Fine Diamond Coating



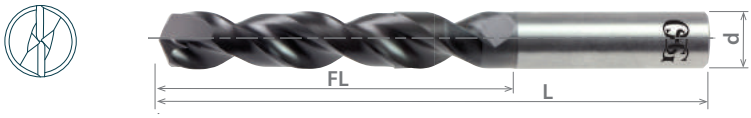
Competitor Diamond Coating
(Industry Standard)

List 7532 NEW!

Stack Drill

SPEED FEED P 49 | CARBIDE | DIA | REG | 40°

Tolerance
+0/-0.001"



EDP Number	Approximate Hole Size			Drill Size		Flute Length	Overall Length	Shank Diameter
	Fractional Size	Wire Gage	Letter Size	mm	Inch	FL	L	d
753209816	–	#40	–	2.50	0.0985	0.6	2	0.0985
753212916	–	#30	–	3.28	0.1290	0.8	3	0.1290
753216116	–	#20	–	4.10	0.1615	1.0	4	0.1615
753219116	–	#11	–	4.86	0.1915	1.1	4	0.1915
753222116	–	#2	–	5.63	0.2215	1.3	4	0.2215
753225116	1/4	–	–	6.38	0.2510	1.5	4	0.2510
753231316	5/16	–	–	7.96	0.3135	1.9	4	0.3135
753237616	3/8	–	–	9.55	0.3760	2.3	6	0.3760
753243816	7/16	–	–	11.14	0.4385	2.6	6	0.4385
753250116	1/2	–	–	12.73	0.5010	3.0	6	0.5010

Drills are oversize over nominal.

EP

Work Material													
List No.	Carbon Fiber (CFRP)	Glass Fiber (GFRP)	Aramid Fiber (AFRP)	Honeycomb					Carbon/ Carbon	Carbon Fiber/ Aluminum Stack	Carbon Fiber/ Titanium Stack	Carbon Fiber/ Al/ Ti/CRES Stack
				CFRP/Nomex	GFRP/Nomex	AFRP	CFRP/Al	Al/Al				
7532	◎									○	◎	◎

○ Good ◎ Best

EXOCARB® AERO-H

TiAlN Coated Stack Drill for All Stack Applications

The EXOCARB® AERO-H is a TiAlN coated carbide drill designed for composite/metal stacks. It features a high helix and parabolic flute form for improved chip evacuation as well as corner radius and end gash to resist chipping.

Applications

- Designed for difficult metal alloys such as Titanium, PH Stainless and Nickel Alloys

Features

- Parabolic flute form for improved chip evacuation
- Corner radius and end gash to resist chipping
- TiAlN coating for a sharper cutting edge to reduce burr height

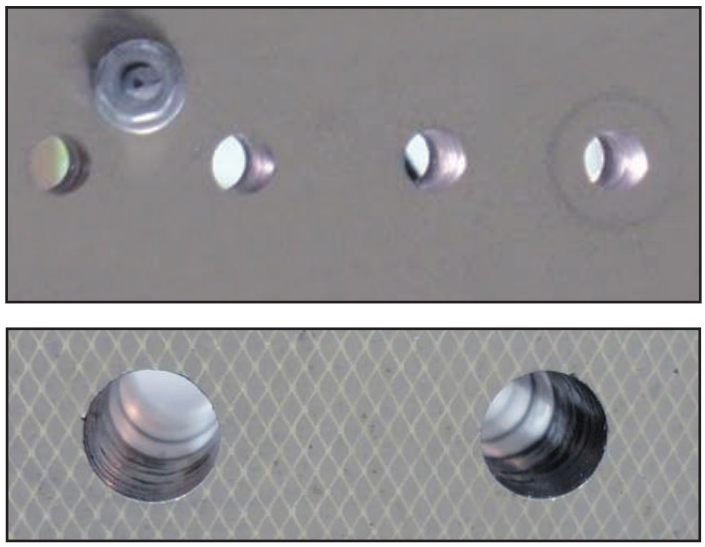
Performance Highlights

EXOCARB® AERO-H

Performance Analysis

The AERO-H is designed to excel in difficult metal alloys such as Titanium, PH Stainless and Nickel Alloys with a cutting edge gash to reduce chipping and burr height. The AERO-H comes standard with either OSG's diamond coating (EXOPRO® AERO-H - Page 16) or TiAlN coating (EXOCARB® AERO-H). TiAlN coating creates a sharper cutting edge to reduce burr height.

In the below example of CFRP/Ai/CFRP/Ti, the EXOCARB® AERO-H was able to successfully make over 120 quality holes.

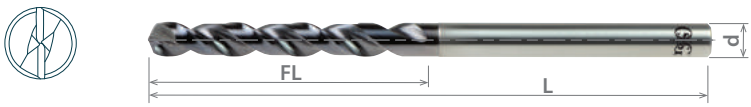


List 5732 NEW!

Stack Drill

SPEED FEED P 49 | CARBIDE | TiAlN | REG | 40°

Tolerance
h8



EDP Number	Approximate Hole Size			Drill Size		Flute Length	Overall Length	Shank Diameter
	Fractional Size	Wire Gage	Letter Size	mm	Inch	FL	L	d
573219111	–	#11	–	4.86	0.1915	2	4	0.1915
573225111	1/4	–	–	6.38	0.2510	2	4	0.2510
573237611	3/8	–	–	9.55	0.3760	2	4	0.3760
573250111	1/2	–	–	12.73	0.5010	4	6	0.5010

Drills are oversize over nominal.

HTE

Work Material													
List No.	Carbon Fiber (CFRP)	Glass Fiber (GFRP)	Aramid Fiber (AFRP)	Honeycomb					Carbon/ Carbon	Carbon Fiber/ Aluminum Stack	Carbon Fiber/ Titanium Stack	Carbon Fiber/ Al/ Ti/CRES Stack
				CFRP/Nomex	GFRP/Nomex	AFRP	CFRP/Al	Al/Al				
5732	◎									○	◎	◎

○ Good ◎ Best

HY-PRO® CARB NEPTUNE®

Three Flute Drill for Hand Drilling Tough Materials

The HY-PRO® CARB NEPTUNE® is an innovative hand drill designed for a wide variety of tough to machine alloys and specifically engineered for efficient hand drilling. The NEPTUNE® features a 3-flute design which improves stability and productivity.

Applications

- Designed for Inconel, titanium alloys, stainless steel and aluminum applications
- Excellent in hand drilling applications

Features

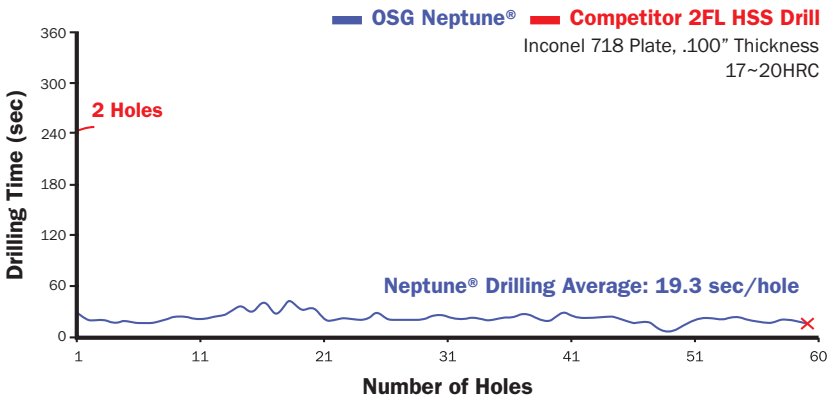
- 3 flutes for improved stability and increased productivity
- TiAlN coating for a sharper cutting edge

Performance Highlights

HY-PRO® CARB NEPTUNE®

Performance Analysis

During a customer test in Inconel, the HY-PRO® CARB NEPTUNE® reduced cycle time by 12.5% and increased tool life by 60 times!

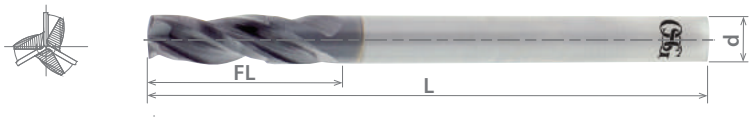


List HP700 NEW!

Three Flute Drill

SPEED FEED P 50 | CARBIDE | TiAlN | REG | 30°

Tolerance
h8



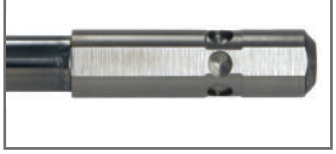
EDP Number	Approximate Hole Size			Drill Size		Flute Length	Overall Length	Shank Diameter
	Fractional Size	Wire Gage	Letter Size	mm	Inch	FL	L	d
HP700-0980	–	#40	–	–	0.0980	0.500	1.5	0.0980
HP700-1285	–	#30	–	–	0.1285	0.500	1.5	0.1285
HP700-1610	–	#20	–	–	0.1610	0.500	1.5	0.1610
HP700-1910	–	#11	–	–	0.1910	0.500	1.5	0.1910
HP700-2500	1/4	–	–	–	0.2500	0.500	1.5	0.2500
HP700-2512	1/4	–	–	–	#20 x 0.250 Step	0.625	1.5	0.2500

Brazed shanks available on demand: Threaded, Quick Change and Tri-Flat.

HPC

Threaded Shank

Quick Change Shank



Tri-Flat Shank

Work Material												
List No.	Carbon Fiber (CFRP)	Glass Fiber (GFRP)	Aramid Fiber (AFRP)	Honeycomb					Carbon/ Carbon	Carbon Fiber/ Aluminum Stack	Carbon Fiber/ Titanium Stack	Carbon Fiber/ Al/ Ti/CRES Stack
				CFRP/Nomex	GFRP/Nomex	AFRP	CFRP/Al	Al/Al				
HP700	▣									▣	▣	▣

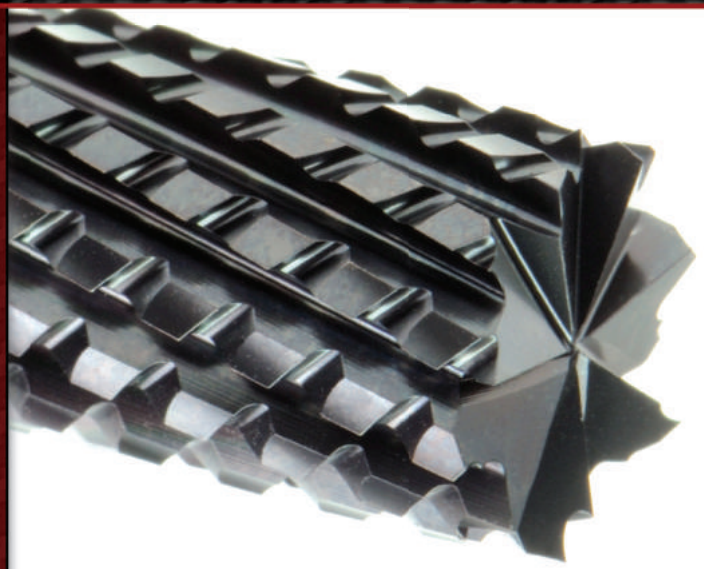
▢ Good ▣ Best

EXOPRO® AERO-BNC

Diamond Coated Routers for Milling CFRP and Other Composites

ULTRA FINE

The EXOPRO® AERO-BNC is a fine nicked router specifically designed for carbon fiber composite trimming. The router features a patented cutting geometry coupled with OSG's patented diamond coating.

