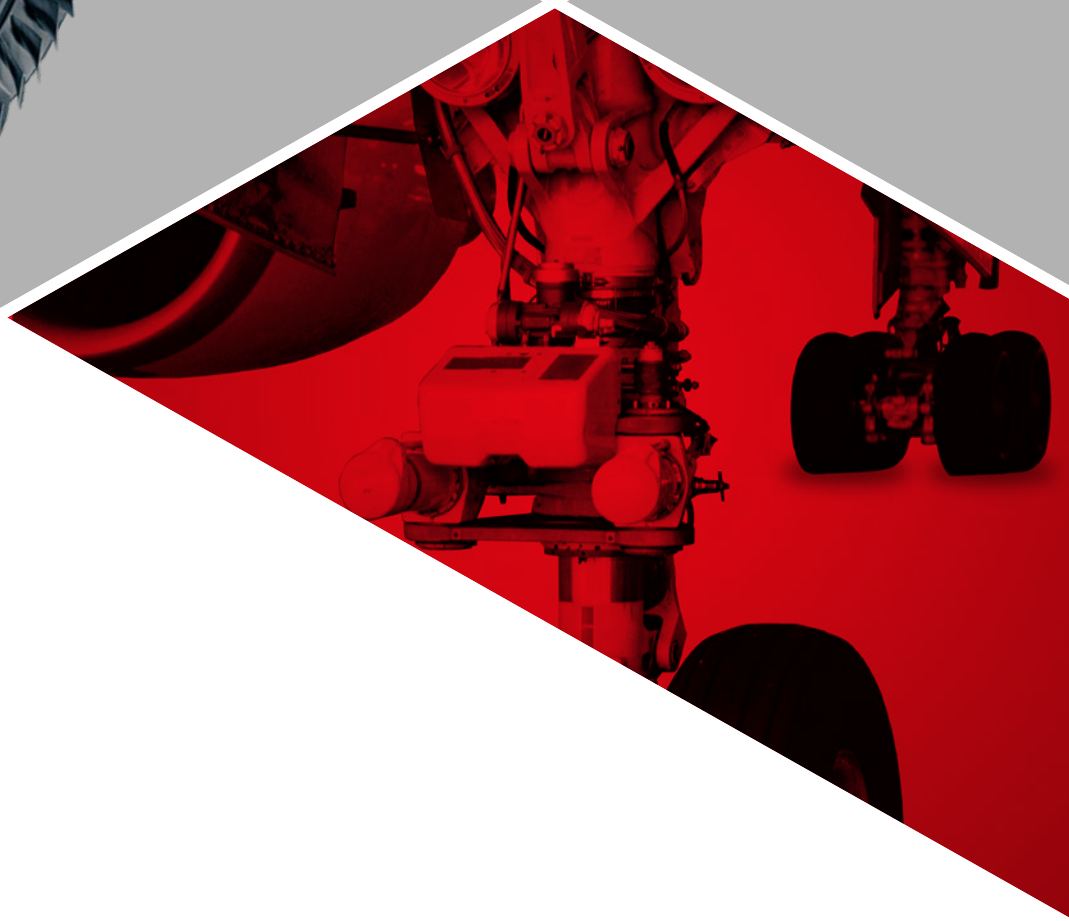
A612E

AEROSPACE

APPLICATIONS



DIAEDGE

MITSUBISHI MATERIALS

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AIR FRAME

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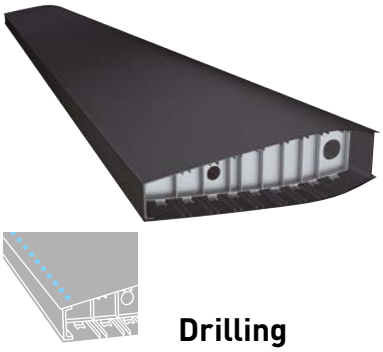
Application Example

- CVD diamond coated drills with optimized cutting geometry for composite materials reduces burr formation and delamination.

Work Materials [CFRP, CF/Al]



Drilling

MCS

S-TAW

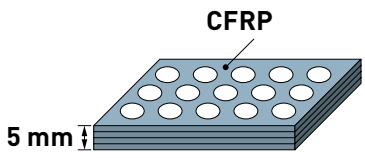
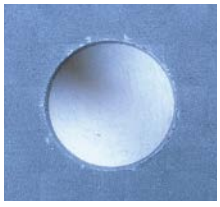
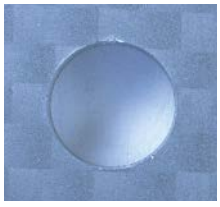
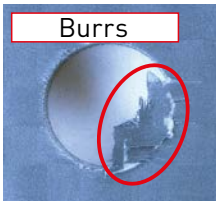
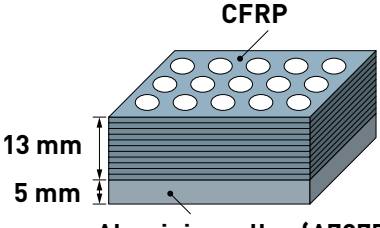
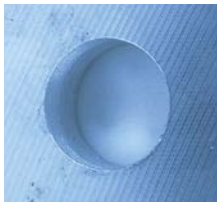
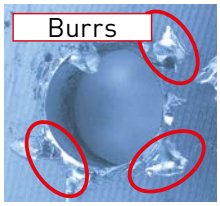
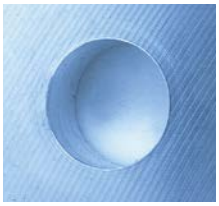
New CVD diamond coated drills

Optimized cutting geometry

Drill	ø 6.375
Cutting Speed	vc100 m/min (4995 min^{-1})
Feed	f0.04 mm/rev
Machine	Vertical type M/C
Coolant	Internal air blow

Key Point on Machining

- Cutting tool life is usually extremely short because of the high strength and abrasive properties of carbon fibre, additionally delamination and burring easily occurs during cutting.
  It is effective to use a coated tool with high wear resistance.
  MCS drills and S-TAW drills reduce burrs and delamination due to the CVD diamond coating.
  In combination with an optimized tool geometry, long tool life and high-quality machining can be achieved.

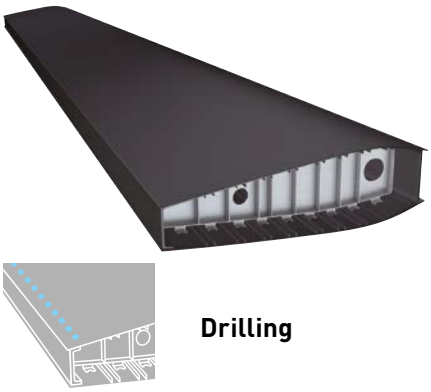
Work Material	MCS	Conventional A for CFRP	Conventional B for CFRP + Al
 **CFRP** **Bottom plate -CFRP**			
 **CFRP + Al** **Bottom plate - aluminium alloy**			

AIR FRAME

Application Example

- PCD drills with optimized cutting geometry for composite materials reduces burr formation and delamination.

Work Materials [CFRP, CF/Ti]



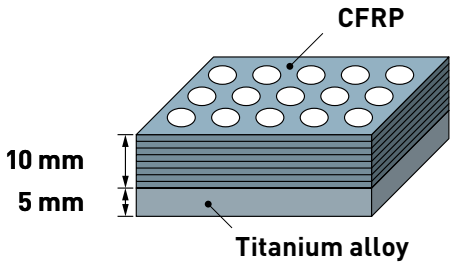
Drilling

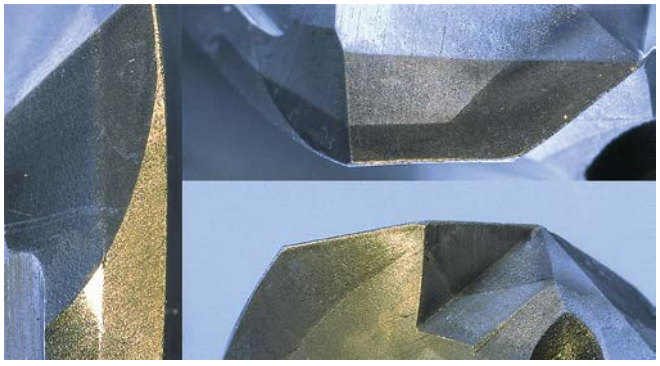
Special PCD Drill

Drill	ø 6.375
Work Material	CFRP + Titanium Alloy (Ti-6Al-4V)
Cutting Speed	vc10 m/min (500 min^{-1})
Feed	f0.05 mm/rev
Machine	Vertical type M/C
Coolant	Internal mist

Key Point on Machining

- Cutting tool life is usually extremely short because of the high strength and abrasive properties of carbon fibre, additionally delamination and burring easily occurs during cutting.
  It is effective to use a PCD tool (sintered diamond) with high wear resistance. PCD drills reduce burrs and delamination due to the PCD (sintered diamond) coating. In combination with an optimized tool geometry, long tool life and high-quality machining can be achieved.





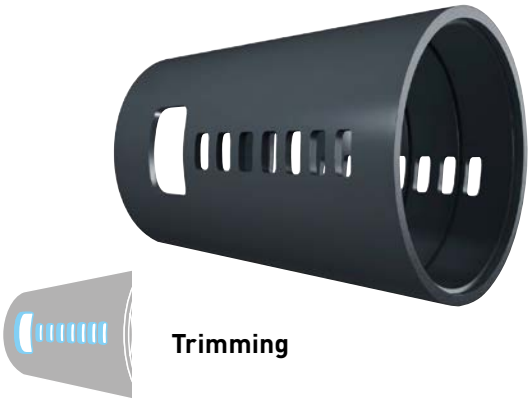
Good edge condition (120 holes machined)

AIR FRAME

Application Example

- CVD diamond coated end mills with optimized cutting geometry for composite materials reduces burr formation and delamination.

Work Material [CFRP]



Trimming

New CVD diamond coated end mills

Optimized cutting geometry

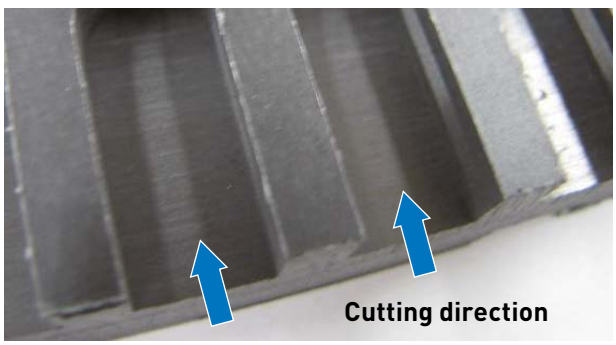
DFC

End mill	DFC4JCD1000 (ø 10)
Work Material	CFRP
Revolution	n6000 min^{-1} (vc188 m/min)
Feed	vf750 mm/min (fz0.03 mm/tooth)
Depth of Cut	ap5 mm
Coolant	Air blow

Key Point on Machining

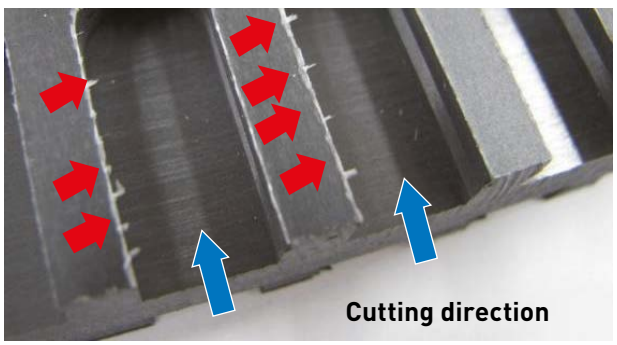
- Cutting tool life is usually extremely short because of the high strength and abrasive properties of carbon fibre, additionally delamination and burring easily occurs during cutting. It is effective use a to use a PCD tool (sintered diamond) with high wear resistance. DFC endmills reduce burrs and delamination due to the CVD diamond coating. In combination with an optimized tool geometry, long tool life and high-quality machining can be achieved.

