2018.04

VFX

VFX FOR HIGH EFFICIENCY ROUGH MACHINING OF TITANIUM ALLOYS

MIRACLE SIGMA

DIAEDGE

MITSUBISHI MATERIALS

VFX5/6 SERIES

UNPARALLELED CHIP EJECTION PROPERTIES HELP RE-DEFINE THE PARAMETERS FOR MACHINING TITANIUM ALLOYS

HIGH RIGIDITY DESIGN

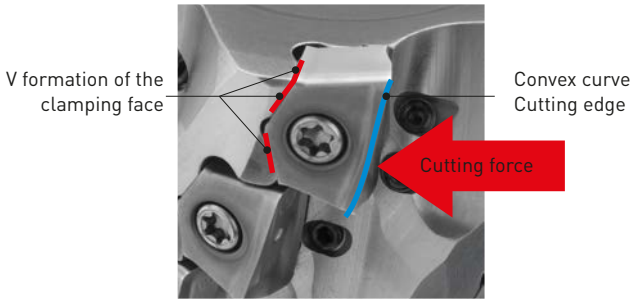
Arranging the inserts vertically absorbs the principal cutting force through the thickness of the insert and achieves extremely high rigidity.

HIGHLY RELIABLE CLAMPING MECHANISM

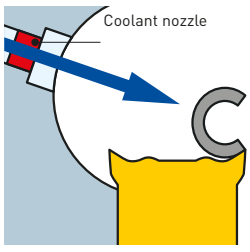
The insert seat has a curved seating face in the radial direction of the tool and a V-shaped seating face on the axis of rotation that can securely handle cutting forces from any direction.

LOW RESISTANCE CONVEX CURVE CUTTING EDGE

The curved cutting edge resembles the geometry of a solid end mill and achieves low cutting resistance that enables high quality machining.



IMPROVED CHIP REMOVAL WITH COOLANT



Coolant disoharge position

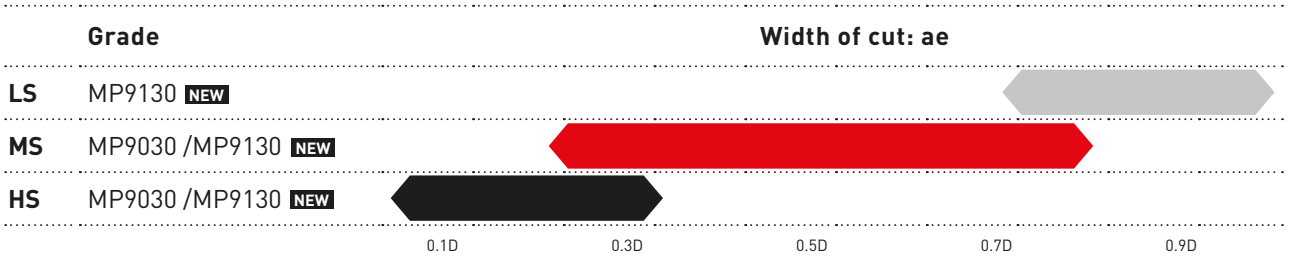
The internal coolant is directed slightly above the rake face of the cutting edge so that it is aimed directly at the chip. Forcibly ejecting the chips prevents them from welding to the cutting edge, enabling higher efficiency machining.

CHANGEABLE COOLANT NOZZLE

A replaceable nozzle is used for the internal coolant (hole diameter of the standard nozzle supplied: Ø 0.8). The coolant pressure can be adjusted by using a nozzle with a smaller or larger diameter. Nozzles with different diameters are available as options.

INSERTS

LS	MS	HS
		
Produces compact chips without increases in cutting resistance. Excellent performance at large widths of cut and during slotting.	Covers a wide range of cutting conditions and applications.	Excellent chip separation and strong cutting edge. Highly efficient machining is possible at small widths of cut.



GENERAL PURPOSE GRADE
MP9030

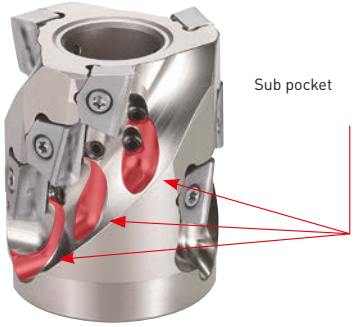
MP9030 uses an accumulated type coating based on a Ti compound that demonstrates excellent abrasion and fracture resistance during titanium alloy machining. The cemented carbide substrate also has properties balanced for wear and fracture resistance for superior performance when machining difficult-to-cut materials.

