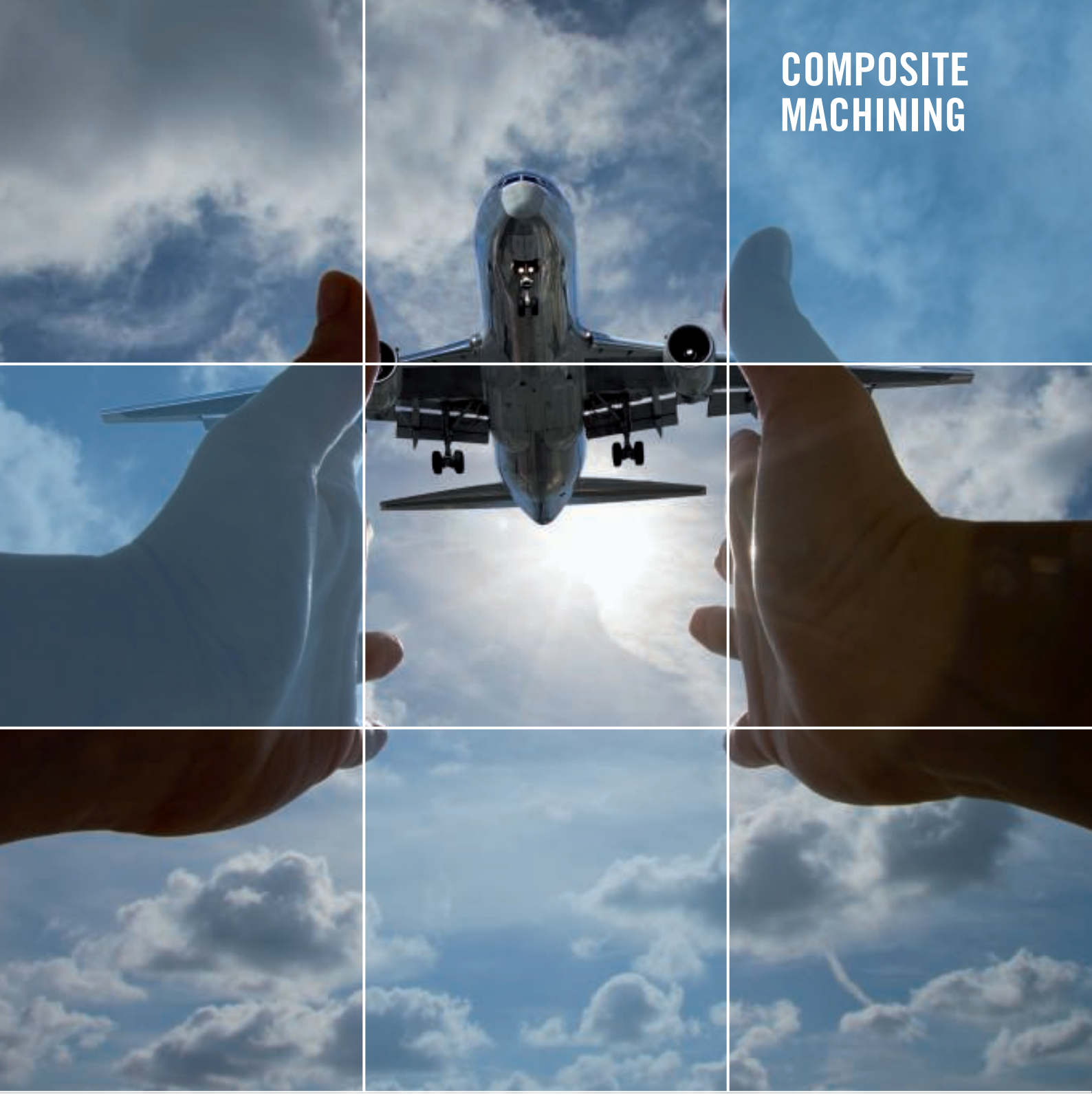


COMPOSITE MACHINING

SOLID CARBIDE, PCD AND TOOLING SYSTEMS SOLUTIONS

SECO

COMPLETE COMPOSITE SUPPORT

Seco works closely with those manufacturers processing composite materials to create and provide solutions that increase productivity and bolster profitability. With 5,000 team members in over 45 countries, we offer a globally networked resource dedicated to solving your composite challenges and supporting your operations. Through cooperative partnerships within key composite-using industries, such as medical and aerospace, as well as other entities around the world, we monitor trends, identify challenges and develop innovative solutions, such as our solid-carbide and Polycrystalline Diamond (PCD) tooling tailored to your specific needs.

When you work with Seco, you experience a true partnership based on trust, respect and communication. Our solutions extend well beyond milling, holemaking, turning and tool holding products, as we work closely with your team to address and improve upon every aspect of your production.

For over 80 years, Seco has developed the tools, processes and services that leading manufacturers have come to depend on for maximum performance. Whatever composite challenges you encounter, our team is always nearby to help you overcome them through extensive expertise and high-quality products.

Seco customers can also access the latest information regarding new products, machining data, manufacturing techniques and other developments for composite materials by visiting our website at **www.secotools.com.**

PRODUCT CENTRE SOLID TOOLS SUPPORT NETWORK

Headquartered in Lottum, The Netherlands, Seco's Product Centre Solid Tools (PCST) is responsible for Seco's global solid-tool business. PCST exists out of several product and reconditioning centres located worldwide. Each centre provides three fundamental competences: R&D, Supply and Marketing. Specialising in solid-carbide and PCD tooling, the PCST product portfolio consists of drills, end mills, reamers, thread mills and a full range of taps (coming soon).
Within PCST, a composite team, well versed in the materials used in aerospace, medical and other industrial applications, shares its latest know-how on composite machining and provides winning solutions on a daily basis while taking the constantly changing environmental factors into account.
PCST consists of four product centres – three are based in Europe and one is in the United States.

SOLID CARBIDE MILLING

Seco end mills are developed and produced by the product centres located in Lottum, The Netherlands and Reynoldsville, Pennsylvania, USA. With marketing and R&D as part of its production facilities, PCST is able to react quickly to changing geographical market needs. In addition to a complete standard range on nano-crystalline diamond coated solid-carbide cutters, both product centres can supply custom tooling as well.

SOLID CARBIDE DRILLING

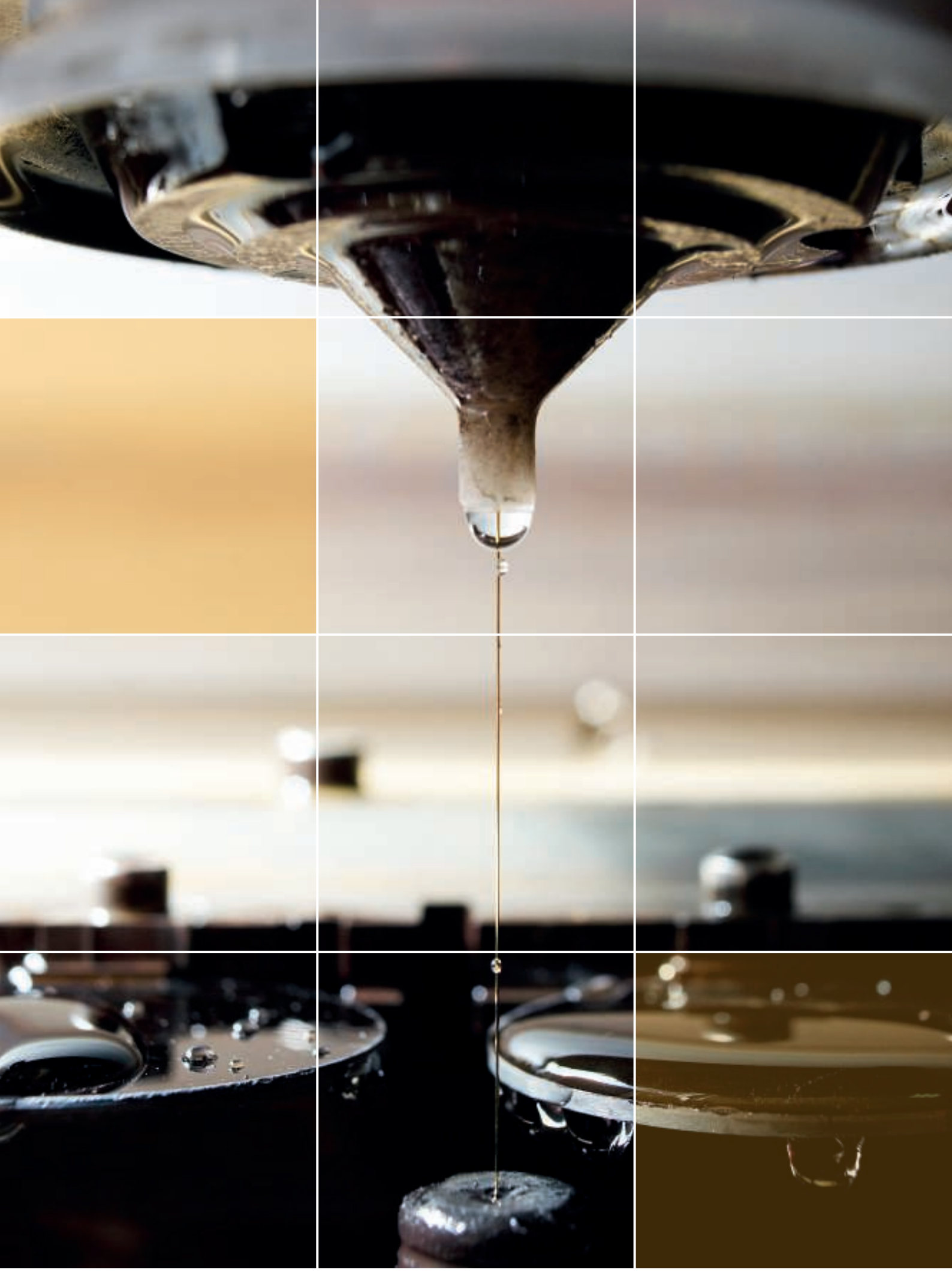
The third product centre of PCST is located in Norrköping, Sweden, and is responsible for the development, marketing and supplying of diamond-coated and PCD-tipped drills.

PCD (MILLING & DRILLING)

Located in Mortagne-sur-Sevre, near Nantes, France, the fourth PCST centre specialises in cutters with brazed polycrystalline diamond (PCD) cutting edges. This product centre has more than 25 years experience in machining using PCD tipped tools and over 13 years experience working within the aerospace industry. The centre also collaborates with the milling and drilling centres for standard and special PCD drills and end mills to assist in providing composite machining solutions in the aerospace industry.

SHARPENING/RE-TIPPING CENTRE

PCST has two sharpening/re-tipping centres located in Mortagne-sur-Sevre and Shanghai. Re-tipping and sharpening can only be applied on PCD cutters with electrical discharge machining (EDM). DURA coated tools are not suitable for reconditioning because the cost of doing so would exceed that of a new cutter.



SECO TEAM: A PARTNER IN MANUFACTURING

With a global composites support group, PCST tracks the latest developments related to machining composites in aerospace and other industries. International application engineers are allocated to three key regional areas – United States, Europe and Asia / Pacific. For further information please contact our team at **composites.support@secotools.com**

What that means to you:

- Dedicated professional project support.
- Exchange of information, clear and concise communication and a complete understanding of your business-needs.
- Continuous improvements based on experience, collected data and extensive evaluations to offer you the best possible service and tools.
- Extensive resources to test your applications and/or new products in 7+ Seco test environments.
- Broad network of industry partners. The best universities and research centres work with Seco.

SECO'S BUSINESS SERVICES

R&D

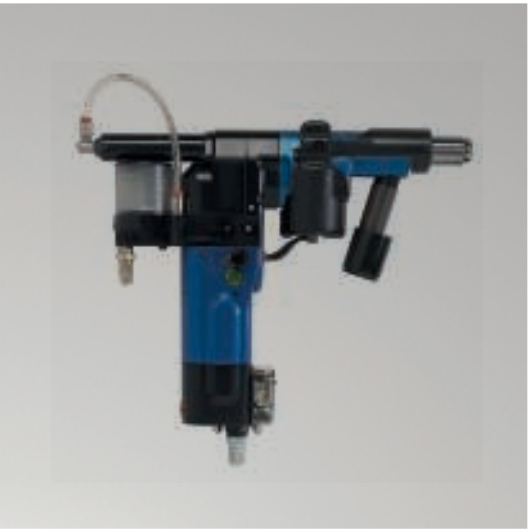
Seco's global composite project group researches and develops standard and special solutions incorporating the latest technologies to fulfil the needs of today's manufacturers. Researchers within the group each have their own expertise in solid-carbide milling, drilling and PCD-tipped products.

TESTING

Seco's test centres, located worldwide, provide additional testing services for optimising customer processes. Each centre performs application simulations and houses modified CNC machines for extensive composite testing. Seco collaborates closely with universities and research institutions to learn from each other and keep up with the latest technologies.

TRAINING & EDUCATION

Available at our global technical centres or on-site at your own facility, Seco STEP provides training courses on every aspect of cutting, at every level of expertise. Whether instructing apprentices on the basics of cutting processes or helping experts stay abreast of the latest technological innovations, Seco STEP is an invaluable resource in maximising workforce knowledge.



MACHINABILITY OF CARBON FIBRE MATERIALS

A carbon fibre is a long, thin strand of material with a diameter between 5 and 10 µm and composed mostly of carbon atoms. Several thousand carbon fibres are twisted together to form a yarn that may be used by itself or woven into a fabric. Among carbon fibre materials, Carbon Fibre Reinforced Plastics (CFRPs) are used the most in many of today's industries.

As compared with traditional metals, CFRP weighs less, which in turn in-creases efficiency and ergonomics for assembly processes. The material also provides specific rigidity and stiffness, impact resistance, thermal and acoustic insulation, better vibration and noise dampening and eliminates any issues related to galvanic corrosion. Plus, by controlling fibre construction, the material can be formed easily to meet specific end user requirements involving more complex shapes.

CFRPs have outstanding shear strength and static strength compared with high tech aluminium alloys. CFRPs also possess the fatigue properties of titanium alloys while delivering flexural strengths exceeding those of titanium and aluminium. Additionally, metal-to-composite joints eliminate the occurrence of chemical and contact erosion. In the case of CFRP / aluminium stacks, corrosion is prevented by an additional thin glass layer.

Several factors influence the cutting behaviour or “machinability” of composite materials. Those factors include:

1. BASE MATERIAL:

Polyacrylonitrile (PAN) and petroleum based fibres or (Pitch) are the most commonly used in the manufacturing industry. The aerospace industry uses mainly PAN fibres because they have the highest tensile strength, whereas Pitch fibres are stiff with lower thermal conductivity capability.

2. FIBRE TYPE:

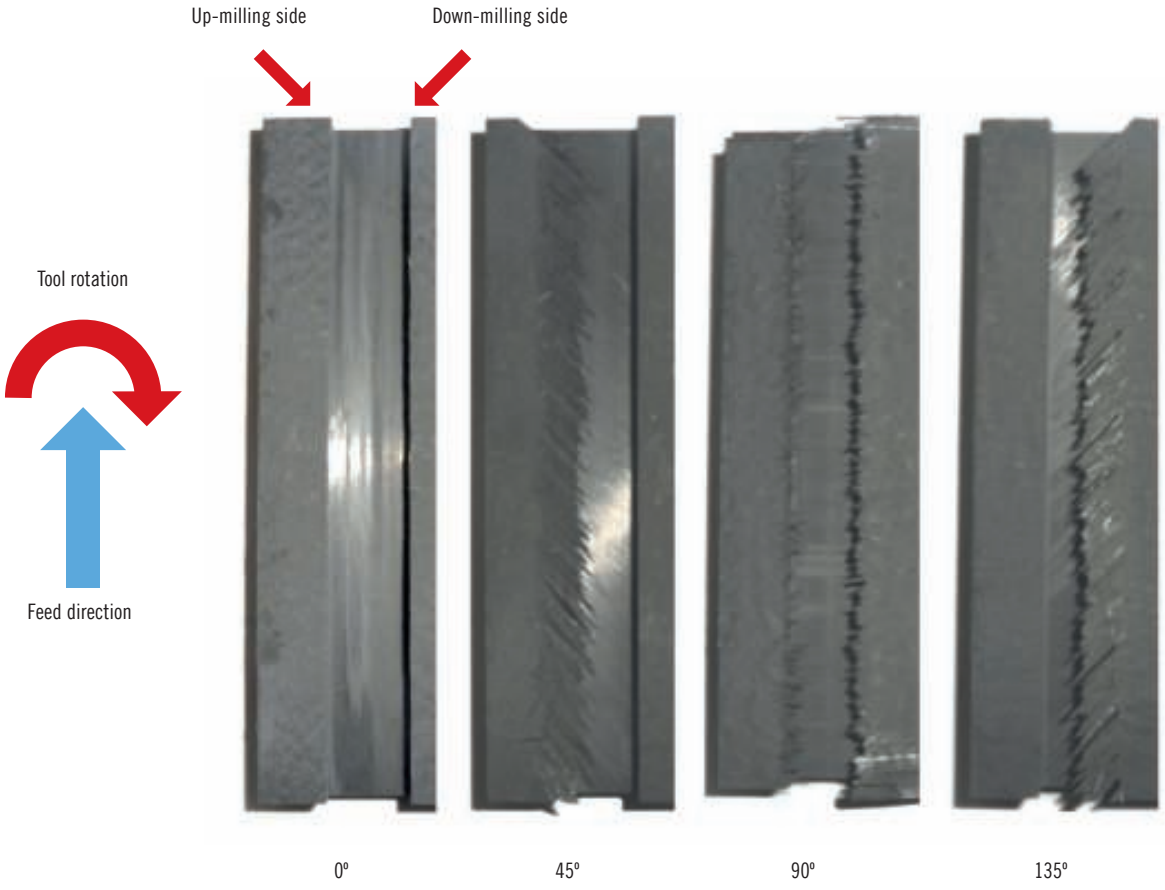
Variation of the graphitisation process produces either high strength fibres (@ 2600 C) or high modulus fibres (@ 3000 C) with other types in between. Carbon fibres are usually grouped according to their modulus bands in which their properties fall.

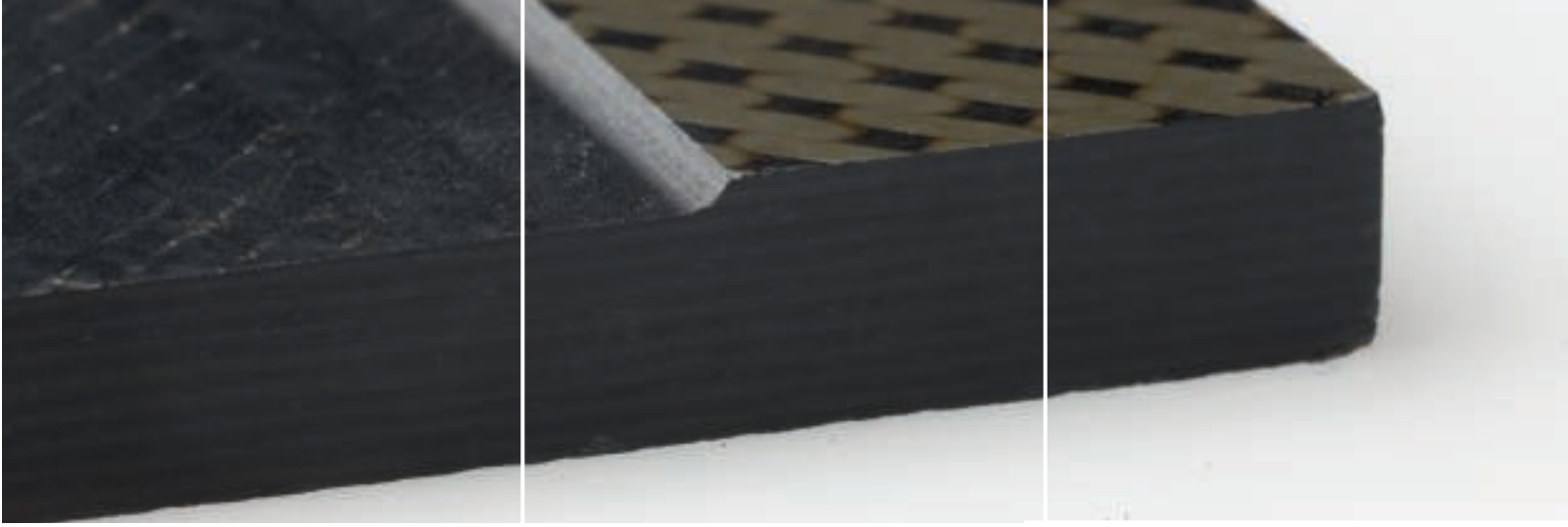
	High strength (HS) or standard modulus	Intermediate modulus (IM)	High modulus (HM)	Ultra high modulus (UHM)
Tensile strength (Gpa)	3500	5300	3500	2000
Tensile modulus (g/cc)	160 - 270	270 - 325	325 - 440	440+

Fibres and Properties

3. FIBRE ORIENTATION:

The fibre orientation refers to the placement of each layer onto one another to form a ply. Most common are those plies with 0° - 90°, 0° - 45° - 90 and 0° - 45° - 90° - 135° stacking patterns. When machining, the 45° and 135° layers are most difficult to cut. To overcome this challenge, Seco has developed several geometries to successfully machine those types of CFRP.