DFC4JCD1000



No burr formation

Conventional



Burr formation

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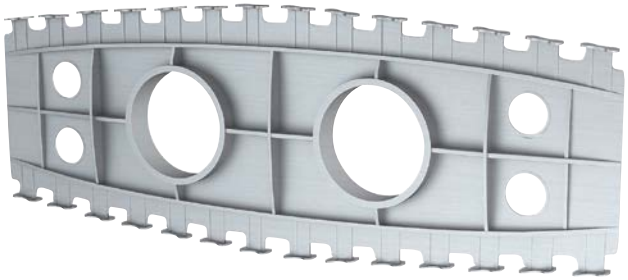
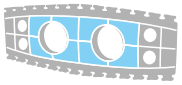
Application Example

- Chip removal of 10000 cm^3/min. is achieved with the super efficient AXD7000-HSK type.

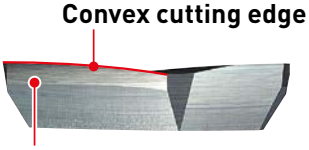
Work Material [Aluminium Alloy]





Face Milling
Pocket Milling

AXD



Low cutting resistance

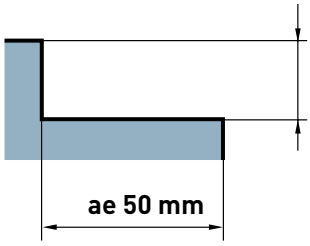
Holder	AXD7000R05003A-H63A
Insert (Grade)	XDGX227030PDFR-GL (TF15)
Work Material	A7075
Cutting Speed	vc2830 m/min (n18000 min^{-1})
Feed	fz0.21 mm/tooth (vf11340 mm/min)
Depth of Cut	ap18 mm, ae50 mm
Coolant	Emulsion

Key Point on Machining

- Milling of rib type components involves removing large volumes of stock material. Therefore high efficiency machining at high speeds is required to reduce costs. The AXD series achieves low cutting resistance without lowering the insert edge strength due to a helical flank and optimized relief angle. Additionally, the convex cutting edge allows good chip removal resulting in high speed, highly efficient machining.

Point

Avoids poor wall surface finishes because the tool is designed to interpolate corners of the pocket, thereby also preventing vibration.



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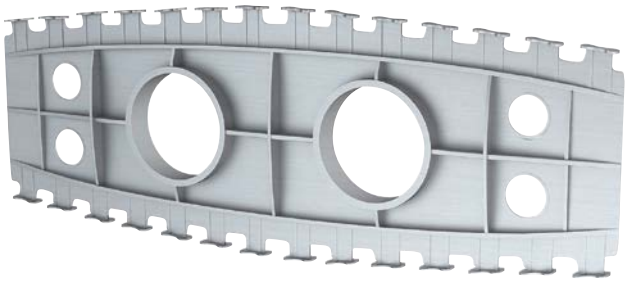
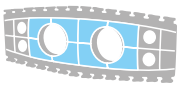
Application Example

- GM breaker (MP9120) with high strength cutting edges reduces insert chipping when cutting aluminium-lithium alloy, therefore offering a reliable cutting performance.

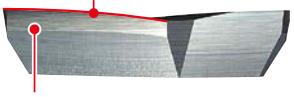
Work Material [Aluminium-lithium Alloy]





Face Milling
Pocket Milling

AXD



Low cutting resistance

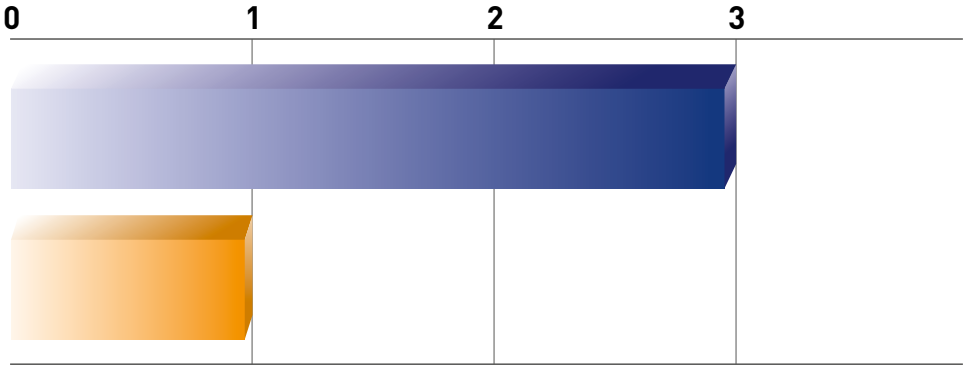
Holder	AXD4000-050A04RA
Insert (Grade)	XDGX175024PDER-GM (MP9120)
Work Material	Aluminium-lithium Alloy
Cutting Speed	vc4712 m/min (n30000 min^{-1})
Feed	fz0.1 mm/tooth (vf12000 mm/min)
Depth of Cut	ap6 mm, ae50 mm
Coolant	Emulsion

Key Point on Machining

- Milling of rib type components involves removing large volumes of stock material. Therefore high efficiency machining at high speeds is required to reduce costs. The AXD series achieves low cutting resistance without lowering the insert edge strength due to a helical flank and optimized relief angle. Use of the MP9120 grade is highly effective for ultra-high-speed cutting.

GM

Tool life (Number of components)

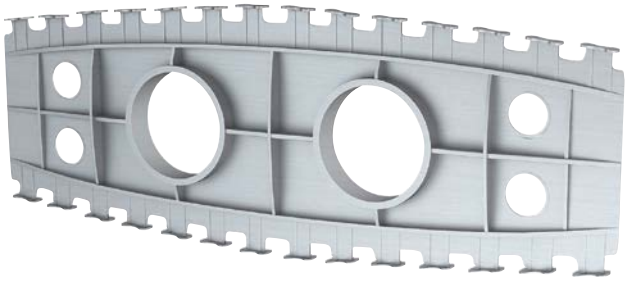


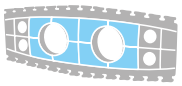
AIR FRAME

Application Example

- Chip removal of 5000cm^3/min. is achieved when using a high power machine at high speeds.

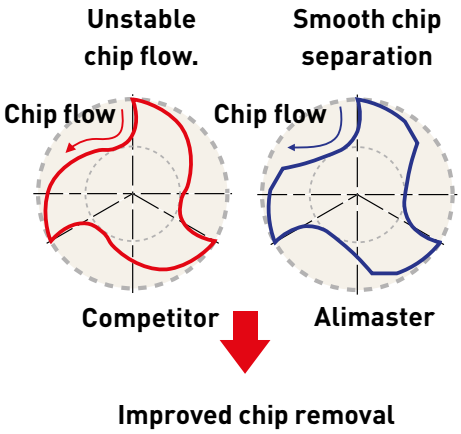
Work Material [Aluminium Alloy]





Face Milling
Pocket Milling

Alimaster



End mill	CSRARBD2500R300 (ø 25/R3)
Work Material	A7075
Cutting Speed	vc1178 m/min (n15000 min^{-1})
Feed	fz0.22 mm/tooth (vf10000 mm/min)
Depth of Cut	ap25 mm, ae20 mm
Coolant	Emulsion

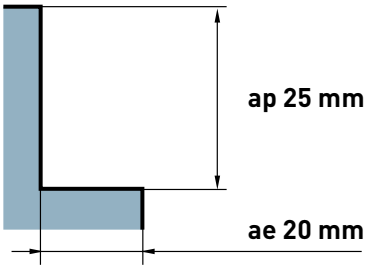
Key Point on Machining

- Milling of rib type components involves removing large volumes of stock material. Therefore highly efficient machining at high speeds is required to reduce costs. The ALIMASTER series achieves good chip removal and efficiency due to the unique cross-sectional shape of the flute geometry.

Point

Avoids poor wall surface finishes because the tool is designed to interpolate corners of the pocket, thereby also preventing vibration.

<Machine specification>
15000min-1/75kW, BT50

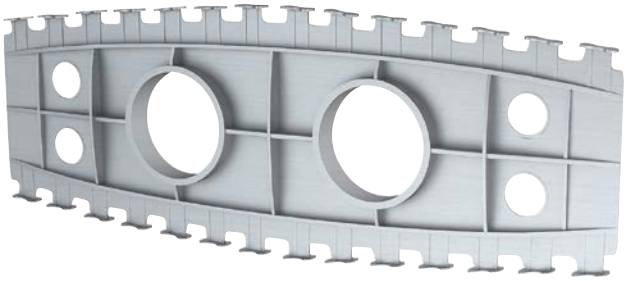


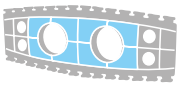
AIR FRAME

Application Example

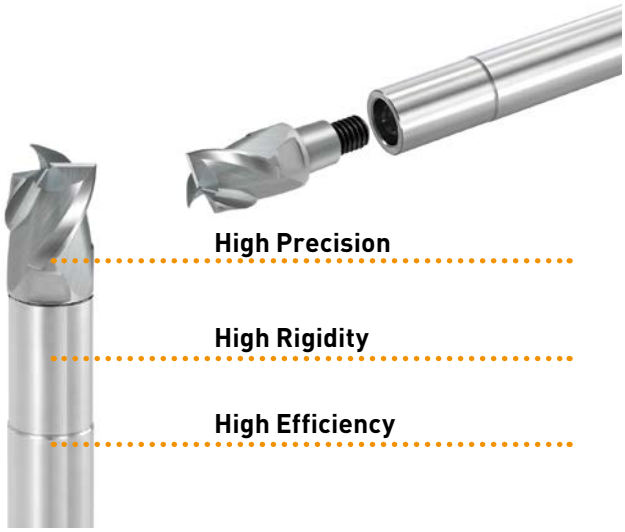
- Solid carbide holder enables stable, deep slot machining with vastly reduced vibration.

Work Material [Aluminium Alloy]





Face Milling
Pocket Milling

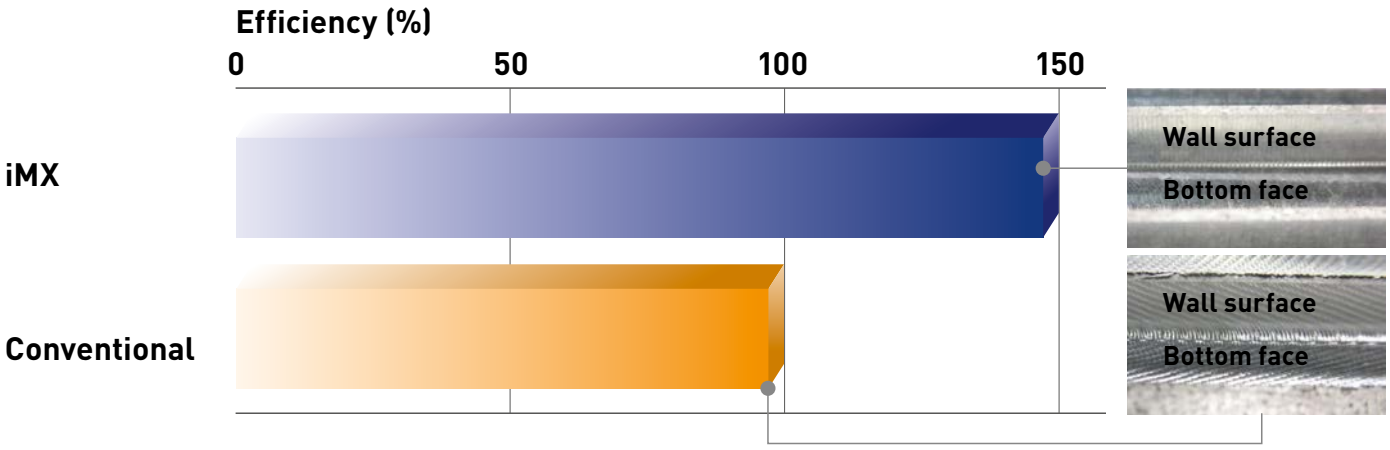


iMX
Exchangeable Head End Mills

Head (Grade)	IMX10S3A10008 (ET2020)
Holder	IMX10-U10N014L070C
Overhang length	35 mm
Work Material	A7075
Cutting Speed	vc408 m/min (n13000 min^{-1})
Feed	fz0.12 mm/tooth (vf4680 mm/min)
Depth of Cut	ap5 mm, ae10 mm
Coolant	Emulsion

Key Point on Machining

- Milling of rib type components involves removing large volumes of stock material. Therefore highly efficient machining at high speeds is required to reduce costs. The iMX exchangeable head end mill geometry for machining aluminium alloy prevents welding due to a large rake angle and with a mirror finish surface treatment on the flutes.