NEW ADVANCED GRADE
MP9130 NEW

A new and enhanced super fine cemented carbide substrate has increased toughness whilst maintaining hardness.
The Al-Ti-Cr-N accumulated type coating ensures optimum heat and wear resistance. The combination of these properties gives excellent fracture resistance and a very low coefficient of friction for class leading welding resistance when machining titanium alloys.

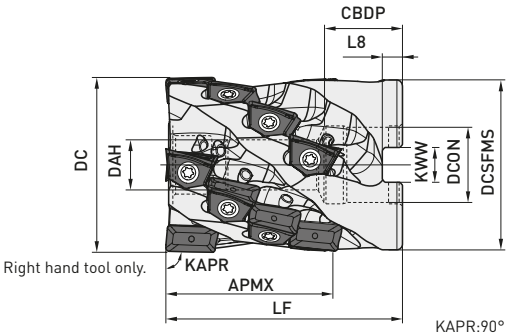
NEWLY DEVELOPED VFX5 3-FLUTE HOLDER

During high chip volume applications such as slotting, chip evacuation performance is important and if insufficient can lead to chipping of the insert. To solve this problem a 3 flute cutter with maximised main flutes and chip pockets has been developed. Use of the new LS breaker in conjunction with the 3 flute cutter will maximise the performance benefits.



VFX5

S



KAPR:90°

SHELL TYPE

Order Number	R	ZEFP	Teeth	DC	LF	DCON	CBDP	DAH	DCSFMS	KWW	L8	APMX	WT* (kg)
VFX5-040A03A026R	●	3	6	40	50	16	21	8.5	38.2	8.4	5.6	26	0.3
VFX5-040A03A038R	●	3	9	40	60	16	21	8.5	38.2	8.4	5.6	38	0.4
VFX5-050X03A026R	●	3	6	50	50	27	23	12.5	48.2	12.4	7.0	26	0.4
VFX5-050X03A038R	●	3	9	50	60	27	23	12.5	48.2	12.4	7.0	38	0.5
VFX5-050A04A026R	●	4	8	50	50	22	21	10.5	48.2	10.4	6.3	26	0.5
VFX5-050A04A038R	●	4	12	50	60	22	21	10.5	48.2	10.4	6.3	38	0.6
VFX5-050X04A038R	●	4	12	50	60	27	23	12.5	48.2	12.4	7.0	38	0.5
VFX5-050A04A050R	●	4	16	50	70	22	21	10.5	48.2	10.4	6.3	50	0.7
VFX5-063A05A026R	●	5	10	63	60	27	28	12.5	61	12.4	7.0	26	1.0
VFX5-063A05A063R	●	5	25	63	85	27	28	12.5	61	12.4	7.0	63	1.4
VFX5-080A06A075R	●	6	36	80	100	32	28	16.5	77.3	14.4	8.0	75	2.8

* WT : Tool Weight

Vc ➤P6

SPARE PARTS

Order Number	Clamp Screw	Qty. *2	Seal Washer	Wrench	Coolant Nozzle *3	Amount	Anti-seize Lubricant	Set Bolt	Number of Insert: End Cutting Edge XNMU1607 ○○R-○○	Number of Insert: Peripheral Cutting Edge *1 XNMU1607 08R-○○
VFX5-040A03A026R	TS352	6	W8-S1	TKY10D	HSD04004H08	9	MK1KS	HSC08040	3	3
VFX5-040A03A038R	TS352	9	W8-S1	TKY10D	HSD04004H08	12	MK1KS	HSC08050	3	6
VFX5-050X03A026R	TS352	6	W12-S1	TKY10D	HSD04004H08	9	MK1KS	HSC12035	3	3
VFX5-050X03A038R	TS352	9	W12-S1	TKY10D	HSD04004H08	12	MK1KS	HSC12045	3	6
VFX5-050A04A026R	TS352	8	W10-S1	TKY10D	HSD04004H08	12	MK1KS	HSC10035	4	4
VFX5-050A04A038R	TS352	12	W10-S1	TKY10D	HSD04004H08	16	MK1KS	HSC10045	4	8
VFX5-050X04A038R	TS352	12	W12-S1	TKY10D	HSD04004H08	16	MK1KS	HSC12045	4	8
VFX5-050A04A050R	TS352	16	W10-S1	TKY10D	HSD04004H08	20	MK1KS	HSC10055	4	12
VFX5-063A05A026R	TS352	10	W12-S1	TKY10D	HSD04004H08	15	MK1KS	HSC12045	5	5
VFX5-063A05A063R	TS352	25	W12-S1	TKY10D	HSD04004H08	30	MK1KS	HSC12070	5	20
VFX5-080A06A075R	TS352	36	W16-S1	TKY10D	HSD04004H08	42	MK1KS	HSC16080	6	30