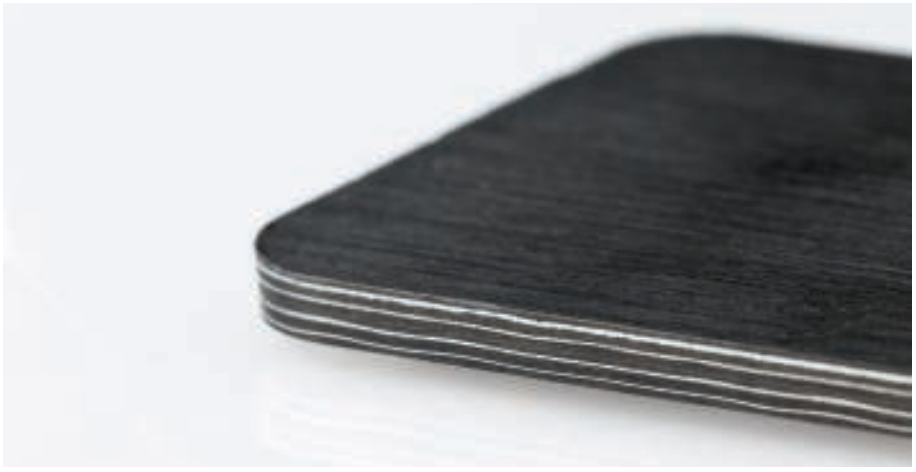




4. STRUCTURE:
The fabrics (layers) within a workpiece may have a certain structure. Basically the distinction is made between a woven structure (0°-90°) and a unidirectional one (UD). The majority of products feature woven structures.

Common weave styles include:
- **Plain:** symmetrical with good stability most difficult one to drape, with low mechanical properties.
- **Twill:** compared to plain, superior wet out with only a small reduction in stability. With reduced crimp the fabric has a smoother surface and slightly higher mechanical properties.
- **Satin:** these weaves are very flat, have good wet out and a high degree of drape as well as good mechanical properties. Satin weaves allow fibres to be woven in the closest proximity.
- **Basket:** this weave is fundamentally the same as a plain weave except that two or more warp fibres alternatively interlace with two or more weft fibres. The arrangement of fibres is not symmetrical. Basket weaves are flatter and stronger, but less stable.

5. FIBRE VOLUME FRACTION (FVF):
The fibre volume fraction is the ratio of carbon fibre to resin. In general, the mechanical properties of the fibres are much higher than those of the resin. Thus, the higher the FVF the higher the mechanical properties of the resultant composite. Also as a general rule, the stiffness and strength of a laminate will increase in proportion to the amount of the fibres present. From a machining perspective, the higher the FVF is the more difficult the material is to machine, meaning that flank wear increases, which causes tool life to rapidly decrease.



6. RESIN:
Also known as the matrix or as polymers, resin can be classified under two types – thermoplastic and thermoset according to the effect of heat on their properties.

- **Thermoplastic resins,** like metals, soften while heating and eventually melt, hardening again by cooling. Thermoplastics are usually reinforced with short chopped fibres such as glass.
- **Thermoset resins** are formed from a chemical reaction by combining a resin with a catalyst or hardener that then undergo a non-reversible chemical reaction to form a hard infusible product. The majority of thermoset resins used for structural parts are polyester, vinylester and epoxy.

From a machining standpoint, thermosets are characterised by producing dust while thermoplastics produce microchips. When machining thermosets, the temperature in the cutting zone must be controlled so that the material's integrity remains uncompromised. Generally Dura coated carbide and PCD cutters produce less heat than routers. PCD tools, however, provide higher tool-life with better surface roughness while having slightly higher temperatures in the process. Those temperatures are in most cases still far below any that would be detrimental to the thermoset resins.

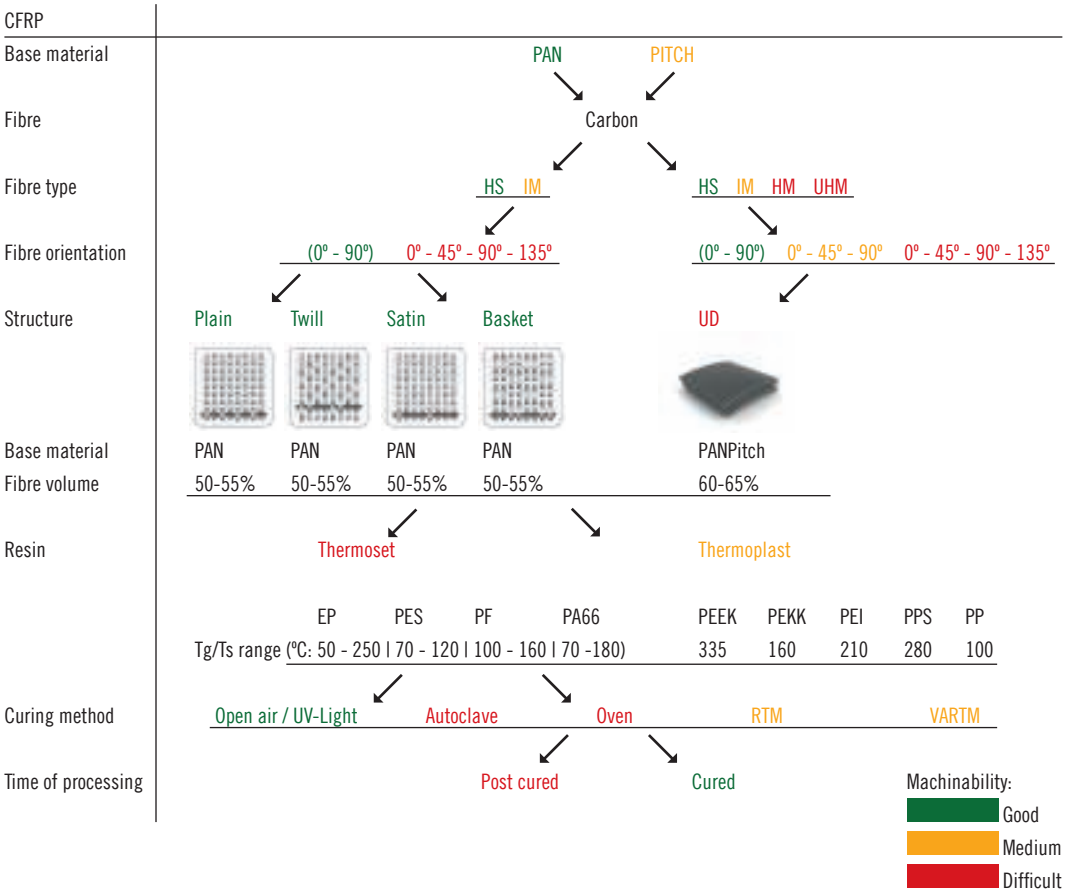
When machining thermoplastics the resin can become soft. Therefore cutters with larger flute cavities are preferred over routers. By using routers in thermoplastic resins the risk of buildup is higher due to increased heat generation and less flute space.

7. CURING METHODS:

These methods vary from spray lay-up to ovens and autoclaves to the most advanced resin transfer moulding systems (RTM) with or without vacuum assistance (VARTM). RTM is mainly used for more complex aircraft and automotive components, whereas autoclaves are the preferred choice for wings and tail sections.

8. TIME OF PROCESSING:

CFRP parts can be machined in either a post-cured or fully cured state. A workpiece material that is post cured means that its resin is partly cured and still in a soft or not fully hardened state. This condition makes machining more difficult and one in which sharp cutters with very smooth coatings and significant flute cavities are more advantageous to prevent buildup.



As shown in the table, for each CFRP machinability factor, the conditions are categorised as good, medium or difficult.

THERMOSET:

Epoxy
Polyester
Vinylester
Polyurethane
Phenolic resins

THERMOPLASTICS:

Polyphenylene Sulphide (PPS)
Polyether ether ketone (PEEK)
Polyamide (PA or Nylon)
Polypropylene (PP)
Polybutylene terephthalate (PBT)
Polyethylene terephthalate (PET)
Polycabonate (PC)
Polyethylene (PE)
Polyvinyl chloride (PVC)

HIGH STRENGTH

Grade	Tensile Modulus (GPa)	Tensile Strength (GPa)	Country of Manufacture
T300	230	3.53	France/Japan
T700	235	5.3	Japan
HTA	238	3.95	Germany
UTS	240	4.8	Japan
34-700	234	4.5	Japan/USA
AS4	241	4.0	USA
T650-35	241	4.55	USA
Panex 33	228	3.6	USA/Hungary
F3C	228	3.8	USA
TR50S	235	4.83	Japan
TR30S	234	4.41	Japan

INTERMEDIATE MODULUS

Grade	Tensile Modulus (GPa)	Tensile Strength (GPa)	Country of Manufacture
T800	294	5.94	France/Japan
M30S	294	5.49	France
IMS	295	4.12/5.5	Japan
MR40/MR50	289	4.4/5.1	Japan
IM6/IM7	303	5.1/5.3	USA
IM9	310	5.3	USA
T650-42	290	4.82	USA
T40	290	5.65	USA

HIGH MODULUS

Grade	Tensile Modulus (GPa)	Tensile Strength (GPa)	Country of Manufacture
M40	392	2.74	Japan
M40J	377	4.41	France/Japan
HMA	358	3.0	Japan
UMS2526	395	4.56	Japan
MS40	340	4.8	Japan
HR40	381	4.8	Japan

ULTRA HIGH MODULUS

Grade	Tensile Modulus (GPa)	Tensile Strength (GPa)	Country of Manufacture
M46J	436	4.21	Japan
UMS3536	435	4.5	Japan
HS40	441	4.4	Japan
UHMS	441	3.45	USA

DRILLING SOLUTIONS

DRILLING PERFECT HOLES

FEEDMAX™-COMPOSITE: PCD DRILLS

Feedmax-Composite is Seco's family of composite drills designed to fulfil customer needs through various geometries, diamond (DURA) coating technology and PCD brazed cutting edges. This expansive range of advanced tools includes the C1 and C2 diamond coated and CX31, CX1 and CX2 PCD-tipped drills.

C1 - GEOMETRY FOR EXITING IN CFRP

FEATURES:
- Internal through coolant channels
- Sharp optimised double point geometry
- Nano crystalline diamond DURA coating

BENEFITS:
- High hole quality
- Minimised delamination at hole entry/exit
- **Excellent chip breaking with enhanced chip evacuation for better surface finish**
- **Increased productivity**

C2 - GEOMETRY FOR EXITING IN TI OR AL WHEN DRILLING STACKS WITH CFRP

FEATURES:
- Internal through coolant channels
- Sharp strong point geometries
- Wear resistant micro grain substrates

BENEFITS:
- Increased hole quality
- Minimised delamination at hole entry/exit
- **Excellent chip breaking with enhanced chip evacuation for better surface finish**
- **Increased productivity**

CX31 - GEOMETRY FOR DRILLING IN CFRP AND GFRP MATERIALS

FEATURES:
- Polycrystalline diamond tips with very sharp cutting edges
- Wear resistance
- High accuracy
- Reconditionable (dependent on wear) 3 - 4 times

BENEFITS:
- Process stability and low heat generation
- Enhanced hole quality, precision and surface finish

ADVANCED DRILLING TECHNOLOGY

Seco's Feedmax-Composite – CX1 and CX2 PCD-tipped drills represent today's most advanced composite drilling. The drills incorporate technological innovations that include enhanced geometries and three-flute designs.

CX1 - GEOMETRY FOR EXITING IN CFRP

FEATURES:

- The full PCD tip features lead and full geometry, connecting smoothly to the helix angle of the flutes
- Optimised drill design for reduced axial cutting forces and to prevent delamination and uncut fibres
- Three flutes ensure hole roundness, surface finish and straightness
- Polycrystalline diamond for extremely sharp cutting edges
- Reconditionable (dependent on wear) 3 - 4 times

BENEFITS:

- High hole quality
- Minimised delamination at hole entry/exit
- **Excellent chip breaking with enhanced chip evacuation for better surface finish**
- Long tool life
- **Increased productivity 33%. Your benefits include higher output and improved profitability**

CX2 - GEOMETRY FOR EXITING IN STACKED MATERIALS (METALS, AI OR TI)

FEATURES:

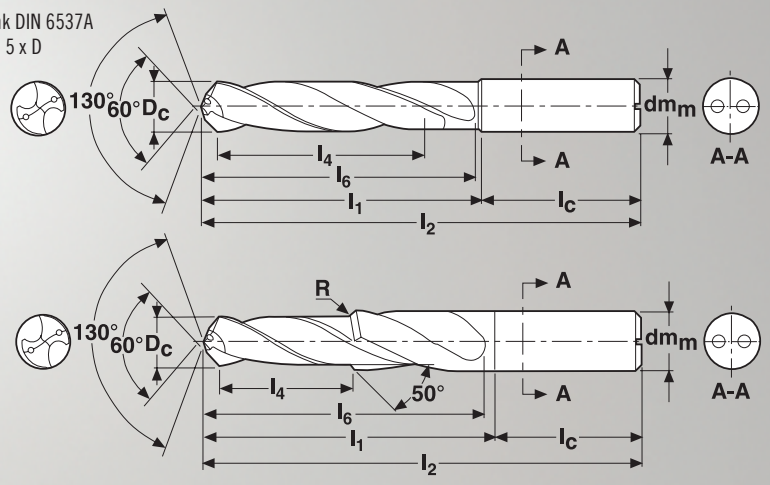
- For stack drilling applications, special drill point geometry creates short and clean chips easily evacuated without affecting the CFRP material.
- Advanced geometry eliminates exit burrs Full PCD tip features lead and full geometry, connecting smoothly to the helix angle of the flutes
- Polycrystalline diamond for extremely sharp cutting edges
- Reconditionable (dependent on wear) 3 - 4 times

BENEFITS:

- Enhanced chip evacuation and dust removal
- Excellent surface quality and low heat generation
- **High accuracy results in tight dimensional tolerances**
- Elimination of hole exit deburring
- **Extreme wear resistance for long, predictable tool life**

A=Internal 'through' coolant
Dura diamond coating

Cylindrical Shank DIN 6537A
Drilling Depth ~ 5 x D



SECO FEEDMAX™ SD205A, -C1 GEOMETRY

D_c (mm)	D_c (inch)	Expected hole tolerance	Manufacturing tolerance drill	l_4 (mm)	Part No.*	Dimensions in mm				
						l_2	l_1	l_c	l_6	dm_m h6
3.20		3.175/3. 225	3.200 m7	20	SD205A-3.2-20-6R1-C1	66	30	36	26	6
4.10		4.075/4.125	4.100 m7	26	SD205A-4.1-26-6R1-C1	74	38	36	37	6
	3/16	4.755/4.805	4.780 m7	31	SD205A-4.78-31-6R1-C1	82	46	36	44	6
6.00		5.975/6.025	6.000 m7	31	SD205A-6.0-31-6R1-C1	82	46	36	44	6
	1/4	6.350/6.401	6.376 m7	34	SD205A-6.38-34-8R1-C1	91	55	36	53	8
	5/16	7.938/7.988	7.963 m7	40	SD205A-7.963-40-8R1-C1	91	55	36	53	8
	3/8	9.525/9.576	9.551 m7	46	SD205A-9.55-46-10R1-C1	103	63	40	61	10
	7/16	11.112/11.163	11.138 m7	53	SD205A-11.138-53-12R1-C1	118	73	45	71	12
	1/12	12.700/12.751	12.726 m7	53	SD205A-12.726-53-14R1-C1	124	79	45	77	14

SECO FEEDMAX™ SD205A, -C1 GEOMETRY CHAMFER DRILLS

D_c (mm)	D_c (inch)	Expected hole tolerance	Manufacturing tolerance drill	l_4 (mm)	Part No.*	Dimensions in mm					
						l_2	l_1	l_c	l_6	dm_m h6	R
	3/16	4.755/4.805	4.780 m7	31	SD205A-C50-4.78-31-10R1-C1	89	49	40	47	10	0,9
6.00		5.975/6.025	6.000 m7	31	SD205A-C50-6.0-31-12R1-C1	94	49	45	47	12	0,9
	1/4	6.350/6.401	6.376 m7	34	SD205A-C50-6.376-34-12R1-C1	103	58	45	56	12	0,9
	5/16	7.938/7.988	7.963 m7	40	SD205A-C50-7.963-40-14R1-C1	103	58	45	56	14	1,15
	3/8	9.525/9.576	9.551 m7	46	SD205A-C50-9.551-46-18R1-C1	115	67	48	65	18	1,15
	7/16	11.112/11.163	11.138 m7	53	SD205A-C50-11.138-53-20R1-C1	127	77	50	75	20	1,4
	1/12	12.700/12.751	12.726 m7	53	SD205A-C50-12.726-53-22R1-C1	133	83	50	81	22	1,4

* For intermediate diameters see the Custom Design software.

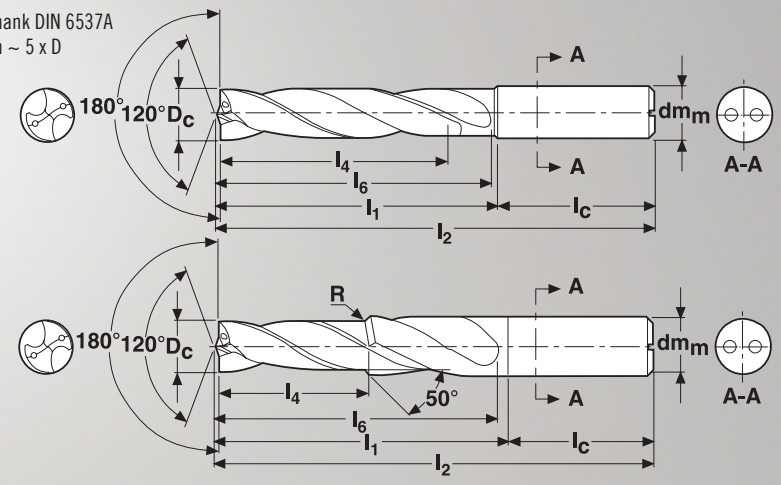
Scan this code to see more on C1.