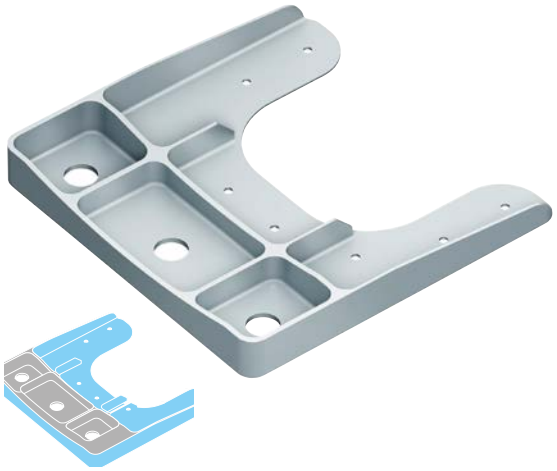


AIR FRAME

Application Example

- Achieved 150% efficiency by combining effective geometry with high pressure internal through coolant.

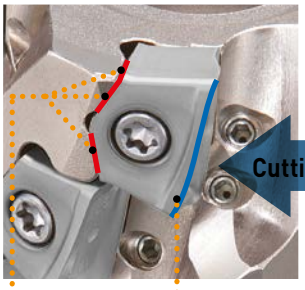
Work Material [Titanium Alloy]



Side Milling
Rough Pocket Milling

VFX

Arranging the inserts vertically



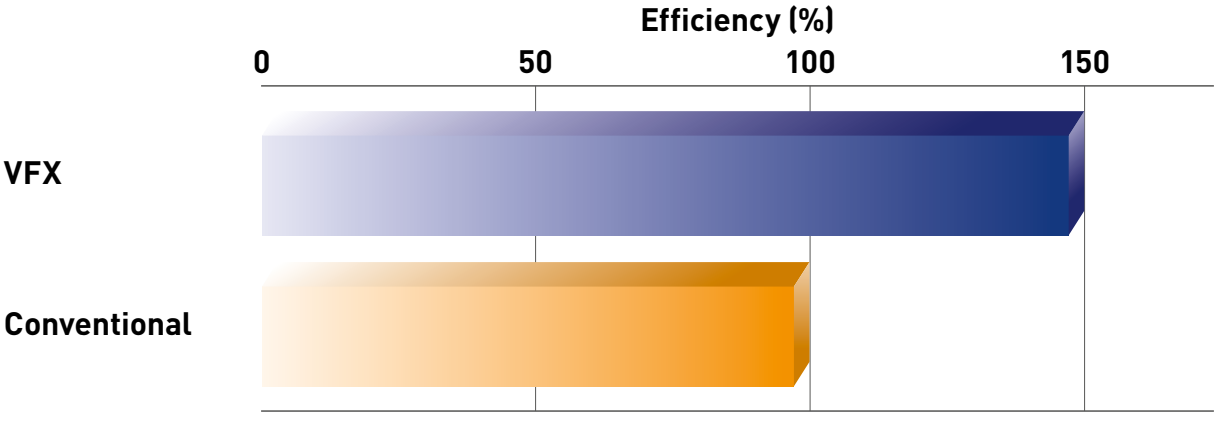
V formation of the clamping face

Convex curve cutting edge

Holder	VFX6-063A04A060R
Insert (Grade)	XNMU190912R-LS (MP9130)
Work Material	Ti-6Al-4V
Cutting Speed	vc55 m/min (n280 min^{-1})
Feed	fz0.12 mm/tooth (vf135 mm/min)
Depth of Cut	ap25-60 mm, ae10-45 mm
Coolant	Emulsion (10 MPa)

Key Point on Machining

- When rough machining titanium alloy, chipping and abnormal damage of the cutting edge easily occurs if low rigidity tools are used. Using high rigidity tools and low cutting resistance inserts are recommended. Stable machining is possible because the VFX series has a high rigidity design and the cutting resistance is lower due to the convex curve cutting edge and the V-formation of the clamping face respectively.



AIR FRAME

Application Example

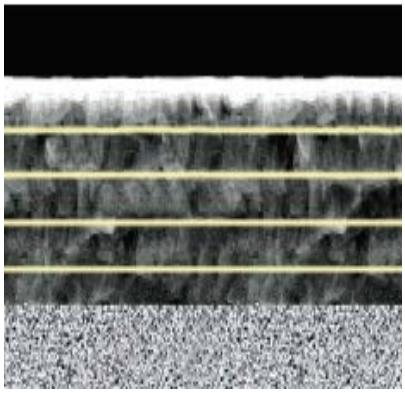
- Achieved 1.5 times longer tool life with reduced chipping of the insert.

Work Material [Titanium Alloy]

Face Milling
Side Milling

AJX

New PVD coated grade with superior fracture resistance



*Graphical representation
Multi-layering of the coating prevents any cracks penetrating through to the substrate.

Holder	AJX12R322SA32S
Insert (Grade)	JDMT120420ZDER-JL (MP9130)
Work Material	Ti-6Al-4V
Cutting Speed	vc50 m/min (n500 min^{-1})
Feed	fz0.6 mm/tooth (vf600 mm/min)
Depth of Cut	ap1 mm, ae20-32 mm
Coolant	Emulsion

Key Point on Machining

- Chipping and fracturing is a concern during high speed roughing of titanium alloy because of the variations in cutting resistance during the process. The new MP9130 grade with excellent wear resistance due to multi-layering of the coating; in combination with the JL breaker with low cutting resistance, enables a more stable high speed roughing process.

AIR FRAME

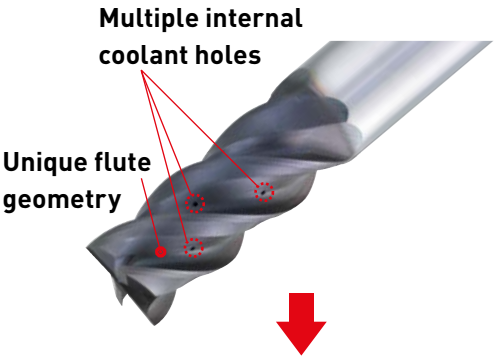
Application Example

• Eliminates chip adhesion due to the excellent cooling effect of the multiple through coolant holes.

Work Material [Titanium Alloy]

Side Milling, Pocket Milling

Coolstar



End mill	VF6MHVCHD1600 (ø 16)
Work Material	Ti-6Al-4V
Cutting Speed	vc150 m/min (n3000 min-1)
Feed	fz0.1 mm/tooth (vf1800 mm/min)
Depth of Cut	ap24 mm, ae1.6 mm (Trochoid)
Coolant	Emulsion (0.7 MPa)

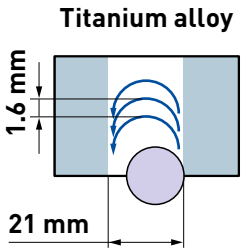
Key Point on Machining

• The low thermal conductivity of titanium alloys can lead to adhesion and concentration of heat on the cutting edge occur easily during machining. It is therefore is important to remove heat from the cutting edge and to evacuate chips smoothly. The Coolstar series offers optimum cooling effect and chip removal due to the multi coolant holes and unique flute shape. This enabled stable machining of difficult-to-cut material applications.

VF-6MHV-CH

Excellent chip removal and cooling.

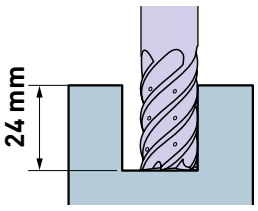
Feed rate: 1800 mm/min (0.1 mm/tooth)



Conventional (External coolant)

Adhesion

Feed rate: 1350 mm/min (0.075 mm/tooth)



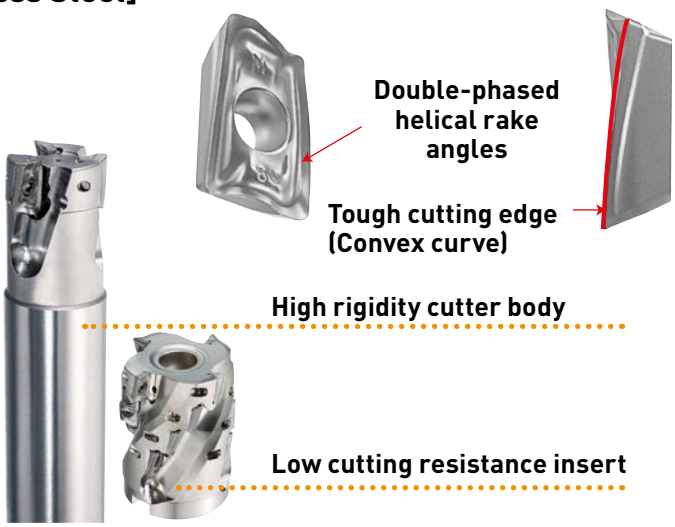
AIR FRAME

Application Example

• The newly developed MP9120 offers reliable cutting performance and achieved 250% efficiency when compared to conventional products.

Work Material [Precipitation Hardening Stainless Steel]

Rough Pocket Milling

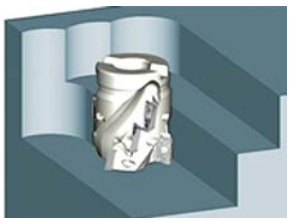


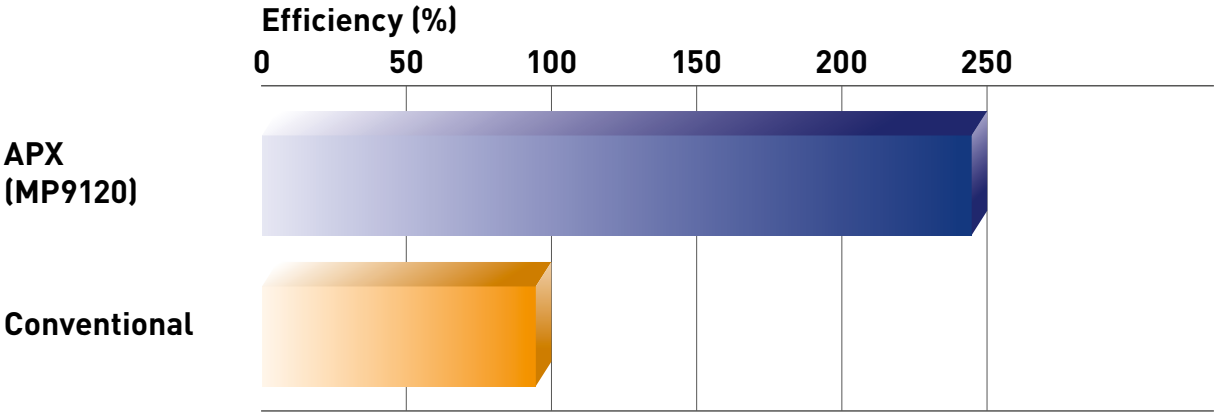
APX

Holder (Shell type)	APX4K-050A09A042RA
Insert (Grade)	AOMT184816PEER-H (MP9120)
Work Material	15-5PH
Cutting Speed	vc80 m/min (n510 min^{-1})
Feed	fz0.1 mm/tooth (vf80 mm/min)
Depth of Cut	ap35 mm, ae35 mm
Coolant	Emulsion

Key Point on Machining

• Abnormal damage such as chipping and fracturing of the cutting edge occurs easily because of the high strength of 15-5PH; a material often used for aircraft components. The APX series enables stable machining due to an excellent coating in combination with optimized tool geometry.