*1 Only corner radius R0.8 can be used for the peripheral cutting edges.
*2 Clamp Torque (Nm) : TS352=2.5
*3 Coolant nozzles are available with varying diameters for adjusting coolant pressure. Select nozzles as required by the specification.

	<1Mpa (<20 l/min.)	←Standard→	>5Mpa (>30 l/min.)	>7Mpa (>50 l/min.)
Nozzle Dia.	Ø0.6mm	Ø0.8mm	Ø1.2mm	Ø1.6mm
Order Number	HSD04004H06	HSD04004H08	HSD04004H12	HSD04004H16

* Clamp Torque (N • m) : HSD04004H○○=1.5

1. The part number for a blank screw without a through nozzle is HSS04004.
2. Note for insert with a corner radius of 3.2 and above, as corner radius increases the LF dimension increases.
   Corner radius: 3.2: LF+0.7mm Corner radius: 4.0: LF+1.5mm

● : Inventory maintained. ★ : Inventory maintained in Japan.

INSERTS

Order Number	MP9030	MP9130 NEW	L	LE	W1	INSL	S	BS	RE	Geometry
MS										
XNMU160708R-MS	●	●	16.0	14.0	7.0	11.1	6.5	1.0	0.8	
XNMU160712R-MS	●	●	16.0	14.0	7.0	11.1	6.5	1.0	1.2	
XNMU160716R-MS	●	●	16.0	14.0	7.0	11.1	6.5	1.0	1.6	
XNMU160724R-MS	●	●	16.0	14.0	7.0	11.1	6.5	1.0	2.4	
*XNMU160732R-MS	●	●	17.3	14.7	7.0	11.1	6.5	–	3.2	
*XNMU160740R-MS	●	●	18.9	15.5	7.0	11.1	6.5	–	4.0	
										General purpose
HS										
XNMU160708R-HS	●	●	16.0	14.0	7.0	11.1	6.5	1.0	0.8	
										Cutting edge enhancement type
LS										
XNMU160708R-LS		●	16.0	14.0	7.0	11.1	6.5	1.0	0.8	
										Chip processing type

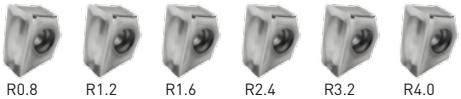
* Note for insert with a corner radius of 3.2 and above, as corner radius increases the LF dimension increases.
Corner radius: 3.2: LF+0.7mm Corner radius: 4.0: LF+1.5mm

COMBINATION OF CUTTER AND INSERT CORNER RADIUS

VFX5

Diameter Ø40-Ø80
Flutes 3,4,5,6
Depth of cut 26-75 mm

Breaker: MS

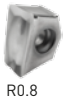


R0.8 R1.2 R1.6 R2.4 R3.2 R4.0

Breaker: HS

R0.8

Breaker: LS



R0.8

VFX6

Diameter Ø63-Ø100
Flutes 4,5,6
Depth of cut 31-90mm

Breaker: MS

R1.2 R1.6 R2.4 R3.2 R4.0 R5.0

Breaker: HS

R1.2

Breaker: LS

R1.2

* Only the insert radius at the bottom insert can be changed. On the peripheral inserts please use R1.2 for VfX6 and R0.8 for VfX5 for perfect overlapping.