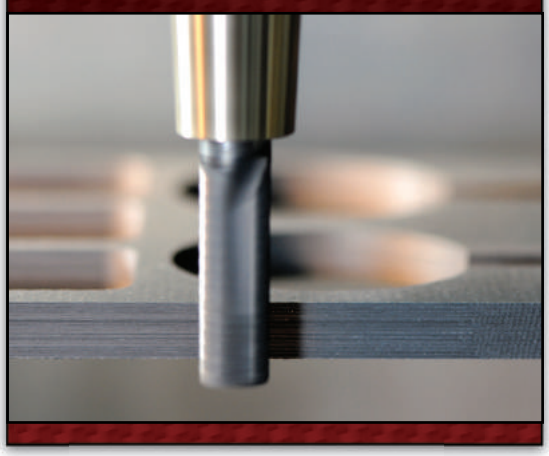


Applications

- Best in carbon fiber, also good for carbon/carbon and honeycombs
- High feed roughing and finishing
- Applied in both thick and thin laminates
- ***Type 1*** - Non end cutting
  Type 2 - for ramping and helical interpolation
  Type 3 - for plunging and helical interpolation
  Type 4 - for drilling

Features

- Patented nick and flute form to eliminate uncut fibers and delamination
- Extremely low cutting forces for long tool life
- Flute management can be applied by changing the milling position at the flute to increase tool life

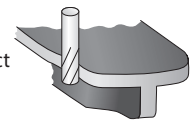


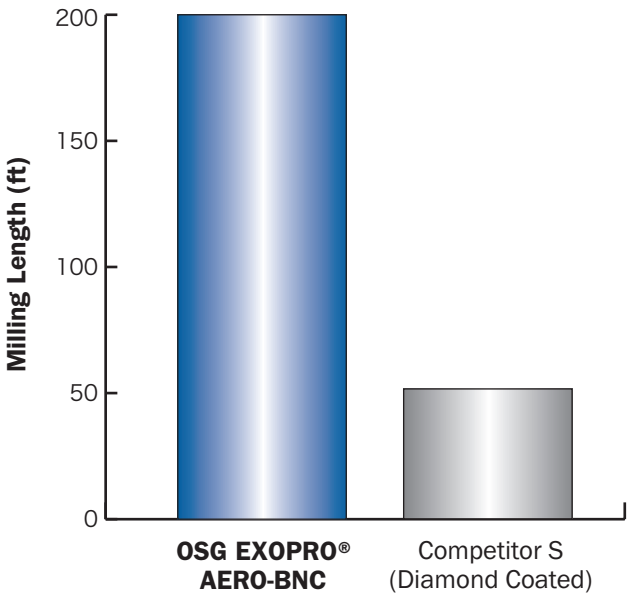
Performance Highlights

OSG's EXOPRO® AERO-BNC End Trimming of a CFRP Stringer

Performance Analysis

Achieve exceptional tool life with EXOPRO® AERO-BNC. Although the details of the machining conditions cannot be disclosed, OSG's AERO-BNC achieved approximately ***4 times the tool life*** versus the competitor product when performing end trimming of a CFRP stringer.



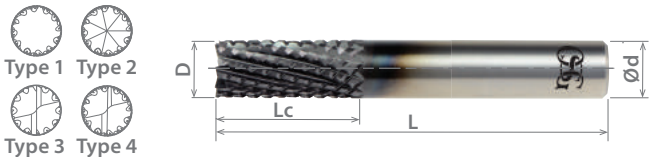


List 2061

Regular Length, Multiple Flutes, Nicked Router

SPEED FEED P 51 | CARBIDE | DIA | 15° | SHRINK h6

h8 Tolerance
+0/-0.002"



EDP Number	Mill Diameter	Length of Cut	OAL	Shank Diameter	Number of Flutes	Type	Corner Radius
	D	LC	L	d			
20610116	1/8	1/4	1-1/2	1/8	6	2	-
20611116	1/8	3/8	1-1/2	1/8	6	3	-
20612116	1/8	1/2	1-1/2	1/8	8	3	-
20610216	3/16	3/8	2	3/16	6	2	-
20611216	3/16	9/16	2	3/16	6	3	-
20612216	3/16	3/4	2	3/16	8	3	-
20610316	1/4	1/2	2-1/2	1/4	8	2	-
20613416	1/4	3/4	2-1/2	1/4	8	2	-
20612316	1/4	3/4	2-1/2	1/4	10	2	-
20612416	1/4	3/4	2-1/2	1/4	12	2	-
20611316	1/4	3/4	2-1/2	1/4	10	3	-
20613216	1/4	1	3	1/4	8	2	-
20614316	1/4	1	3	1/4	10	2	-
20614400	1/4	1	3	1/4	12	2	-
20614416	1/4	1	3	1/4	12	2	-
20617316	1/4	1	3	1/4	12	2	0.030
20613316	1/4	1	3	1/4	10	3	-
20616316	1/4	1	3	1/4	8	4	-
20616416	1/4	1	3	1/4	12	4	-
20615316	1/4	1-1/4	4	1/4	12	1	-
20615216	1/4	1-1/4	4	1/4	8	2	-
20610416	5/16	1	2-1/2	5/16	10	3	-
20610516	3/8	3/4	2-1/2	3/8	12	2	-
20612516	3/8	1-1/8	3	3/8	12	2	-
20616816	3/8	1-1/8	3	3/8	12	2	0.030
20611516	3/8	1-1/8	3	3/8	12	3	-
20616516	3/8	1-1/4	3	3/8	12	4	-
20614516	3/8	1-1/2	4	3/8	12	2	-
20613516	3/8	1-1/2	4	3/8	12	3	-
20615516	3/8	2	4	3/8	12	1	-
20616716	1/2	7/8	2-7/8	1/2	14	1	-
20611716	1/2	1	3	1/2	14	2	-
20613716	1/2	1	3	1/2	14	2	0.030
20610716	1/2	1	3	1/2	14	3	-
20615716	1/2	1	3	1/2	14	4	-
20612716	1/2	2	4	1/2	16	2	-

Red EDP numbers indicate the item is uncoated.

EP

Type 1 - Non End Cutting
Type 2 - Burr End
Type 3 - End Mill Cut
Type 4 - Drill Point

Work Material												
List No.	Carbon Fiber (CFRP)	Glass Fiber (GFRP)	Aramid Fiber (AFRP)	Honeycomb					Carbon/ Carbon	Carbon Fiber/ Aluminum Stack	Carbon Fiber/ Titanium Stack	Carbon Fiber/ Al/ Ti/CRES Stack
				CFRP/Nomex	GFRP/Nomex	AFRP	CFRP/Al	Al/Al				
2061	◎	○		○	○		○	○	◎			

○ Good ◎ Best

EXOPRO® AERO-HBC

Diamond Coated Routers for Milling CFRP and Other Composites

ULTRA FINE

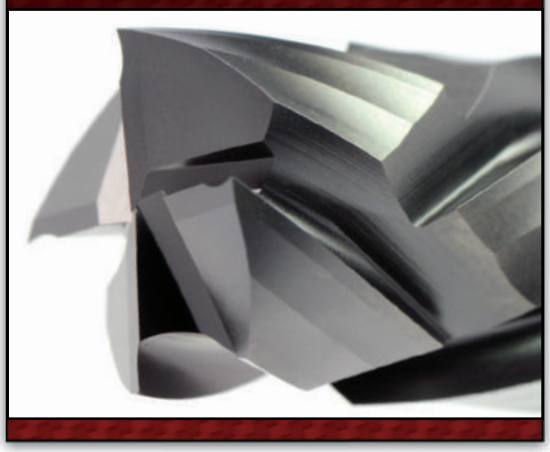
The EXOPRO® AERO-HBC is a diamond coated herringbone style router for high feed rates and excellent surface finishes. The router features a compression cutting mechanism along with OSG's patented diamond coating.

Applications

- Excels in carbon and glass composites and honeycombs
- High feed routing and finishing
- Best in thick laminates (Ref. L2 length on next page)
- Excellent in thermoplastic matrix

Features

- Compression mechanism to neutralize cutting forces to prevent delamination on both top and bottom laminates
- Low cutting forces for longer tool life



Performance Highlights

OSG's EXOPRO® AERO-HBC in Carbon Fiber Composite

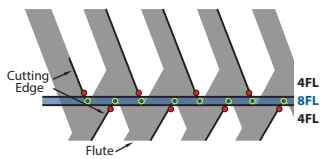
Performance Analysis

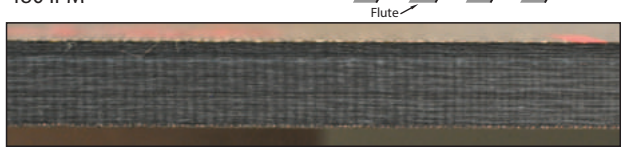
The EXOPRO® AERO-HBC showed excellent performance and surface finish at high feed rates. The 4-flute herringbone design was able to mill up to 480 IPM without leaving streak marks on the composite.

Tool	EXOPRO® AERO-HBC	Competitor
	4 Flutes	6 Flutes
	Herringbone Router - Diamond Coated	
Size	0.500"	
Work Material	Carbon Fiber Composite	
Drilling Speed	6000 RPM	
Feed Rate	Various (24 to 480 IPM)	
Depth of Cut	Aa: 0.250" • Ar: 0.125"	
Coolant	Dry	
Machine	Vertical Machining Center	

OSG EXOPRO® AERO-HBC
(List 2066)

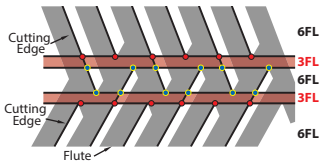
Clean milling at 480 IPM





Competitor

Streaking and Torn/Uncut Fibers

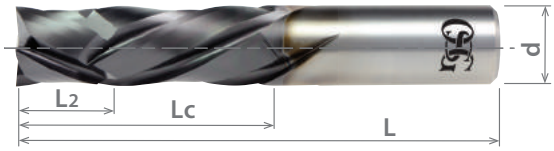


List 2066

Regular Length, 4 Flute, 30° Compression Router

SPEED FEED P 51 | CARBIDE | DIA | 30° | SHRINK h6

h8 Tolerance
+0/-0.002"



EDP Number	Mill Diameter	Compression Length	Length of Cut	OAL	Shank Diameter
	D	L2	Lc	L	d
20660116	0.125	0.125	0.560	1.5	0.125
20660316	0.250	0.250	0.750	2.5	0.250
20660516	0.375	0.375	0.875	3.0	0.375
20660716	0.500	0.500	1.500	3.0	0.500

Packed: 1 pc. Available Diamond coating only.