AIR FRAME

Application Example

- Extended use is possible because there was only a small amount of wear after machining 400 holes. (Benchmark target was 200 holes)

Work Material [Precipitation Hardening Stainless Steel]

Drilling

MMS

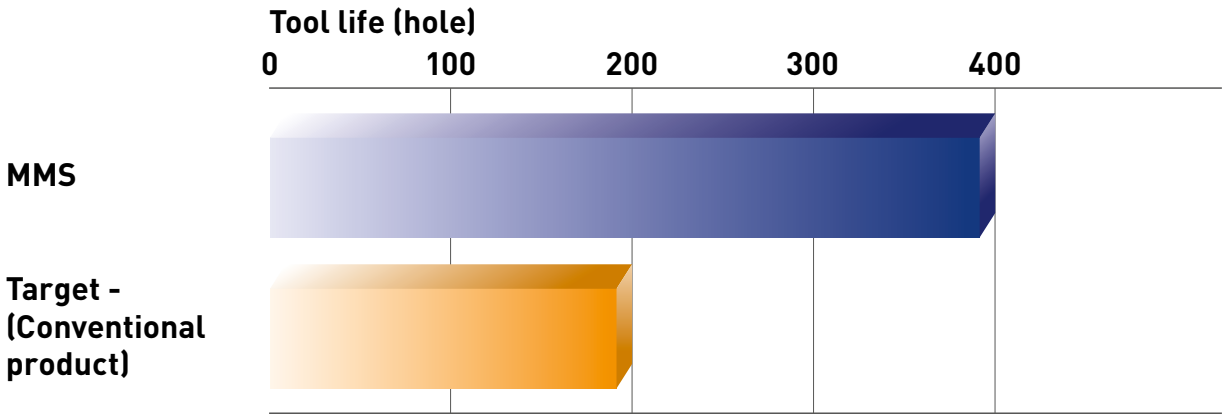
Excellent cooling performance

"**TRI-Cooling** Technology"

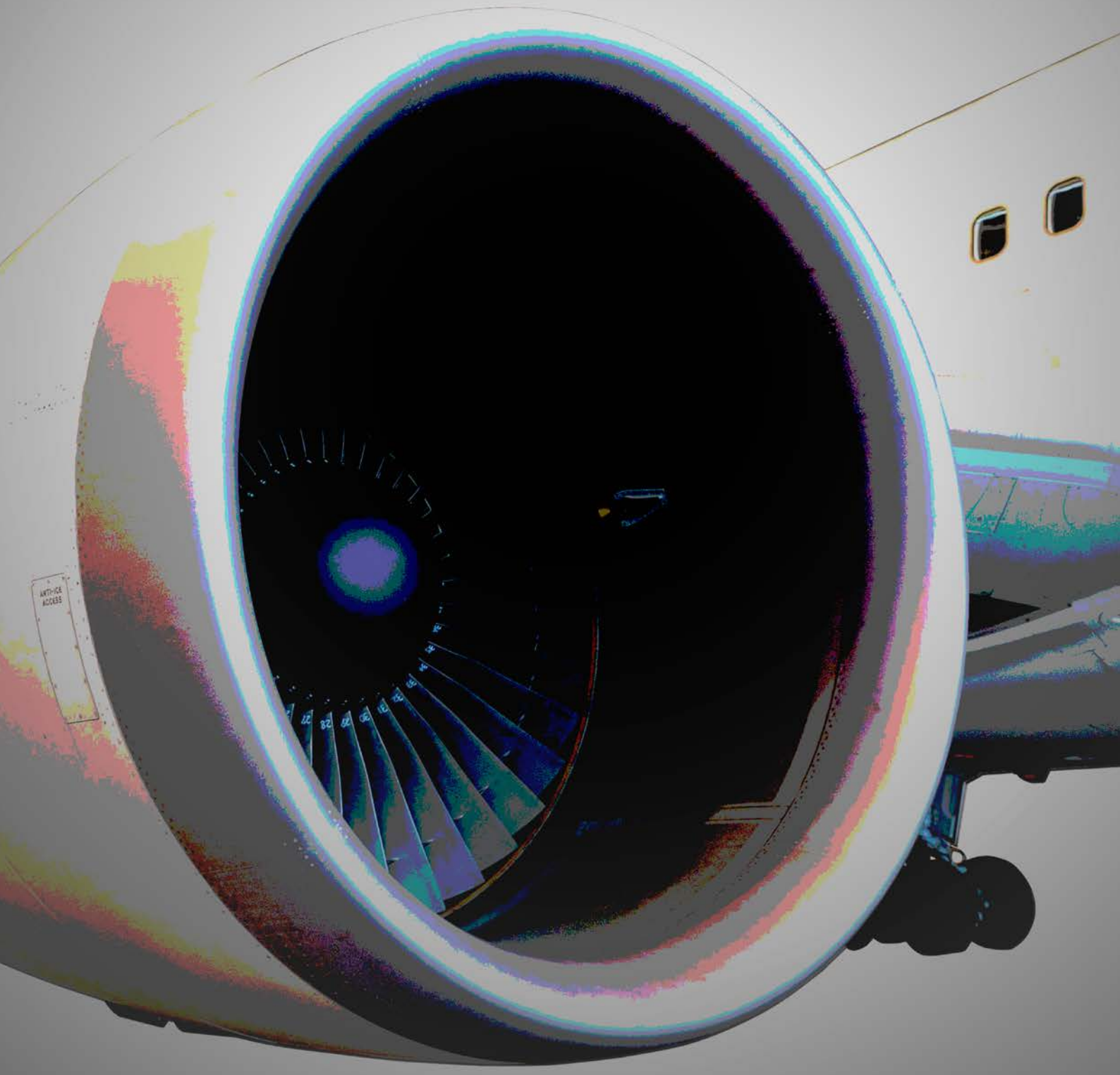
Drill (Grade)	MMS0800X3DB (DP7020)
Work Material	15-5PH (42HRC)
Cutting Speed	vc100 m/min (n3980 min^{-1})
Feed	f0.2 mm/rev
Hole Depth	24 mm
Coolant	Emulsion

Key Point on Machining

- During high performance drilling of 15-5PH precipitation hardening stainless steel, abnormal damage such as chipping and fracturing of the cutting edge occurs easily because of the high strength of the material. The MMS drill series enables stable machining due to an excellent coating in combination with an optimized tool geometry.



ENGINE



ENGINE

Application Example

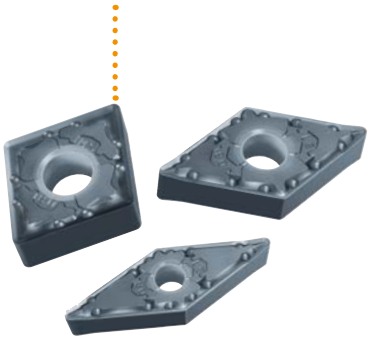
- Achieved double tool life during rough-medium cutting of heat resistant super alloys.

Work Material [Ni-based Superalloy]

External and Face and Internal Turning

HSK-T

Good cutting performance

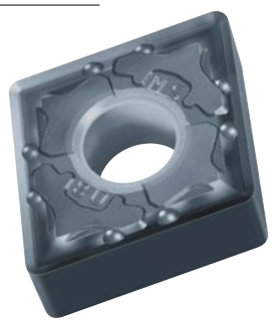


LS/MS/RS
MP9005/MP9015/MT9015

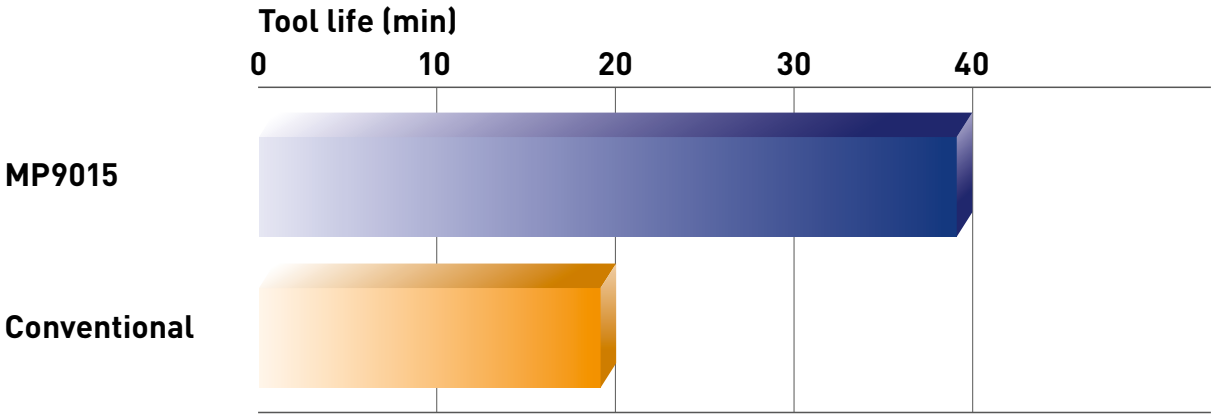
Holder	DCLNL3225P12
Insert (Grade)	CNMG120408-MS (MP9015)
Work Material	Inconel® 718
Cutting Speed	vc40 m/min
Feed	f0.2 mm/rev
Depth of Cut	ap2 mm
Coolant	Emulsion

Key Point on Machining

- Good rough and medium cutting performance on Ni-based alloy applications using MP9015.



MS



ENGINE

Application Example

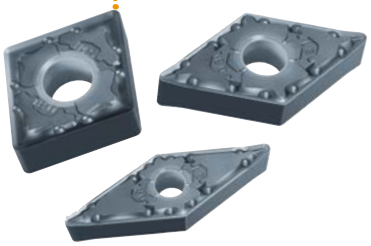
- Achieved double tool life during low speed finishing of heat resistant super alloys.

Work Material [Ni-based Superalloy]

External and Face and Internal Turning

HSK-T

Good cutting performance

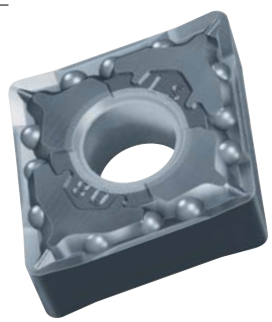


LS/MS/RS
MP9005/MP9015/MT9015

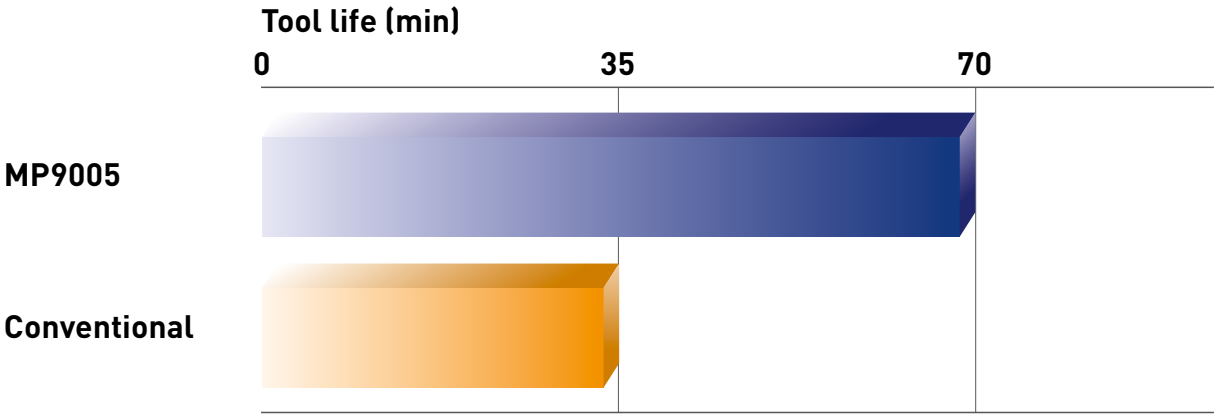
Holder	DCLNL3225P12
Insert (Grade)	CNMG120408-LS (MP9005)
Work Material	Inconel® 718
Cutting Speed	vc50 m/min
Feed	f0.15 mm/rev
Depth of Cut	ap0.5 mm
Coolant	Emulsion

Key Point on Machining

- MP9005 gave a good low speed finishing performance when machining Ni-based alloys. MP9005 is also suitable for higher speed cutting.



