

THE NEW VALUE FRONTIER

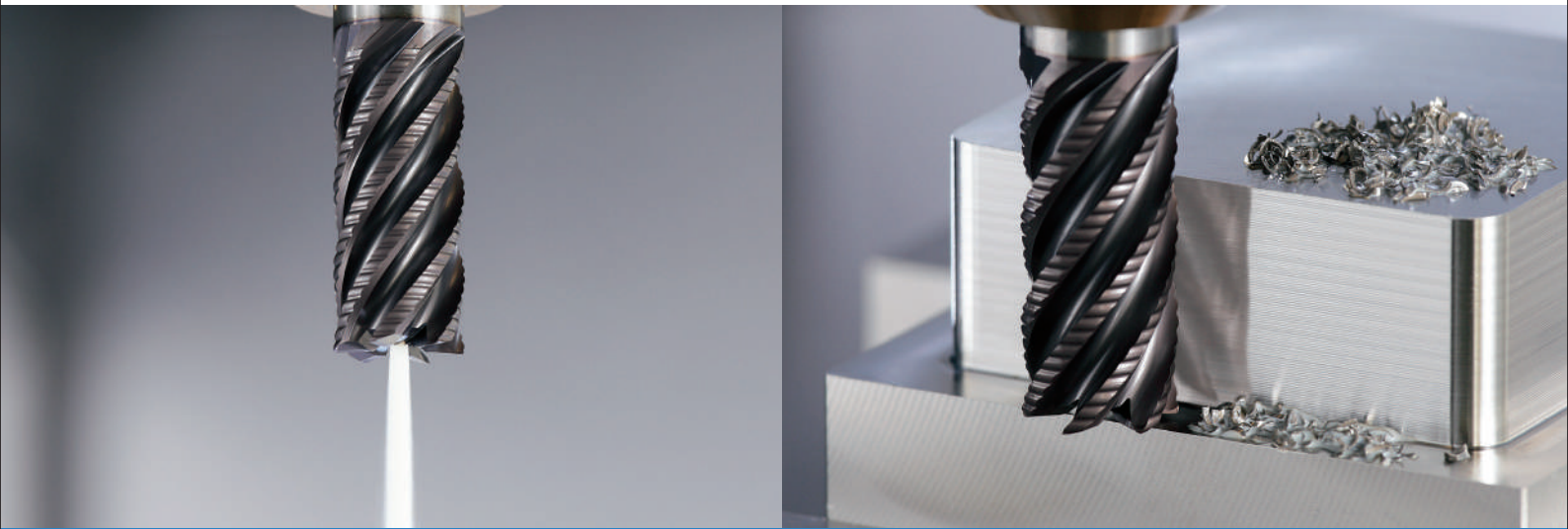


For Difficult-to-Cut Material  
High Efficiency Roughing End Mill

4/5/6RFH

High Efficiency Roughing End Mill for Difficult-to-Cut Material

# 4/5/6RFH



High Efficiency Machining of Difficult-to-Cut Material with Multi-edge Design and Coolant Hole

Deep Slotting ( $a_p = 2 \times D_c$ ) for Stainless Steel and Titanium Alloy

Defect Resistant with Special R Shaped Serrated Edge

High Efficiency Machining and Excellent Surface Finish with  
Multi-edge Design and Internal Coolant



High Efficiency Roughing End Mill for Difficult-to-Cut Material

# 4/5/6RFH

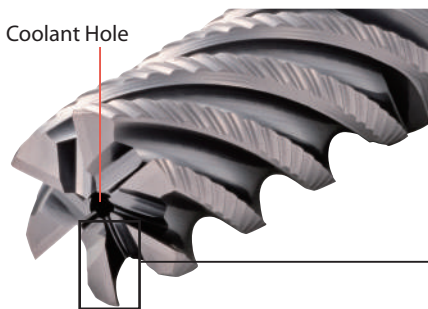
High Efficiency and Stable Machining with Multi-edge Design and Coolant Hole  
Deep Slotting ( $a_p = 2 \times D_c$ ) for Stainless Steel and Titanium Alloy