EP

Work Material												
List No.	Carbon Fiber (CFRP)	Glass Fiber (GFRP)	Aramid Fiber (AFRP)	Honeycomb					Carbon/ Carbon	Carbon Fiber/ Aluminum Stack	Carbon Fiber/ Titanium Stack	Carbon Fiber/ Al/ Ti/CRES Stack
				CFRP/Nomex	GFRP/Nomex	AFRP	CFRP/Al	Al/Al				
2066	◎	◎	○	○	○	○	○	○				

○ Good ◎ Best

EXOPRO® AERO-HBC 45

Diamond Coated Routers for Milling CFRP and Other Composites

ULTRA FINE

The EXOPRO® AERO-HBC 45 is a diamond coated compression router with a higher helix angle to shear tougher materials. It features compression cutting and OSG's patented diamond coating.

Applications

- Designed for tough carbon fibers and honeycomb applications

Features

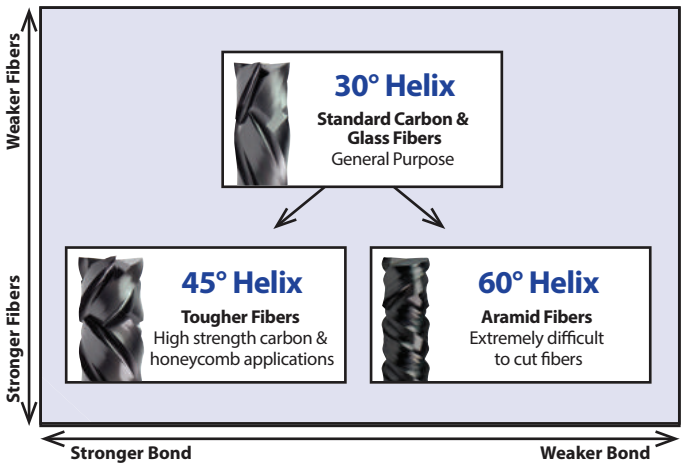
- 45° helix angle to shear tougher fibers
- Compressive geometry to prevent pullout
- OSG's patented diamond coating

Performance Highlights

OSG's AERO-HBC 45 Angle Comparison Chart

Performance Analysis

While similar to the AERO-HBC, the AERO-HBC 45's higher helix angle is able to shear tougher fibers like high strength carbon and honeycomb materials. If you are machining aramid fibers, try OSG's EXOPRO® AERO-HBC 60 (Page 28).

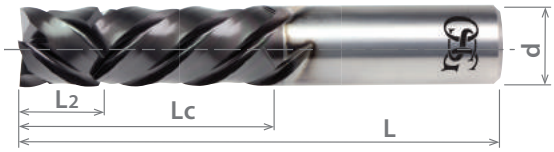


List 2064 NEW!

Regular Length, 45° Compression Router

SPEED FEED P 51 | CARBIDE | DIA | 45° | SHRINK h6

h8 Tolerance
+0/-0.002"



EDP Number	Mill Diameter	Compression Length	Length of Cut	OAL	Shank Diameter
	D	L2	Lc	L	d
20642516	0.250	0.250	0.75	3	0.250
20643516	0.375	0.375	0.75	3	0.375
20643616	0.375	0.375	2.00	4	0.375
20645016	0.500	0.500	1.00	3	0.500
20645116	0.500	0.500	2.00	4	0.500

Packed: 1 pc. Available Diamond coating only.

EP

Work Material

List No.	Carbon Fiber (CFRP)	Glass Fiber (GFRP)	Aramid Fiber (AFRP)	Honeycomb					Carbon/ Carbon	Carbon Fiber/ Aluminum Stack	Carbon Fiber/ Titanium Stack	Carbon Fiber/ Al/ Ti/CRES Stack
				CFRP/Nomex	GFRP/Nomex	AFRP	CFRP/Al	Al/Al				
2064	◎	◎	○	○	○	○	○	○				

○ Good ◎ Best

EXOPRO® AERO-HBC 60

Diamond Coated Routers for Milling CFRP and Other Composites

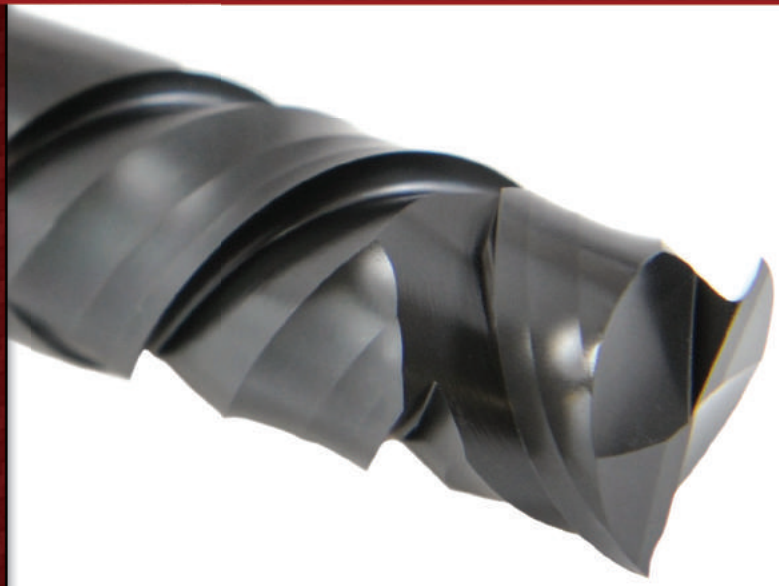
The EXOPRO® AERO-HBC 60 is a compression router featuring a 60° helix angle designed to shear fibers in aramid fiber applications and OSG's patented diamond coating for longer tool life.

Applications

- Excels in Aramid fiber applications

Features

- 60° helix angle for even sharper cutting edges for shearing fibers
- OSG's patented diamond coating

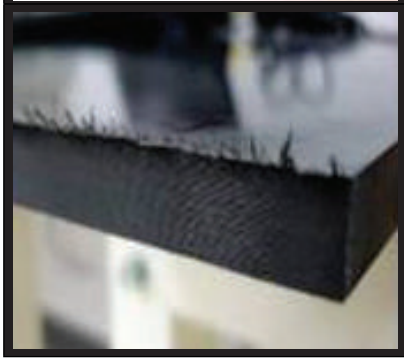


Performance Highlights

OSG's AERO-HBC 60 in Aramid Fiber

Performance Analysis

The AERO-HBC 60's high helix angle shears fibers in Aramid applications and prevents tearout.

Conventional End Mill	EXOPRO® AERO-HBC 60
	
	

List 2068 NEW!

SPEED FEED P 52 | CARBIDE | DIA | 60° | SHRINK h6

Regular Length, 60° Compression Router

h8 Tolerance
+0/-0.002"

EDP Number	Mill Diameter	Compression Length	Length of Cut	OAL	Shank Diameter
	D	L2	Lc	L	d
20682516	0.250	0.188	0.75	3	0.250
20683516	0.375	0.281	0.75	3	0.375
20683616	0.375	0.281	2.00	4	0.375
20685016	0.500	0.375	1.00	3	0.500
20685116	0.500	0.375	2.00	4	0.500

Packed: 1 pc. Available Diamond coating only.

EP

Work Material												
List No.	Carbon Fiber (CFRP)	Glass Fiber (GFRP)	Aramid Fiber (AFRP)	Honeycomb					Carbon/ Carbon	Carbon Fiber/ Aluminum Stack	Carbon Fiber/ Titanium Stack	Carbon Fiber/ Al/ Ti/CRES Stack
				CFRP/Nomex	GFRP/Nomex	AFRP	CFRP/Al	Al/Al				
2068	◎	◎	○	◎	◎	◎	◎	◎				

○ Good ◎ Best

EXOPRO® AERO-REC

Diamond Coated Routers for Milling CFRP and Other Composites

ULTRA FINE

The EXOPRO® AERO-REC is a diamond coated router for roughing and semi-finishing composites. The AERO-REC uses extremely low cutting forces for low rigid fixtures and weak spindles.

Applications

- Low rigid fixtures, setups and weak spindles
- Can be used in combination with the AERO-MFR for finishing

Features

- Roughing nicks for efficient milling providing extremely low cutting forces
- Flute management can be applied by changing the milling position at the flute to increase tool life

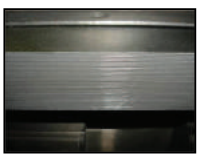
Performance Highlights

OSG's AERO-REC Demonstrates Extremely Low Cutting Forces

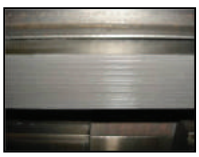
Performance Analysis

Due to the roughing nick profile, the AERO-REC can significantly reduce cutting force when compared to our herringbone 6-flute competitor.

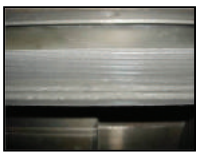
Tool	EXOPRO® AERO-REC	EXOPRO® AERO-BNC	Competitor
Size	0.3937"		
Work Material	CFRP		
Drilling Speed	656 SFM		
Feed Rate	15.7 IPM		
Depth of Cut	Aa: 1" • Ar: 0.3937"		
Coolant	Dry		



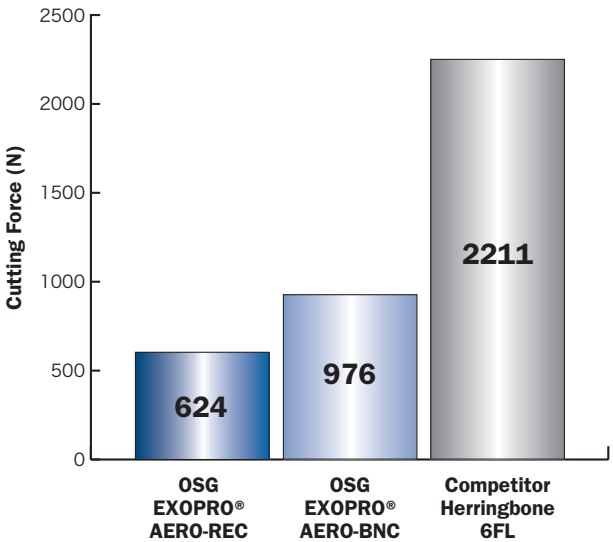
OSG EXOPRO® AERO-REC



OSG EXOPRO® AERO-BNC



Competitor Herringbone 6FL



List 2680

Regular Length, Multiple Flute, Roughing Router

SPEED FEED P 53 | CARBIDE | DIA | 15° | SHRINK h6

h8 Tolerance
+0/-0.002"

EDP Number	Mill Diameter	Length of Cut	OAL	Shank Diameter	Number of Flutes
	D	Lc	L	d	
26809316	15/64	3/4	2-1/2	1/4	4
26805316	1/4	1/2	2-1/2	1/4	4
26800316	1/4	3/4	2-1/2	1/4	4
26806316	1/4	1	3	1/4	4
26809416	5/16	15/16	3	3/8	6
26809516	23/64	1-1/8	3	3/8	6
26805516	3/8	3/4	3	3/8	6
26800516	3/8	1-1/8	3	3/8	6
26809616	7/16	1-5/16	3	1/2	8
26809716	31/64	1-1/2	3	1/2	8
26805716	1/2	1	3	1/2	8
26800716	1/2	1-1/2	3	1/2	8

Packed: 1 pc. Available Diamond coating only.