LS



ENGINE

Application Example

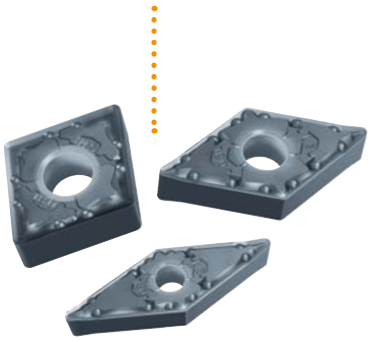
- Achieved 2.5 times longer tool life during high speed finish machining of heat resistant super alloys.

Work Material [Ni-based Superalloy]

External and Face and Internal Turning

HSK-T

Good cutting performance

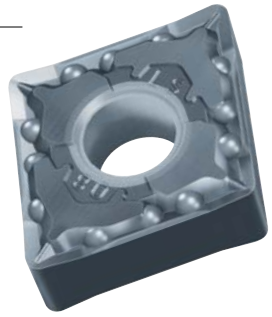


LS/MS/RS
MP9005/MP9015/MT9015

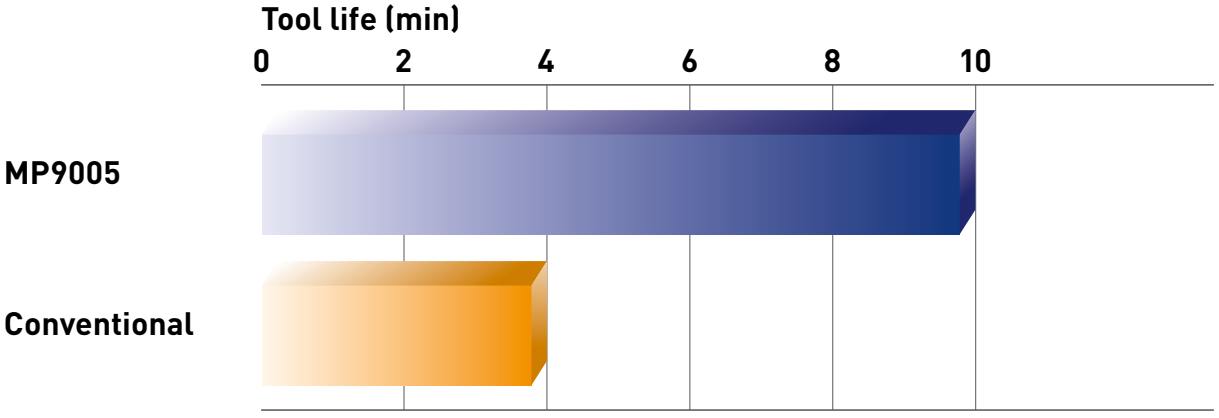
Holder	DCLNL3225P12
Insert (Grade)	CNMG120408-LS (MP9005)
Work Material	Inconel® 718
Cutting Speed	vc100 m/min
Feed	f0.15 mm/rev
Depth of Cut	ap0.25 mm
Coolant	Emulsion

Key Point on Machining

- MP9005 provides an excellent high speed finishing performance when machining Ni-based alloys. MP9005 is also suitable for low and medium speed cutting.



LS

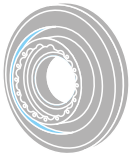


ENGINE

Application Example

- Stable machining is possible on heat resistant super alloys.

Work Materials [Ni-based Superalloy]



Copy Turning

GY

GS
(Low feeds)

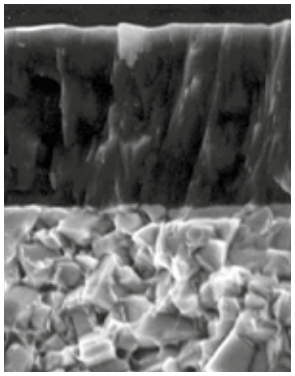
Good cutting performance

Holder	GYHL2525M00-M25L
Insert (Grade)	GY2M0600J030N-GS (VP10RT)
Work Material	Waspaloy
Cutting Speed	vc35 m/min
Feed	f0.05 mm/rev
Depth of Cut	ap10 mm
Coolant	Emulsion

Key Point on Machining

- Ni-based alloy machining requires a sharp edge geometry. An increase in tool life can be achieved by using GS breaker that is specially designed to reduce cutting resistance.

VB: 0.122 mm



VP10RT

Miracle coating

Carbide substrate
(HRA92.0)

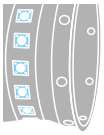
Extended tool life possible because of redcued tool wear. (after 25 min. machining)

ENGINE

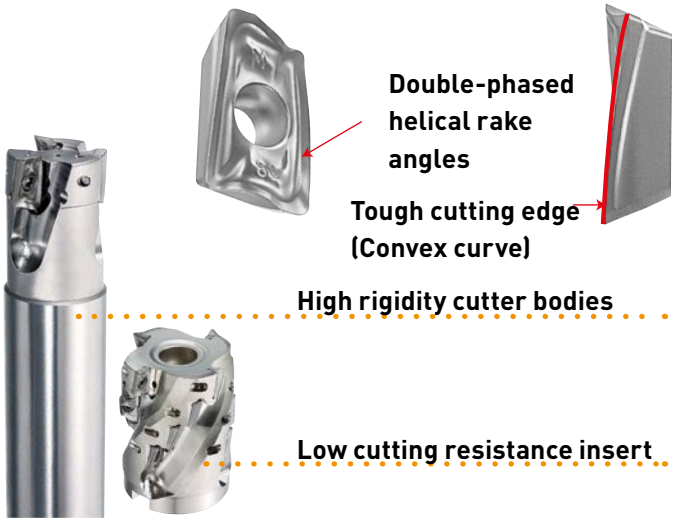
Application Example

- Achieved double tool life compared to conventional products.

Work Material [Ni-based Superalloy]



Face and Profile milling

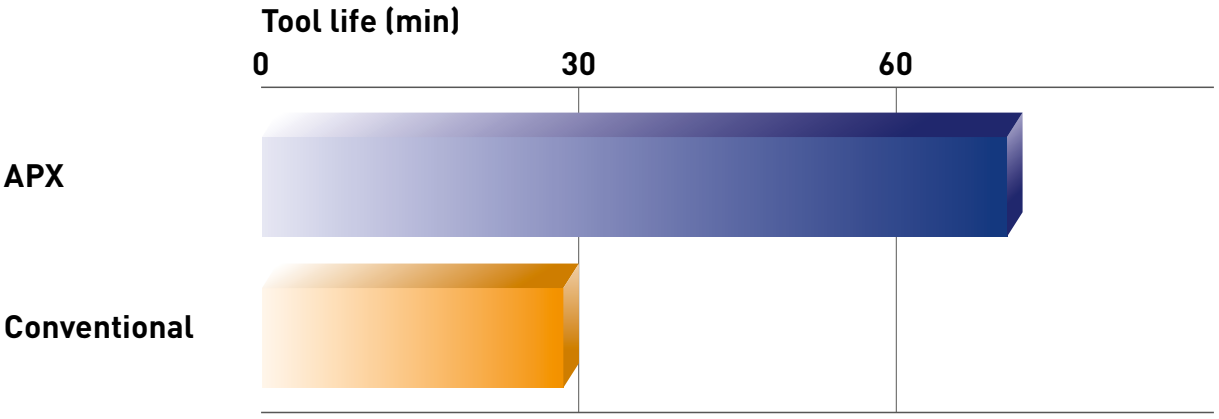


APX

Holder	APX3000-050A07RA
Insert (Grade)	AOMT123620PEER-M (MP9130)
Work Material	Inconel® 718
Cutting Speed	vc30 m/min (n190 min-1)
Feed	fz0.03 mm/tooth (vf40 mm/min)
Depth of Cut	ap1 mm, ae40 mm
Coolant	Emulsion

Key Point on Machining

- Ni-based alloys that have low thermal conductivity and are prone to work hardening require a superior coated grade combined with an optimum cutting edge to be machined effectively. APX series provides extended tool life due to an optimized cutting edge geometry and new insert grade.

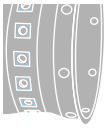


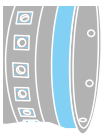
ENGINE

Application Example

- Large holes in heat resistant super alloys are machined using helical interpolation with small diameter radius end mills.

Work Material [Ni-based Superalloy]





Helical Cutting, Profile Milling

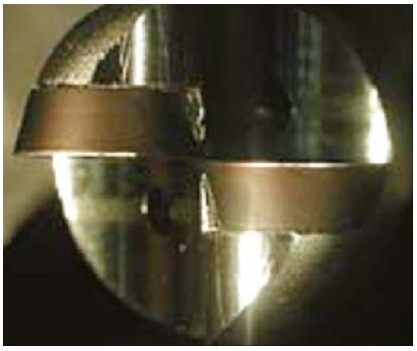
Multifunction

ARX

Holder	ARX35R142SA12S
Insert (Grade)	RDMW0724M0E (VP15TF)
Work Material	Inconel® 718
Cutting Speed	vc30 m/min
Feed	f0.2 mm/rev (Helical Cutting)
Hole Depth	20 mm (1 mm/rev), Hole dia. 25 mm
Coolant	Emulsion

Key Point on Machining

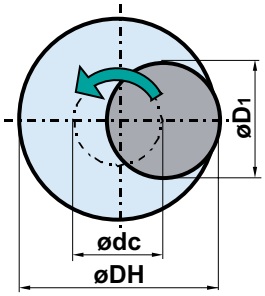
- For machining of flanges on the outer side of the engine cases, helical machining with a small diameter radius end mill is effective. ARX end mills deliver an excellent machining performance when profile machining the outer flanges.



VB: 0.08 mm

Further use is possible because of reduced tool wear. (after 7 min. machining)

• Helical Cutting



• Setting a tool's centre excursion

ødc = øDH - øD1

Tool's centre excursion	Required bore diameter	Tool's cutting diameter

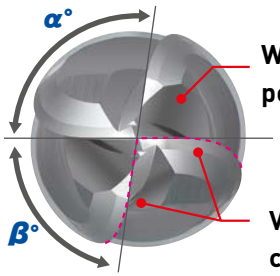
ENGINE

Application Example

- Achieved 1.5 times longer tool life and stable machining without vibration.

Work Material [Ni-based Superalloy]

Finish Profile Milling



SMART MIRACLE Coating

Variable pitch

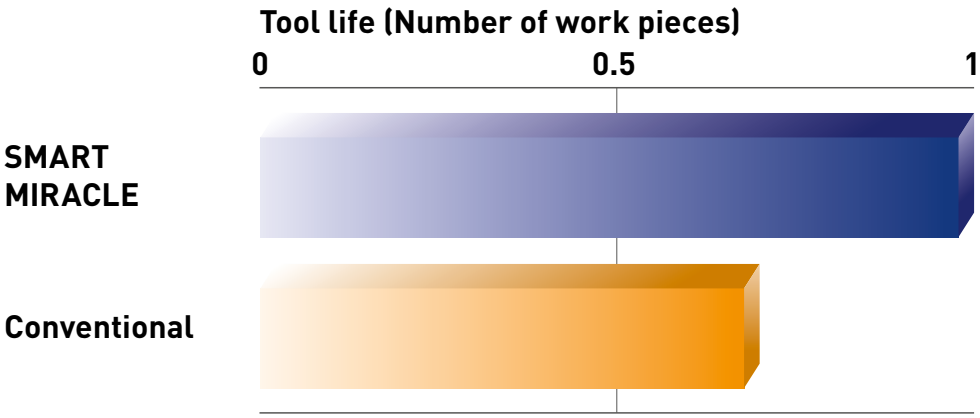
Newly designed cutting edges reduce vibration

SMART MIRACLE
Vibration Control ball nose end mill

End mill	(ø 6/R3) 4 flute Smart Miracle taper ball nose end mill
Work Material	Inconel® 718
Cutting Speed	vc113 m/min (n6000 min-1)
Feed	fz0.06 mm/tooth (vf1440 mm-min)
Depth of Cut	ap0.4 mm, ae 0.5 mm
Coolant	Emulsion

Key Point on Machining

- Ni-based alloys that have low thermal conductivity and are prone to work hardening require a superior coated grade combined with an optimum cutting edge to be machined effectively. The latest SMART MIRACLE vibration control ball nose end mills have variable pitch geometry with newly designed cutting edges to reduce vibration.