## 1 High Efficiency Machining with Multi-edge Design

Multi-edge Design with Coolant Hole

Good Chip Evacuation with Serrated Edge

Multi-edge Design ( $\phi 16$  - 6 flutes)



Original Serration Shape



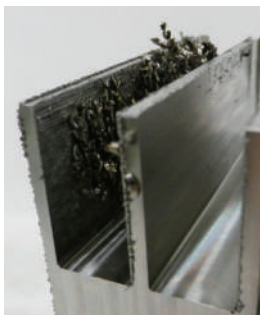
Good Chip Evacuation

High Efficiency Slotting

Deep Slotting ( $a_p = 2 \times D_c$ ) for Stainless Steel and Titanium Alloy

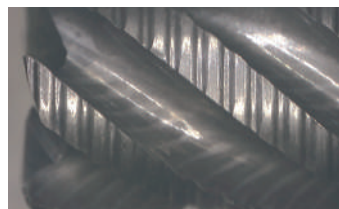
Slotting Performance Comparison (Internal Evaluation)

After Machining 1 Pass



5RFH

5RFH (Internal and External Coolant)



Cutting Conditions:  $n = 2,550 \text{ min}^{-1}$ ,  $V_f = 336 \text{ mm/min}$ ,  $a_p = 20 \text{ mm}$   
End Mill Dia.  $\phi 10$ , Wet, Slotting Workpiece: SUS304

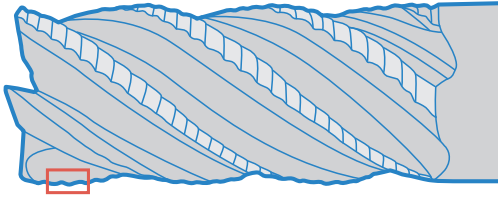
No Defects when Deep Slotting

Competitor A (External Coolant)

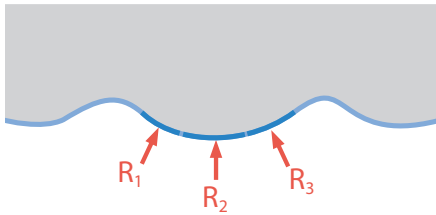


## 2 Defect Resistant

Reduces Cutting Pressure with Radial Serrated Edge  
Stable Machining

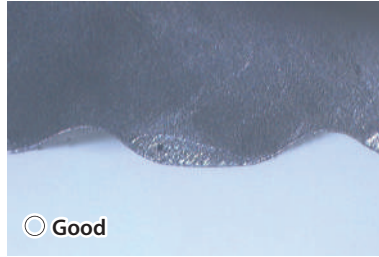


Special Curved Radius Serrated Edge

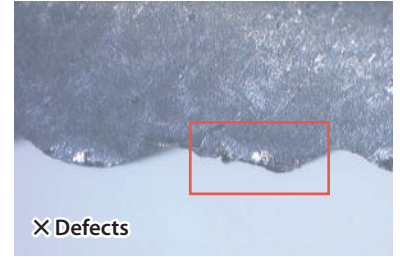


Serrated Curved Edge with Different Radii  
(Compound Radius Shape)  
Distributes cutting pressure and provides stress reduction

Blade Edge after Machining 12m (Internal Evaluation)



5RFH



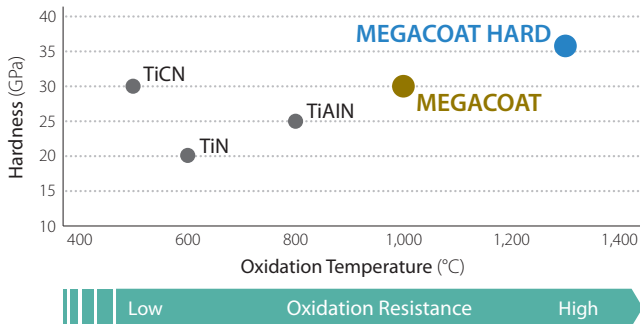
Competitor B

Cutting Conditions:  $n = 2,900 \text{ min}^{-1}$ ,  $V_f = 712 \text{ mm/min}$ ,  $a_p \times a_e = 5 \times 3 \text{ mm}$   
End Mill Dia.  $\phi 10$ , Wet, Shouldering Workpiece: Ti-6Al-4V