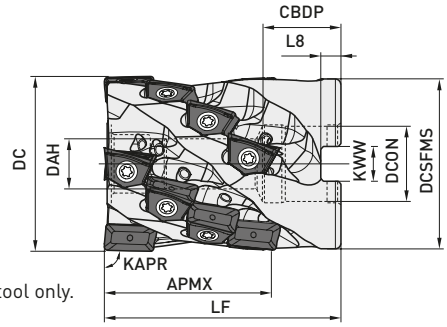
RECOMMENDED CUTTING CONDITIONS

	Work Material	DC (mm)	ZEFP	Recommended Insert	Vc (m/min)	n (min^{-1})	APMX (mm)	ae (mm)	fz (mm/t.)	Vf (mm/min)	Q (cm3/min)	Pc (kW)	Expected Torque (Nm)	TL (%)
S	Titanium Alloy (Ti-Al-4V)	Ø 40	3	LS	40	318	38	40	0.10	95	145	6.5	194	40
			3	MS	50	398	38	24	0.10	119	109	4.5	109	60
			3	MS	60	477	38	16	0.10	143	87	3.5	69	80
			3	HS	60	477	38	8	0.12	172	52	2.3	45	100
		Ø 50	3	LS	40	255	38	50	0.10	76	145	6.5	242	40
			4	MS	50	318	50	30	0.10	127	191	7.9	237	60
			4	MS	60	382	50	20	0.10	153	153	6.0	151	80
			4	HS	60	382	50	10	0.12	183	92	3.9	98	100
		Ø 63	5	LS	40	202	60	63	0.10	101	382	16.8	793	40
			5	MS	50	253	60	38	0.10	126	286	11.8	447	60
			5	MS	60	303	60	25	0.10	152	229	9.0	285	80
			5	HS	60	303	60	13	0.12	182	138	5.9	185	100
		Ø 80	6	LS	40	159	75	80	0.10	95	573	25.0	1500	40
			6	MS	50	199	75	48	0.10	119	430	17.6	846	60
			6	MS	60	239	75	32	0.10	143	344	13.5	539	80
			6	HS	60	239	75	16	0.12	172	206	8.7	350	100
	Titanium Alloy (Ti-5Al-5V-5Mo-3Cr)	Ø 40	3	LS	25	199	38	40	0.08	48	73	3.4	161	30
			3	MS	25	199	38	24	0.08	48	44	1.9	92	50
			3	MS	30	239	38	16	0.10	72	44	1.8	74	70
			3	HS	30	239	38	8	0.10	72	22	1.0	41	90
		Ø 50	4	LS	25	159	50	50	0.08	51	127	5.8	350	30
			4	MS	25	159	50	30	0.08	51	76	3.4	201	50
			4	MS	30	191	50	20	0.10	76	76	3.2	160	70
			4	HS	30	191	50	10	0.10	76	38	1.8	89	90
		Ø 63	5	LS	25	126	60	63	0.08	51	191	8.7	658	30
			5	MS	25	126	60	38	0.08	51	115	5.0	378	50
			5	MS	30	152	60	25	0.10	76	115	4.8	301	70
			5	HS	30	152	60	13	0.10	76	57	2.6	167	90
		Ø 80	6	LS	25	99	75	80	0.08	48	286	13.0	1246	30
			6	MS	25	99	75	48	0.08	48	172	7.5	716	50
			6	MS	30	119	75	32	0.10	72	172	7.1	570	70
			6	HS	30	119	75	16	0.10	72	86	3.9	316	90

1. Please note that machining performance varies depending to the conditions such as machine rigidity, work clamping rigidity, coolant supply system, pressure and flow volume etc.
2. Internal coolant is recommended. Please use an FMH type arbor for through coolant. Using external coolant in combination with through coolant is even more effective.

VFX6

S



Right hand tool only.

SHELL TYPE

KAPR:90°

Order Number	R	ZEFP	Teeth	DC	LF	DCON	CBDP	DAH	DCSFMS	KWW	L8	APMX	WT* (kg)
VFX6-063A04A031R	●	4	8	63	60	27	28	12.5	61	12.4	7	31	0.9
VFX6-063A04A060R	●	4	16	63	85	27	28	12.5	61	12.4	7	60	1.3
VFX6-080A05A031R	●	5	10	80	60	32	28	16.5	77.3	14.4	8	31	1.5
VFX6-080A05A075R	●	5	25	80	100	32	28	16.5	77.3	14.4	8	75	2.6
VFX6-100A06A031R	●	6	12	100	65	40	30	20.5	96.6	16.4	9	31	2.7
VFX6-100A06A090R	●	6	36	100	115	40	30	20.5	96.6	16.4	9	90	4.8