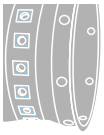


ENGINE

Application Example

- 15 times longer tool life is achieved when using high pressure internal coolant and the new TRI-cooling technology.

Work Material [Ni-based Superalloy]



Drilling

MMS

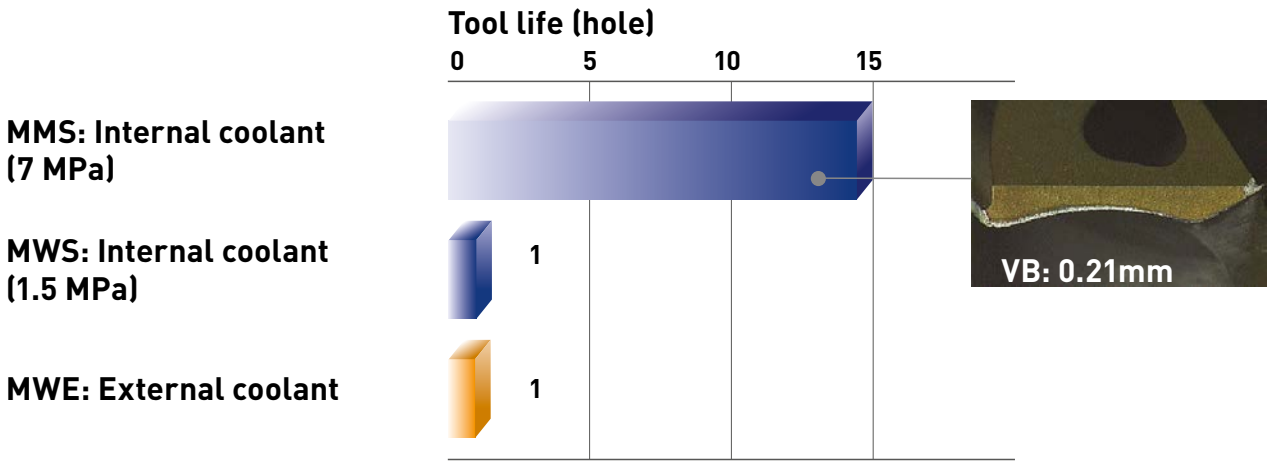
Excellent cooling effect

"TRI-Cooling Technology"

Drill (Grade)	MMS0610X3DB (DP7020)
Work Material	Inconel® 718
Cutting Speed	vc14 m/min
Feed	f0.06 mm/rev
Hole Depth	15 mm
Coolant	Emulsion

Key Point on Machining

- Cooling of the cutting edge is a key factor when drilling Ni-based alloys.
  It is possible to extend tool life greatly by using a solid carbide drill that employs TRI-Cooling through coolant hole technology with a high pressure coolant supply.

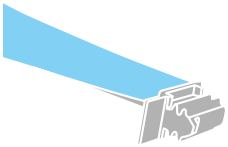


ENGINE

Application Example

- The smoothening treatment of the coating layer reduces cutting resistance and drastically improves tool life.

Work Materials [Titanium-aluminium Alloy]



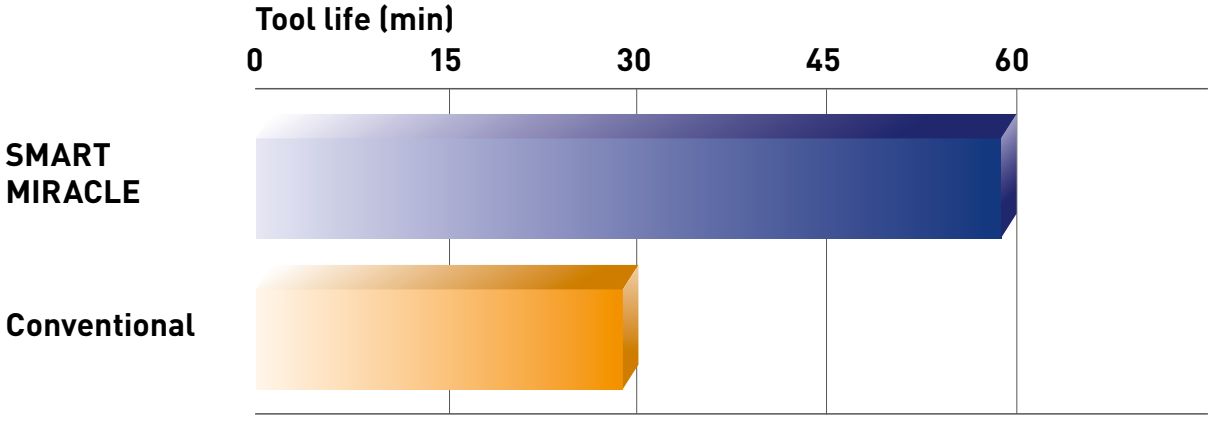
Finish Profile Milling

SMART MIRACLE

End mill	VQMHVRBD1200R100
Work Material	Titanium-aluminium alloy
Cutting Speed	vc60 m/min (n1592 min^{-1})
Feed	fz0.08 mm/tooth (vf509 mm/min)
Depth of Cut	ap 2 mm, ae 1 mm
Coolant	Emulsion

Key Point on Machining

- Titanium-aluminium alloy has low thermal conductivity and therefore tends to concentrate heat on the edge of a cutting tool during machining. Additionally peeling of the coating surface can occur easily when cutting Titanium-aluminium alloy. Therefore, it is important to remove heat from the cutting edge efficiently and to evacuate chips smoothly. The Smart Miracle end mills series with an optimum balance of sharpness and smoothness of the coating layer enables stable cutting.



ENGINE

Application Example

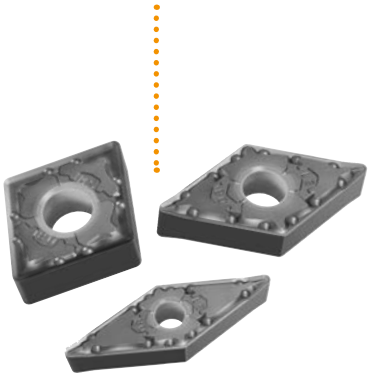
- Over 3 times tool life is achieved by utilising the appropriate cutting conditions.

Work Material [Titanium Alloy]

External, Face and Internal Turning

HSK-T

Good cutting performance

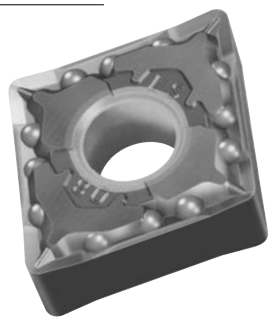


LS/MS/RS

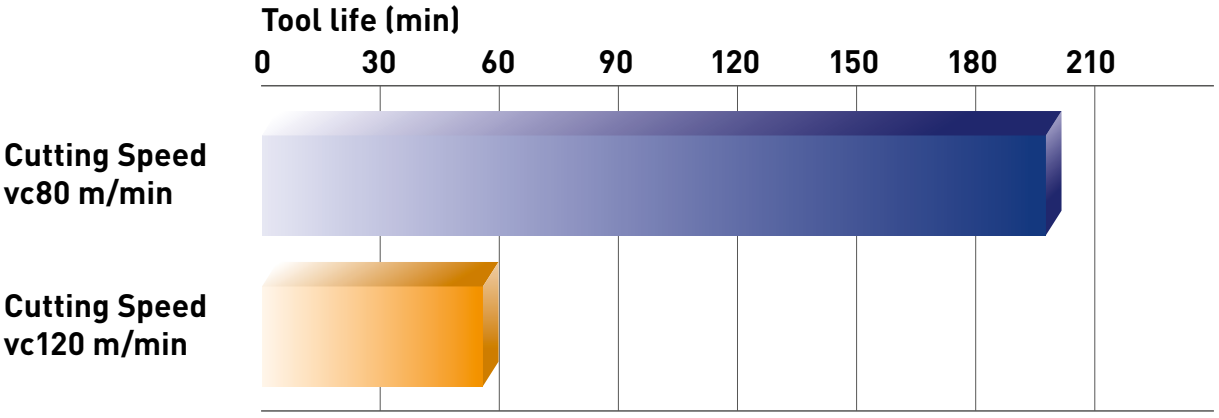
Holder	H63TH-DCLNR-DX12
Insert (Grade)	CNMG120408-LS (MT9015)
Work Material	Ti-6Al-4V
Cutting Speed	vc80, 120 m/min
Feed	f0.15 mm/rev
Depth of Cut	ap0.25 mm
Coolant	Emulsion

Key Point on Machining

- When finish machining titanium alloy, tool life is estimated at 180 minutes at 80 m/min cutting speed and 60 minutes at 120 m/min cutting speed. Non-coated grades are the first recommendation.



LS

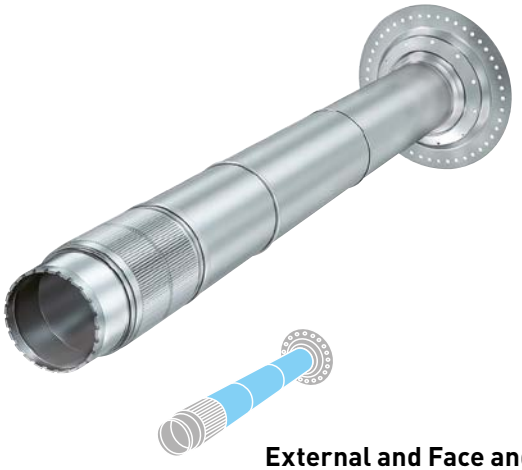


ENGINE

Application Example

- Double tool life is achieved when using VP05RT.

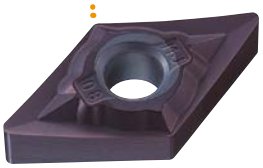
Work Material [Maraging Steel]



External and Face and Internal Turning

HSK-T

Good cutting performance

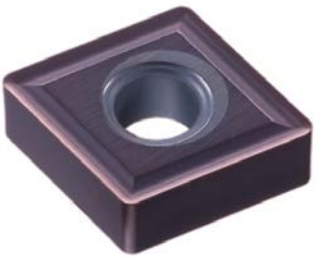


FJ/MS/GJ
VP05RT/VP10RT

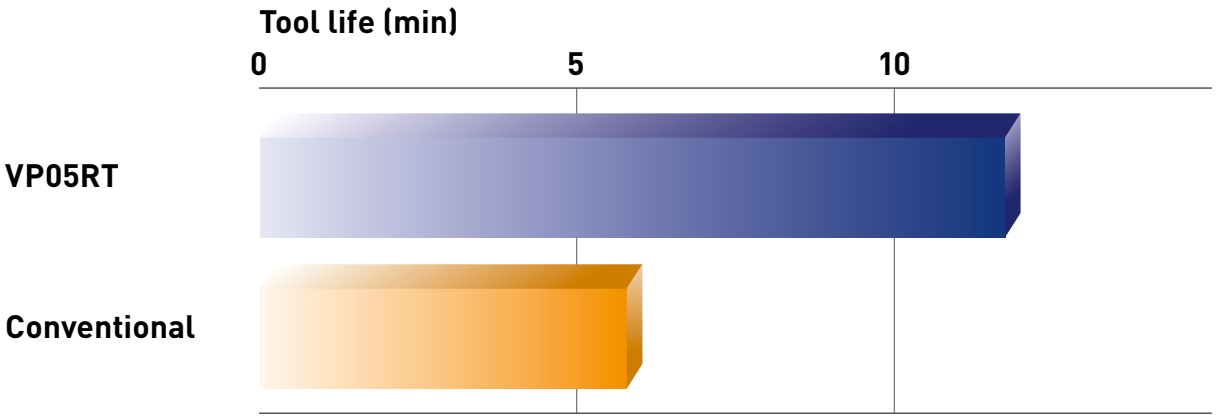
Holder	PSC63-DDJNR
Insert (Grade)	DNMG150412-MS (VP05RT)
Work Material	Maraging Steel (48-50HRC)
Cutting Speed	vc90 m/min
Feed	f0.23 mm/rev
Depth of Cut	ap2 mm
Coolant	Emulsion

Key Point on Machining

- When rough machining engine shafts made from maraging steel, the use of grades for hard materials such as CBN and VP05RT is recommended.