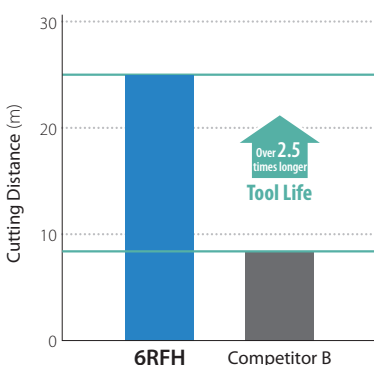
## 3 Achieves Long Tool Life and Stable Machining

The MEGACOAT HARD Coating Technology Delivers the Highest Hardness and Thermal Resistance of Kyocera's PVD Coating

Coating Properties



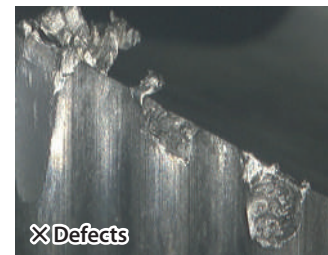
Tool Life Comparison (Internal Evaluation)



Blade Edge after Machining 8.4m



6RFH



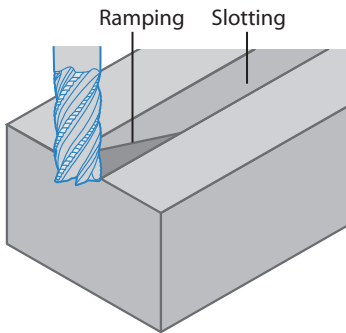
Competitor B

Cutting Conditions:  $n = 3,500 \text{ min}^{-1}$ ,  $V_f = 840 \text{ mm/min}$ ,  $a_p \times a_e = 5 \times 4.8 \text{ mm}$   
End Mill Dia.  $\phi 16$ , Shouldering, Wet Workpiece: SUS304

# Machining Information

Corresponding to medium finishing from rough machining. Reach maximum tool integration

## Case Studies



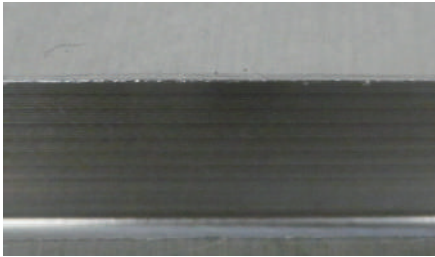
**RFH is internal coolant support**

**RFH with multi-edge design produces excellent surface finish even at the same table feed of competitor B (By lowering the feed per tooth)**

## Side Surface Finish Comparison (Internal Evaluation)

### 5RFH (5 Flutes)

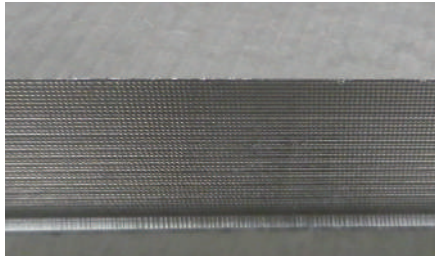
with Coolant Hole



Surface Finish: 0.20  $\mu\text{mRa}$

### Competitor B (4 Flutes)

without Coolant Hole



Surface Finish: 1.66  $\mu\text{mRa}$

Cutting Conditions:  $n = 3,200 \text{ min}^{-1}$   
 $V_f = 310 \text{ mm/min}$ ,  $a_p = 10 \text{ mm}$   
 End Mill Dia.  $\phi 10$ , Wet  
 Ramping (Ramping Angle  $5^\circ$ ) - Slotting  
 Workpiece: SUS304

**Competitor B needed a semi-finishing tool because of bad surface finish**  
**5RFH did not need a semi-finishing tool because of its excellent surface finish**