CASE STUDY C1

Component:	Stringer ATR72			
Material:	T2H-EH25			
Machine tool:	Jobs			
Lubrication:	Outside - pure water			
Hole depth:	5 mm			
Fixturing:	Vacuum zone			
Tool:	SD290A-7.21-835758, custom drill & chamfer			
Tool holder:	EPB 5603 Shrinkfit holder, DIN type, with HSK-A63 machine side connection E9304 5603 1085			
Cutting data		N	v_c	v_f
	Metric	8000 rpm	80 m/min	100 mm/min
	Inch	8000 rpm	262.3 sfm	3.94 ipm
Results	**• Machined more than 500 holes per tool**			

A=Internal ‚through' coolant
Dura diamond coating

Cylindrical Shank DIN 6537A
Drilling Depth ~ 5 x D



SECO FEEDMAX™ SD205A, -C2 GEOMETRY

D_c (mm)	D_c (inch)	Expected hole tolerance	Manufacturing tolerance drill	l_4 (mm)	Part No.*	Dimensions in mm				
						l_2	l_1	l_c	l_6	dm_m h6
3.20		3.175/3.225	3.200 m7	21	SD205A-3.2-21-6R1-C2	66	30	36	26	6
4.10		4.075/4.125	4.100 m7	27	SD205A-4.1-27-6R1-C2	74	38	36	37	6
	3/16	4.755/4.805	4.780 m7	32	SD205A-4.78-32-6R1-C2	82	46	36	44	6
6.00		5.975/6.025	6.000 m7	32	SD205A-6.0-32-6R1-C2	82	46	36	44	6
	1/4	6.350/6.401	6.376 m7	35	SD205A-6.38-35-8R1-C2	91	55	36	53	8
	5/16	7.938/7.988	7.963 m7	42	SD205A-7.963-42-8R1-C2	91	55	36	53	8
	3/8	9.525/9.576	9.551 m7	48	SD205A-9.55-48-10R1-C2	103	63	40	61	10
	7/16	11.112/11.163	11.138 m7	56	SD205A-11.138-56-12R1-C2	118	73	45	71	12
	1/12	12.700/12.751	12.726 m7	56	SD205A-12.726-56-14R1-C2	124	79	45	77	14

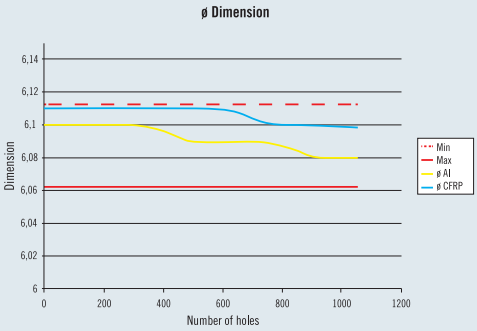
SECO FEEDMAX™ SD205A, -C2 GEOMETRY CHAMFER DRILLS

D_c (mm)	D_c (inch)	Expected hole tolerance	Manufacturing tolerance drill	l_4 (mm)	Part No.*	Dimensions in mm					
						l_2	l_1	l_c	l_6	dm_m h6	R
	3/16	4.755/4.805	4.780 m7	32	SD205A-C50-4.78-32-10R1-C2	89	49	40	47	10	0,9
6.00		5.975/6.025	6.000 m7	32	SD205A-C50-6.0-32-12R1-C2	94	49	45	47	12	0,9
	1/4	6.350/6.401	6.376 m7	35	SD205A-C50-6.376-35-12R1-C2	103	58	45	56	12	0,9
	5/16	7.938/7.988	7.963 m7	42	SD205A-C50-7.963-42-14R1-C2	103	58	45	56	14	1,15
	3/8	9.525/9.576	9.551 m7	48	SD205A-C50-9.551-48-18R1-C2	115	67	48	65	18	1,15
	7/16	11.112/11.163	11.138 m7	56	SD205A-C50-11.138-56-20R1-C2	127	77	50	75	20	1,4
	1/12	12.700/12.751	12.726 m7	56	SD205A-C50-12.726-56-22R1-C2	133	83	50	81	22	1,4

* For intermediate diameters see the Custom Design software.

Scan this code to see more on C2.

Hole dimensions



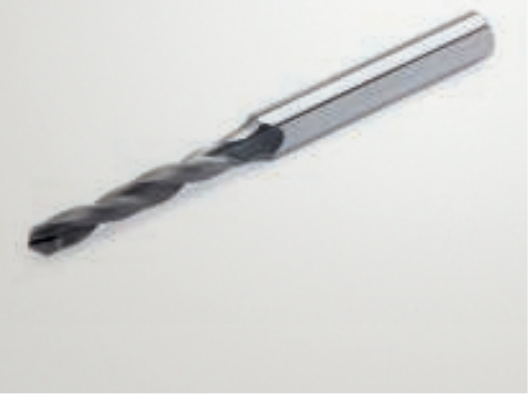
CASE STUDY C2

Component:	Wing flap
Material:	5 mm CFRP & 5 mm Al 7050
Machine tool:	Handheld
Lubrication:	None
Hole depth:	Clamping
Fixturing:	Vacuum zone
Tool:	Special tool with C2 point
Tool holder:	EPB 5834 hydraulic chuck, with DIN40 back end connection E3469 5834 1280

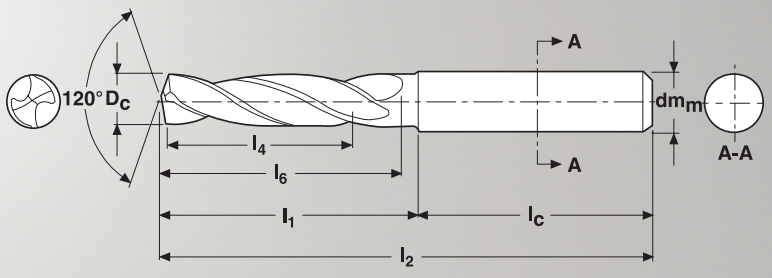
Cutting data		v_c	f
	Metric	60-70 m/min	0.05 mm/rev
	Inch	196.7-229.5 sfm	0.002 ipr

Results
- **Increased tool life from 70 to 1800 holes**
- **Maintained tight inside reaming tolerances**
- **Signigicantly reduced delamination**

PCD cutting edge
Dura diamond coating



Cylindrical Shank DIN 6537A
Drilling Depth ~ 5 x D



SECO FEEDMAX™ SD205A, -CX31 GEOMETRY

D_c (mm)	D_c (inch)	Expected hole tolerance	Manufacturing tolerance drill	l_4 (mm)	Part No.*	Dimensions in mm				
						l_2	l_1	l_c	l_6	dm_m h6
4.10		4.075/4.125	4.100 m7	26	SD205-4.10-26-6R1-CX31	74	38	36	37	6
	3/16	4.755/4.805	4.780 m7	31	SD205-4.78-31-6R1-CX31	82	46	36	44	6
6.00		5.975/6.025	6.000 m7	31	SD205-6.00-31-6R1-CX31	82	46	36	44	6
	1/4	6.350/6.401	6.376 m7	34	SD205-6.38-34-8R1-CX31	91	55	36	53	8
	5/16	7.938/7.988	7.963 m7	40	SD205-7.963-40-8R1-CX31	91	55	36	53	8

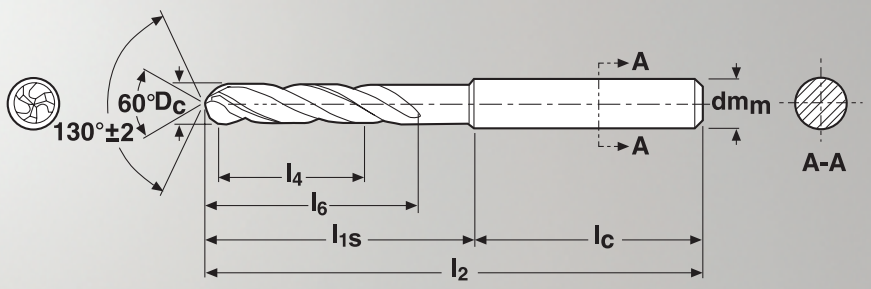
* For intermediate diameters see the Custom Design software.

CASE STUDY CX31

Component:	Fin A3xx			
Material:	CFRP			
Machine tool:	Jobs Jomach 159			
Lubrication:	None			
Fixturing:	Bridle and suction pads			
Tool:	PCD chamfer drill 2 dents, Ø 6.35 mm (0.25")			
Tool holder:	EPB 5675 ER collet chuck, with HSK-A63 back end connection E9304 5675 16100			
Cutting data		N	v_c	v_f
	Metric	8500 rpm	170 m/min	850 mm/min
	Inch	8500 rpm	557.38 sfm	32.46 ipm
Results	**• Increased tool life to 48 min**			

PCD cutting edge

Cylindrical Shank DIN 6537A
Drilling Depth ~ 3 x D

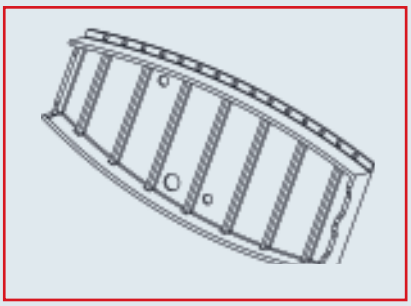


Scan this code to see more on CX1.

SECO FEEDMAX™ SD203, -CX1 GEOMETRY

D_c (mm)	Expected hole tolerance	Manufacturing tolerance drill	l_4 (mm)	Part No.*	Dimensions in mm				
					l_2	l_{1S}	l_c	l_6	dm_m
3.26	3.100/3.300	3.260 m7	14	SD203-3.26-14-6R1-CX1	62	26	36	21	6
4.17	4.166/4.185	4.167 m7	17	SD203-4.17-17-6R1-CX1	66	30	36	25	6
4.83	4.826/4.845	4.830 m7	20	SD203-4.83-20-6R1-CX1	66	30	36	28	6
6.06	5.900/6.100	6.060 m7	21	SD203-6.06-21-6R1-CX1	66	30	36	28	6
6.36	6.350/6.375	6.355 m7	23	SD203-6.36-23-8R1-CX1	79	43	36	34	8
7.94	7.938/7.963	7.938 m7	27	SD203-7.94-27-8R1-CX1	79	43	36	41	8
9.53	9.525/9.552	9.529 m7	31	SD203-9.53-31-10R1-CX1	89	49	40	47	10

* For intermediate diameters see the Custom Design software.

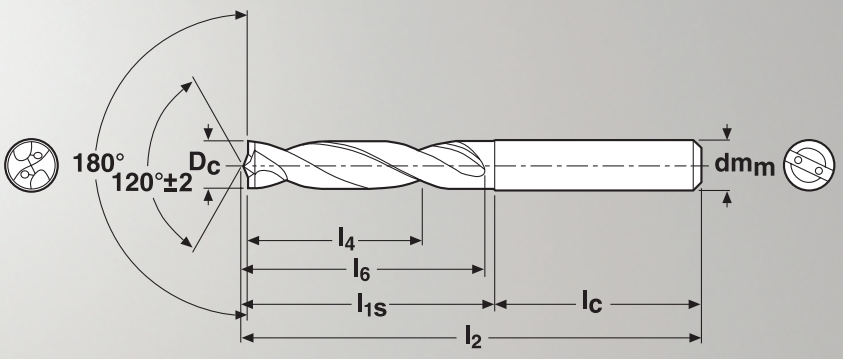


CASE STUDY CX1

Component:	Wingbox part		
Material:	5-18 mm CFRP		
Machine:	CNC machine		
Lubrication:	None		
Fixturing:	Clamping		
Tool:	Standard CX1, Ø 6.36 mm (0.25")		
Tool holder:	EPB 5834 hydraulic chuck, with Seco-Capto™ C6 back end connection C6-391.5834-08065		
Cutting data		v_c	f
	Metric	220 m/min	0.08 mm/rev
	Inch	721.32 sfm	0.003 ipr
Results	**• Achieved inside tolerances of 6.35-6.375 mm (0.25.-0.25098")**		

A=Internal 'through' coolant
PCD cutting edges

Cylindrical Shank DIN 6537A
Drilling Depth ~ 3 x D

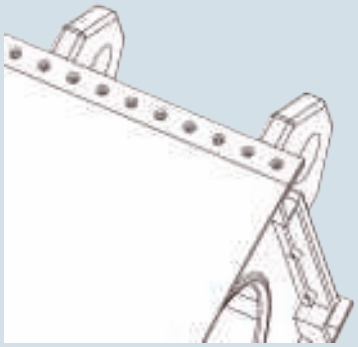


Scan this code to see more on CX2.

SECO FEEDMAX™ SD203A, -CX2 GEOMETRY

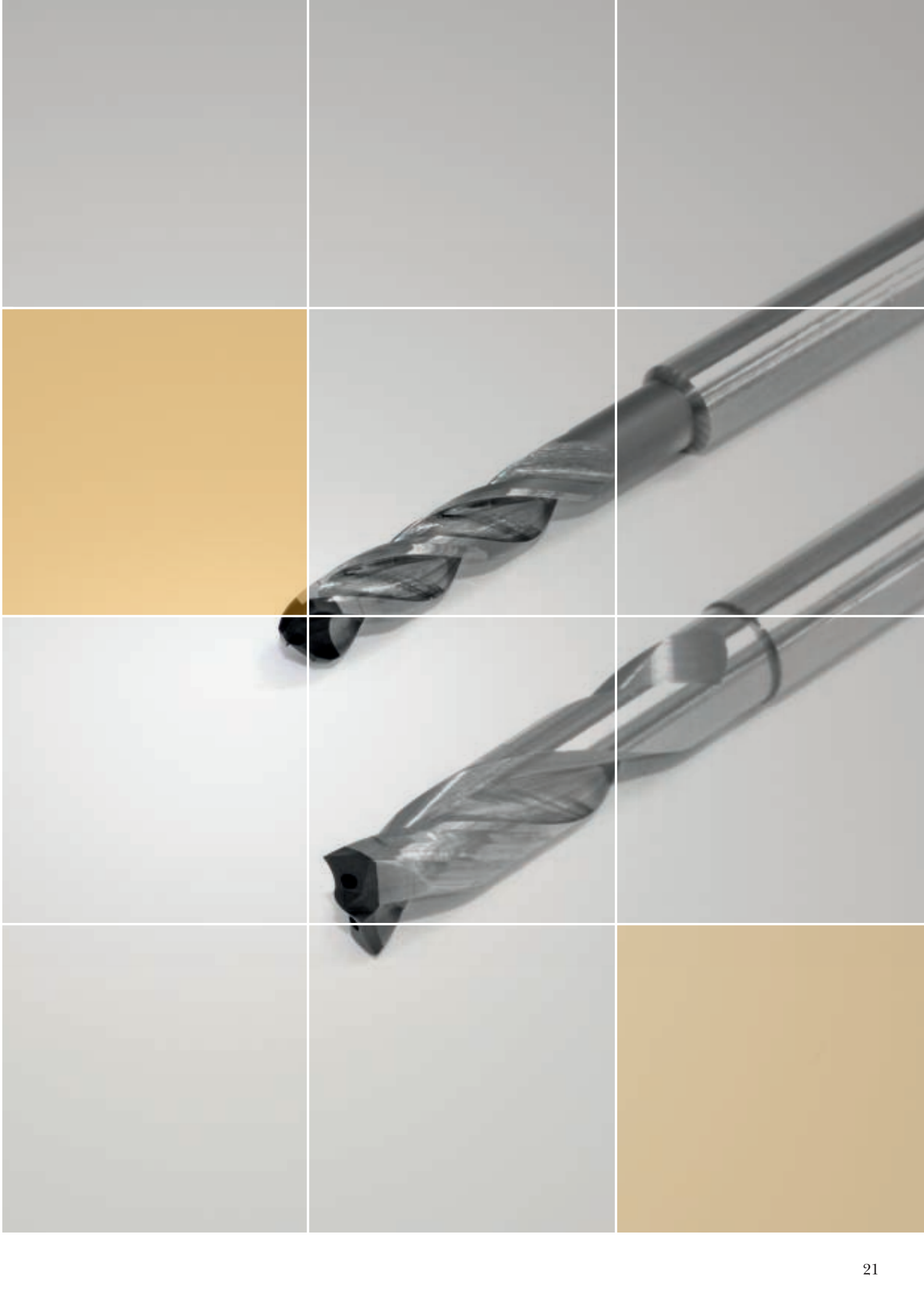
D_c (mm)	Expected hole tolerance	Manufacturing tolerance drill	l_4 (mm)	Part No.*	Dimensions in mm				
					l_2	l_{1S}	l_c	l_6	dm_m
3.26	3.100/3.300	3.260 m7	14	SD203A-3.26-14-6R1-CX2	62	26	36	20	6
4.17	4.166/4.185	4.167 m7	17	SD203A-4.17-17-6R1-CX2	66	30	36	24	6
4.83	4.826/4.845	4.830 m7	20	SD203A-4.83-20-6R1-CX2	66	30	36	28	6
6.06	5.900/6.100	6.060 m7	21	SD203A-6.06-21-6R1-CX2	66	30	36	28	6
6.36	6.350/6.375	6.355 m7	23	SD203A-6.36-23-8R1-CX2	79	43	36	34	8
7.94	7.938/7.963	7.938 m7	27	SD203A-7.94-27-8R1-CX2	79	43	36	41	8
9.53	9.525/9.552	9.529 m7	31	SD203A-9.53-31-10R1-CX2	89	49	40	47	10

* For intermediate diameters see the Custom Design software.



CASE STUDY CX2

Component:	Wing flap		
Material:	5 mm CFRP & 5 mm Al 7050		
Machine:	CNC machine		
Lubrication:	None		
Fixturing:	Clamping		
Tool:	Standard CX2, Ø 6.36 mm (0.25") & special chamfer tool		
Tool holder:	EPB 5603 Shrinkfit holder, DIN type with BT40 back end connection E3414 5603 08160		
Cutting data		v_c	f
	Metric	200 m/min	0.09 mm/rev
	Inch	655.74 sfm	0.0035 ipr
Results	**• Achieved inside reaming tolerances of 6.35-6.375 mm (0.25-0.25098")** **• Eliminated uncut fibres** **• Eliminated delamination** **• Recuced exit burr to less than 0.1 mm (0.0039")**		



SECO FEEDMAX™ – CUTTING DATA

SD205A FOR -C1, -C2 AND -CX31 GEOMETRIES

The recommended start values for general applications are marked bold.
Reduce the values in case of poor stability in the application.

SD205A -C1, -C2, DIAMOND COATED DRILLS FOR CFRP AND GFRP (METRIC)

SMG		Application	Tool geometry	Recommended cutting speed v_c(m/min)	Recommended feed f_2 (mm/rev) ø 4	ø 6	ø 10	ø 12	ø 14
PMC	CFRP	CFRP	C1	50-**56**-150	0.03-**0.06**-0.08	0.03-**0.06**-0.08	0.03-**0.06**-0.09	0.03-**0.07**-0.10	0.03-**0.08**-0.11
		CFRP/Al (stacked)	C2*	50-**56**-150	0.08-**0.10**-0.12	0.08-**0.10**-0.12	0.10-**0.13**-0.15	0.10-**0.13**-0.15	0.10-**0.14**-0.16
		CFRP/Ti (stacked)	C2*	30-**40**-50	0.05-**0.06**-0.07	0.05-**0.06**-0.07	0.08-**0.10**-0.12	0.10-**0.12**-0.15	0.10-**0.12**-0.16
	GFRP	GFRP	C1	40-**50**-100	0.03-**0.06**-0.08	0.03-**0.06**-0.08	0.03-**0.06**-0.09	0.03-**0.07**-0.10	0.03-**0.08**-0.11
		GFRP/Al (stacked)	C2*	40-**50**-100	0.08-**0.10**-0.12	0.08-**0.10**-0.12	0.10-**0.13**-0.15	0.10-**0.13**-0.15	0.10-**0.14**-0.16
		GFRP/Ti (stacked)	C2*	30-**40**-50	0.05-**0.06**-0.07	0.05-**0.06**-0.07	0.08-**0.10**-0.12	0.10-**0.12**-0.15	0.10-**0.13**-0.16

SD205A -C1, -C2, DIAMOND COATED DRILLS FOR CFRP AND GFRP (IMPERIAL)

SMG		Application	Tool geometry	Recommended cutting speed v_c(m/min)	Recommended feed f_2 (inch/rev) ø 3/16	ø 1/4	ø 5/16	ø 3/8	ø 7/16
PMC	CFRP	CFRP	C1	164-**213**-492	0.0018-**0.00236**-0.00315	0.0018-**0.00236**-0.00315	0.0018-**0.00236**-0.00315	0.0018-**0.00236**-0.00354	0.0018-**0.00236**-0.00354
		CFRP/Al (stacked)	C2*	131.2-**164**-328	0.0018-**0.00236**-0.00315	0.0018-**0.00236**-0.00315	0.0018-**0.00236**-0.00315	0.0018-**0.00236**-0.00354	0.0018-**0.00236**-0.00354
		CFRP/Ti (stacked)	C2*	164-**213**-492	0.00314-**0.00393**-0.00472	0.00314-**0.00393**-0.00472	0.00314-**0.00393**-0.00472	0.00393-**0.00511**-0.00590	0.00393-**0.00511**-0.00590
	GFRP	GFRP	C1	98.4-**131.2**-164	0.00196-**0.00236**-0.00275	0.00196-**0.00275**-0.00315	0.00196-**0.00275**-0.00315	0.00315-**0.00393**-0.00472	0.00315-**0.00393**-0.00472
		GFRP/Al (stacked)	C2*	131.2-**164**-328	0.00314-**0.00393**-0.00472	0.00314-**0.00393**-0.00472	0.00314-**0.00393**-0.00472	0.00393-**0.00511**-0.00590	0.00393-**0.00511**-0.00590
		GFRP/Ti (stacked)	C2*	98.4-**131.2**-164	0.00196-**0.00236**-0.00275	0.00196-**0.00275**-0.00315	0.00196-**0.00275**-0.00315	0.00315-**0.00393**-0.00472	0.00315-**0.00393**-0.00472

SD205-CX31, PCD DRILLS FOR CFRP AND GFRP (METRIC)

SMG	Application	Tool geometry	Recommended cutting speed v_c(m/min)	Recommended feed f_2 (mm/rev) ø 4	ø 6	ø 8	ø 10	ø 12	ø 14
PMC	CFRP	CX31	60-**125**-500	0.05-**0.08**-0.14	0.05-**0.08**-0.14	0.05-**0.10**-0.16	0.06-**0.12**-0.20	0.06-**0.12**-0.22	0.06-**0.12**-0.22
	GFRP	CX31	48-**100**-400	0.05-**0.08**-0.14	0.05-**0.08**-0.14	0.05-**0.10**-0.16	0.06-**0.12**-0.20	0.06-**0.12**-0.22	0.06-**0.12**-0.22

SD205-CX31, PCD DRILLS FOR CFRP AND GFRP (IMPERIAL)

SMG	Application	Tool geometry	Recommended cutting speed v_c(m/min)	Recommended feed f_2 (inch/rev) ø 3/16	ø 1/4	ø 5/16
PMC	CFRP	CX31	197-**410**-1640	0.00196-**0.00315**-0.00590	0.00196-**0.00315**-0.00590	0.00196-**0.00394**-0.00629
	GFRP	CX31	157-**328**-1312	0.00196-**0.00315**-0.00590	0.00196-**0.00315**-0.00590	0.00196-**0.00394**-0.00629

* C2 geometry to be used when exit layer is Alu or Ti. If exit layer is composite use C1 geometry.
CFRP=Carbon Fibre Reinforced Plastic
GFRP=Glass Fibre Reinforced Plastic
PMC = Polyesther Matrix Composite

SECO FEEDMAX™ – CUTTING DATA

SD205 FOR -CX1/CX2 GEOMETRIES

The recommended start values for general applications are marked bold.