EP

Work Material												
List No.	Carbon Fiber (CFRP)	Glass Fiber (GFRP)	Aramid Fiber (AFRP)	Honeycomb					Carbon/ Carbon	Carbon Fiber/ Aluminum Stack	Carbon Fiber/ Titanium Stack	Carbon Fiber/ Al/ Ti/CRES Stack
				CFRP/Nomex	GFRP/Nomex	AFRP	CFRP/Al	Al/Al				
2080	▣	▣		▢	▢		▢	▢	▣			

▢ Good ▣ Best

EXOPRO® AERO-MFR

Diamond Coated Routers for Milling CFRP and Other Composites

The EXOPRO® AERO-MFR is a highly rigid multi-fluted finishing router designed for high precision and accuracy requirements. This router features a large core and OSG's patented diamond coating.

Applications

- Excellent for tight tolerances and high precision applications
- Can be used in combination with the AERO-REC for roughing

Features

- Multi-fluted for superior finishes
- Large core for ultra rigidity
- Flute management can be applied by changing the milling position at the flute to increase tool life

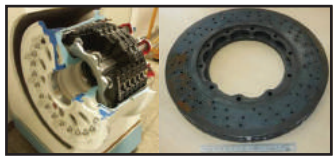
Performance Highlights

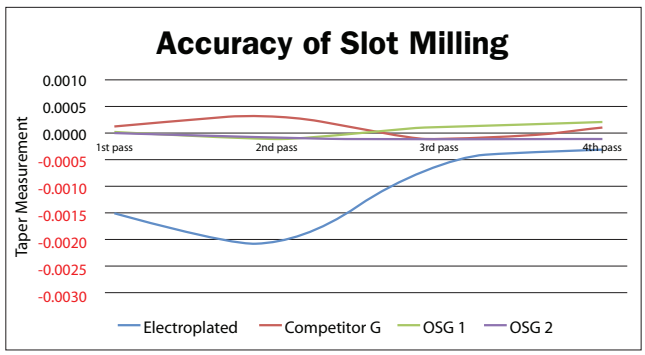
OSG's AERO-MFR Holds Highest Accuracy vs Competition

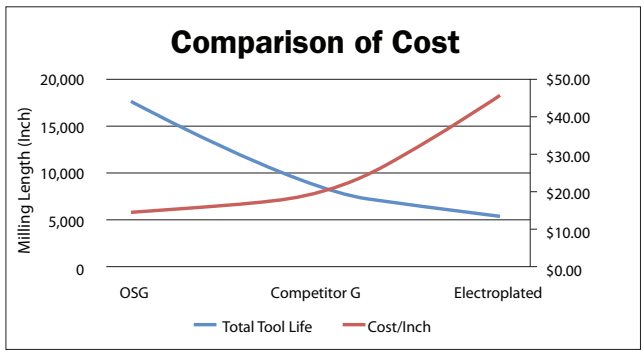
Performance Analysis

The EXOPRO® AERO-MFR showed exceptional accuracy when compared against its diamond coated and electroplated competition.

Tool	OSG AERO-MFR	Competitor G	Electroplated
Material	Carbon / Carbon		
Diameter	5/16"		
Milling Method	Slotting		
Speed	2700 RPM		9795 RPM
Feed	50 IPM		
DOC	Aa: 0.400"		
Coolant	Dry		







List 2650

Regular Length, Multiple Flute, Non End Cutting, Finishing Router

SPEED FEED P 54 | CARBIDE | DIA | 15° | SHRINK h6

h8 Tolerance
+0/-0.002"

EDP Number	Mill Diameter	Length of Cut	OAL	Shank Diameter	Number of Flutes
	D	Lc	L	d	
26500316	1/4	3/4	2-1/2	1/4	8
26501316	1/4	1	3	1/4	8
26500616	3/8	1-1/8	3	3/8	12
26501516	3/8	1-1/2	3	3/8	12
26500716	1/2	1-1/2	4	1/2	14
26501716	1/2	2	4	1/2	14

Packed: 1 pc. Available Diamond coating only.

EP

Work Material												
List No.	Carbon Fiber (CFRP)	Glass Fiber (GFRP)	Aramid Fiber (AFRP)	Honeycomb					Carbon/ Carbon	Carbon Fiber/ Aluminum Stack	Carbon Fiber/ Titanium Stack	Carbon Fiber/ Al/ Ti/CRES Stack
				CFRP/Nomex	GFRP/Nomex	AFRP	CFRP/Al	Al/Al				
2650	◎	◎		○	○		○	○	◎			

○ Good ◎ Best

CARBIDE AERO-HBC 60

Carbide Router for Honeycomb & Other Composites

The Carbide AERO-HBC 60 is a compression router featuring a 60° helix angle designed to shear off fibers in aramid fiber applications.

Applications

- Excels in Aramid fiber materials

Features

- 60° helix angle for even sharper cutting edges for shearing fibers

Performance Highlights

OSG's AERO-HBC 60 Eliminates Tearout

Performance Analysis

The AERO-HBC 60's high helix angle successfully shears fibers and prevents tearout.

Kevlar material has been generally accepted to require a second or third processing to achieve a clean cut. In the test shown below, the HBC 60 demonstrates that a clean edge can be cut with no secondary processing.

OSG's EXOPRO® AERO-HBC 60 (page 28) features the same capabilities as the CARBIDE AERO-HBC 60 but features OSG's patented diamond coating for longer tool life.

Tool	Carbide AERO-HBC 60	Competitor FG Router
Size	0.25"	
Work Material	Aramid Fiber Laminate (0.250" Thickness)	
Speed	14,500 RPM	
Feed Rate	10 IPM	
Ar	0.050	
Milling Method	Conventional (Up) Milling	
Coolant	Dry	
Machine	VMC	

Carbide AERO-HBC 60

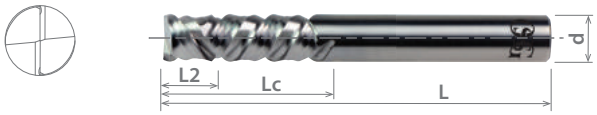
Competitor FG Router

List 668 NEW!

Regular Length, 60° Compression Router

SPEED FEED P 52 | CARBIDE | BR | 60° | SHRINK h6

h8 Tolerance
+0/-0.0015"



EDP Number	Mill Diameter	Compression Length	Length of Cut	OAL	Shank Diameter
	D	L2	Lc	L	d
668-2501	0.250	0.188	0.75	2-1/2	0.250
668-3751	0.375	0.281	0.75	3	0.375
668-3752	0.375	0.281	2.00	4	0.375
668-5001	0.500	0.375	1.00	3	0.500
668-5002	0.500	0.375	2.00	4	0.500

Packed: 1 pc.

HYE

Work Material												
List No.	Carbon Fiber (CFRP)	Glass Fiber (GFRP)	Aramid Fiber (AFRP)	Honeycomb					Carbon/ Carbon	Carbon Fiber/ Aluminum Stack	Carbon Fiber/ Titanium Stack	Carbon Fiber/ Al/ Ti/CRES Stack
				CFRP/Nomex	GFRP/Nomex	AFRP	CFRP/Al	Al/Al				
668			◎	◎	◎	◎	◎	◎				

○ Good ◎ Best

CARBIDE AERO-HFR

Carbide Router for CFRP & Composites

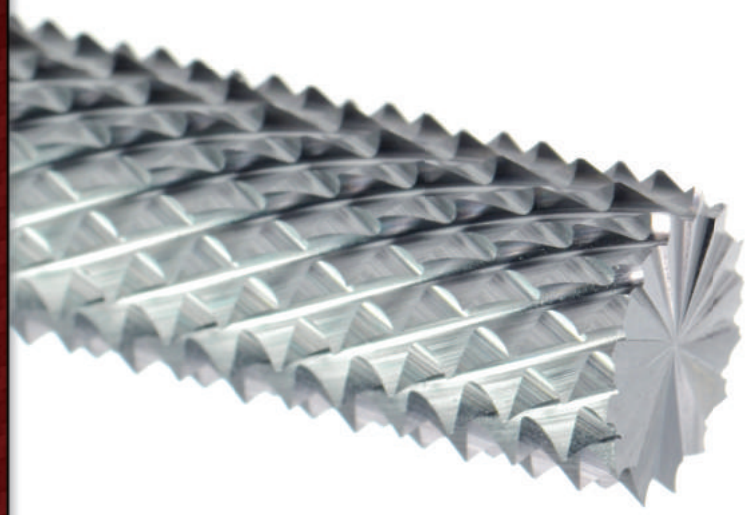
The AERO-HFR is a nicked router featuring a trapezoidal nicked geometry that reduces heat and friction with very low cutting forces. The AERO-HFR can be successfully used in hand routers or machines to provide excellent surface finish and good tool life.

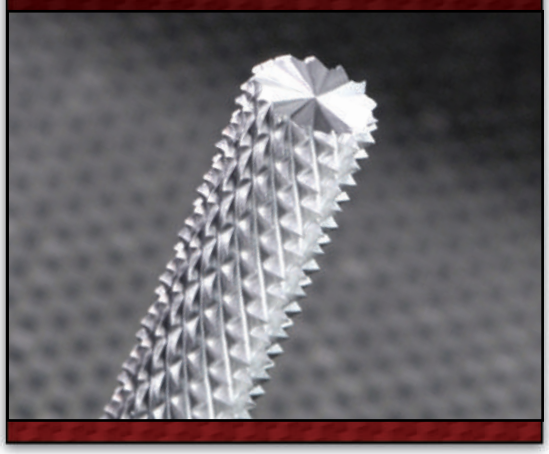
Applications

- Designed for hand trimming
- Used for roughing

Features

- Sharp cutting edges
- Low cutting forces
- Trapezoidal cutting edges reduce friction
- Variety of end cut options for different applications



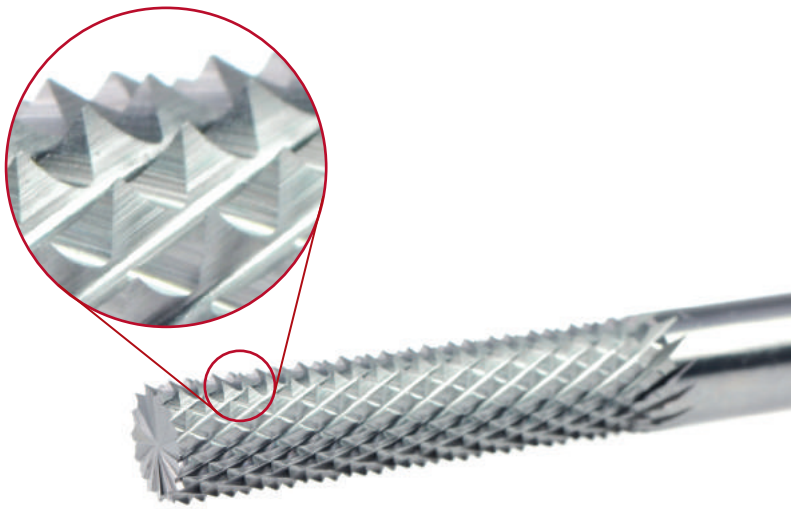


Performance Highlights

OSG's AERO-HFR Performs in a Variety of Applications

Performance Analysis

The AERO-HFR's trapezoidal cutting edge works well in many hand applications.