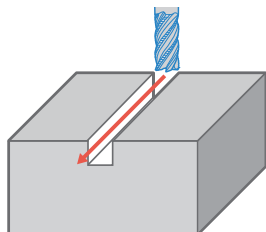
**4/5/6RFH can be custom-made for NIKKEN's X-Treme chuck**

**Great for Difficult-to-cut Materials and Heavy Machining**  
**For more information, please contact your Kyocera sales representative**

## Case Studies

### Test Piece SUS304

$n = 1,800 \text{ min}^{-1}$   
 $(V_c = 56 \text{ m/min})$   
 $V_f = 250 \text{ mm/min}$   
 $(f_z = 0.027 \text{ mm/t})$   
 $a_p \times a_e = 3 \times 10 \text{ mm (Slotting)}$   
 3 passes  
 Wet (Internal Coolant)  
 SRFH100-250



Load on the main spindle

**SRFH**  
100-250

**20%**

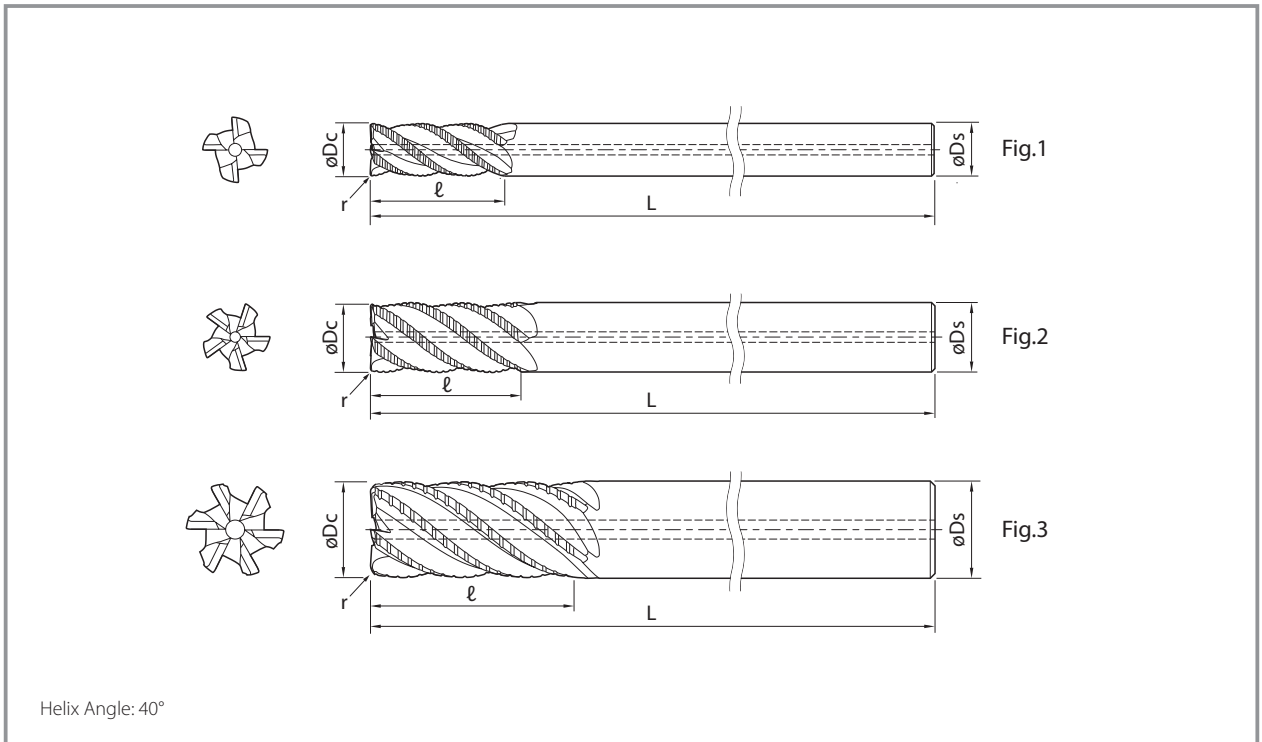


Competitor C

**30%**

SRFH shows 10% reduced load compared to competitor C. Reduced vibration for quieter machining with excellent surface finish.