* WT:ToolWeight

Vc ➤P9

SPARE PARTS

Order Number	*2				*3				Number of Insert	
									End Cutting Edge	Peripheral Cutting Edge *1
	Clamp Screw	Amount	Seal Washer	Wrench	Coolant Nozzle	Amount	Anti-seize Lubricant	Set Bolt	XNMU1909 ooR-oo	XNMU1909 12R-oo
VfX6-063A04A031R	TS450	8	W12-S1	TKY20T	HSD04004H08	12	MK1KS	HSC12045	4	4
VfX6-063A04A060R	TS450	16	W12-S1	TKY20T	HSD04004H08	20	MK1KS	HSC12070	4	12
VfX6-080A05A031R	TS450	10	W16-S1	TKY20T	HSD04004H08	15	MK1KS	HSC16040	5	5
VfX6-080A05A075R	TS450	25	W16-S1	TKY20T	HSD04004H08	30	MK1KS	HSC16080	5	20
VfX6-100A06A031R	TS450	12	W20-S1	TKY20T	HSD04004H08	18	MK1KS	HSC20040	6	6
VfX6-100A06A090R	TS450	36	W20-S1	TKY20T	HSD04004H08	42	MK1KS	HSC20090	6	30

*1 Only corner radius R1.2 can be used for the peripheral cutting edges.
*2 Clamp Torque (Nm) : TS450=5.0
*3 Coolant nozzles are available with varying diameters for adjusting coolant pressure. Select nozzles as required by the specification.

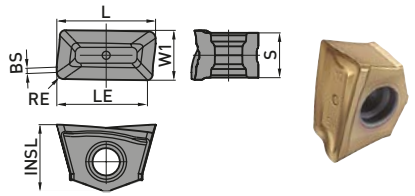
	<1Mpa (<20 l/min.)	←Standard→	>5Mpa (>30 l/min.)	>7Mpa (>50 l/min.)
Nozzle Dia.	Ø0.6mm	Ø0.8mm	Ø1.2mm	Ø1.6mm
Order Number	HSD04004H06	HSD04004H08	HSD04004H12	HSD04004H16

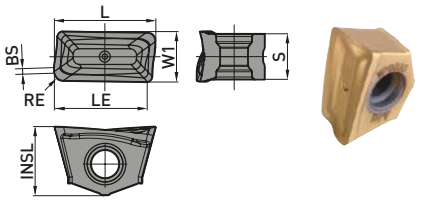
* Clamp Torque (N • m) : HSD04004H○○=1.5

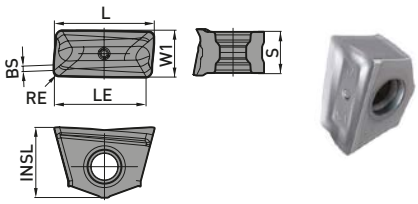
1. The part number for a blank screw without a through nozzle is HSS04004.
2. Note for insert with a corner radius of 3.2 and above, as corner radius increases the LF dimension increases.
   Corner radius: 3.2: LF+0.7mm Corner radius: 4.0: LF+1.5mm Corner radius: 5.0: LF+1.5mm

INSERTS

Order Number	MP9030	NEW MP9130	L	LE	W1	INSL	S	BS	RE	Geometry
MS										
XNMU190912R-MS	●	●	19.1	16.5	9.5	12.7	8.5	1.0	1.2	
XNMU190916R-MS	●	●	19.1	16.5	9.5	12.7	8.5	1.0	1.6	
XNMU190924R-MS	●	●	19.1	16.5	9.5	12.7	8.5	1.0	2.4	
*XNMU190932R-MS	●	●	20.2	17.2	9.5	12.7	8.5	–	3.2	
*XNMU190940R-MS	●	●	21.8	18.0	9.5	12.7	8.5	–	4.0	
*XNMU190950R-MS	●	●	21.8	18.0	9.5	12.7	8.5	–	5.0	General purpose
HS										
XNMU190912R-HS	●	●	19.1	16.5	9.5	12.7	8.5	1.0	1.2	Cutting edge enhancement type
LS										
XNMU190912R-LS		●	19.1	16.5	9.5	12.7	8.5	1.0	1.2	Chip processing type







* Note for insert with a corner radius of 3.2 and above, as corner radius increases the LF dimension increases.
Corner radius: 3.2: LF+0.7mm Corner radius 4.0: LF+1.5mm Corner radius 5.0: LF+1.5mm

■ : MIRACLE SIGMA ●: Inventory maintained. ★: Inventory maintained in Japan.