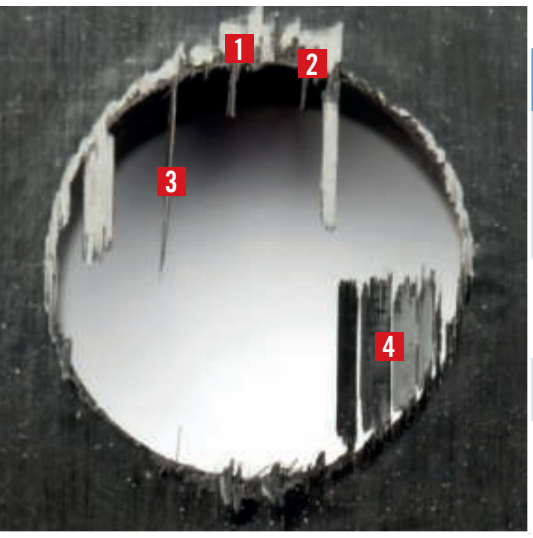
SD205-CX1/CX2, PCD DRILLS FOR CFRP AND GFRP (METRIC)

SMG		Application	Tool geometry	Recommended cutting speed v_c(m/min)	Recommended feed f_2 (mm/rev)					
					ø 4	ø 6	ø 8	ø 10	ø 12	ø 14
PMC	CFRP	CFRP	CX1	60-**150**-500	0.05-**0.08**-0.14	0.05-**0.08**-0.14	0.05-**0.10**-0.16	0.06-**0.12**-0.20	0.06-**0.12**-0.22	0.06-**0.12**-0.22
		CFRP/Al	CX2	60-**150**-500	0.05-**0.10**-0.16	0.05-**0.10**-0.16	0.06-**0.12**-0.20	0.07-**0.14**-0.20	0.08-**0.14**-0.25	0.08-**0.14**-0.25
		CFRP/Ti	CX2	10-**15**-30	0.03-**0.04**-0.06	0.03-**0.04**-0.06	0.03-**0.05**-0.07	0.03-**0.06**-0.08	0.03-**0.06**-0.08	0.03-**0.06**-0.08
	GFRP	GFRP	CX1	48-**120**-400	0.05-**0.08**-0.14	0.05-**0.08**-0.14	0.05-**0.10**-0.16	0.06-**0.12**-0.20	0.06-**0.12**-0.22	0.06-**0.12**-0.22
		GFRP/Al	CX2	48-**120**-400	0.05-**0.10**-0.16	0.05-**0.10**-0.16	0.06-**0.12**-0.20	0.07-**0.14**-0.20	0.08-**0.14**-0.25	0.08-**0.14**-0.25
		GFRP/Ti	CX2	8-**12**-24	0.03-**0.04**-0.06	0.03-**0.04**-0.06	0.03-**0.05**-0.07	0.03-**0.06**-0.08	0.03-**0.06**-0.08	0.03-**0.06**-0.08

SMG - Seco material group
v_c - Recommended geometry, grade and cutting speed (m/min)
f - Recommended feed in mm/rev for drill diameter

CFRP=Carbon Fibre Reinforced Plastic
PMC = Polyester Matrix Composite

SECO FEEDMAX™– TROUBLESHOOTING



HOLE EXIT

Problem:	Delamination (peal up/ push down)	Spalling	Uncut fibres	Uncut resin
Solution:	Peel up - Use tool with more negative geometry - Reduce feed/rev.	- Use tool with more positive geometry - Reduce feed/rev.	- Use tool with a sharper geometry - Reduce feed/rev.	- Use tool with a sharper geometry - Reduce feed/rev. - Reduce cutting speed
	Push down - Reduce feed/rev.			
Problem:	Melted resin Too much heat	Poor tool life		
Solution:	- Reduce cutting speed	- Reduce cutting speed		

1 Delamination 2 Spalling 3 Uncut fibres 4 Uncut resin

HIGH PERFORMANCE MILLING

JABRO™-COMPOSITE: SERIES OF SOLID-CARBIDE AND PCD END MILLS FOR COMPOSITES

As a complete product range for the machining of glass and carbon fibre reinforced plastics, Seco's Jabro™- Composite family of diamond-coated solid-carbide and PCD end mills incorporates different geometries, diamond (DURA) coated and uncoated as well as with PCD brazed cutting edges. The product range offers optimised tools for difficult cutting conditions on challenging workpiece materials and includes the JC880 and JC885; JC870 and JC871; JC840 and JC845; JC850 and JC860; and JPD890 series end mills.

JC880 & JC885 - LOW HELIX END MILLS

FEATURES:

- Four flute cutters with 10° helix angle for slotting and side milling
- Nano crystalline diamond coating (DURA)
- CFRP and CFRP sandwiched materials (Ti &Al), GRP and GRP with Al and Ti capability (JC885 same geometry applied with left hand helix)

BENEFITS:

- Five to six times higher tool life than uncoated tools
- **No finish pass or manual rework required**
- **Practically zero de-lamination or splintering (≤ 1,0 mm)**
- Smooth, vibration-free machining

JC860 - HONEYCOMB ROUTER

FEATURES:

- 15° left-hand helix and sharp 90° edge
- Side milling and slotting functionality
- Chip splitter
- Five, six and nine-flute versions
- Designed for non-ferrous honeycomb materials with carbon and/or glass top layers

BENEFITS:

- **Downward axial cutting forces eliminate part lifting and delamination**
- Smaller, better managed chips
- Decreased cutting forces, lower tool deflection, less spindle load and reduced chatter and vibration
- **Higher cutting feed rates (MRR)**

JC850 - BALL NOSE CUTTER

FEATURES:

- Four flute with 20° helix design for 3D operations
- DURA coating
- Made for CFRP and CFRP sandwiched materials (Ti & Al), GRP and GRP with Al and Ti

BENEFITS:

- Five to six times higher tool life than uncoated tools
- Reduced axial forces and less delamination
- Balanced machining and effective chip/dust evacuation
- **Smooth surface finishes when milling 3D shapes**

JC840 & JC845 - LEFT/RIGHT HAND HELIX CUTTERS

FEATURES:

- JC840 compression tool offered with four to nine flutes and DURA coating
- JC840 tools have large core diameters
- JC840 is available in metric and inch sizes
- JC845 compression tool offered with three to five flutes, chip breakers and DURA coating
- JC845 tools have chip splitters and less flutes for (semi) roughing applications
- JC845 features large flute cavities

BENEFITS:

- **Elimination of delamination when machining sandwich materials**
- High dimensional accuracy and process reliability.
- Enhanced micro chip evacuation
- **Lower cutting temperatures and forces and minimised surface contact (JC845)**
- Increased productivity

JC870 & JC871 - MULTI-FLUTE ROUTERS

FEATURES:

- Both models offered with or without DURA coating
- Designed for slotting and side milling applications
- Shark teeth design deflects cutting forces
- Cross cut serration increases coating adhesion
- JC870 center cutting, JC871 non-centre cutting
- Applicable for all carbon and glass fibre composites and are an alternative for honeycomb materials
- Available in metric and inch sizes

BENEFITS:

- Five to six times higher tool life than uncoated tools
- **Easy material penetration**
- **Reduced downward cutting forces**
- **JC871 provides enhanced bottom surface finishes**
- **JC870 excels in plunging and drilling applications**
- Uncoated versions for small operations significantly reduce tool costs
- Coated versions for large operations help increase productivity and reduce costs per part

JPD890 - PCD CUTTERS WITH NEUTRAL POSITIVE AND NEGATIVE SHEAR ANGLES

FEATURES:

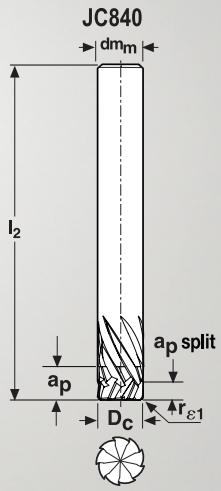
- Series designs include JPD890 neutral shear angle, JPD891 negative shear angle and JPD892 positive shear angle
- Internal through coolant
- Polycrystalline diamond for sharp cutting edges and hardness
- Applicable for side-milling, slotting and centre cutting
- Re-tipping (10 times) and sharpening (two or three times) – depending on wear – offered as after sales services

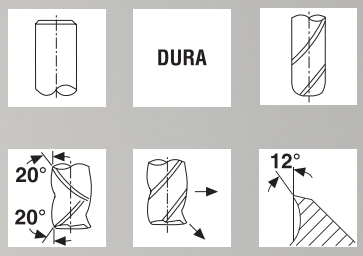
BENEFITS:

- Excellent part surface quality and low heat generation
- **Superior wear resistance and long tool life**
- Low process temperatures
- High accuracy for less required finishing operations

Tolerances:
run-out < 0.01 mm
dm_m = h5

D_c= -0.02/-0.04 mm
r_{e1} = ± 0.01 mm





JABRO™ COMPOSITE-JC840
SOLID CARBIDE END MILL - DOUBLE HELIX TO AVOID DELAMINATION

Part No.	Dimensions in mm/inch							
	D_c	dm_m	l_2	a_p	a_p split	r_{e1}	z_n	Cylindrical
mm								
JC840060R050Z4.0-DURA	6	6	65	12	3	0.500	4	■
JC840080R050Z6.0-DURA	8	8	70	16	4	0.500	6	■
JC840100R050Z7.0-DURA	10	10	80	20	5	0.500	7	■
JC840120R050Z9.0-DURA	12	12	90	24	6	0.500	9	■
inch								
JC8400250R015Z4.0-DURA	1/4	1/4	2	1/2	1/8	0.015	4	■
JC8400375R015Z7.0-DURA	3/8	3/8	3	3/4	3/16	0.015	7	■
JC8400500R015Z9.0-DURA	1/2	1/2	3 3/4	1	1/4	0.015	9	■

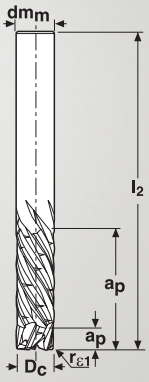
CASE STUDY JABRO™ COMPOSITE JC840

Material:	Termoset epoxy resin with 55% fibre volume fraction			
Machine:	Hermle C42V with dust cleaner			
Lubrication:	No			
Operation:	Side finishing			
Holder:	HSK-A63 Shrinkfit			
Tool:	JC840080R050Z6.0-DURA			
Cutting data		N	v_c	f_z
	Metric	7960 rpm	200 m/min	0.064 mm
	Inch	7960 rpm	655 sfm	0.003"
		a_p	a_e	v_f
		4 mm	0.16 mm	3055 mm/min
		0.157"	0.006"	120.3 ipm
Results	• **Average surface roughness (Ra) = 0.69 µm** • **Increased productivity due to 6 flutes (v_f= 3055 mm/min)**			

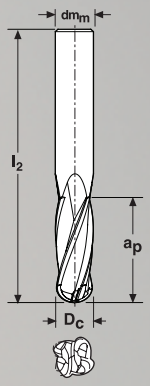
Scan this code to see more on JC840.

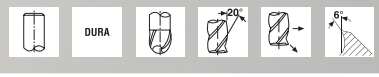
Tolerances:
run-out < 0.01 mm D_c= -0.02/-0.04 mm
dm_m = h5 $r_{\varepsilon 1}$ = ±0.01 mm (JC845)/±0.02 mm (JC850)

JC845



JC850





JABRO™ COMPOSITE-JC845
SOLID CARBIDE END MILL - DOUBLE HELIX TO AVOID DELAMINATION

Part No.	Dimensions in mm							
	D_c	dm_m	l_2	a_p	a_p split	r_e	z_n	Cylindrical
JC845060D2R050.0Z3-DURA	6	6	65	18	4	0.5	3	■
JC845080D2R050.0Z3-DURA	8	8	75	24	5	0.5	3	■
JC845100D2R050.0Z3-DURA	10	10	85	30	6	0.5	3	■
JC845120D2R050.0Z5-DURA	12	12	100	36	8	0.5	5	■

CASE STUDY JABRO™ COMPOSITE JC845

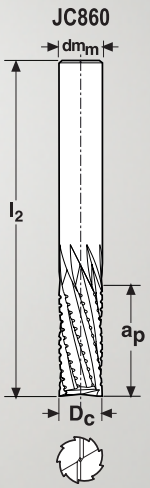
Material:	Termoset epoxy resin with 55% fibre volume fraction			
Machine:	Hermle C42V with dust cleaner			
Lubrication:	No			
Operation:	Side finishing			
Holder:	HSK-A Shrinkfit			
Tool:	JC845080D2R050.0Z3-DURA			
Cutting data		N	v_c	f_z
	Metric	7960 rpm	200 m/min	0.064 mm
	Inch	7960 rpm	656 sfm	0.003"
		a_p	a_e	v_f
		4 mm	0.5 mm	1530 mm/min
		0.157"	0.02"	60.2 ipm
Results	**• Surface roughness of 1.02 µm and good wear pattern as shown on the picture after 30 m (19 min. 35 sec.)**			

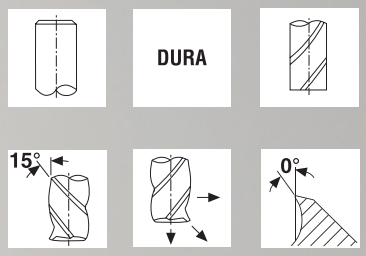
JABRO™ COMPOSITE-JC850
SOLID CARBIDE END MILL - BALL NOSE

Part No.	Dimensions in mm					Cylindrical
	D_c	dm_m	l_2	a_p	z_n	
JC850030Z4.0-DURA	3	3	50	9	4	■
JC850040Z4.0-DURA	4	4	50	12	4	■
JC850060Z4.0-DURA	6	6	65	18	4	■
JC850080Z4.0-DURA	8	8	70	24	4	■
JC850100Z4.0-DURA	10	10	85	30	4	■
JC850120Z4.0-DURA	12	12	100	36	4	■

Scan this code to see more on JC845.

Tolerances:
dm_m = h5
D_c = -0.02/-0.04 mm





JABRO™ COMPOSITE-JC860
SOLID CARBIDE END MILL - HONEYCOMB ROUTER

Part No.	Dimensions in mm						
	D_c	dm_m	l_2	a_p	frontal z_n	z_n	Cylindrical
JC860060Z5.0-DURA	6	6	70	18	2	5	■
JC860080Z6.0-DURA	8	8	80	24	2	6	■
JC860100Z8.0-DURA	10	10	90	30	2	8	■
JC860120Z9.0-DURA	12	12	110	36	2	9	■
JC860160Z11.0-DURA	16	16	125	48	2	11	■

Part No.	Dimensions in inch					
	D_c	dm_m	l_2	a_p	frontal z_n	Cylindrical
JC8600250Z5.0-DURA	1/4	1/4	2 1/4	3/4	5	■
JC8600500Z9.0-DURA	1/2	1/2	4	1 1/2	9	■

CASE STUDY JABRO™ COMPOSITE JC860

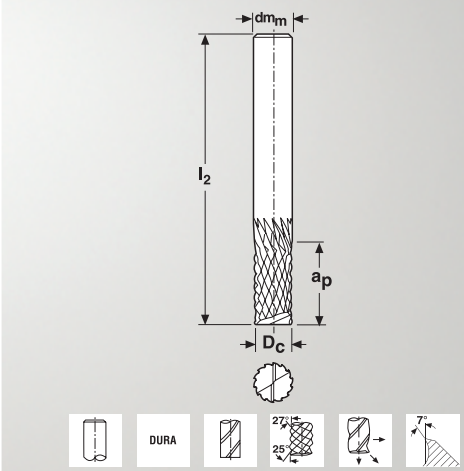
Component:	Engine part/ envelope
Material:	Sandwich carbon & aluminium
Machine:	CRENO LINEAR 5-axis
Lubrication:	None
Operation:	Slot milling
Holder:	HSK 63 - Shrinkfit
Tool:	JC860 honeycomb router
Tool holder:	EPB Shrinkfit holder, with HSK-A63 back end connection E9304 5603 12160

Cutting data		N	v_c	f_z	
	Metric	5000 rpm	157 m/min	0.008 mm	
	Inch	5000 rpm	515 sfm	0.0003"	
		v_f	a_p	a_e	TL
	Metric	300 mm/min	40 mm	10 mm	13 min
	Inch	11.8 ipm	1.57"	0.394"	13 min

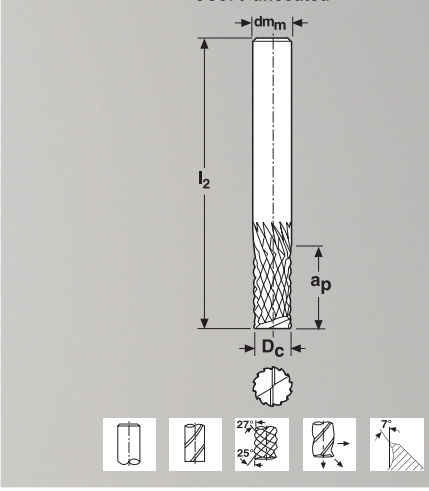
Results • Increased tool life to 4 m and depth 40 mm in the cut

Tolerances:
dm_m = h5
D_c = -0.02/-0.08 mm

JC870



JC870 uncoated



JABRO™ COMPOSITE-JC870
SOLID CARBIDE END MILL - ROUTER (DOWNCUT)*

Part No.	Dimensions in mm				
	D_c	dm_m	l_2	a_p	Cylindrical
JC870030.0-DURA	3	3	50	9	■
JC870040.0-DURA	4	4	50	12	■
JC870050.0-DURA	5	5	50	15	■
JC870060.0-DURA	6	6	65	18	■
JC870080.0-DURA	8	8	75	24	■
JC870100.0-DURA	10	10	85	30	■
JC870120.0-DURA	12	12	100	36	■

Part No.	Dimensions in mm				
	D_c	dm_m	l_2	a_p	Cylindrical
JC8700250.0-DURA	1/4	1/4	2 1/4	3/4	■
JC8700375.0-DURA	3/8	3/8	3 1/2	1 1/4	■
JC8700500.0-DURA	1/2	1/2	4	1 1/2	■

JABRO™ COMPOSITE-JC870-UNCOATED
SOLID CARBIDE END MILL - ROUTER UNCOATED (DOWNCUT)*

Part No.	Dimensions in mm				
	D_c	dm_m	l_2	a_p	Cylindrical
JC870030.0	3	3	50	9	■
JC870040.0	4	4	50	12	■
JC870050.0	5	5	50	15	■
JC870060.0	6	6	65	18	■
JC870080.0	8	8	75	24	■
JC870100.0	10	10	85	30	■
JC870120.0	12	12	100	36	■

Part No.	Dimensions in mm				
	D_c	dm_m	l_2	a_p	Cylindrical
JC8700250.0	1/4	1/4	2 1/4	3/4	■
JC8700375.0	3/8	3/8	3 1/2	1 1/4	■
JC8700500.0	1/2	1/2	4	1 1/2	■

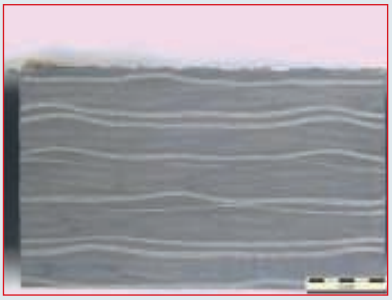
* Downcut indicates flute geometries that are combined to create small down forces that assist with maintaining component clamping, particularly where vacuum clamping is employed.