(User Evaluation)



4/5/6RFH (Medium Type)

(Unit: mm)

Description	Stock	Outside Dia.	Mill Dia.	* Corner-R	Length of Cut	Shank Dia.	Overall Length	No. of Flutes	Shape
		øDc	Tolerance	r	ℓ	øDs	L	Z	
4RFH060-150	●	6.0	0 -0.050	0.3	15	6	60	4	Fig.1
4RFH080-200	●	8.0	0 -0.050	0.3	20	8	70	4	Fig.1
5RFH100-250	●	10.0	0 -0.050	0.5	25	10	80	5	Fig.2
5RFH120-260	●	12.0	0 -0.050	0.5	26	12	100	5	Fig.2
6RFH160-350	●	16.0	0 -0.060	0.5	35	16	110	6	Fig.3
6RFH200-450	●	20.0	0 -0.060	0.5	45	20	125	6	Fig.3

\* Corner-R dimension is reference only

● : Stock Std.

4/5/6RFH (Long Type)

(Unit: mm)

Description	Stock	Outside Dia.	Mill Dia.	* Corner-R	Length of Cut	Shank Dia.	Overall Length	No. of Flutes	Shape
		øDc	Tolerance	r	ℓ	øDs	L	Z	
4RFH060-300	●	6.0	0 -0.050	0.3	30	6	80	4	Fig.1
4RFH080-400	●	8.0	0 -0.050	0.3	40	8	100	4	Fig.1
5RFH100-500	●	10.0	0 -0.050	0.5	50	10	110	5	Fig.2
5RFH120-600	●	12.0	0 -0.050	0.5	60	12	130	5	Fig.2
6RFH160-800	●	16.0	0 -0.060	0.5	80	16	160	6	Fig.3
6RFH200-1000	●	20.0	0 -0.060	0.5	100	20	180	6	Fig.3

\* Corner-R dimension is reference only

● : Stock Std.

# Cutting Conditions

## 4/5/6RFH (Medium Type)

Applications	Workpiece	Application	Depth of Cut ap X ae (mm)	Outside Dia. Dc (mm)	ø 6	ø 8	ø 10	ø 12	ø 16	ø 20
<p>Shouldering</p> <p>Slotting</p>	Carbon Steel, Alloy Steel, Cast Iron S45C, SCM, SNCM FC	Shouldering	1.5Dc X 0.3Dc	Spindle Revolution (min <sup>-1</sup> )	6,400	4,800	3,800	3,200	2,400	1,900
				Feed Rate (mm/min)	1,040	1,050	1,100	1,000	980	920
		Slotting	1.0Dc	Spindle Revolution (min <sup>-1</sup> )	5,300	4,000	3,200	2,700	2,000	1,600
				Feed Rate (mm/min)	790	790	830	740	700	640
			2.0Dc	Spindle Revolution (min <sup>-1</sup> )	5,300	4,000	3,200	2,700	2,000	1,600
				Feed Rate (mm/min)	550	550	580	510	490	450
	Pre-hardened Steel (30~45HRC)	Shouldering	1.5Dc X 0.3Dc	Spindle Revolution (min <sup>-1</sup> )	4,200	3,200	2,500	2,100	1,600	1,300
				Feed Rate (mm/min)	490	620	580	540	490	460
		Slotting	1.0Dc	Spindle Revolution (min <sup>-1</sup> )	3,700	2,800	2,200	1,900	1,400	1,100
				Feed Rate (mm/min)	410	410	430	400	370	360
			2.0Dc	Spindle Revolution (min <sup>-1</sup> )	3,700	2,800	2,200	1,900	1,400	1,100
				Feed Rate (mm/min)	290	290	300	280	260	250
	Stainless Steel SUS304	Shouldering	1.5Dc X 0.3Dc	Spindle Revolution (min <sup>-1</sup> )	6,400	4,800	3,800	3,200	2,400	1,900
				Feed Rate (mm/min)	410	410	410	400	380	380
Slotting		1.0Dc	Spindle Revolution (min <sup>-1</sup> )	5,300	4,000	3,200	2,700	2,000	1,600	
			Feed Rate (mm/min)	280	260	310	240	250	250	
		2.0Dc	Spindle Revolution (min <sup>-1</sup> )	5,300	4,000	3,200	2,700	2,000	1,600	
			Feed Rate (mm/min)	220	210	250	190	200	200	
Titanium Alloys	Shouldering	1.5Dc X 0.3Dc	Spindle Revolution (min <sup>-1</sup> )	4,200	3,200	2,500	2,100	1,600	1,300	
			Feed Rate (mm/min)	330	420	410	390	380	370	
	Slotting	1.0Dc	Spindle Revolution (min <sup>-1</sup> )	3,700	2,800	2,200	1,900	1,400	1,100	
			Feed Rate (mm/min)	220	240	240	240	250	250	
		2.0Dc	Spindle Revolution (min <sup>-1</sup> )	3,700	2,800	2,200	1,900	1,400	1,100	
			Feed Rate (mm/min)	180	190	190	190	200	200	
Super Alloy	Shouldering	1.5Dc X 0.2Dc	Spindle Revolution (min <sup>-1</sup> )	800	600	480	400	300	240	
			Feed Rate (mm/min)	60	60	60	60	60	60	
	Slotting	1.0Dc	Spindle Revolution (min <sup>-1</sup> )	530	400	320	270	200	160	
			Feed Rate (mm/min)	28	28	28	28	28	28	
		2.0Dc	Spindle Revolution (min <sup>-1</sup> )	530	400	320	270	200	160	
			Feed Rate (mm/min)	20	20	20	20	20	20	