RECOMMENDED CUTTING CONDITIONS

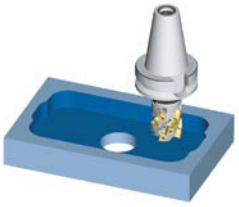
	Work Material	DC (mm)	ZEFP	Recommended Insert	Vc (m/min)	n (min^{-1})	APMX (mm)	ae (mm)	fz (mm/t.)	Vf (mm/min)	Q (cm3/min)	Pc (kW)	Expected Torque (Nm)	TL (%)
S	Titanium Alloy (Ti-Al-4V)	Ø 63	4	LS	40	202	60	63	0.10	81	306	13.4	634	40
			4	MS	50	253	60	38	0.10	101	229	9.5	357	60
			4	MS	60	303	60	25	0.10	121	183	7.2	228	80
			4	HS	60	303	60	13	0.12	146	110	4.7	148	100
		Ø 80	5	LS	40	159	75	80	0.10	80	477	20.8	1250	40
			5	MS	50	199	75	48	0.10	99	358	14.7	705	60
			5	MS	60	239	75	32	0.10	119	286	11.2	449	80
			5	HS	60	239	75	16	0.12	143	172	7.3	291	100
		Ø 100	6	LS	40	127	90	100	0.10	76	688	29.6	2218	40
			6	MS	50	159	90	60	0.10	95	516	20.9	1252	60
			6	MS	60	191	90	40	0.10	115	413	16.0	798	80
			6	HS	60	191	90	20	0.12	138	248	10.3	517	100
	Titanium Alloy (Ti-5Al-5V-5Mo-3Cr)	Ø 63	4	LS	25	126	60	63	0.08	40	153	7.0	527	30
			4	MS	25	126	60	38	0.08	40	92	4.0	303	50
			4	MS	30	152	60	25	0.10	61	92	3.8	241	70
			4	HS	30	152	60	13	0.10	61	46	2.1	133	80
		Ø 80	5	LS	25	99	75	80	0.08	40	239	10.8	1038	30
			5	MS	25	99	75	48	0.08	40	143	6.2	597	50
			5	MS	30	119	75	32	0.10	60	143	5.9	475	70
			5	HS	30	119	75	16	0.10	60	72	3.3	263	80
		Ø 100	6	LS	25	80	90	100	0.08	38	344	15.3	1841	30
			6	MS	25	80	90	60	0.08	38	206	8.8	1059	50
			6	MS	30	95	90	40	0.10	57	206	8.4	844	70
			6	HS	30	95	90	20	0.10	57	103	4.7	466	80

1. Please note that machining performance varies depending to the conditions such as machine rigidity, work clamping rigidity, coolant supply system, pressure and flow volume etc.
2. Internal coolant is recommended. Please use an FMH type arbor for through coolant. Using external coolant in combination with through coolant is even more effective.

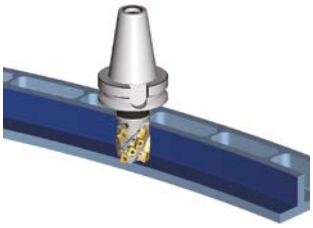
VFX

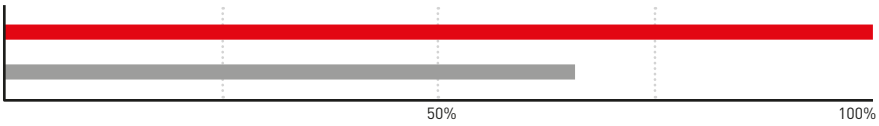
APPLICATION EXAMPLES

Tool	**VFX5-050A04A050R**
Workpiece	Titanium alloy (Ti-6Al-4V)
Component	Aerospace parts
Cutting Speed Vc (m/min)	40
Table Feed Vf (mm/min)	102
Feed per Tooth fz (mm/tooth)	0.10
Radial Depth of cut ae (mm)	5-30
Axial Depth of cut ap (mm)	5-60
Coolant	Wet cutting (Internal:3MPa)
Results	Efficiency was increased by a factor of 1.3.