CASE STUDY JABRO™ COMPOSITE JC870

Component:	Engine part/ envelope
Material:	Monolithic carbon - composite
Machine:	CRENO LINEAR 5-axis
Lubrication:	None
Operation:	Slot milling
Holder:	HSK 63 - Shrinkfit
Tool:	JC870 diamond cut router
Tool holder:	EPB Shrinkfit holder, with HSK-A63 back end connection E9304 5603 12160

Cutting data:		n	v_c	f_z	
	Metric	10000 rpm	314 m/min	0.009 mm	
	Inch	10000 rpm	1030 sfm	0.0003"	
		v_f	a_p	a_e	TL
	Metric	1500 mm/min	12 mm	10 mm	11 min
	Inch	59.01 ipm	0.47"	0.374"	11 min

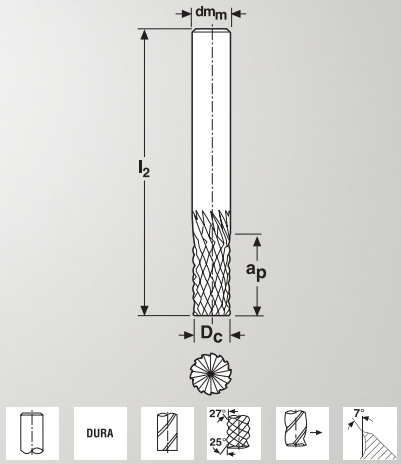
Results • Increased tool life to 16 m in the cut



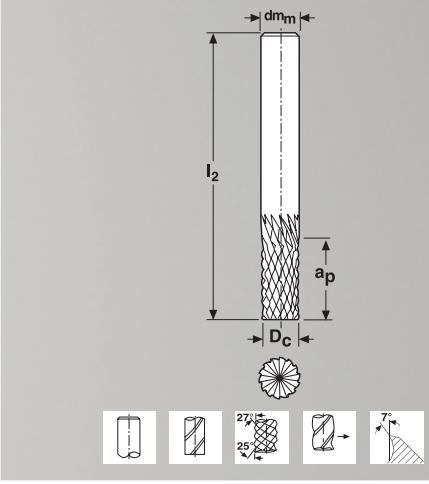
Scan this code to see more on JC870.

Tolerances:
dm_m = h5
D_c = -0.02/-0.08 mm

JC871



JC871 uncoated



JABRO™ COMPOSITE-JC871
SOLID CARBIDE END MILL - ROUTER (DOWNCUT)*

Dimensions in mm						Dimensions in inch					
Part No.	D_c	dm_m	l_2	a_p	Cylindrical	Part No.	D_c	dm_m	l_2	a_p	Cylindrical
JC871030.0-DURA	3	3	50	9	■	JC8710250.0-DURA	1/4	1/4	2 1/4	3/4	■
JC871040.0-DURA	4	4	50	12	■	JC8710375.0-DURA	3/8	3/8	3 1/2	1 1/4	■
JC871050.0-DURA	5	5	50	15	■	JC8710500.0-DURA	1/2	1/2	4	1 1/2	■
JC871060.0-DURA	6	6	65	18	■						
JC871080.0-DURA	8	8	75	24	■						
JC871100.0-DURA	10	10	85	30	■						
JC871120.0-DURA	12	12	100	36	■						

JABRO™ COMPOSITE-JC871-UNCOATED
SOLID CARBIDE END MILL - ROUTER UNCOATED (DOWNCUT)*

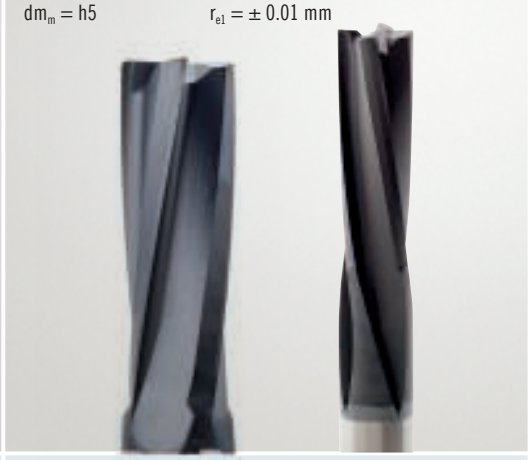
Dimensions in mm						Dimensions in mm					
Part No.	D_c	dm_m	l_2	a_p	Cylindrical	Part No.	D_c	dm_m	l_2	a_p	Cylindrical
JC871030.0	3	3	50	9	■	JC8710250.0	1/4	1/4	2 1/4	3/4	■
JC871040.0	4	4	50	12	■	JC8710375.0	3/8	3/8	3 1/2	1 1/4	■
JC871050.0	5	5	50	15	■	JC8710500.0	1/2	1/2	4	1 1/2	■
JC871060.0	6	6	65	18	■						
JC871080.0	8	8	75	24	■						
JC871100.0	10	10	85	30	■						
JC871120.0	12	12	100	36	■						

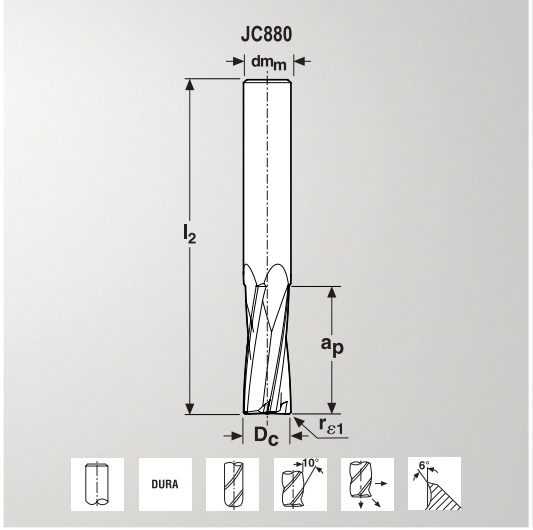
* Downcut indicates flute geometries that are combined to create small down forces that assist with maintaining component clamping, particularly where vacuum clamping is employed.

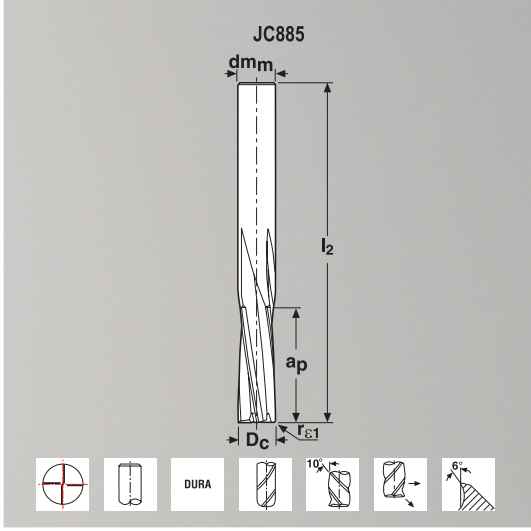
CASE STUDY
JABRO™ COMPOSITE JC871

Component:	CFRP exit doors for Boeing and Airbus						
Material:	Termoset, top layer with bronze fibres, thickness 3.2 mm						
Machine:	Jobs LinX Compact 5-axis, HSK63, max. rev/min. 25000						
Lubrication:	None						
Operation:	Slot milling						
Milling length:	1 pc: 1400 mm						
Total number of pcs:	13						
Tool holder:	EPB Shrinkfit holders, cylindrical type, with HSK-A63 machine side connection E9304 5800 1070						
Tool:	871100.0-DURA						
Cutting data		N	v_c	f	a_p	a_e	v_f
	Metric	3800 rpm	120 m/min	0.26 mm	3.2 mm	310 mm	1000 mm/min
	Inch	3800 rpm	394 sfm	0.010 ipr	0.125"	12.20"	39.37"
Results	**• After milling 9.8 m (7 pcs), the cutter shows almost no damage on the teeth (chipping wear) and no damage at all on the surface. The test continues.** **• After milling 18.2 m (13 pcs) a small problem shows up in surface quality (top layer with bronze fibres). The overall result is very good.**						

Tolerances:
run-out < 0.01 mm
dm_m = h5
D_c = -0.02/-0.04 mm
$r_{\varepsilon 1}$ = ± 0.01 mm







JABRO™ COMPOSITE-JC880
SOLID CARBIDE END MILL - LOW HELIX

	Dimensions in mm						
Part No.	D_c	dm_m	l_2	a_p	r_e	z_n	Cylindrical
JC880040R020Z4.0-DURA	4	4	50	12	0.2	4	■
JC880050R020Z4.0-DURA	5	5	50	15	0.2	4	■
JC880060R020Z4.0-DURA	6	6	65	18	0.2	4	■
JC880080R020Z4.0-DURA	8	8	70	24	0.2	4	■
JC880100R020Z4.0-DURA	10	10	80	30	0.2	4	■
JC880120R020Z4.0-DURA	12	12	100	20	0.2	4	■
JC880160R020Z4.0-DURA	16	16	110	48	0.2	4	■
JC880200R020Z4.0-DURA	20	20	130	60	0.2	4	■

JABRO™ COMPOSITE-JC885
SOLID CARBIDE END MILL - LOW HELIX (LEFT & RIGHT HELIX)

	Dimensions in mm						
Part No.	D_c	dm_m	l_2	a_p	r_e	z_n	Cylindrical
JC885040D2R020.0Z4-DURA	4	4	50	12	0.2	4	■
JC885050D2R020.0Z4-DURA	5	5	60	15	0.2	4	■
JC885060D2R020.0Z4-DURA	6	6	70	18	0.2	4	■
JC885080D2R020.0Z4-DURA	8	8	80	24	0.2	4	■
JC885100D2R020.0Z4-DURA	10	10	90	30	0.2	4	■
JC885120D2R020.0Z4-DURA	12	12	100	36	0.2	4	■

CASE STUDY JABRO™ COMPOSITE JC880

Component:	Structural part
Customer:	German (aero) space centre
Material:	(Stacked) CFRP's
Machine:	3-axis HSK 32A spindle
Lubrication:	None, air used to evacuate material
Operation:	Drilling, slotting, side milling, facing
Criterion:	Delamination < 1 mm, visual surface
Tool holder:	EPB ER collet chuck, with BT40 machine side connection E3414 5675 16100

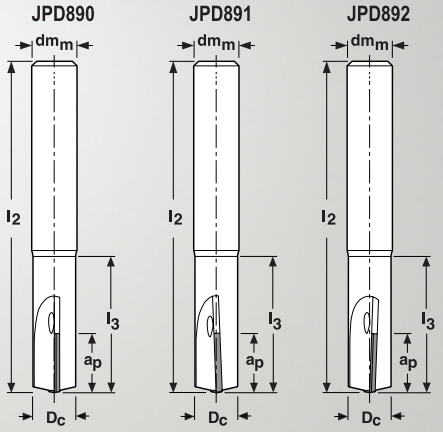
Cutting data		D_c	z_n	a_p	f_z	v_c
	Metric	6 mm	4	0.25 mm	0.018 mm	200 m/min
	Inch	0.236"	4	0.0098"	0.0007"	655.7 sfm
		N	a_e	v_f	Q	
	Metric	10800 rpm	6 mm	760 mm/min	1.14 cm^3/min	
	Inch	10800 rpm	0.236"	29.9 ipm	0.069 ^{3}/min	

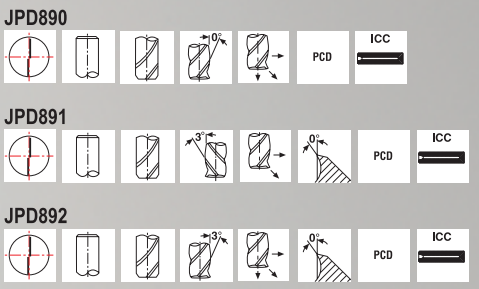
Results • < 0,2 mm delamination

Scan this code to see more on JC880.

Tolerances:
dm_m = h5
D_c = h10

ICC = 2 straight channels





CASE STUDY JABRO™ PCD-JPD890

Part:	Connecting rod – tank renfort		
Material:	Composite		
Machine tool:	CU special		
Tool:	JPD890 custom tool		
Lubrification:	None, suction and air used to evacuate material		
Fixturing:	Pneumatic fitting		
Tool:	JPD890 custom tool		
Mill:	PCD 4 Z, Ø 21 mm (0.826")		
Cutting data		v_c	N
	Metric	257 m/min	8000 rpm
	Inch	843 sfm	8000 rpm
		f	v_f
	Metric	0.4 mm/rev	3200 mm/min
	Inch	0.0157 ipr	126 ipm
Results	• **Increased tool life to 70 m (2756") in the cut**		

JABRO™ PCD-JPD890
PCD END MILL - NEUTRAL

		Dimensions in mm						
Part No.	ICC	D_c	dm_m	l_2	l_3	a_p	C	z_n	Cylindrical
JPD890060G2S.0Z2A	■	6	8	64	20	13	0.1	2	■
JPD890080E2S.0Z2A	■	8	8	64	20	15	0.1	2	■
JPD890100E2S.0Z2A	■	10	10	73	30	13	0.1	2	■
JPD890100E3S.0Z2A	■	10	10	73	30	20	0.1	2	■
JPD890120E2S.0Z2A	■	12	12	83	30	13	0.1	2	■
JPD890120E3S.0Z2A	■	12	12	83	30	20	0.1	2	■
JPD890160E2S.0Z2A	■	16	16	90	35	13	0.1	2	■
JPD890160E3S.0Z2A	■	16	16	90	35	20	0.1	2	■

JABRO™ PCD-JPD891
PCD END MILL - DOWNCUT

		Dimensions in mm						
Part No.	ICC	D_c	dm_m	l_2	l_3	a_p	C	z_n	Cylindrical
JPD891060G2S.0Z2A	■	6	8	64	20	13	0.1	2	■
JPD891080E2S.0Z2A	■	8	8	64	20	15	0.1	2	■
JPD891100E2S.0Z2A	■	10	10	73	30	13	0.1	2	■
JPD891100E3S.0Z2A	■	10	10	73	30	20	0.1	2	■
JPD891120E2S.0Z2A	■	12	12	83	30	13	0.1	2	■
JPD891120E3S.0Z2A	■	12	12	83	30	20	0.1	2	■
JPD891160E2S.0Z2A	■	16	16	90	35	13	0.1	2	■
JPD891160E3S.0Z2A	■	16	16	90	35	20	0.1	2	■

JABRO™ PCD-JPD892
PCD END MILL - UP CUT

		Dimensions in mm						
Part No.	ICC	D_c	dm_m	l_2	l_3	a_p	C	z_n	Cylindrical
JPD892060G2S.0Z2A	■	6	8	64	20	13	0.1	2	■
JPD892080E2S.0Z2A	■	8	8	64	20	15	0.1	2	■
JPD892100E2S.0Z2A	■	10	10	73	30	13	0.1	2	■
JPD892100E3S.0Z2A	■	10	10	73	30	20	0.1	2	■
JPD892120E2S.0Z2A	■	12	12	83	30	13	0.1	2	■
JPD892120E3S.0Z2A	■	12	12	83	30	20	0.1	2	■
JPD892160E2S.0Z2A	■	16	16	90	35	13	0.1	2	■
JPD892160E3S.0Z2A	■	16	16	90	35	20	0.1	2	■

Scan this code to see more on JPD890.

Scan this code to see more on JPD891.

JABRO™ – COMPOSITE – JC840 – CUTTING DATA

JC840 SLOTTING (METRIC)

SMG		Application	a_p x D_c	a_e x D_c	v_c (m/min)		D_c 6	8	10	12
PMC	Thermoplast	CFRP	1.00	1.00	150 (100-200)	n (rev/min)	7960	5970	4770	3980
						f_z (mm)	0.024	0.032	0.040	0.048
						v_f (mm/min)	765	1145	1335	1720
		GRP (GFRP)	0.80	1.00	100 (70-130)	n (rev/min)	5310	3980	3180	2650
						f_z (mm)	0.024	0.032	0.040	0,048
						v_f (mm/min)	510	765	890	1145
	Thermoset	CFRP	1.00	1.00	100 (50-150)	n (rev/min)	5310	3980	3180	2650
						f_z (mm)	0.024	0.032	0.040	0.048
						v_f (mm/min)	510	765	890	1145
		GRP (GFRP)	0.80	1.00	70 (50-90)	n (rev/min)	3710	2790	2230	1860
						f_z (mm)	0.024	0.032	0.040	0.048
						v_f (mm/min)	355	535	625	805

JC840 SIDE MILLING ROUGHING (METRIC)

SMG		Application	a_p x D_c	a_e x D_c	v_c (m/min)		D_c 6	8	10	12
PMC	Thermoplast	CFRP	1.00	0.40	200 (150-250)	n (rev/min)	10610	7960	6370	5310
						f_z (mm)	0.036	0.048	0.060	0.072
						v_f (mm/min)	1530	2290	2675	3440
		GRP (GFRP)	0.80	0.40	130 (100-160)	n (rev/min)	6900	5170	4140	3450
						f_z (mm)	0.036	0.048	0.060	0.072
						v_f (mm/min)	995	1490	1740	2235
	Thermoset	CFRP	1.00	0.40	150 (100-200)	n (rev/min)	7960	5970	4770	3980
						f_z (mm)	0.036	0.048	0.060	0.072
						v_f (mm/min)	1145	1720	2005	2580
		GRP (GFRP)	0.80	0.40	75 (45-105)	n (rev/min)	3980	2980	2390	1990
						f_z (mm)	0.036	0.048	0.060	0.072
						v_f (mm/min)	575	860	1005	1290

JC840 SIDE MILLING FINISHING (METRIC)

SMG		Application	a_p x D_c	a_e x D_c	v_c (m/min)		D_c 6	8	10	12
PMC	Thermoplast	CFRP	1.00	0.02	250 (200-300)	n (rev/min)	13260	9950	7960	6630
						f_z (mm)	0.048	0.064	0.080	0.096
						v_f (mm/min)	2545	3820	4460	5730
		GRP (GFRP)	1.00	0.02	160 (130-190)	n (rev/min)	8490	6370	5090	4240
						f_z (mm)	0.036	0.048	0.060	0.072
						v_f (mm/min)	1225	1835	2140	2750
	Thermoset	CFRP	1.00	0.02	200 (150-250)	n (rev/min)	10610	7960	6370	5310
						f_z (mm)	0.048	0.064	0.080	0.096
						v_f (mm/min)	2035	3055	3565	4590
		GRP (GFRP)	1.00	0.02	100 (70-130)	n (rev/min)	5310	3980	3180	2650
						f_z (mm)	0.036	0.048	0.060	0.072
						v_f (mm/min)	765	1145	1335	1715

CFRP = Carbon Fibre Reinforced Plastic I GRP (GFRP) = Glass Reinforced Plastic I PMC = Polyesther Matrix Composite. All cutting data are target values.