MS



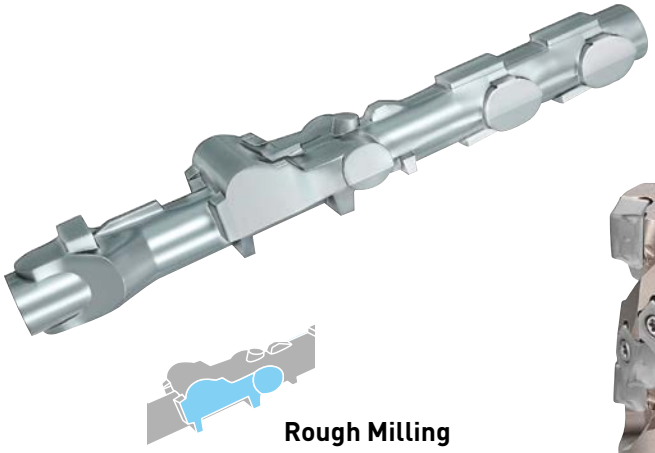
LANDING GEAR

LANDING GEAR

Application Example

- Up to 7 times tool life can be achieved when high pressure internal coolant is used.

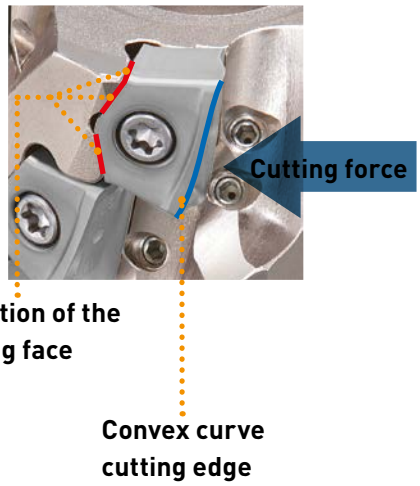
Work Material [Titanium Alloy]



Rough Milling

VFX

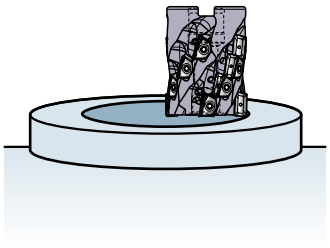
Arranging the inserts vertically

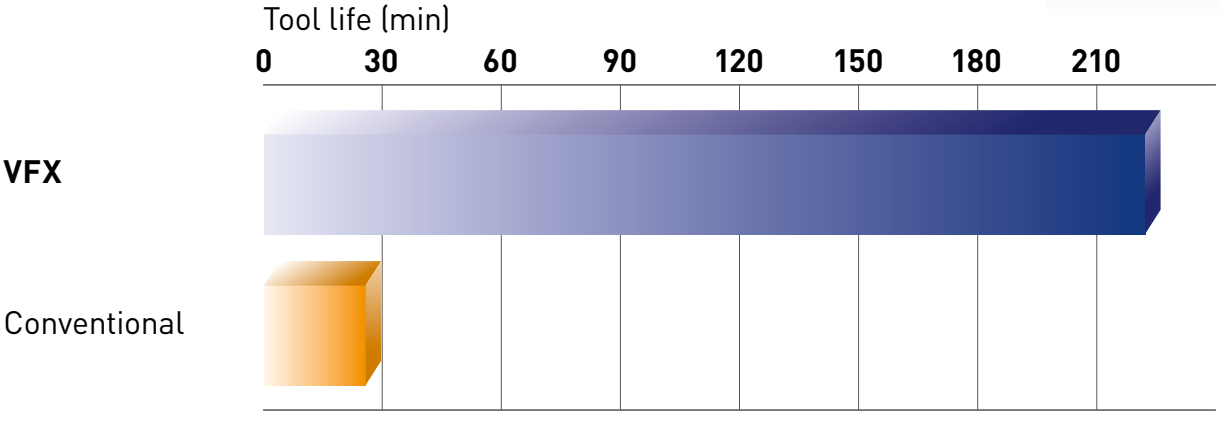


Holder	VFX6-080A05A075R
Insert (Grade)	XNMU190912R-LS (MP9130)
Work Material	Ti-5Al-5Mo-5V-3Cr
Cutting Speed	vc40 m/min (n160 min^{-1})
Feed	fz0.1 mm/tooth (vf80 mm/min)
Depth of Cut	ap65 mm, ae5 mm
Coolant	Emulsion (8 MPa)

Key Point on Machining

- When rough machining titanium alloy, chipping and abnormal damage of the cutting edge easily occurs if low rigidity tools are used. The use of high rigidity tools and low cutting resistance inserts are recommended. Stable machining is possible because the VFX series has a high rigidity design and the cutting resistance is lower due to the convex curve cutting edge and the V-formation of the clamping face respectively.



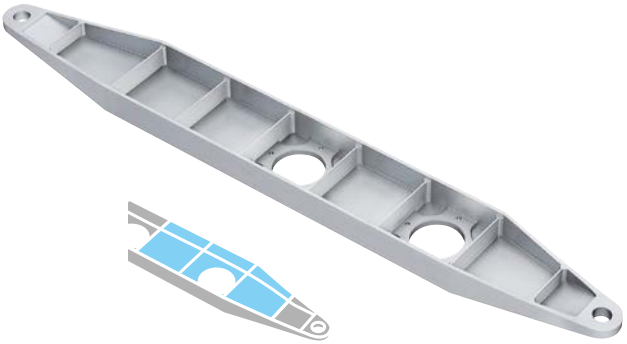


LANDING GEAR

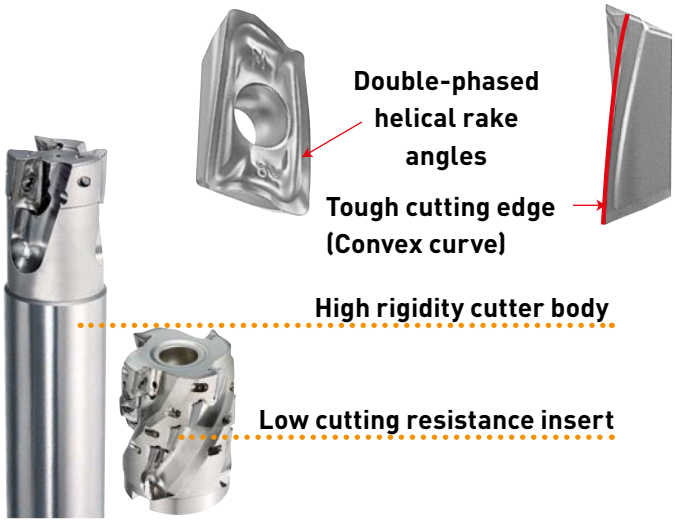
Application Example

- Long tool life is achieved even on long reach applications by combining a screw-in head with a carbide shank.

Work Material [Titanium Alloy]



Rough Pocket Milling

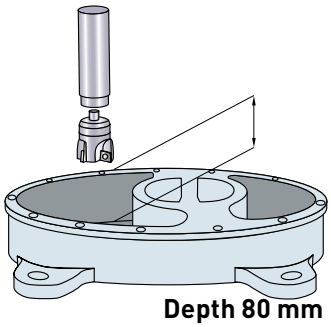


APX

Holder (Screw-in type)	APX3000R254M12A35 SC25M12S125SW
Insert (Grade)	AOMT123620PEER-M (MP9120)
Work Material	Ti-6Al-4V
Cutting Speed	vc40 m/min (n510 min^{-1})
Feed	fz0.08 mm/tooth (vf160 mm/min)
Depth of Cut	ap6 mm, ae25 mm
Coolant	Emulsion

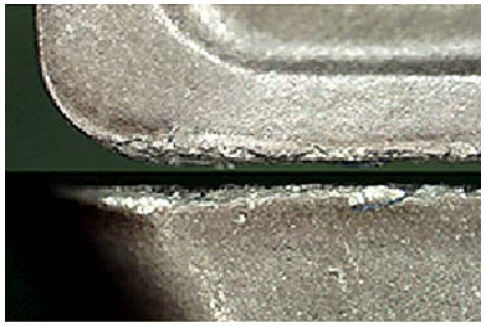
Key Point on Machining

- Abnormal damage of the cutting edge such as chipping and vibration can occur easily when rough machining titanium alloy. APX series enables stable machining due to the employment of a low cutting resistance insert with a unique convex curve cutting edge and a high rigidity cutter body with internal coolant holes.



Depth 80 mm

Edge condition (85 min.)

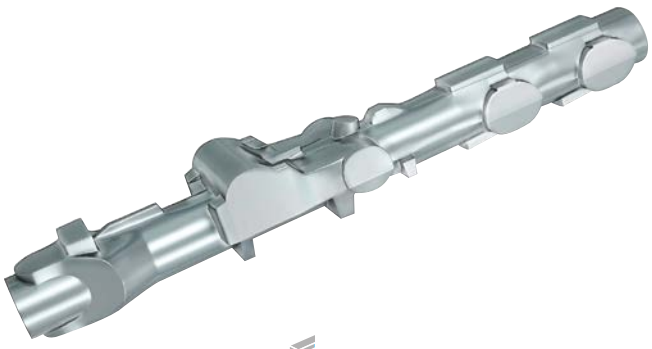


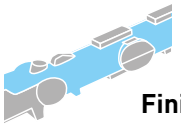
LANDING GEAR

Application Example

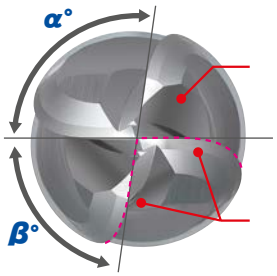
- Stable machining is achieved without vibration. Tool life is approximately 3 times longer when using the 6 flute type due to the increase in the number of flutes.

Work Material [Titanium Alloy]





Finish Profile Milling



α° ≠ β°
Variable pitch

SMART MIRACLE Coating

Variable pitch

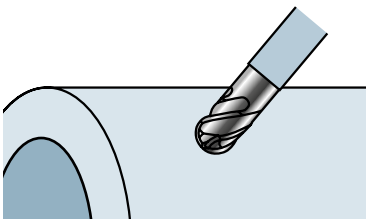
Newly designed cutting edge reduces vibration

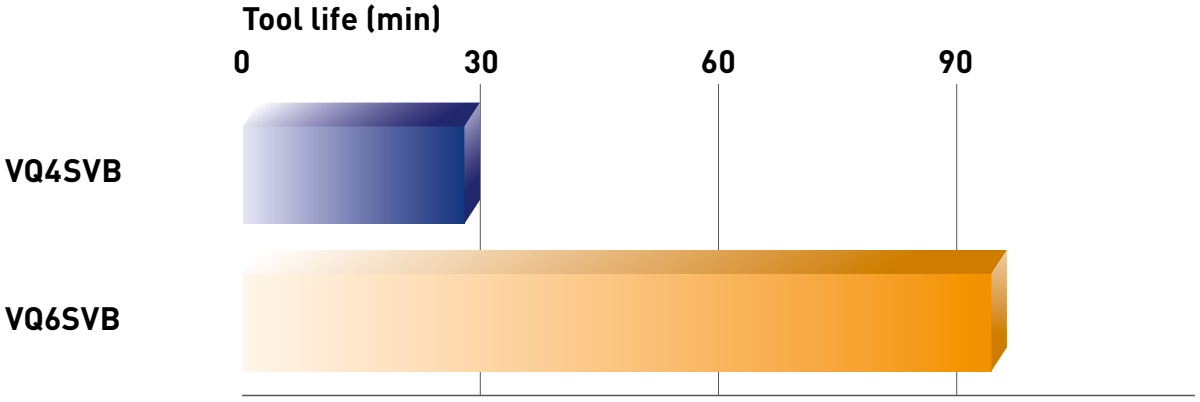
Smart Miracle
Vibration control ball nose end mill

End mill	VQ4SVBR0600
Work Material	Ti-10V-2Fe-3Al
Cutting Speed	vc200 m/min (n5300 min^{-1})
Feed	vf1590 mm/min
Depth of Cut	ap1.0 mm, ae0.5 mm
Coolant	Emulsion

Key Point on Machining

- When profile machining titanium alloy, vibrations, chipping and abnormal damage of the cutting edge can occur. Use of a tool which is designed for vibration control is effective. The latest SMART MIRACLE vibration control ball nose end mills have variable pitch geometry with a newly designed cutting edge geometry to reduce vibration.