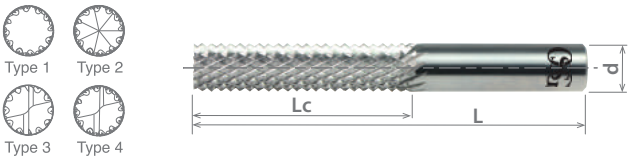


List 641R NEW!

Regular Length, General Purpose Router

SPEED FEED P 55 | CARBIDE | BR | 30° | SHRINK h6

h8 Tolerance
+0/-0.003"



EDP Number	Mill Diameter	Length of Cut	OAL	Shank Diameter	Type
	D	Lc	L	d	
641-1871	3/16	1	3	1/4	1
641-1872	3/16	1	3	1/4	2
641-1873	3/16	1	3	1/4	3
641-1874	3/16	1	3	1/4	4
641-2501	1/4	1	3	1/4	1
641-2502	1/4	1	3	1/4	2
641-2503	1/4	1	3	1/4	3
641-2504	1/4	1	3	1/4	4
641-3751	3/8	1	3	3/8	1
641-3752	3/8	1	3	3/8	2
641-3753	3/8	1	3	3/8	3
641-3754	3/8	1	3	3/8	4
641-5001	1/2	1	3	1/2	1
641-5002	1/2	1	3	1/2	2
641-5003	1/2	1	3	1/2	3
641-5004	1/2	1	3	1/2	4

Packed: 1 pc.

HYE

Type #1 - Non End Cutting
Type #2 - Burr End
Type #3 - End Mill Cut
Type #4 - Drill Point

Work Material												
List No.	Carbon Fiber (CFRP)	Glass Fiber (GFRP)	Aramid Fiber (AFRP)	Honeycomb					Carbon/ Carbon	Carbon Fiber/ Aluminum Stack	Carbon Fiber/ Titanium Stack	Carbon Fiber/ Al/ Ti/CRES Stack
				CFRP/Nomex	GFRP/Nomex	AFRP	CFRP/Al	Al/Al				
641	▣	▣		▢	▢		▢	▢	▢			

▢ Good ▣ Best

OSG PHOENIX® PFB

Finishing Ball End Mill

The PHOENIX® PFB is a high precision indexable finish ballnose end mill designed for superior surface finish and tool life. The PFB features a high insert radius of ±6µm!

Applications

- Ideal for 3-D finishing operations where precision and surface finish are critical
- PVD coated grades for milling mold materials for composites
- 3-D machining operations in composites utilizing OSG's XC4505 grade diamond-coated insert

Features

- Very high insert radius precision (±6µm) provides superior milling surface finish
- Spiral cutting edge for excellent strength and sharpness
- Carbide shank to inhibit chattering and to increase both precision and tool life
- Steel shank for superior cost performance when working with shorter projection lengths

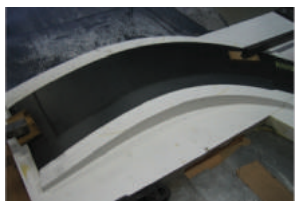
Performance Highlights

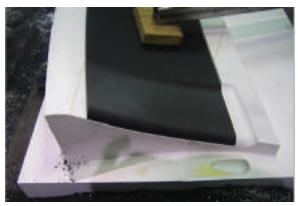
OSG's PHOENIX® PFB High Wear Resistance in CFRP

Performance Analysis

In addition to the exceptional insert radius precision, the PHOENIX® PFB showed high wear resistance while machining the CFRP propeller shown below.

Tool	PFB
Insert (Grade)	PFB300-D (XC4505)
Workpiece	Propeller
Work Material	CFRP-Unidirectional
Tool Overhang	4.7"
Cutting Speed	670 SFM (6000 RPM)
Feed	78 IPM (0.0065 IPT)
Milling Method	3D Milling
Depth of Cut	Aa = 0.040 in • Ar = 0.236 in
Coolant	Air Blow
Machine	Vertical Machining Center





Total Cutting Length: 120"
Flank Wear Amount: 0.005"

Features & Benefits

The steel shank achieves superior cost performance when working with relatively short projection lengths.

The high precision mounting of the insert into the body enables a superior milling surface and long tool life.

The carbide shank inhibits chattering and produces a favorable milling surface even when machining with a long projection length. High precision and long tool life are possible even when milling at high speeds.

±6µm Precision

The PFB features an exceptionally high insert radius precision of ±6µm.

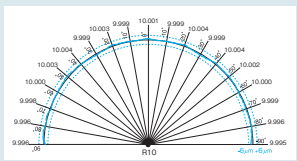
Inserts & Grades

PFB-Q

- The effective cutting edge has a 220˚ angle, applicable for undercut milling.
- The 220˚ cutting edge reduces chatter on vertical walls and produces improved surface finishes.
- High insert radius precision (±6µm).

PFB-SP

- Spiral edge form handles a wide range of work materials.
- High insert radius precision (±6µm).



PFB-SH

- Specialized cutting edge shape for cast iron, ductile cast iron and hardened steel.
- Improved resistance to chipping and breakage by special edge treatment.
- High insert radius precision (±6µm).

PFB-D

- Employs a spiral edge form for outstanding sharpness.
- Amazing durability when machining graphite, copper, aluminum, MMC and carbon fiber composite material!
- High insert radius precision (±6µm).

XP3225 Grade

- Stable machining is possible in a wide range of cutting conditions.
- Especially good performance in stainless steel and carbon steel.

XP3320 Grade

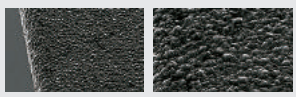
- Utilizes a carbide substrate with a superior balance of wear resistance and anti-chipping properties.
- Oxidation temperature 1300˚C
- Surface hardness 3500 HV
- Capable of long tool life during high speed, high-efficiency machining.

XP3310 Grade

- Highly wear resistant carbide substrate.
- Utilizes a coating with excellent heat resistance and wear resistance.

XC4505 Grade

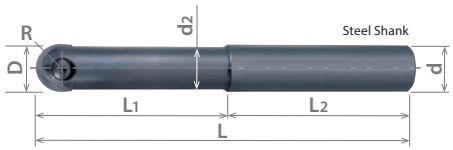
- Utilizes a special carbide substrate for diamond coating.
- A sharp edge is attained through the combination of our high-level grinding techniques and leading diamond coating technology.

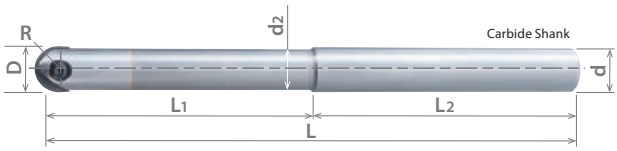


List 52100

SPEED FEED P 45 INDEX.

PFB SA (Inch)





EDP Number	Body Type	Designation	Tool Diameter (mm)	Tool Radius (mm)	Overall Length (mm)	Neck Length (mm)	L/D Ratio	No. of Teeth	Shank Diameter (mm)	Shank Length (mm)	Neck Diameter (mm)
			D	R	L	l1			d	l2	d2
52100001	Cylindrical Shank Steel	PFB-R0375SA0375-S550	0.375	0.1875	5.500	1.6880	4.5	2	0.375	4.3120	0.335
52100002		PFB-R0500SA0500-S550	0.500	0.2500	5.500	2.2500	4.5	2	0.500	3.2500	0.460
52100003		PFB-R0625SA0625-S550	0.625	0.3125	5.500	2.5000	4.0	2	0.625	3.0000	0.585
52100004		PFB-R0750SA0750-S600	0.750	0.3750	6.000	3.0000	4.0	2	0.750	3.0000	0.710
52100005		PFB-R1000SA1000-S650	1.000	0.5000	6.500	3.0000	3.0	2	1.000	3.5000	0.960
52100021	Cylindrical Shank Short Carbide	PFB-R0375SA0375-S400CS	0.375	0.1875	4.000	0.9375	2.5	2	0.375	3.0625	0.335
52100022		PFB-R0500SA0500-S450CS	0.500	0.2500	4.500	1.2500	2.5	2	0.500	3.2500	0.460
52100023		PFB-R0625SA0625-S550CS	0.625	0.3125	5.500	1.5625	2.5	2	0.625	3.9375	0.585
52100024		PFB-R0750SA0750-S600CS	0.750	0.3750	6.000	1.8750	2.5	2	0.750	4.1250	0.710
52100025		PFB-R1000SA1000-S650CS	1.000	0.5000	6.500	2.5000	2.5	2	1.000	4.0000	0.960
52100011	Cylindrical Shank Long Carbide	PFB-R0375SA0375-LL650CS	0.375	0.1875	6.500	2.6250	7.0	2	0.375	3.8750	0.335
52100012		PFB-R0500SA0500-LL700CS	0.500	0.2500	7.000	3.5000	7.0	2	0.500	3.5000	0.460
52100013		PFB-R0625SA0625-LL750CS	0.625	0.3125	7.500	3.7500	6.0	2	0.625	3.7500	0.585
52100014		PFB-R0750SA0750-LL900CS	0.750	0.3750	9.000	4.5000	6.0	2	0.750	4.5000	0.710
52100015		PFB-R1000SA1000-LL1050CS	1.000	0.5000	10.500	5.5000	5.5	2	1.000	5.0000	0.960

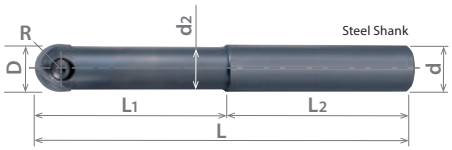
Packed: 1 pc.

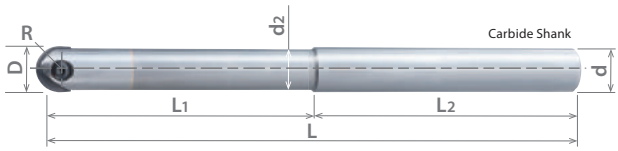
PXT

List 78014

SPEED FEED P 45 INDEX.