JABRO™ – COMPOSITE – JC840 – CUTTING DATA

JC840 SLOTTING (IMPERIAL)

SMG		Application	a_p x D_c	a_e x D_c	v_c (sfm)		D_c 1/4	1/3	2/5	1/2
PMC	Thermoplast	CFRP	1.00	1.00	490 (330-660)	n (min^{-1})	7920	5940	4750	3960
						f_z (in)	0.0009	0.0013	0.0016	0.0019
						v_f (in/min)	30	45	50	65
		GRP (GFRP)	0.80	1.00	330 (230-430)	n (min^{-1})	5340	4000	3200	2670
						f_z (in)	0.0009	0.0013	0.0016	0.0019
						v_f (in/min)	20	30	35	45
	Thermoset	CFRP	1.00	1.00	330 (160-490)	n (min^{-1})	5340	4000	3200	2670
						f_z (in)	0.0009	0.0013	0.0016	0.0019
						v_f (in/min)	20	30	35	45
		GRP (GFRP)	0.80	1.00	230 (160-300)	n (min^{-1})	3720	2790	2230	1860
						f_z (in)	0.0009	0.0013	0.0016	0.0019
						v_f (in/min)	15	20	25	30

JC840 SIDE MILLING ROUGHING (IMPERIAL)

SMG		Application	a_p x D_c	a_e x D_c	v_c (sfm)		D_c 1/4	1/3	2/5	1/2
PMC	Thermoplast	CFRP	1.00	0.40	660 (490-820)	n (min^{-1})	10670	8000	6400	5340
						f_z (in)	0.0014	0.0019	0.0024	0.0028
						v_f (in/min)	60	90	105	135
		GRP (GFRP)	1.00	0.40	820 (330-520)	n (min^{-1})	6950	5220	4170	3480
						f_z (in)	0.0014	0.0019	0.0024	0.0028
						v_f (in/min)	40	60	70	90
	Thermoset	CFRP	1.00	0.40	490 (330-660)	n (min^{-1})	7920	5940	4750	3960
						f_z (in)	0.0014	0.0019	0.0024	0.0028
						v_f (in/min)	45	65	80	100
		GRP (GFRP)	1.00	0.40	250 (150-340)	n (min^{-1})	4040	3030	2430	2020
						f_z (in)	0.0014	0.0019	0.0024	0.0028
						v_f (in/min)	25	35	40	50

JC840 SIDE MILLING FINISHING (IMPERIAL)

SMG		Application	a_p x D_c	a_e x D_c	v_c (sfm)		D_c 6	8	10	12
PMC	Thermoplast	CFRP	1.00	0.02	820 (660-980)	n (min^{-1})	13260	9950	7960	6630
						f_z (in)	0.0019	0.0025	0.0031	0.0038
						v_f (in/min)	100	150	175	225
		GRP (GFRP)	1.00	0.02	520 (430-620)	n (min^{-1})	8410	6310	5050	4200
						f_z (in)	0.0014	0.0019	0.0024	0.0028
						v_f (in/min)	50	70	85	225
	Thermoset	CFRP	1.00	0.02	660 (490-820)	n (min^{-1})	10670	8000	6400	5340
						f_z (in)	0.0019	0.0025	0.0031	0.0038
						v_f (in/min)	80	120	140	180
		GRP (GFRP)	1.00	0.02	330 (230-430)	n (min^{-1})	5340	4000	3200	2670
						f_z (in)	0.0014	0.0019	0.0024	0.0028
						v_f (in/min)	30	45	55	70

JABRO™ – COMPOSITE – JC845 – CUTTING DATA

JC845 SLOTTING (METRIC)

SMG		Application	a_p x D_c	a_e x D_c	v_c (m/min)		D_c 6	8	10	12
PMC	Thermoplast	CFRP	1.00	1.00	150 (100-200)	n (rev/min)	7960	5970	4770	3980
						f_z (mm)	0.024	0.032	0.040	0.048
						v_f (mm/min)	575	575	570	955
		GRP (GFRP)	0.80	1.00	100 (70-130)	n (rev/min)	5310	3980	3180	2650
						f_z (mm)	0.024	0.032	0.040	0.048
						v_f (mm/min)	380	380	380	635
	Thermoset	CFRP	1.00	1.00	100 (50-150)	n (rev/min)	5310	3980	3180	2650
						f_z (mm)	0.024	0.032	0.040	0.048
						v_f (mm/min)	380	380	380	635
		GRP (GFRP)	0.80	1.00	70 (50-90)	n (rev/min)	3710	2790	2230	1860
						f_z (mm)	0.024	0.032	0.040	0.048
						v_f (mm/min)	265	270	270	445

JC845 SIDE MILLING ROUGHING (METRIC)

SMG		Application	a_p x D_c	a_e x D_c	v_c (m/min)		D_c 6	8	10	12
PMC	Thermoplast	CFRP	1.00	0.40	200 (150-250)	n (rev/min)	10610	7960	6370	5310
						f_z (mm)	0.036	0.048	0.060	0.072
						v_f (mm/min)	1145	1145	1145	1910
		GRP (GFRP)	1.00	0.40	130 (100-160)	n (rev/min)	6900	5170	4140	3450
						f_z (mm)	0.036	0.048	0.060	0.072
						v_f (mm/min)	745	745	745	1240
	Thermoset	CFRP	1.00	0.40	150 (100-200)	n (rev/min)	7960	5970	4770	3980
						f_z (mm)	0.036	0.048	0.060	0.072
						v_f (mm/min)	860	860	860	1435
		GRP (GFRP)	1.00	0.40	75 (45-105)	n (rev/min)	3980	2980	2390	1990
						f_z (mm)	0.036	0.048	0.060	0.072
						v_f (mm/min)	430	430	430	715

JC845 SIDE MILLING FINISHING (METRIC)

SMG		Application	a_p x D_c	a_e x D_c	v_c (m/min)		D_c 6	8	10	12
PMC	Thermoplast	CFRP	1.00	0.02	250 (200-300)	n (rev/min)	13260	9950	7960	6630
						f_z (mm)	0.048	0.064	0.080	0.096
						v_f (mm/min)	1910	1910	1910	3180
		GRP (GFRP)	1.00	0.02	160 (130-190)	n (rev/min)	8490	6370	5090	4240
						f_z (mm)	0.036	0.048	0.060	0.072
						v_f (mm/min)	915	915	915	1525
	Thermoset	CFRP	1.00	0.02	200 (150-250)	n (rev/min)	10610	7960	6370	5310
						f_z (mm)	0.048	0.064	0.080	0.096
						v_f (mm/min)	1530	1530	1530	2550
		GRP (GFRP)	1.00	0.02	100 (70-130)	n (rev/min)	5310	3980	3180	2650
						f_z (mm)	0.036	0.048	0.060	0.072
						v_f (mm/min)	575	575	570	955

CFRP = Carbon Fibre Reinforced Plastic I GRP (GFRP) = Glass Reinforced Plastic I PMC = Polyester Matrix Composite. All cutting data are target values.

JABRO™ – COMPOSITE – JC850 – CUTTING DATA

JC850 COPY MILLING ROUGHING (METRIC)

SMG		Application	a_p x D_c	a_e x D_c	v_c (m/min)		D_c 3	4	6	8	10	12
PMC	Thermoplast	CFRP	0.20	0.20	300 (300-350)	n (rev/min)	31830	23870	15920	11940	9550	7960
						f_z (mm)	0.030	0.040	0.060	0.048	0.100	0.120
						v_f (mm/min)	3820	3820	3820	3820	3820	3820
		GRP (GFRP)	0.20	0.20	250 (200-300)	n (rev/min)	26530	19890	13260	9950	7960	6630
						f_z (mm)	0.024	0.032	0.048	0.064	0.080	0.096
						v_f (mm/min)	2545	2545	2545	2545	2545	2545
	Thermoset	CFRP	0.20	0.20	250 (200-300)	n (rev/min)	26530	19890	13260	9950	7960	6630
						f_z (mm)	0.030	0.040	0.060	0.080	0.100	0.120
						v_f (mm/min)	3185	3180	3180	3185	3185	3180
		GRP (GFRP)	0.20	0.20	200 (150-250)	n (rev/min)	21220	15920	10610	7960	6370	5310
						f_z (mm)	0.024	0.032	0.048	0.064	0.080	0.096
						v_f (mm/min)	2035	2040	2035	2040	2040	2040

JC850 COPY MILLING FINISHING (METRIC)

SMG		Application	a_p x D_c	a_e x D_c	v_c (m/min)		D_c 3	4	6	8	10	12
PMC	Thermoplast	CFRP	0.02	0.02	400 (300-500)	n (rev/min)	42440	31830	21220	15920	12730	10610
						f_z (mm)	0.018	0.024	0.060	0.048	0.060	0.072
						v_f (mm/min)	3055	3055	3055	3055	3055	3055
		GRP (GFRP)	0.02	0.02	250 (200-300)	n (rev/min)	26530	19890	13260	9950	7960	6630
						f_z (mm)	0.012	0.016	0.024	0.032	0.040	0.048
						v_f (mm/min)	1275	1275	1275	1275	1275	1275
	Thermoset	CFRP	0.02	0.02	400 (300-500)	n (rev/min)	42440	31830	21220	15920	12730	10610
						f_z (mm)	0.018	0.024	0.060	0.048	0.060	0.072
						v_f (mm/min)	3055	3055	3055	3055	3055	3055
		GRP (GFRP)	0.02	0.02	250 (200-300)	n (rev/min)	26530	19890	13260	9950	7960	6630
						f_z (mm)	0.012	0.016	0.024	0.032	0.040	0.048
						v_f (mm/min)	1275	1275	1275	1275	1275	1275

CFRP = Carbon Fibre Reinforced Plastic I GRP (GFRP) = Glass Reinforced Plastic I PMC = Polyester Matrix Composite. All cutting data are target values.

JABRO™ – COMPOSITE – JC850 – CUTTING DATA

JC850 SIDE MILLING (COPY) ROUGHING (METRIC)

SMG		Application	a_p x D_c	a_e x D_c	v_c (m/min)		D_c 3	4	6	8	10	12
PMC	Thermoplast	CFRP	2.00	0.20	250 (200-300)	n (rev/min)	26530	19890	13260	9950	7960	6630
						f_z (mm)	0.030	0.040	0.060	0.080	0.100	0.120
						v_f (mm/min)	3185	3180	3180	3185	3185	3180
		GRP (GFRP)	2.00	0.20	150 (100-200)	n (rev/min)	15920	11940	7960	5970	4770	3980
						f_z (mm)	0.024	0.032	0.048	0.064	0.080	0.096
						v_f (mm/min)	1530	1530	1530	1530	1525	1530
	Thermoset	CFRP	2.00	0.20	200 (100-300)	n (rev/min)	21220	15920	10610	7960	6370	5310
						f_z (mm)	0.030	0.040	0.060	0.080	0.100	0.120
						v_f (mm/min)	2545	2545	2545	2545	2550	2550
		GRP (GFRP)	2.00	0.20	100 (50-150)	n (rev/min)	10610	7960	5310	3980	3180	2650
						f_z (mm)	0.024	0.032	0.048	0.064	0.080	0.096
						v_f (mm/min)	1020	1020	1020	1020	1020	1020

JC850 SIDE MILLING (COPY) FINISHING (METRIC)

SMG		Application	a_p x D_c	a_e x D_c	v_c (m/min)		D_c 3	4	6	8	10	12
PMC	Thermoplast	CFRP	2.00	0.20	400 (300-500)	n (rev/min)	42440	31830	21220	15920	12730	10610
						f_z (mm)	0.018	0.024	0.060	0.048	0.060	0.072
						v_f (mm/min)	3055	3055	3055	3055	3055	3055
		GRP (GFRP)	2.00	0.20	300 (250-350)	n (rev/min)	31830	23870	15920	11940	9550	7960
						f_z (mm)	0.012	0.016	0.024	0.032	0.040	0.048
						v_f (mm/min)	1530	1530	1530	1530	1530	1530
	Thermoset	CFRP	2.00	0.20	300 (200-400)	n (rev/min)	31830	23870	15920	11940	9550	7960
						f_z (mm)	0.018	0.024	0.060	0.048	0.060	0.072
						v_f (mm/min)	2290	2290	2290	2290	2290	2290
		GRP (GFRP)	2.00	0.20	200 (150-250)	n (rev/min)	21220	15920	10610	7960	6370	5310
						f_z (mm)	0.012	0.016	0.024	0.032	0.040	0.048
						v_f (mm/min)	1020	1020	1020	1020	1020	1020

CFRP = Carbon Fibre Reinforced Plastic I GRP (GFRP) = Glass Reinforced Plastic I PMC = Polyester Matrix Composite. All cutting data are target values.

JABRO™ – COMPOSITE – JC860 – CUTTING DATA

JC860 SIDE MILLING (SEMI) ROUGHING (METRIC)

SMG		Application	a_p x D_c	a_e x D_c	v_c (m/min)		D_c 6	8	10	12	16
PMC	Thermoplast	CFRP	0.50	1.00	150 (125-175)	n (rev/min)	7960	5970	4770	3980	2980
						f_z (mm)	0.012	0.016	0.020	0.024	0.032
						v_f (mm/min)	480	575	765	860	1050
		GRP (GFRP)	0.50	1.00	100 (80-120)	n (rev/min)	5310	3980	3180	2650	1990
						f_z (mm)	0.012	0.016	0.020	0.024	0.032
						v_f (mm/min)	320	380	510	570	700
		Honeycomb (non ferrous)	1.00	1.00	200 (175-225)	n (rev/min)	10610	7960	6370	5310	3980
						f_z (mm)	0.012	0.016	0.020	0.024	0.032
						v_f (mm/min)	635	795	1020	1145	1400
	Thermoset	CFRP	0.50	1.00	100 (75-125)	n (rev/min)	5310	3980	3180	2650	1990
						f_z (mm)	0.012	0.016	0.020	0.024	0.032
						v_f (mm/min)	320	380	510	570	700
		GRP (GFRP)	0.50	1.00	50 (30-70)	n (rev/min)	2650	1990	1590	1330	990
						f_z (mm)	0.012	0.016	0.020	0.024	0.032
						v_f (mm/min)	160	190	255	285	350
		Honeycomb (non ferrous)	1.00	1.00	150 (125-175)	n (rev/min)	7960	5970	4770	3980	2980
						f_z (mm)	0.012	0.016	0.020	0.024	0.032
						v_f (mm/min)	480	575	765	860	1050

JC860 SLOTTING (WITH BOTTOM) (METRIC)

SMG		Application	a_p x D_c	a_e x D_c	v_c (m/min)		D_c 6	8	10	12	16
PMC	Thermoplast	CFRP	1.00	1.00	150 (125-175)	n (rev/min)	7960	5970	4770	3980	2980
						f_z (mm)	0.018	0.024	0.030	0.036	0.048
						v_f (mm/min)	715	860	1145	1290	1575
		GRP (GFRP)	1.00	1.00	100 (80-120)	n (rev/min)	5310	3980	3180	2650	1990
						f_z (mm)	0.018	0.024	0.030	0.036	0.048
						v_f (mm/min)	480	575	765	860	1050
		Honeycomb (non ferrous)	1.00	1.00	200 (175-225)	n (rev/min)	10610	7960	6370	5310	3980
						f_z (mm)	0.018	0.024	0.030	0.036	0.048
						v_f (mm/min)	955	1145	1530	1720	2100
	Thermoset	CFRP	1.00	1.00	100 (75-125)	n (rev/min)	5310	3980	3180	2650	1990
						f_z (mm)	0.018	0.024	0.030	0.036	0.048
						v_f (mm/min)	480	575	765	860	1050
		GRP (GFRP)	1.00	1.00	50 (30-70)	n (rev/min)	2650	1990	1590	1330	990
						f_z (mm)	0.018	0.024	0.030	0.036	0.048
						v_f (mm/min)	240	285	380	430	525
		Honeycomb (non ferrous)	1.00	1.00	150 (125-175)	n (rev/min)	7960	5970	4770	3980	2980
						f_z (mm)	0.018	0.024	0.030	0.036	0.048
						v_f (mm/min)	715	860	1145	1290	1575

CFRP = Carbon Fibre Reinforced Plastic I GRP (GFRP) = Glass Reinforced Plastic I PMC = Polyester Matrix Composite. All cutting data are target values.

JABRO™ – COMPOSITE – JC860 – CUTTING DATA

JC860 SLOTTING (WITH BOTTOM) (METRIC)

SMG		Application	a_p x D_c	a_e x D_c	v_c (m/min)		D_c 6	8	10	12	16
PMC	Thermoplast	CFRP	1.00	0.10	250 (150-350)	n (rev/min)	13260	9950	7960	6630	4970
						f_z (mm)	0.024	0.032	0.040	0.048	0.064
						v_f (mm/min)	1590	1910	2545	2865	3500
		GRP (GFRP)	1.00	0.10	150 (100-200)	n (rev/min)	7960	5970	4770	3980	2980
						f_z (mm)	0.024	0.032	0.040	0.048	0.064
						v_f (mm/min)	955	1145	1525	1720	2100
		Honeycomb (non ferrous)	1.50	0.30	300 (250-350)	n (rev/min)	15920	11940	9550	7960	5970
						f_z (mm)	0.024	0.032	0.040	0.048	0.064
						v_f (mm/min)	1910	2290	3055	3440	4205
	Thermoset	CFRP	1.00	0.10	200 (100-300)	n (rev/min)	10610	7960	6370	5310	3980
						f_z (mm)	0.024	0.032	0.040	0.048	0.064
						v_f (mm/min)	1275	1530	2040	2295	2800
		GRP (GFRP)	1.00	0.10	100 (50-150)	n (rev/min)	5310	3980	3180	2650	1990
						f_z (mm)	0.024	0.032	0.040	0.048	0.064
						v_f (mm/min)	635	765	1020	1145	1400
		Honeycomb (non ferrous)	1.50	0.30	200 (150-250)	n (rev/min)	10610	7960	6370	5310	3980
						f_z (mm)	0.024	0.032	0.040	0.048	0.064
						v_f (mm/min)	1275	1530	2040	2295	2800

JC860 SLOTTING (WITH BOTTOM) (IMPERIAL)

SMG		Application	a_p x D_c	a_e x D_c	v_c (sfm)		D_c 1/4	1/3	2/5	1/2	5/8
PMC	Thermoplast	CFRP	0.50	1.00	490 (410-570)	n (min^{-1})	7920	5940	4750	3960	2970
						f_z (in)	0.0005	0.0006	0.0008	0.0009	0.0013
						v_f (in/min)	20	20	30	35	40
		GRP (GFRP)	0.50	1.00	330 (260-390)	n (min^{-1})	5340	4000	3200	2670	2000
						f_z (in)	0.0005	0.0006	0.0008	0.0009	0.0013
						v_f (in/min)	15	15	20	25	30
		Honeycomb (non ferrous)	1.00	1.00	660 (570-740)	n (min^{-1})	10670	8000	6400	5340	4000
						f_z (in)	0.0005	0.0006	0.0008	0.0009	0.0013
						v_f (in/min)	25	30	40	45	55
	Thermoset	CFRP	0.50	1.00	330 (250-410)	n (min^{-1})	5340	4000	3200	2670	2000
						f_z (in)	0.0005	0.0006	0.0008	0.0009	0.0013
						v_f (in/min)	15	15	20	25	30
		GRP (GFRP)	0.50	1.00	160 (100-230)	n (min^{-1})	2590	1940	1550	1290	970
						f_z (in)	0.0005	0.0006	0.0008	0.0009	0.0013
						v_f (in/min)	5	5	10	10	15
		Honeycomb (non ferrous)	1.00	1.00	490 (410-570)	n (min^{-1})	7920	5940	4750	3960	2970
						f_z (in)	0.0005	0.0006	0.0008	0.0009	0.0013
						v_f (in/min)	20	20	30	35	40

CFRP = Carbon Fibre Reinforced Plastic I GRP (GFRP) = Glass Reinforced Plastic I PMC = Polyester Matrix Composite. All cutting data are target values.