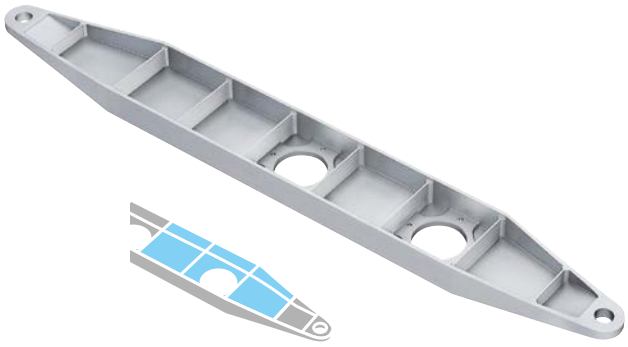


LANDING GEAR

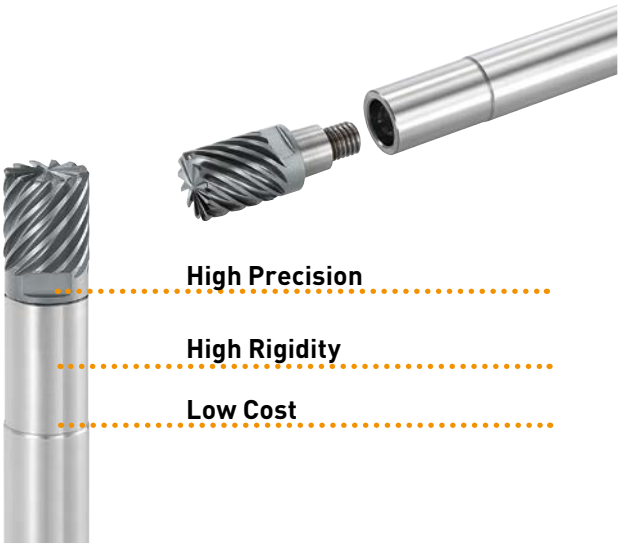
Application Example

- Up to 7 times tool life and stable machining are achieved without vibration.

Work Material [Titanium Alloy]



Finish Pocket Milling

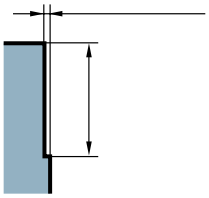


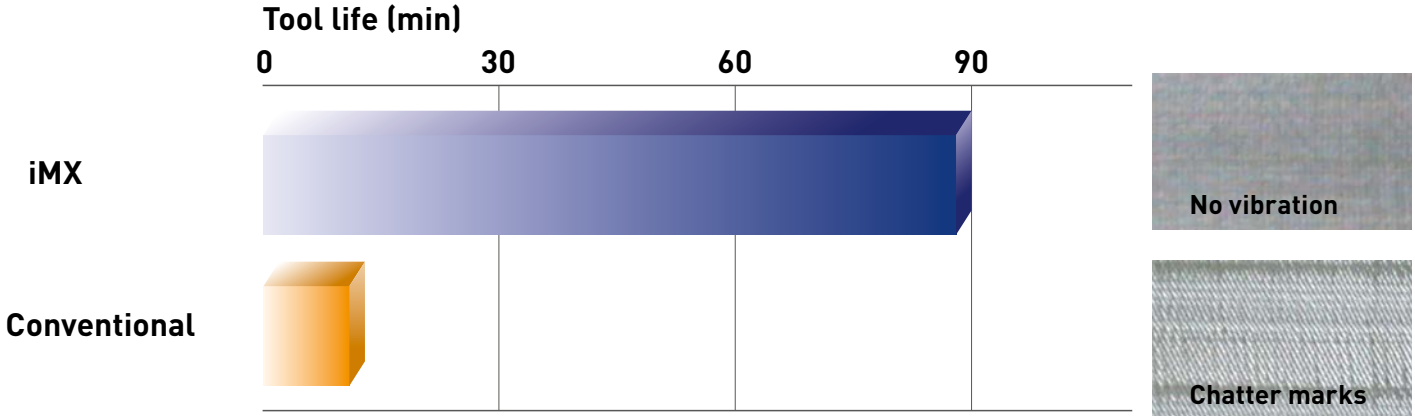
iMX
Exchangeable Head End Mills

Head (Grade)	IMX16C10HV160R10016 (EP7020)
Holder	IMX16-U16N056L110C
Work Material	Ti-6Al-4V
Cutting Speed	vc150 m/min (n3000 min^{-1})
Feed	fz0.05 mm/tooth (vf1500 mm/min)
Depth of Cut	ap12 mm, ae0.5 mm
Coolant	Emulsion

Key Point on Machining

- When profile machining titanium alloy, vibrations, chipping and abnormal damage of the cutting edge can occur. Use of a tool which is designed for vibration control is effective. Exchangeable head end mills with variable pitch geometry prevents vibration and improves chip discharge performance.



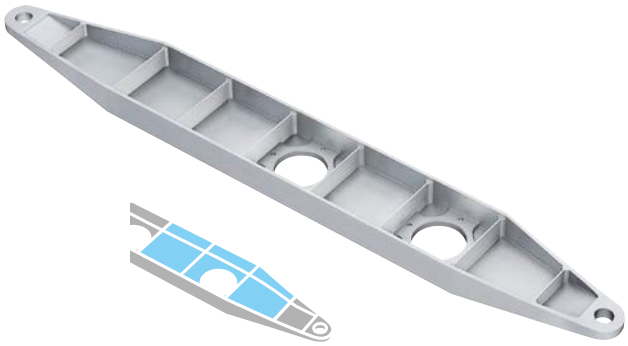


LANDING GEAR

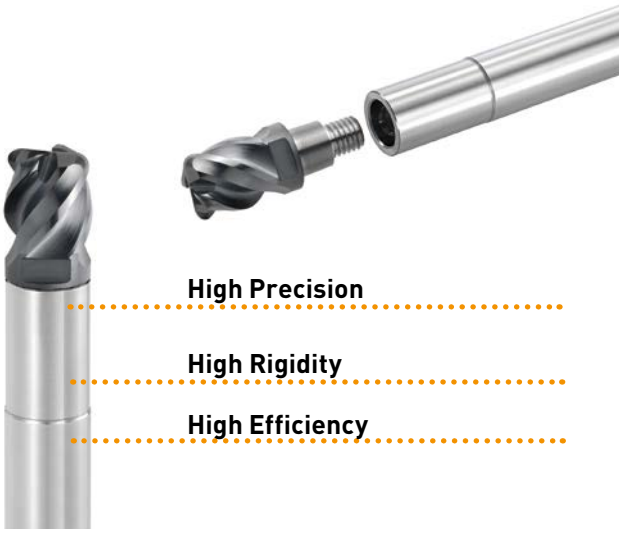
Application Example

- Achieved double tool life and stable machining without vibration.

Work Material [Titanium Alloy]



Finish Pocket Milling

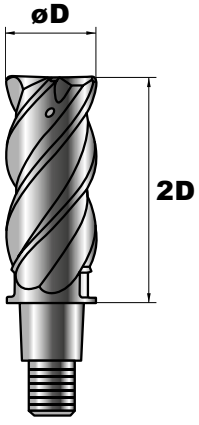


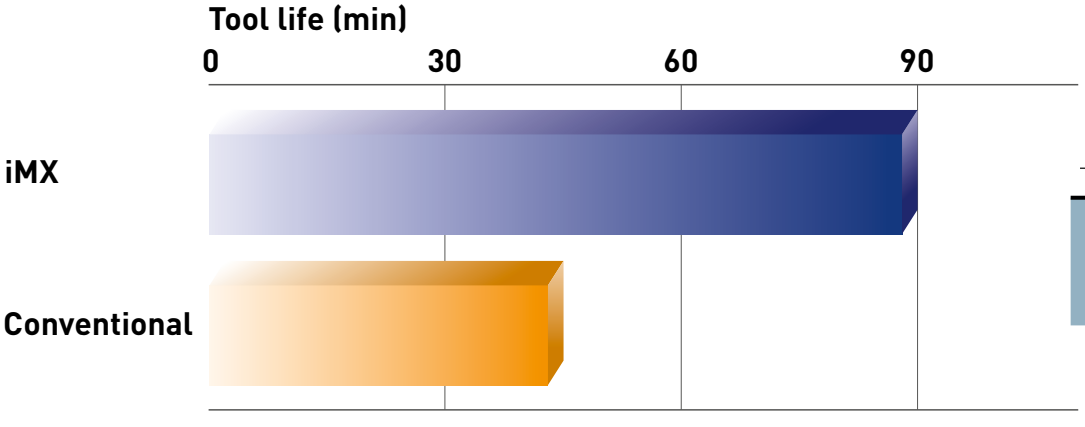
iMX
Exchangeable Head End Mills

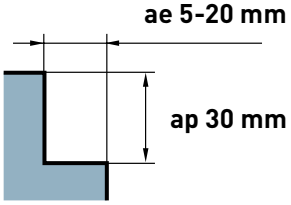
Head (Grade)	IMX20C4HV200R10040 (EP7020) Length of cutting edge 2D/ Non-stocked item
Holder	IMX20-U20N070L130C
Overhang length	125 mm
Work Material	Ti-5Al-5Mo-5V-3Cr
Cutting Speed	vc38 m/min (n600 min^{-1})
Feed	fz0.04 mm/tooth (vf60 mm/min)
Depth of Cut	ap30 mm, ae5-20 mm
Coolant	Emulsion

Key Point on Machining

- When finish machining titanium alloy, chipping and abnormal damage of the cutting edge can occur and vibration is easily generated. Use of a tool which is designed for vibration control is effective. The iMX exchangeable head end mill series with variable pitch geometry prevents vibration and improves chip discharge performance. This achieves a stability when machining applications that require a long tool overhang.





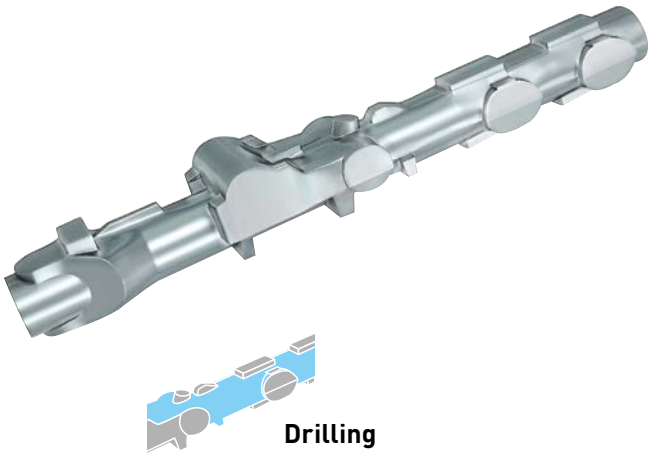


LANDING GEAR

Application Example

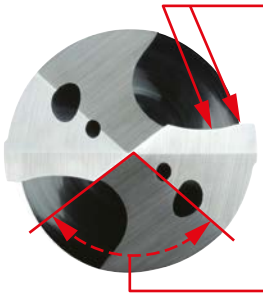
- Achieves stable machining due to excellent cooling and chip discharge.

Work Material [Titanium Alloy]



Drilling

MNS



Outstanding sharpness and high edge strength

Excellent cooling performance

Improved chip removal

Drill (Grade)	MNS0600X20DB (TF15)
Work Material	Ti-6Al-4V
Cutting Speed	vc30 m/min
Feed	f0.06 mm/rev
Hole Depth	120 mm
Coolant	Emulsion (3 MPa)

Key Point on Machining

- Adhesion and concentration of heat on the cutting edge occur easily during drilling of titanium alloys because of the low thermal conductivity, thus it is important to remove heat from the cutting edge efficiently and to evacuate chips smoothly. MNS drills provide stable drilling with excellent cooling and chip discharge performance due to the unique arrangement of coolant holes and the employment of optimum flute shape respectively.

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