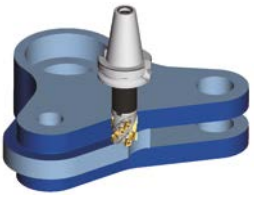


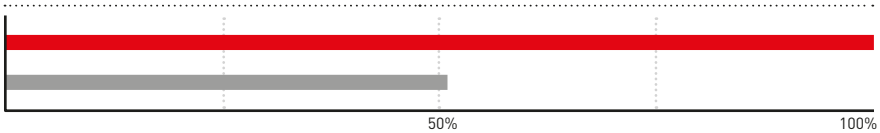
Tool	**VFX5-050A04A050R**
Workpiece	Titanium alloy (Ti-6Al-4V)
Component	Aerospace parts
Cutting Speed Vc (m/min)	50
Table Feed Vf (mm/min)	127
Feed per Tooth fz (mm/tooth)	0.1
Radial Depth of cut ae (mm)	50
Axial Depth of cut ap (mm)	10
Coolant	Wet cutting (External:1.5MPa)
Results	Efficiency increased by a factor of 1.5 and was also possible to achieve stable machining of thin walled parts.





Tool	**VFX5-050A04A050R**
Workpiece	Titanium alloy (Ti-6Al-4V)
Component	Aerospace parts
Cutting Speed Vc (m/min)	55
Table Feed Vf (mm/min)	140
Feed per Tooth fz (mm/tooth)	0.1
Radial Depth of cut ae (mm)	35
Axial Depth of cut ap (mm)	15
Coolant	Wet cutting (External:3MPa)
Results	It was possible to use 2 times increased cutting conditions for greater cost reduction.



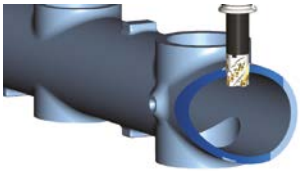


With reference to the above examples, adjust the cutting conditions according to the machine specifications, workpiece geometry and clamping method used.

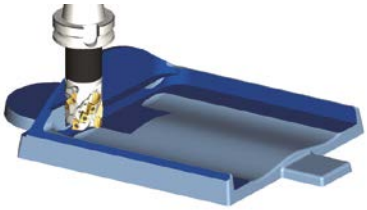
■ : Mitsubishi Materials Tool ■ : Conventional Tool

VFX

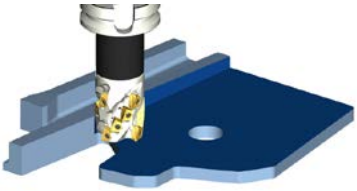
APPLICATION EXAMPLES



Tool	VFX6-080A05A075R
Workpiece	Titanium alloy (Ti-5553)
Component	Aerospace parts
Cutting Speed Vc (m/min)	32.5
Table Feed Vf (mm/min)	25
Feed per Tooth fz (mm/tooth)	0.04
Radial Depth of cut ae (mm)	10-30
Axial Depth of cut ap (mm)	30-60
Coolant	Wet cutting (Internal:7MPa)
Results	With the same tool life (190 mins) as conventional tools, it was possible to use 1.2 times increased cutting conditions for greater efficiency.



Tool	**VFX6-063A04A060R**
Workpiece	Titanium alloy (Ti-6Al-4V)
Component	Aerospace parts
Cutting Speed Vc (m/min)	55
Table Feed Vf (mm/min)	278
Feed per Tooth fz (mm/tooth)	0.12
Radial Depth of cut ae (mm)	10-45
Axial Depth of cut ap (mm)	25-60
Coolant	Wet cutting (Internal:10MPa)
Results	At a metal removal rate of 120cm3 /min, tool life was constant at 60 mins and efficiency increased x 1.5. VFX was stable in tests at a max. metal removal rate of 400cm3 /min.



Tool	**VFX6-063A04A060R**
Workpiece	Titanium alloy (Ti-6Al-4V)
Component	Aerospace parts
Cutting Speed Vc (m/min)	45
Table Feed Vf (mm/min)	227
Feed per Tooth fz (mm/tooth)	0.05
Radial Depth of cut ae (mm)	12-37
Axial Depth of cut ap (mm)	5-24
Coolant	Wet cutting (External:1.5MPa)
Results	Three times tool life at cutting conditions improved by a factor of 2.7. Total cost reductions of 62%.

With reference to the above examples, adjust the cutting conditions according to the machine specifications, workpiece geometry and clamping method used.

■ : Mitsubishi Materials Tool ■ : Conventional Tool

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