PFB SS (Metric)



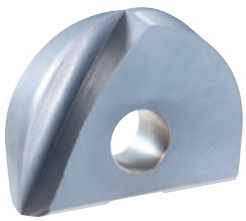


EDP Number	Body Type	Designation	Tool Diameter (mm)	Tool Radius (mm)	Overall Length (mm)	Neck Length (mm)	L/D Ratio	No. of Teeth	Shank Diameter (mm)	Shank Length (mm)	Neck Diameter (mm)
			D	R	L	l1			d	l2	d2
7801400	Cylindrical Shank Steel	PFB-R080SS08-S120	8	4.0	120	36.0	4.5	2	8	84.0	7
7801401		PFB-R100SS10-S130	10	5.0	130	45.0	4.5	2	10	85.0	9
7801402		PFB-R120SS12-S130	12	6.0	130	54.0	4.5	2	12	76.0	11
7801403		PFB-R160SS16-S140	16	8.0	140	64.0	4.0	2	16	76.0	14
7801404		PFB-R200SS20-S160	20	10.0	160	80.0	4.0	2	20	80.0	18
7801405		PFB-R250SS25-S160	25	12.5	160	75.0	3.0	2	25	85.0	22
7801406		PFB-R300SS32-S170	30	15.0	170	90.0	3.0	2	32	80.0	27
7801430	Cylindrical Shank Short Carbide	PFB-R080SS08-S100CS	8	4.0	100	20.0	2.5	2	8	80.0	7
7801431		PFB-R100SS10-S100CS	10	5.0	100	25.0	2.5	2	10	75.0	9
7801432		PFB-R120SS12-S110CS	12	6.0	110	30.0	2.5	2	12	80.0	11
7801433		PFB-R160SS16-S140CS	16	8.0	140	40.0	2.5	2	16	100.0	14
7801434		PFB-R200SS20-S160CS	20	10.0	160	50.0	2.5	2	20	110.0	18
7801435		PFB-R250SS25-S160CS	25	12.5	160	62.5	2.5	2	25	97.5	22
7801436		PFB-R300SS32-S170CS	30	15.0	170	75.0	2.5	2	32	95.0	27
7801420	Cylindrical Shank Long Carbide	PFB-R080SS08-LL140CS	8	4.0	140	56.0	7.0	2	8	84.0	7
7801421		PFB-R100SS10-LL150CS	10	5.0	150	70.0	7.0	2	10	80.0	9
7801422		PFB-R120SS12-LL160CS	12	6.0	160	84.0	7.0	2	12	76.0	11
7801423		PFB-R160SS16-LL200CS	16	8.0	200	96.0	6.0	2	16	104.0	14
7801424		PFB-R200SS20-LL240CS	20	10.0	240	120.0	6.0	2	20	120.0	18
7801425		PFB-R250SS25-LL260CS	25	12.5	260	137.5	5.5	2	25	122.5	22
7801426		PFB-R300SS32-LL290CS	30	15.0	290	165.0	5.5	2	32	125.0	27

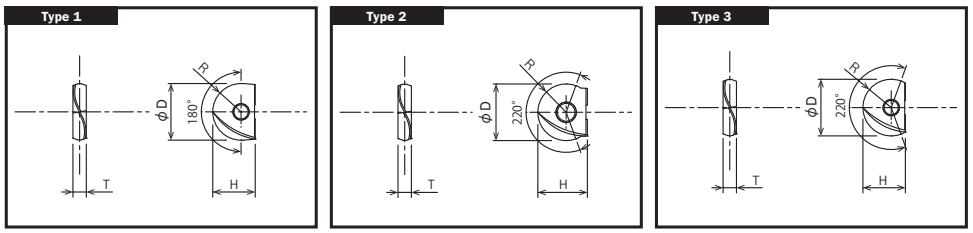
Packed: 1 pc.

PXT

OSG PHOENIX® PFB Inserts

Appearance	Designation	Type	Specification	Number of Cutting Edges	Range
	PFB0375-SP	1	Spiral	2	180°
	PFB0500-SP			2	
	PFB0625-SP			2	
	PFB0750-SP			2	
	PFB1000-SP			2	
	PFB080-SP			2	
	PFB100-SP			2	
	PFB120-SP			2	
	PFB160-SP			2	
	PFB200-SP			2	
	PFB250-SP			2	
	PFB300-SP			2	
	PFB0375-SH		Spiral (Edge Strengthened)	2	
	PFB0500-SH			2	
	PFB0625-SH			2	
	PFB0750-SH			2	
	PFB1000-SH			2	
	PFB080-SH			2	
	PFB100-SH			2	
	PFB120-SH			2	
	PFB160-SH			2	
	PFB200-SH			2	
	PFB250-SH			2	
	PFB300-SH			2	
	PFB0375-D		Spiral (Diamond Coated)	2	
	PFB0500-D			2	
	PFB0625-D			2	
	PFB0750-D			2	
	PFB1000-D			2	
	PFB080-D			2	
	PFB100-D			2	
	PFB120-D			2	
	PFB160-D			2	
	PFB200-D			2	
	PFB250-D			2	
	PFB300-D			2	
	PFB0375-Q	2	Spiral (Full Radius)	2	220°
	PFB0500-Q			2	
	PFB0625-Q	3		2	
	PFB0750-Q			2	
	PFB1000-Q			2	
	PFB080-Q	2		2	
	PFB100-Q			2	
	PFB120-Q			2	
	PFB160-Q	3		2	
	PFB200-Q			2	
	PFB250-Q			2	
	PFB300-Q			2	

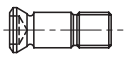
Packed = 1 pc.



Insert Size						EDP Number			
D		R		T (mm)	H (mm)				
(inch)	(mm)	(inch)	(mm)			XP3225	XP3310	XP3320	XC4505
0.375	-	0.1875	-	2.6	8.5	52101021	-	52101011	-
0.500	-	0.2500	-	3.0	10.0	52101022	-	52101012	-
0.625	-	0.3125	-	4.0	12.0	52101023	-	52101013	-
0.750	-	0.3750	-	5.0	15.0	52101024	-	52101014	-
1.000	-	0.5000	-	6.0	18.5	52101025	-	52101015	-
-	8	-	4.0	2.4	7.0	7820030	-	7820010	-
-	10	-	5.0	2.6	8.5	7820031	-	7820011	-
-	12	-	6.0	3.0	10.0	7820032	-	7820012	-
-	16	-	8.0	4.0	12.0	7820033	-	7820013	-
-	20	-	10.0	5.0	15.0	7820034	-	7820014	-
-	25	-	12.5	6.0	18.5	7820035	-	7820015	-
-	30	-	15.0	7.0	22.5	7820036	-	7820016	-
0.375	-	0.1875	-	2.6	8.5	-	52101031	-	-
0.500	-	0.2500	-	3.0	10.0	-	52101032	-	-
0.625	-	0.3125	-	4.0	12.0	-	52101033	-	-
0.750	-	0.3750	-	5.0	15.0	-	52101034	-	-
1.000	-	0.5000	-	6.0	18.5	-	52101035	-	-
-	8	-	4.0	2.4	7.0	-	7820040	-	-
-	10	-	5.0	2.6	8.5	-	7820041	-	-
-	12	-	6.0	3.0	10.0	-	7820042	-	-
-	16	-	8.0	4.0	12.0	-	7820043	-	-
-	20	-	10.0	5.0	15.0	-	7820044	-	-
-	25	-	12.5	6.0	18.5	-	7820045	-	-
-	30	-	15.0	7.0	22.5	-	7820046	-	-
0.375	-	0.1875	-	2.6	8.5	-	-	-	52101001
0.500	-	0.2500	-	3.0	10.0	-	-	-	52101002
0.625	-	0.3125	-	4.0	12.0	-	-	-	52101003
0.750	-	0.3750	-	5.0	15.0	-	-	-	52101004
1.000	-	0.5000	-	6.0	18.5	-	-	-	52101005
-	8	-	4.0	2.4	7.0	-	-	-	7820020
-	10	-	5.0	2.6	8.5	-	-	-	7820021
-	12	-	6.0	3.0	10.0	-	-	-	7820022
-	16	-	8.0	4.0	12.0	-	-	-	7820023
-	20	-	10.0	5.0	15.0	-	-	-	7820024
-	25	-	12.5	6.0	18.5	-	-	-	7820025
-	30	-	15.0	7.0	22.5	-	-	-	7820026
0.375	-	0.1875	-	2.6	8.5	52101041	-	-	-
0.500	-	0.2500	-	3.0	10.0	52101042	-	-	-
0.625	-	0.3125	-	4.0	12.0	52101043	-	-	-
0.750	-	0.3750	-	5.0	15.0	52101044	-	-	-
1.000	-	0.5000	-	6.0	18.5	52101045	-	-	-
-	8	-	4.0	2.4	7.0	7820050	-	-	-
-	10	-	5.0	2.6	8.5	7820051	-	-	-
-	12	-	6.0	3.0	10.0	7820052	-	-	-
-	16	-	8.0	4.0	12.0	7820053	-	-	-
-	20	-	10.0	5.0	15.0	7820054	-	-	-
-	25	-	12.5	6.0	18.5	7820055	-	-	-
-	30	-	15.0	7.0	22.5	7820056	-	-	-

PXI

OSG PHOENIX® PFB Accessories

	EDP No.	Designation	Applicable Insert (inch)	Applicable Insert (mm)	Rec'd Tightening Torque
 Clamping Screw	7808123	FS25669RB (Torx 7)	-	8	1Nm
	7808117	FS30686RB (Torx 8)	0.375	10	1.2Nm
	7808118	FS35610RB (Torx 10)	0.500	12	2Nm
	7808119	FS40613RB (Torx 15)	0.625	16	3Nm
	7808120	FS50615RB (Torx 20)	0.750	20	5Nm
	7808121	FS60620RB (Torx 20)	1.000	25	5Nm
	7808122	FS80624RB (Torx 30)	-	30	6Nm

Packed: 1 pc.

PXT

	EDP No.	Designation	Applicable Insert (inch)	Applicable Insert (mm)
 Wrench	7808204	T7-D (Torx 7)	-	8
	7808205	T8-D (Torx 8)	0.375	10
	7808207	T10-D (Torx 10)	0.500	12
	7808208	T15-D (Torx 15)	0.625	16
	7808209	T20-D (Torx 20)	0.750-1.000	20-25
	7808212	T30-T (Torx 30)	-	30

Note: Wrench sold separately.
Packed: 1 pc.