Water soluble coolant is recommended for stainless steel, titanium alloy, and super alloy.

## 4/5/6RFH (Long Type)

Applications	Workpiece	Application	Depth of Cut ap X ae (mm)	Outside Dia. Dc (mm)	ø 6	ø 8	ø 10	ø 12	ø 16	ø 20
<p>Shouldering</p>	Carbon Steel, Alloy Steel, Cast Iron S45C, SCM, SNCM FC	Shouldering	ap: 4.0Dc ae: 0.1Dc (Dc ≤ ø12) ae: 1.2mm (Dc > ø12)	Spindle Revolution (min <sup>-1</sup> )	5,100	3,800	3,100	2,500	1,900	1,500
				Feed Rate (mm/min)	620	630	660	600	590	550
	Pre-hardened Steel (30~45HRC)	Shouldering	ap: 4.0Dc ae: 0.1Dc (Dc ≤ ø12) ae: 1.2mm (Dc > ø12)	Spindle Revolution (min <sup>-1</sup> )	3,400	2,500	2,000	1,700	1,300	1,000
				Feed Rate (mm/min)	340	430	410	380	340	320
	Stainless Steel SUS304	Shouldering	ap: 4.0Dc ae: 0.1Dc (Dc ≤ ø12) ae: 1.2mm (Dc > ø12)	Spindle Revolution (min <sup>-1</sup> )	5,100	3,800	3,100	2,500	1,900	1,500
				Feed Rate (mm/min)	290	290	290	280	270	270
	Titanium Alloys	Shouldering	ap: 4.0Dc ae: 0.1Dc (Dc ≤ ø12) ae: 1.2mm (Dc > ø12)	Spindle Revolution (min <sup>-1</sup> )	3,400	2,500	2,000	1,700	1,300	1,000
				Feed Rate (mm/min)	230	290	290	270	270	260
	Super Alloy	Shouldering	ap: 4.0 X Dc ae: 0.1Dc (Dc ≤ ø12) ae: 1.0mm (Dc > ø12)	Spindle Revolution (min <sup>-1</sup> )	640	480	380	320	240	190
				Feed Rate (mm/min)	20	20	20	20	20	20

Water soluble coolant is recommended for stainless steel, titanium alloy, and super alloy.