JABRO™ – COMPOSITE – JC860 – CUTTING DATA

JC860 SLOTTING (OPEN) (IMPERIAL)

SMG		Application	a_p x D_c	a_e x D_c	v_c (sfm)		D_c 1/4	1/3	2/5	1/2	5/8
PMC	Thermoplast	CFRP	1.00	1.00	490 (410-570)	n (min^{-1})	7920	5940	4750	3960	2970
						f_z (in)	0.0007	0.0009	0.0012	0.0014	0.0019
						v_f (in/min)	30	35	45	50	60
		GRP (GFRP)	1.00	1.00	330 (260-390)	n (min^{-1})	5340	4000	3200	2670	2000
						f_z (in)	0.0007	0.0009	0.0012	0.0014	0.0019
						v_f (in/min)	20	25	30	35	40
		Honeycomb (non ferrous)	1.00	1.00	660 (570-740)	n (min^{-1})	10670	8000	6400	5340	4000
						f_z (in)	0.0007	0.0009	0.0012	0.0014	0.0019
						v_f (in/min)	40	45	60	70	85
	Thermoset	CFRP	1.00	1.00	330 (250-410)	n (min^{-1})	5340	4000	3200	2670	2000
						f_z (in)	0.0007	0.0013	0.0000	0.5669	0.6299
						v_f (in/min)	20	30	0	13625	13860
		GRP (GFRP)	1.00	1.00	160 (100-230)	n (min^{-1})	2590	1940	1550	1290	970
						f_z (in)	0.0007	0.0009	0.0012	0.0014	0.0019
						v_f (in/min)	10	10	15	15	20
		Honeycomb (non ferrous)	1.00	1.00	490 (410-570)	n (min^{-1})	7920	5940	4750	3960	2970
						f_z (in)	0.0007	0.0009	0.0012	0.0014	0.0019
						v_f (in/min)	30	35	45	50	60

JC860 SIDE MILLING (SEMI) ROUGHING (IMPERIAL)

SMG		Application	a_p x D_c	a_e x D_c	v_c (sfm)		D_c 1/4	1/3	2/5	1/2	5/8
PMC	Thermoplast	CFRP	1.00	0.10	820 (490-1150)	n (min^{-1})	13260	9950	7960	6630	4970
						f_z (in)	0.0009	0.0013	0.0016	0.0019	0.0025
						v_f (in/min)	65	75	100	115	140
		GRP (GFRP)	1.00	0.10	490 (330-660)	n (min^{-1})	7920	5940	4750	3960	2970
						f_z (in)	0.0009	0.0013	0.0016	0.0019	0.0025
						v_f (in/min)	35	45	60	65	80
		Honeycomb (non ferrous)	1.50	0.30	980 (570-1150)	n (min^{-1})	15850	11890	9510	7920	5940
						f_z (in)	0.0009	0.0013	0.0016	0.0019	0.0025
						v_f (in/min)	75	90	120	135	165
	Thermoset	CFRP	1.00	0.10	660 (330-980)	n (min^{-1})	10670	8000	6400	5340	4000
						f_z (in)	0.0009	0.0013	0.0016	0.0019	0.0025
						v_f (in/min)	50	60	80	90	110
		GRP (GFRP)	1.00	0.10	330 (160-490)	n (min^{-1})	5340	4000	3200	2670	2000
						f_z (in)	0.0009	0.0013	0.0016	0.0019	0.0025
						v_f (in/min)	25	30	40	45	55
		Honeycomb (non ferrous)	1.50	0.30	660 (490-820)	n (min^{-1})	10670	8000	6400	5340	4000
						f_z (in)	0.0009	0.0013	0.0016	0.0019	0.0025
						v_f (in/min)	50	60	80	90	110

CFRP = Carbon Fibre Reinforced Plastic I GRP (GFRP) = Glass Reinforced Plastic I PMC = Polyester Matrix Composite. All cutting data are target values.

JABRO™ – COMPOSITE – JC870/JC871 – CUTTING DATA

JC870 SLOTTING (WITH BOTTOM) (METRIC)

SMG		Application	a_p x D_c	a_e x D_c	v_c (m/min)		D_c 3	4	5	6	8	10	12
PMC	Thermoplast	CFRP	0.50	1.00	150 (125-175)	n (rev/min)	15920	11940	9550	7960	5970	4770	3980
						f_z (mm)	0.003	0.004	0.005	0.006	0.008	0.010	0.012
						v_f (mm/min)	335	380	480	575	670	765	860
		GRP (GFRP)	0.50	1.00	100 (80-120)	n (rev/min)	10610	7960	6370	5310	3980	3180	2650
						f_z (mm)	0.003	0.004	0.005	0.006	0.008	0.010	0.012
						v_f (mm/min)	225	255	320	380	445	510	570
		Honeycomb (non ferrous)	1.00	1.00	200 (175-225)	n (rev/min)	21220	15920	12730	10610	7960	6370	5310
						f_z (mm)	0.003	0.004	0.005	0.006	0.008	0.010	0.012
						v_f (mm/min)	445	510	635	765	890	1020	1145
	Thermoset	CFRP	0.50	1.00	100 (75-125)	n (rev/min)	10610	7960	6370	5310	3980	3180	2650
						f_z (mm)	0.003	0.004	0.005	0.006	0.008	0.010	0.012
						v_f (mm/min)	225	255	320	380	445	510	570
		GRP (GFRP)	0.50	1.00	50 (30-70)	n (rev/min)	5310	3980	3180	2650	1990	1590	1330
						f_z (mm)	0.003	0.004	0.005	0.006	0.008	0.010	0.012
						v_f (mm/min)	110	125	160	190	225	255	285
		Honeycomb (non ferrous)	1.00	1.00	150 (125-175)	n (rev/min)	15920	11940	9550	7960	5970	4770	3980
						f_z (mm)	0.003	0.004	0.005	0.006	0.008	0.010	0.012
						v_f (mm/min)	335	380	480	575	670	765	860

JC870 AND JC871 SLOTTING (OPEN) (METRIC)

SMG		Application	a_p x D_c	a_e x D_c	v_c (m/min)		D_c 3	4	5	6	8	10	12
PMC	Thermoplast	CFRP	1.00	1.00	150 (125-175)	n (rev/min)	15920	11940	9550	7960	5970	4770	3980
						f_z (mm)	0.006	0.008	0.010	0.012	0.016	0.020	0.024
						v_f (mm/min)	670	765	955	1145	1335	1525	1720
		GRP (GFRP)	1.00	1.00	100 (80-120)	n (rev/min)	10610	7960	6370	5310	3980	3180	2650
						f_z (mm)	0.006	0.008	0.010	0.012	0.016	0.020	0.024
						v_f (mm/min)	445	510	635	765	890	1020	1145
		Honeycomb (non ferrous)	1.00	1.00	200 (175-225)	n (rev/min)	21220	15920	12730	10610	7960	6370	5310
						f_z (mm)	0.006	0.008	0.010	0.012	0.016	0.020	0.024
						v_f (mm/min)	890	1020	1275	1530	1785	2040	2295
	Thermoset	CFRP	1.00	1.00	100 (75-125)	n (rev/min)	10610	7960	6370	5310	3980	3180	2650
						f_z (mm)	0.006	0.008	0.010	0.012	0.016	0.020	0.024
						v_f (mm/min)	445	510	635	765	890	1020	1145
		GRP (GFRP)	1.00	1.00	50 (30-70)	n (rev/min)	5310	3980	3180	2650	1990	1590	1330
						f_z (mm)	0.006	0.008	0.010	0.012	0.016	0.020	0.024
						v_f (mm/min)	225	255	320	380	445	510	575
		Honeycomb (non ferrous)	1.00	1.00	150 (125-175)	n (rev/min)	15920	11940	9550	7960	5970	4770	3980
						f_z (mm)	0.006	0.008	0.010	0.012	0.016	0.020	0.024
						v_f (mm/min)	670	765	955	1145	1335	1525	1720

CFRP = Carbon Fibre Reinforced Plastic, GRP (GFRP) = Glass Reinforced Plastic, PMC = Polyester Matrix Composite. All cutting data are target values.

JABRO™ – COMPOSITE –JC870/JC871 – CUTTING DATA

JC870 AND JC871 SIDE MILLING ROUGHING (METRIC)

SMG		Application	a_p x D_c	a_e x D_c	v_c (m/min)		D_c 3	4	5	6	8	10	12
PMC	Thermoplast	CFRP	2.00	0.35	250 (225-275)	n (rev/min)	26530	19890	15920	13260	9950	7960	6630
						f_z (mm)	0.009	0.012	0.015	0.018	0.024	0.030	0.036
						v_f (mm/min)	1670	1910	2390	2865	3345	3820	4295
		GRP (GFRP)	2.00	0.35	150 (125-175)	n (rev/min)	15920	11940	9550	7960	5970	4770	3980
						f_z (mm)	0.009	0.012	0.015	0.018	0.024	0.030	0.036
						v_f (mm/min)	1005	1145	1435	1720	2005	2290	2580
		Honeycomb (non ferrous)	2.00	0.35	250 (225-275)	n (rev/min)	26530	19890	15920	13260	9950	7960	6630
						f_z (mm)	0.009	0.012	0.015	0.018	0.024	0.030	0.036
						v_f (mm/min)	1670	1910	2390	2865	3345	3820	4295
	Thermoset	CFRP	2.00	0.35	200 (175-225)	n (rev/min)	21220	15920	12730	10610	7960	6370	5310
						f_z (mm)	0.009	0.012	0.015	0.018	0.024	0.030	0.036
						v_f (mm/min)	1335	1530	1910	2290	2675	3060	3440
		GRP (GFRP)	2.00	0.35	100 (75-125)	n (rev/min)	10610	7960	6370	5310	3980	3180	2650
						f_z (mm)	0.009	0.012	0.015	0.018	0.024	0.030	0.036
						v_f (mm/min)	670	765	955	1145	1335	1525	1715
		Honeycomb (non ferrous)	2.00	0.35	200 (175-225)	n (rev/min)	21220	15920	12730	10610	7960	6370	5310
						f_z (mm)	0.009	0.012	0.015	0.018	0.024	0.030	0.036
						v_f (mm/min)	1335	1530	1910	2290	2675	3060	3440

JC870 SLOTTING (WITH BOTTOM) (IMPERIAL)

SMG		Application	a_p x D_c	a_e x D_c	v_c (sfm)		D_c 1/8	1/6	1/5	1/4	1/3	2/5	1/2
PMC	Thermoplast	CFRP	0.50	1.00	490 (410-570)	n (min^{-1})	15850	11890	9510	7920	5940	4750	3960
						f_z (in)	0.0001	0.0002	0.0002	0.0002	0.0003	0.0004	0.0005
						v_f (in/min)	15	15	20	20	25	30	35
		GRP (GFRP)	0.50	1.00	330 (260-390)	n (min^{-1})	10670	8000	6400	5340	4000	3200	2670
						f_z (in)	0.0001	0.0002	0.0002	0.0002	0.0003	0.0004	0.0005
						v_f (in/min)	10	10	15	15	20	20	25
		Honeycomb (non ferrous)	1.00	1.00	660 (570-740)	n (min^{-1})	21350	16010	12810	10670	8000	6400	5340
						f_z (in)	0.0001	0.0002	0.0002	0.0002	0.0003	0.0004	0.0005
						v_f (in/min)	20	20	25	30	35	40	45
	Thermoset	CFRP	0.50	1.00	330 (250-410)	n (min^{-1})	10670	8000	6400	5340	4000	3200	2670
						f_z (in)	0.0001	0.0002	0.0002	0.0002	0.0003	0.0004	0.0005
						v_f (in/min)	10	10	15	15	20	20	25
		GRP (GFRP)	0.50	1.00	160 (100-230)	n (min^{-1})	5170	3880	3100	2590	1940	1550	1290
						f_z (in)	0.0001	0.0002	0.0002	0.0002	0.0003	0.0004	0.0005
						v_f (in/min)	5	5	5	5	10	10	10
		Honeycomb (non ferrous)	1.00	1.00	490 (410-570)	n (min^{-1})	15850	11890	9510	7920	5940	4750	3960
						f_z (in)	0.0001	0.0002	0.0002	0.0002	0.0003	0.0004	0.0005
						v_f (in/min)	15	15	20	20	25	30	35

CFRP = Carbon Fibre Reinforced Plastic, GRP (GFRP) = Glass Reinforced Plastic, PMC = Polyester Matrix Composite. All cutting data are target values.

JABRO™ – COMPOSITE – JC870/JC871 – CUTTING DATA

JABRO™ JC870 AND JC871 SLOTTING (OPEN) (IMPERIAL)

SMG		Application	a_p x D_c	a_e x D_c	v_c (sfm)		D_c 1/8	1/6	1/5	1/4	1/3	2/5	1/2
PMC	Thermoplast	CFRP	1.00	1.00	490 (410-570)	n (min^{-1})	15850	11890	9510	7920	5940	4750	3960
						f_z (in)	0.0002	0.0003	0.0004	0.0005	0.0006	0.0008	0.0009
						v_f (in/min)	25	30	35	45	50	60	65
		GRP (GFRP)	1.00	1.00	330 (260-390)	n (min^{-1})	10670	8000	6400	5340	4000	3200	2670
						f_z (in)	0.0002	0.0003	0.0004	0.0005	0.0006	0.0008	0.0009
						v_f (in/min)	20	20	25	30	35	40	45
		Honeycomb (non ferrous)	1.00	1.00	660 (570-740)	n (min^{-1})	21350	16010	12810	10670	8000	6400	5340
						f_z (in)	0.0002	0.0003	0.0004	0.0005	0.0006	0.0008	0.0009
						v_f (in/min)	35	40	50	60	70	80	90
	Thermoset	CFRP	1.00	1.00	330 (250-410)	n (min^{-1})	10670	8000	6400	5340	4000	3200	2670
						f_z (in)	0.0002	0.0003	0.0004	0.0005	0.0006	0.0008	0.0009
						v_f (in/min)	20	20	25	30	35	40	45
		GRP (GFRP)	1.00	1.00	160 (100-230)	n (min^{-1})	5170	3880	3100	2590	1940	1550	1290
						f_z (in)	0.0002	0.0003	0.0004	0.0005	0.0006	0.0008	0.0009
						v_f (in/min)	10	10	10	15	15	20	20
		Honeycomb (non ferrous)	1.00	1.00	490 (410-570)	n (min^{-1})	15850	11890	9510	7920	5940	4750	3960
						f_z (in)	0.0002	0.0003	0.0004	0.0005	0.0006	0.0008	0.0009
						v_f (in/min)	25	30	35	45	50	60	65

JABRO™ JC870 AND JC871 SIDE MILLING ROUGHING (IMPERIAL)

SMG		Application	a_p x D_c	a_e x D_c	v_c (sfm)		D_c 1/8	1/6	1/5	1/4	1/3	2/5	1/2
PMC	Thermoplast	CFRP	2.00	0.35	820 (740-900)	n (min^{-1})	26520	19890	15910	13260	9950	7960	6630
						f_z (in)	0.0004	0.0005	0.0006	0.0007	0.0009	0.0012	0.0014
						v_f (in/min)	65	75	95	115	130	150	170
		GRP (GFRP)	2.00	0.35	490 (410-570)	n (min^{-1})	15850	11890	9510	7920	5940	4750	3960
						f_z (in)	0.0004	0.0005	0.0006	0.0007	0.0009	0.0012	0.0014
						v_f (in/min)	40	45	55	65	80	90	100
		Honeycomb (non ferrous)	2.00	0.35	820 (740-900)	n (min^{-1})	26520	19890	15910	13260	9950	7960	6630
						f_z (in)	0.0004	0.0005	0.0006	0.0007	0.0009	0.0012	0.0014
						v_f (in/min)	65	75	95	115	130	150	170
	Thermoset	CFRP	2.00	0.35	660 (570-740)	n (min^{-1})	21350	16010	12810	10670	8000	6400	5340
						f_z (in)	0.0004	0.0005	0.0006	0.0007	0.0009	0.0012	0.0014
						v_f (in/min)	55	60	75	90	105	120	135
		GRP (GFRP)	2.00	0.35	330 (250-410)	n (min^{-1})	10670	8000	6400	5340	4000	3200	2670
						f_z (in)	0.0004	0.0005	0.0006	0.0007	0.0009	0.0012	0.0014
						v_f (in/min)	25	30	40	45	55	60	70
		Honeycomb (non ferrous)	2.00	0.35	660 (570-740)	n (min^{-1})	21350	16010	12810	10670	8000	6400	5340
						f_z (in)	0.0004	0.0005	0.0006	0.0007	0.0009	0.0012	0.0014
						v_f (in/min)	55	60	75	90	105	120	135

CFRP = Carbon Fibre Reinforced Plastic, GRP (GFRP) = Glass Reinforced Plastic, PMC = Polyester Matrix Composite. All cutting data are target values.

JABRO™ – COMPOSITE – JC880/JC885 – CUTTING DATA

JC880 SLOTTING / JC885 SLOTTING (METRIC)

SMG		Application	a_p x D_c	a_e x D_c	v_c (m/min)		D_c 4	5	6	8	10	12	16	20
PMC	Thermoplast	CFRP	1.00	1.00	150 (125-175)	n (rev/min)	11940	9550	7960	5970	4770	3980	2980	2390
						f_z (mm)	0.024	0.030	0.036	0.048	0.060	0.072	0.096	0.120
						v_f (mm/min)	1145	1145	1145	1145	1145	1145	1145	1145
		GRP (GFRP)	0.70	1.00	100 (70-130)	n (rev/min)	7960	6370	5310	3980	3180	2650	1990	1590
						f_z (mm)	0.016	0.020	0.024	0.032	0.040	0.048	0.064	0.080
						v_f (mm/min)	510	510	510	510	510	510	510	510
	Thermoset	CFRP	1.00	1.00	100 (75-125)	n (rev/min)	7960	6370	5310	3980	3180	2650	1990	1590
						f_z (mm)	0.024	0.030	0.036	0.048	0.060	0.072	0.096	0.120
						v_f (mm/min)	765	765	765	765	765	765	765	765
		GRP (GFRP)	0.70	1.00	50 (25-75)	n (rev/min)	3980	3180	2650	1990	1590	1330	990	800
						f_z (mm)	0.016	0.020	0.024	0.032	0.040	0.048	0.064	0.080
						v_f (mm/min)	255	255	255	255	255	255	255	255

JC880 SIDE MILLING ROUGHING / JC885 SIDE MILLING ROUGHING (METRIC)

SMG		Application	a_p x D_c	a_e x D_c	v_c (m/min)		D_c 4	5	6	8	10	12	16	20
PMC	Thermoplast	CFRP	2.00	0.40	250 (150-350)	n (rev/min)	19890	15920	13260	9950	7960	6630	4970	3980
						f_z (mm)	0.024	0.030	0.036	0.048	0.060	0.072	0.096	0.120
						v_f (mm/min)	1910	1910	1910	1910	1910	1910	1910	1910
		GRP (GFRP)	2.00	0.30	150 (100-200)	n (rev/min)	11940	9550	7960	5970	4770	3980	2980	2390
						f_z (mm)	0.016	0.020	0.024	0.032	0.040	0.048	0.064	0.080
						v_f (mm/min)	765	765	765	765	765	765	765	765
	Thermoset	CFRP	2.00	0.40	200 (100-300)	n (rev/min)	15920	12730	10610	7960	6370	5310	3980	3180
						f_z (mm)	0.024	0.030	0.036	0.048	0.060	0.072	0.096	0.120
						v_f (mm/min)	1530	1530	1530	1530	1530	1530	1530	1530
		GRP (GFRP)	2.00	0.30	100 (50-150)	n (rev/min)	7960	6370	5310	3980	3180	2650	1990	1590
						f_z (mm)	0.016	0.020	0.024	0.032	0.040	0.048	0.064	0.080
						v_f (mm/min)	510	510	510	510	510	510	510	510

JC880 SIDE MILLING FINISHING /JC885 SIDE MILLING FINISHING (METRIC)

SMG		Application	a_p x D_c	a_e x D_c	v_c (m/min)		D_c 4	5	6	8	10	12	16	20
PMC	Thermoplast	CFRP	2.00	0.10	250 (150-350)	n (rev/min)	19890	15920	13260	9950	7960	6630	4970	3980
						f_z (mm)	0.020	0.025	0.030	0.040	0.050	0.060	0.080	0.100
						v_f (mm/min)	1590	1590	1590	1590	1590	1590	1590	1590
		GRP (GFRP)	2.00	0.10	150 (100-200)	n (rev/min)	11940	9550	7960	5970	4770	3980	2980	2390
						f_z (mm)	0.012	0.015	0.018	0.024	0.030	0.036	0.048	0.060
						v_f (mm/min)	575	575	575	575	575	575	575	575
	Thermoset	CFRP	2.00	0.10	200 (100-300)	n (rev/min)	15920	12730	10610	7960	6370	5310	3980	3180
						f_z (mm)	0.020	0.025	0.030	0.040	0.050	0.060	0.080	0.100
						v_f (mm/min)	1275	1275	1275	1275	1275	1275	1275	1275
		GRP (GFRP)	2.00	0.10	100 (50-150)	n (rev/min)	7960	6370	5310	3980	3180	2650	1990	1590
						f_z (mm)	0.012	0.015	0.018	0.024	0.030	0.036	0.048	0.060
						v_f (mm/min)	380	380	380	380	380	380	380	380

CFRP = Carbon Fibre Reinforced Plastic, GRP (GFRP) = Glass Reinforced Plastic, PMC = Polyester Matrix Composite. All cutting data are target values.