PXT

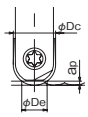
OSG PHOENIX® PFB

OSG PHOENIX® PFB Effective Cutting Diameter

■ Effective cutting diameter ØDc is based on cutting depth (Aa)

Depth of Cut Aa		Effective Cutting Diameter (ØDe)													
		ØDc		ØDc		ØDc		ØDc		ØDc		ØDc		ØDc	
(inch)	(mm)	0.315"	8 mm	0.375"	10 mm	0.500"	12 mm	0.625"	16 mm	0.750"	20 mm	1.000"	25 mm	1.181"	30 mm
0.004	0.1	0.071	1.8	0.079	2.0	0.087	2.2	0.098	2.5	0.110	2.8	0.126	3.2	0.138	3.5
0.008	0.2	0.098	2.5	0.110	2.8	0.122	3.1	0.142	3.6	0.157	4.0	0.177	4.5	0.193	4.9
0.012	0.3	0.118	3.0	0.134	3.4	0.146	3.7	0.169	4.3	0.193	4.9	0.213	5.4	0.236	6.0
0.016	0.4	0.138	3.5	0.154	3.9	0.169	4.3	0.197	5.0	0.220	5.6	0.248	6.3	0.272	6.9
0.020	0.5	0.154	3.9	0.173	4.4	0.189	4.8	0.220	5.6	0.244	6.2	0.276	7.0	0.303	7.7
0.031	0.8	0.189	4.8	0.213	5.4	0.236	6.0	0.276	7.0	0.307	7.8	0.346	8.8	0.382	9.7
0.039	1.0	-	-	0.236	6.0	0.260	6.6	0.303	7.7	0.343	8.7	0.386	9.8	0.425	10.8
0.059	1.5	-	-	0.279	7.1	0.311	7.9	0.366	9.3	0.413	10.5	0.469	11.9	0.418	13.1
0.079	2.0	-	-	-	-	0.350	8.9	0.417	10.6	0.472	12.0	0.535	13.6	0.591	15.0
0.098	2.5	-	-	-	-	-	-	0.457	11.6	0.520	13.2	0.591	15.0	0.654	16.6
0.118	3.0	-	-	-	-	-	-	-	-	0.562	14.3	0.638	16.2	0.709	18.0
0.138	3.5	-	-	-	-	-	-	-	-	0.598	15.2	0.681	17.3	0.760	19.3
0.157	4.0	-	-	-	-	-	-	-	-	-	-	0.720	18.3	0.803	20.4
0.117	4.5	-	-	-	-	-	-	-	-	-	-	-	-	0.843	21.4
0.197	5.0	-	-	-	-	-	-	-	-	-	-	-	-	0.882	22.3

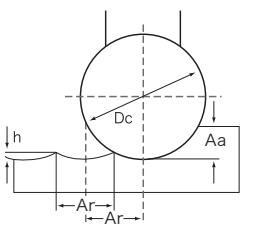
■ How to determine Effective cutting diameter:



$$De=2\sqrt{A_a(D_c-A_a)}$$

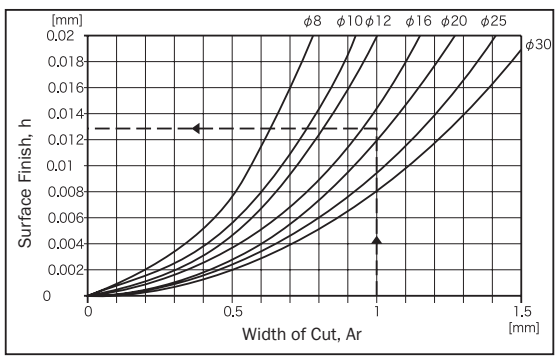
■ OSG PHOENIX® PFB Recommended Width of Cut & Surface Roughness

Tool Dia ØDc		Width of Cut Ar		Surface Roughness h	
(inch)	(mm)	(inch)	(mm)	(inch)	(mm)
-	8	0.0197	0.5	0.00031	0.008
0.375	10	0.0236	0.6	0.00035	0.009
0.500	12	0.0275	0.7	0.00039	0.010
0.625	16	0.0315	0.8	0.00039	0.010
0.750	20	0.0400	1.0	0.00047	0.012
1.000	25	0.0472	1.2	0.00055	0.014
-	30	0.0512	1.3	0.00055	0.014



$$h=0.5\ (Dc-\sqrt{Dc^2-Ar^2})$$

Dc=20mm
Ar=1mm
->h=0.0125mm



OSG PHOENIX® PFB

OSG PHOENIX® PFB Cutting Conditions

	Work Material	Tensile Strength – Hardness	Milling Speed Vc (SFM)	Depth of Cut aa (in)	Feed Per Tooth fz (in/t)			
					Ø0.312 (8mm)	Ø0.375-0.500 (10-12mm)	Ø0.625-0.750 (16-20mm)	Ø1.000 (25-30mm)
P	Mild Steels, Carbon Steels (1010, 1018)	~180HB	985 (655-1310)	0.02Dc	0.0040	0.0047	0.0055	0.0071
	Carbon Steels, Alloy Steels (1050, 4140)	~280HB	985 (655-1310)	0.02Dc	0.0028	0.0040	0.0047	0.0055
	Die Steels (H13, D2)	~280HB	820 (490-1150)	0.02Dc	0.0028	0.0040	0.0047	0.0055
M	Stainless Steels (304SS, 420SS)	~250HB	820 (490-1150)	0.02Dc	0.0028	0.0047	0.0055	0.0067
K	Cast Iron (FC250)	~300N/mm2	1310 (985-1640)	0.02Dc	0.0047	0.0055	0.0071	0.0086
	Ductile Cast Iron (60-40-18)	~600 N/mm²	985 (655-1310)	0.02Dc	0.0040	0.0047	0.0055	0.0071
N	Aluminum Alloys (6061, 7075)	~13% Si	1640 (1310-1970)	0.03Dc	0.0047	0.0055	0.0071	0.0086
	Copper Alloys (C1100)	-	985 (655-1310)	0.03Dc	0.0043	0.0051	0.0067	0.0079
	Graphite	-	1640 (1310-1970)	0.03Dc	0.0055	0.0067	0.0083	0.0980
	CFRP	-	1310 (985-1640)	0.03Dc	0.0043	0.0051	0.0067	0.0079
S	Heat Resistant Alloys (Inconel 718)	–	165 (65-260)	0.015Dc	0.0016	0.0020	0.0024	0.0024
	Titanium Alloy (Ti-6Al-4V)	–	295 (130-395)	0.02Dc	0.0024	0.0031	0.0043	0.0051
H	Pre-hardened Steel (P20, Stavax)	40~43HRC	655 (330-985)	0.015Dc	0.0024	0.0028	0.0031	0.0040
	Die Cast Steels (A2, S7)	43~48HRC	590 (295-655)	0.015Dc	0.0020	0.0024	0.0028	0.0028
	Hardened Steels (D2)	50~60HRC	490 (330-820)	0.01Dc	0.0020	0.0024	0.0028	0.0028

OSG PHOENIX® PFB

Recommended Materials by Application

Insert Grade	P	M	K	N	S	H
XP3225	◻	◻		◻*	▢	
XP3310			◻			◻
XP3320	▢	▢	▢		◻	▢
XC4505				◻**		

*: Best recommended for aluminum & copper alloy applications.
**: Best recommended for graphite & CFRP applications.

▢ good ◻ best

Special Drilling Tools

Spacematic Drill/Countersink

Carbide drill and countersink with internal thread and 60° cone seat straight shank style with pin spanner wrench holes or optional wrench flats for slotted type drill wrenches.
Application: Spacematic Drill motors with 1" stroke.

Drivematic Drill/Countersink

Carbide drill and countersink with solid shank used in aerospace drivematic drill riveting machines.

Dagger Drill

Designed to produce holes in composite materials without delamination around the hole or fraying the composite materials.

Threaded Hex Shank Adapter Drill

Carbide adapter drill manufactured to NAS 907 construction with 135° split points. Used for general to medium duty drilling in low tensile strength materials in confined areas.

NAS 937 Jobbers Length Double Margin Step Drill

Carbide drill with 135° split point. Used for drilling close tolerance holes in low tensile strength materials. Can also be supplied in taper, screw machine lengths or special lengths.

Nutplate Drill/Countersink

Carbide drill and countersink with 135° split point. External thread and 60° cone seat straight shank style with pin spanner wrench holes.
Application: Nutplate and motors with nutplate pressure foot attachments.

Special Milling Tools

Circular Milling Tool

The circular milling tool excels in hole machining utilizing helical interpolation. This tool can produce excellent quality holes in CF/Ti and CF/AL stack materials with an extremely high level of hole circularity. Chipping and burr formation in both metallic and composite structures are also reduced.

Electroplated Diamond Drill/Mill

The electroplated diamond drill can be used in various applications ranging from drilling through and blind holes to side and contour grinding.

Special Threading Tools

Electroplated Thread Mill (Thermosetting Plastics)

The electroplated thread mill is for grinding internal threads and composites.

Thread Mill & Tap (Thermoplastics)

Tapping and thread milling of composites is uncommon. Some composites are capable of being tapped or thread milled. In such cases, OSG can offer special-made tooling for these applications.

Lists 7501, 7520 & 7500

EXOPRO® AERO-STAD, EXOPRO® AERO-LHX & EXOPRO® AERO-D-REAM

Work Material	Carbon & Glass Fiber Reinforced Plastics	
Cutting Speed	150-300 SFM	
Drill Diameter (mm)	Speed RPM	Feed IPR
#40	8,900	0.0010 - 0.002
#30	6,700	0.0010 - 0.002
#20	5,250	0.0010 - 0.002
#11	4,500	0.0010 - 0.002
#2	3,750	0.0015 - 0.003
1/4"	3,350	0.0015 - 0.003
5/16"	2,900	0.0015 - 0.003
3/8"	2,250	0.0015 - 0.003
7/16"	1,950	0.0015 - 0.003
1/2"	1,700	0.0015 - 0.003

1. Coolant is not needed, however, make sure dust is efficiently collected.
2. Peck drilling is not needed if drilling depth is less than 3D.
3. The machinability of CFRP depends on physical makeup and percentage of contents. Both speed & feed may need adjustments depending on material.
4. Feed rate can be and should be adjusted depending on surface layer makeup.
5. Feed rates can be increased when an approved coolant is utilized.
6. Please contact OSG for specific application questions.

List 7530

EXOPRO® AERO-S

Work Material	Carbon & Glass Fiber Reinforced Plastics		CFRP + Aluminum Stack	
Cutting Speed	150-300 SFM		200-400 SFM	
Drill Diameter (mm)	Speed RPM	Feed IPR	Speed RPM	Feed IPR
#40	8,900	0.0010 - 0.002	11,250	0.001 - 0.003
#30	6,700	0.0010 - 0.002	9,000	0.003 - 0.004
#20	5,250	0.0010 - 0.002	7,000	0.004 - 0.005
#11	4,500	0.0010 - 0.002	6,000	0.004 - 0.005
#2	3,750	0.0015 - 0.003	5,250	0.005 - 0.006
1/4"	3,350	0.0015 - 0.003	4,500	0.006 - 0.007
5/16"	2,900	0.0015 - 0.003	3,750	0.007 - 0.008
3/8"	2,250	0.0015 - 0.003	3,000	0.009 - 0.010
7/16"	1,950	0.0015 - 0.003	2,625	0.010 - 0.011
1/2"	1,700	0.0015 - 0.003	2,250	0.012 - 0.013

1. Feed rates can and should be adjusted depending on stack makeup, with higher feed rates in the composite portion and lower feeds in the metal portion.
2. Peck drilling may be necessary for enhanced quality and proper chip evacuation.
3. There are many factors that can effect successful stack drilling. Please contact OSG about your specific application for best recommendation.