JABRO™ – PCD – JPD – JPD890/891/892 – CUTTING DATA

JPD890/891/892 SLOTTING (METRIC)

SMG		Application	a_p x D_c	a_e x D_c	v_c (m/min)		D_c 6	8	10	12	16
PMC	Thermoplast	CFRP	1.00	1.00	600 (500-700)	n (rev/min)	31830	23870	19100	15920	11940
						f_z (mm)	0.060	0.080	0.100	0.120	0.160
						v_f (mm/min)	3820	3820	3820	3820	3820
		GRP (GFRP)	1.00	1.00	425 (300-550)	n (rev/min)	22550	16910	13530	11270	8460
						f_z (mm)	0.042	0.056	0.070	0.084	0.112
						v_f (mm/min)	1895	1895	1895	1895	1895
	Thermoset	CFRP	1.00	1.00	375 (250-500)	n (rev/min)	19890	14920	11940	9950	7460
						f_z (mm)	0.060	0.080	0.100	0.120	0.160
						v_f (mm/min)	2385	2385	2390	2390	2385
		GRP (GFRP)	1.00	1.00	225 (150-300)	n (rev/min)	11940	8950	7160	5970	4480
						f_z (mm)	0.042	0.056	0.070	0.084	0.112
						v_f (mm/min)	1005	1000	1000	1005	1005

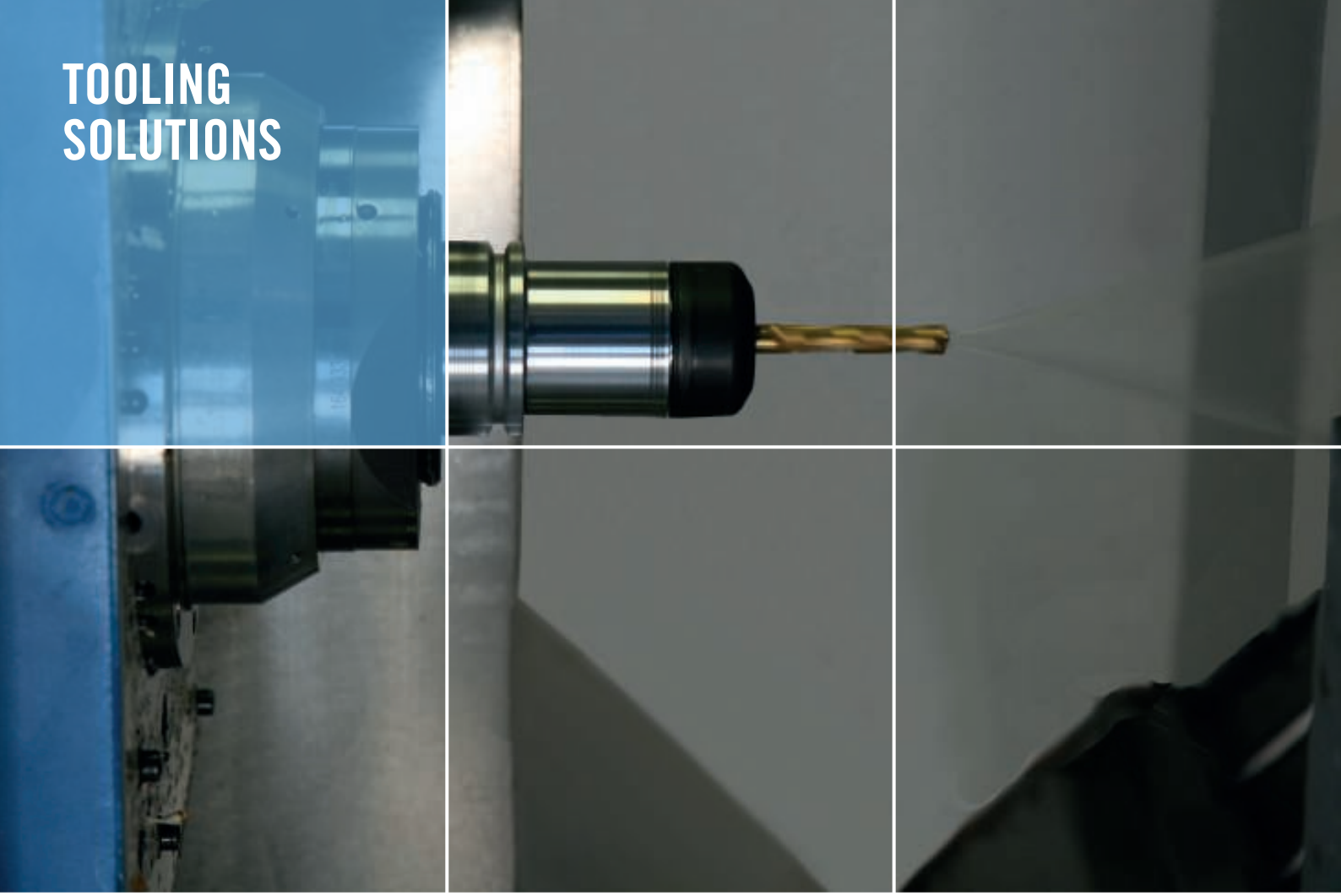
JPD890/891/892 SIDE MILLING ROUGHING (METRIC)

SMG		Application	a_p x D_c	a_e x D_c	v_c (m/min)		D_c 6	8	10	12	16
PMC	Thermoplast	CFRP	1.20	0.30	850 (700-1000)	n (rev/min)	45090	33820	27060	22550	16910
						f_z (mm)	0.120	0.160	0.200	0.240	0.320
						v_f (mm/min)	10820	10820	10825	10825	10820
		GRP (GFRP)	1.20	0.20	500 (250-600)	n (rev/min)	26530	19890	15920	13260	9950
						f_z (mm)	0.060	0.080	0.100	0.120	0.160
						v_f (mm/min)	3185	3185	3815	3180	3185
	Thermoset	CFRP	1.20	0.30	500 (350-650)	n (rev/min)	26530	19890	15920	13260	9950
						f_z (mm)	0.090	0.120	0.150	0.180	0.240
						v_f (mm/min)	4775	4775	4775	4775	4775
		GRP (GFRP)	1.20	0.20	320 (225-400)	n (rev/min)	16980	12730	10190	8490	6370
						f_z (mm)	0.060	0.080	0.100	0.120	0.160
						v_f (mm/min)	2040	2035	2040	2040	2040

JPD890/891/892 SIDE MILLING ROUGHING (METRIC)

SMG		Application	a_p x D_c	a_e x D_c	v_c (m/min)		D_c 6	8	10	12	16
PMC	Thermoplast	CFRP	2.00	0.10	1050 (900-1200)	n (rev/min)	55700	41780	33420	27850	20890
						f_z (mm)	0.030	0.040	0.050	0.060	0.080
						v_f (mm/min)	3340	3340	3340	3340	3340
		GRP (GFRP)	2.00	0.10	550 (350-750)	n (rev/min)	29180	21880	17510	14590	10940
						f_z (mm)	0.018	0.024	0.030	0.036	0.048
						v_f (mm/min)	1050	1050	1050	1050	1050
	Thermoset	CFRP	2.00	0.10	500 (300-700)	n (rev/min)	26530	19890	15920	13260	9950
						f_z (mm)	0.030	0.040	0.050	0.060	0.080
						v_f (mm/min)	1590	1590	1590	1590	1590
		GRP (GFRP)	2.00	0.10	300 (150-450)	n (rev/min)	15920	11940	9550	7960	5970
						f_z (mm)	0.018	0.024	0.030	0.036	0.048
						v_f (mm/min)	575	575	575	575	575

CFRP = Carbon Fibre Reinforced Plastic, GRP (GFRP) = Glass Reinforced Plastic, PMC = Polyester Matrix Composite. All cutting data are target values.



TOOL HOLDING FOR MACHINING COMPOSITES

Within its EPB Tooling Systems line, Seco offers several tool holding technologies that eliminate the issues and challenges associated with machining composite materials. These systems provide the perfect precision, performance and coolant delivery for high-speed, high-torque machining applications such as those often involved with processing CFRPs.
EPB Tooling Systems include Seco's Shrinkfit, hydraulic chuck and collet chuck-style holders. All of which support the company's Jabro™ solid end mills and Feedmax™ drills and deliver high rigidity and very low run-out.
In addressing the specific requirements of composite machining, Seco's EPB Tooling Systems will:

- Reduce the risk of delamination or fibre splintering through high speed machining solutions,
- Efficiently prevent composite dusts from moving up into machine tool spindles through the use of sealed holder designs,
- Deliver coolant internally (through the tool) or externally (directed towards the cutting edge) to provide the best chips and heat evacuation and reduce the risk of deformation of workpieces during machining,
- Provide fast and easy replacement of the tools to help reduce production costs resulting from machine downtime.

EPB 5603 Shrinkfit holders, DIN type

EPB 5603 Shrinkfit holders, DIN type

EPB 5801 Shrinkfit holders, mould and die type

THE POWER OF SECO SHRINKFIT

BENEFITS:

- High precision machining (run-out max. 3µm at 3xD)
- Symmetrical and fine balanced for high speed machining
- Sealed tool clamping to prevent spindle contamination
- Coolant delivery through the tool with JPD890 series end mills or towards cutting edges
- Wide range of holders includes EPB 5603 DIN type; EPB 5801 'Mould & die' type compact design to machine the most complex workpieces; Safe-Lock™ tool retention systems available on EPB 5600 Shrinkfit holders; and EPB 5600 reinforced holders for when higher gripping is required

TAPERS AND SIZES:

Shrinkfit holders are available in a variety of tapers – HSK-A, HSK-E, DIN, BT, CAT, Graflex and Seco-Capto™ – and diameters from 3 mm to 32 mm (0.250" to 1.25") in different length projections.

EPB 5834 hydraulic chucks

THE GRIP OF SECO HYDRAULIC CHUCKS

BENEFITS:

- High precision machining (run-out max. 3µm at 3xD)
- Symmetrical and fine balanced for high speed machining
- Coolant delivery through the tool with JPD890 series end mills
- Sealed tool clamping prevents spindle contamination
- Fast and easy tool replacement

TAPER AND SIZES:

Hydraulic chucks are available in HSK-A, HSK-E, DIN, BT, CAT, Graflex and Seco-Capto for tool shank diameter from 6 mm to 32 mm (0.750" to 1.250").

EPB 5675 ER collet chucks

EPB 5672 high precision collet chucks

THE VERSATILITY OF SECO EPB 5675 AND EPB 5672 COLLET CHUCKS

BENEFITS OF EPB 5675 ER COLLET CHUCKS:

- Flexible system allows various tool shank diameters to be held using the same tool holder body
- Sealing rings and nuts provide sealed tool clamping and through-tool coolant delivery for JPD890 series end mills
- Symmetrically designed and fine balanced for high speed machining
- Fast and easy tool replacement

TAPERS AND SIZES:

EPB 5675 ER collet chucks are available in HSK-A, HSK-E, DIN, BT, CAT, Graflex and Seco-Capto for tool shank diameters of 0.5 mm to 32 mm (1/16" to 1").

BENEFITS OF EPB 5672 HIGH PRECISION COLLET CHUCKS:

- Symmetrically designed and fine balanced for high speed machining
- Designed for high precision machining (run-out max. 3µm at 3xD)
- High clamping torque for high performance cutting (HPC)
- Sealed tool clamping to prevent spindle contamination
- Through-tool coolant delivery for JPD890 series end mills
- Fast and easy tool replacement

TAPERS AND SIZES:

EPB 5672 high precision collet chucks come in HSK-A, HSK-E, DIN, BT, CAT, Graflex and Seco-Capto tapers and accommodate tool shank diameters from 1 mm to 32 mm (1/16" to 3/4").

Easyshrink® 15"

Easyshrink® 20, Pack 1

Easyshrink® 20, Pack 2

ONE STOP SHRINKFIT SHOPPING

To complement its line of Shrinkfit holders, Seco also offers Easyshrink® 15 & 20 Shrinkfit devices needed to 'shrink grip' and 'shrink release' tools in and out of the holder.

EASYSHRINK FEATURES AND BENEFITS:

- Induction heating for perfect heating control in terms of temperature and energy flow. Heating located in the clamping area only, for an optimised Shrinkfit process.
- Efficient coil delivers fast heating for quick release of HSS, carbide and steel shank tools. Less heat transfer to the cutting tool to eliminate adverse affects on tool holder structures.
- Optimised automatic cycles prevent harmful overheating of holders and system coil and help lower energy consumption. Manual modes are available for tuning device to customer-specific needs for special holders.
- Integrated height setting system with stop rods on the Easyshrink 20 eliminates the need for stop screws in the holder so there are no constraints on the tool shank and broken tools can be easily extracted.
- Compact and user-friendly design eliminates external cabling and protects the transmission system of the Z column while providing an all-in-one system. A strong Z column accommodates tooling lengths up to 400 mm.

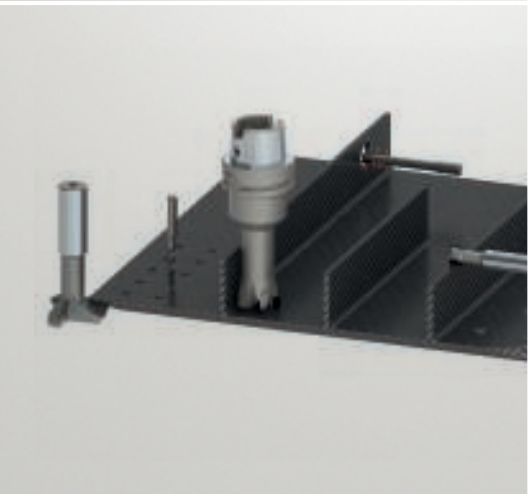
Easyshrink® 20, Pack 3

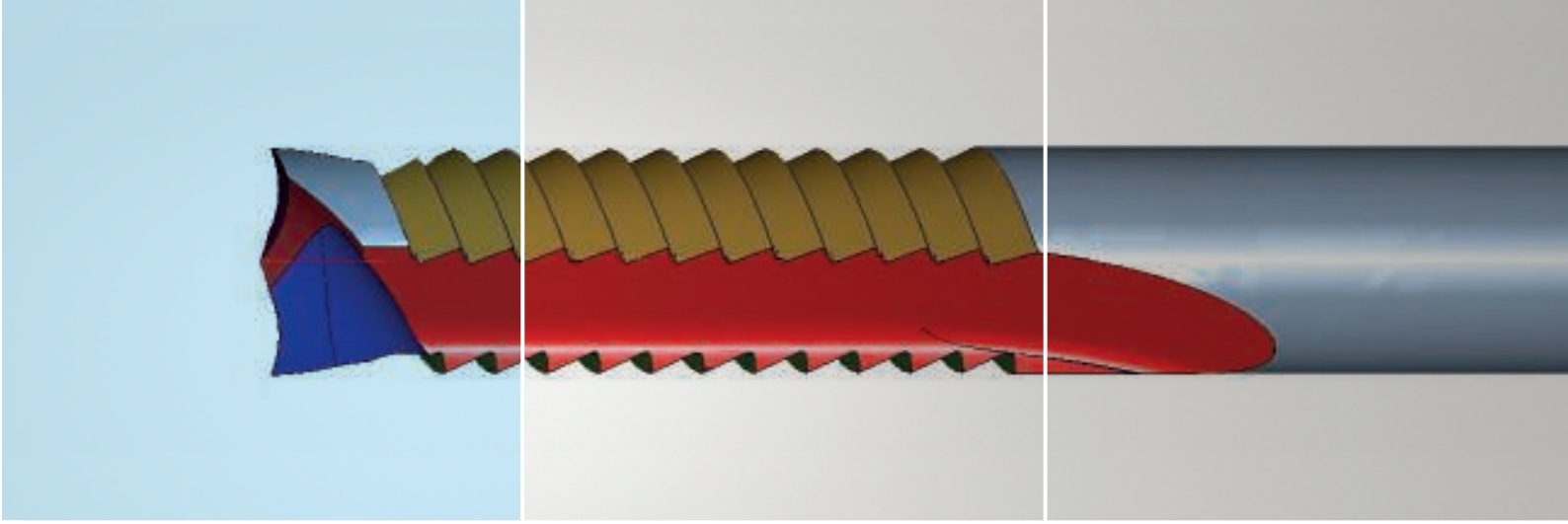
CUSTOM TOOLS FOR COMPOSITES

In addition to its expansive scope of standard composite tooling, Seco has the experience, in-house expertise and capability to also produce special tooling tailored to specific customer needs.

For example, the CX series drills can be customised with 100-degree chamfers as a special. Plus, drill lengths can be modified to, for instance, SD205 dimensions meaning that the drilling length is 5 times the diameter. Or in the case of end mills, Seco can also offer custom tooling for complex stacked composites (example CFRP/ titanium). Next complex stacks, Seco also offers geometries for armour materials like Kevlar (see cyber on next page).

For more information regarding designs and lead times for custom tooling, please contact your international Seco application engineer or send an email to **composites.support@secotools.com**.





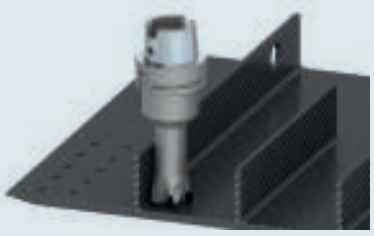
CASE STUDIES

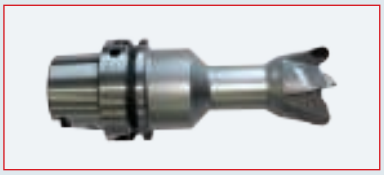
CUSTOMER APPLICATION PCD #1

Component:	Intrados panel
Material:	New thermoset IMA
Machine tool:	CN C5 - table 20 x 4 m
Lubrication:	Outside and internal - spindle
Fixturing:	Bridles and suction pads
Tool:	PCD 5 flutes custom Monobloc™ surfacing Ø 50 mm (1.96") radius 5 mm (0.196")

Cutting data		N	v_c	a_p
	Metric	12000 rpm	1885 m/min	4 mm
	Inch	12000 rpm	6180.4 sfm	0.157"
		a_e	v_f	
	Metric	38 mm	5000 mm/min	
	Inch	1.496"	196.8 ipm	

Results • **Increased tool life to 650 min, or 3250 m (127552"/10662') in the cut**





CUSTOMER APPLICATION PCD #2

Component:	Panel
Material:	Thermoset T700
Machine tool:	CN C5 - table 20 x 4 m
Lubrication:	Outside and internal - spindle
Fixturing:	Bridles and suction pads
Tool:	PCD 5 flutes custom surfacing Ø 50 mm (0.196") radius for chamfer 5 mm (0.196")
Tool holder:	EPB Shrinkfit holder, DIN type, with HSK-A machine side connection E9304 5603 32120

Cutting data		N	v_c	a_p
	Metric	11230 rpm	1764 m /min	5 mm
	Inch	11230 rpm	5783 sfm	0.196"
		a_e	v_f	
	Metric	38 mm	2000 mm/min	
	Inch	1.496"	78.7 ipm	

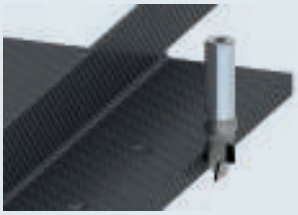
Results • **Increased tool life to 1500 min, or 3050 m (118110"/9842') in the cut**

CUSTOMER APPLICATION PCD #3

Component:	Extrados panel
Material:	T700/M21 - T800
Machine tool:	CN C5 - table 20 x 4 m
Lubrication:	Outside and internal - spindle
Fixturing:	Bridles and suction pads
Tool:	PCD 2x2 flutes custom Routering Ø 16 mm (0.629")
Tool holder:	EPB 5672 high precision collet chuck, with Seco-Capto™ C6 machine side connection C6-391.5672-16075

Cutting data		N	v_c	a_p
	Metric	13500 rpm	680 m /min	18 mm
	Inch	13500 rpm	2229 sfm	0.708"
		a_e	v_f	
	Metric	16 mm	2000 mm/min	
	Inch	0.629"	78.7 ipm	

Results • **Increased tool life to 32 min, or 64 m (2519"/209') in the cut - no delamination**



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