Lists 7532 & 5732

EXOPRO® AERO-H & EXOCARB® AERO-H

Work Material	Carbon & Glass Fiber Reinforced Plastics		CFRP + Aluminum Stack		CFRP + Titanium Stack		CFRP + CRES Stack	
Cutting Speed	150-300 SFM		200-400 SFM		40-60 SFM		30-50 SFM	
Drill Dia. (mm)	Speed RPM	Feed IPR	Speed RPM	Feed IPR	Speed RPM	Feed IPR	Speed RPM	Feed IPR
#40	8,900	0.001-0.002	11,250	0.001 - 0.003	1,900	0.0002 - 0.0007	1,550	0.0002 - 0.0007
#30	6,700	0.001-0.002	9,000	0.003 - 0.004	1,500	0.0004 - 0.0009	1,150	0.0004 - 0.0009
#20	5,250	0.001-0.002	7,000	0.004 - 0.005	1,225	0.0006 - 0.0011	950	0.0006 - 0.0011
#11	4,500	0.001-0.002	6,000	0.004 - 0.005	1,000	0.0007 - 0.0012	800	0.0007 - 0.0012
#2	3,750	0.0015-0.003	5,250	0.005 - 0.006	875	0.0009 - 0.0014	675	0.0009 - 0.0014
1/4"	3,350	0.0015-0.003	4,500	0.006 - 0.007	750	0.0010 - 0.0015	600	0.0010 - 0.0015
5/16"	2,900	0.0015-0.003	3,750	0.007 - 0.008	625	0.0013 - 0.0018	475	0.0013 - 0.0018
3/8"	2,250	0.0015-0.003	3,000	0.009 - 0.010	500	0.0016 - 0.0021	400	0.0016 - 0.0021
7/16"	1,950	0.0015-0.003	2,625	0.010 - 0.011	425	0.0019 - 0.0024	350	0.0019 - 0.0024
1/2"	1,700	0.0015-0.003	2,250	0.012 - 0.013	375	0.0023 - 0.0028	275	0.0023 - 0.0028

1. Feed rates can and should be adjusted depending on stack makeup, with higher feed rates in the composite portion and lower feeds in the metal portion.
2. Peck drilling may be necessary for enhanced quality and proper chip evacuation.
3. There are many factors that can effect successful stack drilling. Please contact OSG about your specific application for best recommendation.

List 7534

EXOPRO® AERO-N

Work Material	Carbon & Glass Fiber Reinforced Plastics		CFRP + Titanium Stack		CFRP + CRES Stack	
Cutting Speed	150-300 SFM		40-60 SFM		30-50 SFM	
Drill Diameter (mm)	Speed RPM	Feed IPR	Speed RPM	Feed IPR	Speed RPM	Feed IPR
#40	8,900	0.0010 - 0.002	1,900	0.0002 - 0.0007	1,550	0.0002 - 0.0007
#30	6,700	0.0010 - 0.002	1,500	0.0004 - 0.0009	1,150	0.0004 - 0.0009
#20	5,250	0.0010 - 0.002	1,225	0.0006 - 0.0011	950	0.0006 - 0.0011
#11	4,500	0.0010 - 0.002	1,000	0.0007 - 0.0012	800	0.0007 - 0.0012
#2	3,750	0.0015 - 0.003	875	0.0009 - 0.0014	675	0.0009 - 0.0014
1/4"	3,350	0.0015 - 0.003	750	0.0010 - 0.0015	600	0.0010 - 0.0015
5/16"	2,900	0.0015 - 0.003	625	0.0013 - 0.0018	475	0.0013 - 0.0018
3/8"	2,250	0.0015 - 0.003	500	0.0016 - 0.0021	400	0.0016 - 0.0021
7/16"	1,950	0.0015 - 0.003	425	0.0019 - 0.0024	350	0.0019 - 0.0024
1/2"	1,700	0.0015 - 0.003	375	0.0023 - 0.0028	275	0.0023 - 0.0028

1. Feed rates can and should be adjusted depending on stack makeup, with higher feed rates in the composite portion and lower feeds in the metal portion.
2. Peck drilling may be necessary for enhanced quality and proper chip evacuation.
3. There are many factors that can effect successful stack drilling. Please contact OSG about your specific application for best recommendation.

List HP700

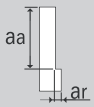
HY-PRO® CARB NEPTUNE®

Work Material	Carbon & Glass Fiber Reinforced Plastics		CFRP + Aluminum Stack		CFRP + Titanium Stack		CFRP + CRES Stack	
Cutting Speed	150-300 SFM		200-400 SFM		40-60 SFM		30-50 SFM	
Drill Diameter (mm)	Speed RPM	Feed IPR	Speed RPM	Feed IPR	Speed RPM	Feed IPR	Speed RPM	Feed IPR
#40	8,900	0.0010 - 0.002	11,250	0.001 - 0.003	1,900	0.0002 - 0.0007	1,550	0.0002 - 0.0007
#30	6,700	0.0010 - 0.002	9,000	0.003 - 0.004	1,500	0.0004 - 0.0009	1,150	0.0004 - 0.0009
#20	5,250	0.0010 - 0.002	7,000	0.004 - 0.005	1,225	0.0006 - 0.0011	950	0.0006 - 0.0011
#11	4,500	0.0010 - 0.002	6,000	0.004 - 0.005	1,000	0.0007 - 0.0012	800	0.0007 - 0.0012
1/4	3,350	0.0015 - 0.003	4,500	0.006 - 0.007	750	0.0010 - 0.0015	675	0.0009 - 0.0014

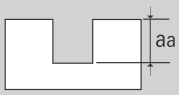
Lists 2061, 2066 & 2064

EXOPRO® AERO-BNC, EXOPRO® AERO-HBC & EXOPRO® AERO-HBC 45

Side Milling

Work Material	Carbon & Glass Fiber Reinforced Plastics			
Cutting Speed	**400-800 SFM**			
Depth of Cut	a_a=1.5D a_r=1D			
Drill Diameter (Inch)	**Speed RPM**	**Feed IPM**	**Speed RPM**	**Feed IPM**
1/8	12,000	20	24,000	40
3/16	8,000	25	16,000	50
1/4	6,000	30	12,000	60
5/16	5,000	35	10,000	70
3/8	4,000	40	8,000	80
1/2	3,000	50	6,000	100

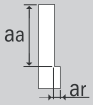
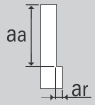
Slotting

Work Material	Carbon & Glass Fiber Reinforced Plastics			
Cutting Speed	**300-600 SFM**			
Depth of Cut	a_a=1D			
Drill Diameter (Inch)	**Speed RPM**	**Feed IPM**	**Speed RPM**	**Feed IPM**
1/8	9,000	10	18,000	20
3/16	6,000	12	12,000	25
1/4	5,000	15	9,000	30
5/16	4,000	18	7,000	35
3/8	3,000	20	6,000	40
1/2	2,000	25	5,000	50

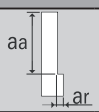
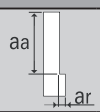
Lists 2068 & 668

EXOPRO® AERO-HBC 60 & CARBIDE AERO-HBC 60

Side Milling

Work Material	Carbon, Glass & Honeycomb Fiber Reinforced Plastics				Aramid Fiber Reinforced Plastics			
Cutting Speed	400-800 SFM				1000-2600 SFM			
Depth of Cut	a_a=1.5D a_r=1D 				a_a=1.5D a_r=1D 			
Drill Diameter (Inch)	Speed RPM	Feed IPM	Speed RPM	Feed IPM	Speed RPM	Feed IPM	Speed RPM	Feed IPM
1/4	6,000	30	12,000	60	15,000	5	40,000	10
3/8	4,000	40	8,000	80	10,000	10	25,000	15
1/2	3,000	50	6,000	100	8,000	15	20,000	20

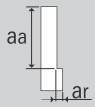
Slotting

Work Material	Carbon, Glass & Honeycomb Fiber Reinforced Plastics				Aramid Fiber Reinforced Plastics			
Cutting Speed	300-600 SFM				750-1900 SFM			
Depth of Cut	a_a=1.5D a_r=1D 				a_a=1.5D a_r=1D 			
Drill Diameter (Inch)	Speed RPM	Feed IPM	Speed RPM	Feed IPM	Speed RPM	Feed IPM	Speed RPM	Feed IPM
1/4	5,000	15	9,000	30	12,000	5	30,000	10
3/8	3,000	20	6,000	40	8,000	10	20,000	15
1/2	2,000	25	5,000	50	6,000	15	15,000	20

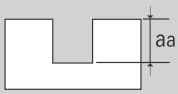
List 2680

EXOPRO® AERO-REC

Side Milling

Work Material	Carbon & Glass Fiber Reinforced Plastics			
Cutting Speed	400-800 SFM			
Depth of Cut	a_a=1.5D a_r=1D 			
Drill Diameter (Inch)	Speed RPM	Feed IPM	Speed RPM	Feed IPM
1/4	6,000	60	12,000	180
3/8	4,000	120	8,000	240
1/2	3,000	150	6,000	300

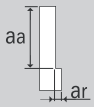
Slotting

Work Material	Carbon & Glass Fiber Reinforced Plastics			
Cutting Speed	300-600 SFM			
Depth of Cut	a_a=1D 			
Drill Diameter (Inch)	Speed RPM	Feed IPM	Speed RPM	Feed IPM
1/4	5,000	45	9,000	90
3/8	3,000	60	6,000	120
1/2	2,000	75	5,000	150

List 2650

EXOPRO® AERO-MFR

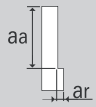
Side Milling

Work Material	Carbon & Glass Fiber Reinforced Plastics			
Cutting Speed	400-800 SFM			
Depth of Cut	a_a>1.0D a_r≤1D			
Drill Diameter (Inch)	Speed RPM	Feed IPM	Speed RPM	Feed IPM
1/4	6,000	30	12,000	120
3/8	4,000	40	8,000	140
1/2	3,000	50	6,000	200

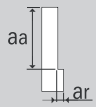
List 641R

Carbide AERO-HFR

Side Milling

Work Material	Carbon & Glass Fiber Reinforced Plastics			
Cutting Speed	400-800 SFM			
Depth of Cut	$a_{a-1.5D}$ a_{r-1D} 			
Drill Diameter (Inch)	Speed RPM	Feed IPM	Speed RPM	Feed IPM
3/16	8,000	20	18,000	40
1/4	6,000	30	12,000	60
3/8	4,000	40	8,000	70
1/2	3,000	50	6,000	100

Slotting

Work Material	Carbon & Glass Fiber Reinforced Plastics			
Cutting Speed	300-600 SFM			
Depth of Cut	a_{a-1D} 			
Drill Diameter (Inch)	Speed RPM	Feed IPM	Speed RPM	Feed IPM
3/16	7,000	10	13,000	20
1/4	5,000	15	9,000	30
3/8	3,000	20	6,000	35
1/2	2,000	25	5,000	50

shaping your dreams

Safe use of cutting tools

- Use safety cover, safety glasses and safety shoes during operation.
- Do not touch cutting edges with bare hands.
- Do not touch cutting chips with bare hands. Chips will be hot after cutting.
- Stop cutting when the tool becomes dull.
- Stop cutting operation immediately if you hear any abnormal cutting sounds.
- Do not modify tools.
- Please use appropriate tools for the operation. Check dimensions to ensure proper selection.

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