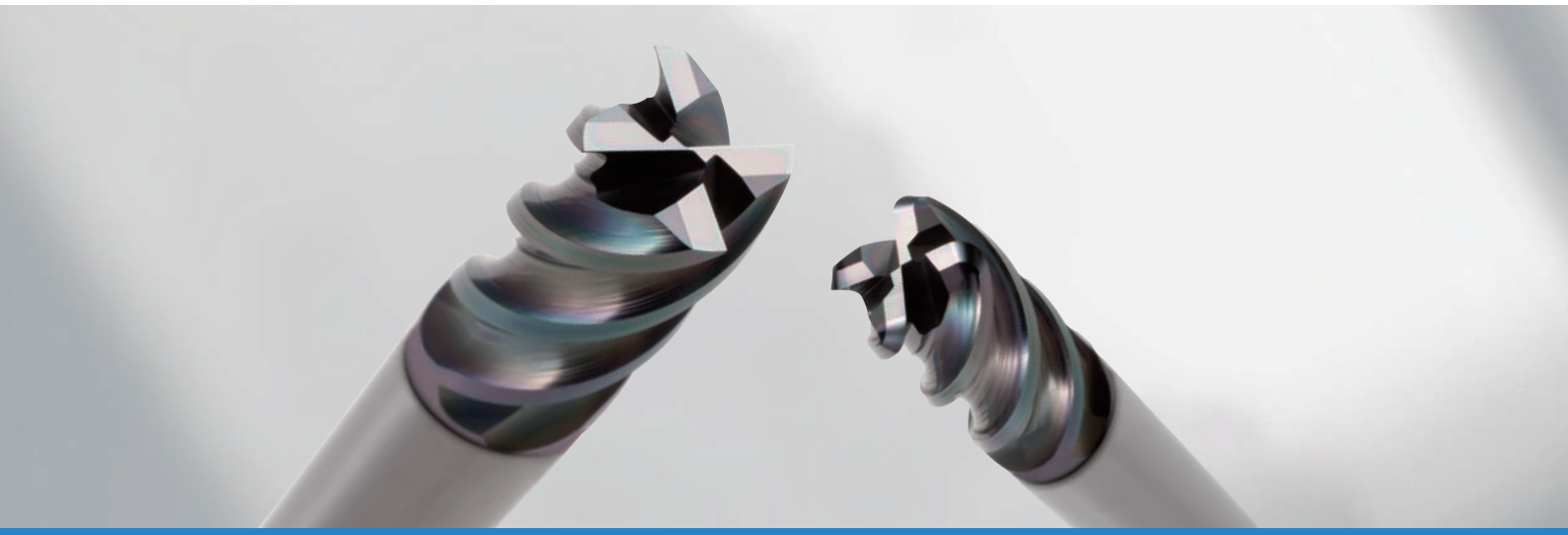
THE NEW VALUE FRONTIER

KYOCERA

Solid End Mill | 4MFK/4MFR

High Efficiency End Mill for Steel Machining

4MFK/4MFR



Resists Chattering for Stable, High Feed Machining of Steel

Chatter Resistant with Unique Variable Helix Design

Good Chip Evacuation

Square End Type (4MFK) and Corner Radius Type (4MFR) are Available

Lineup Expansion NEW

High Efficiency End Mill for Steel Machining

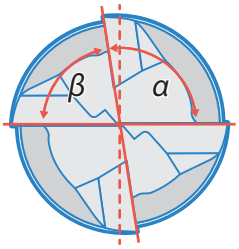
4MFK/4MFR

Good for High Feed Machining of Steel
High Efficiency with Unique Variable Helix Design

1 Chatter Resistant Variable Helix Design

Excellent Surface Finish with Reduced Chattering

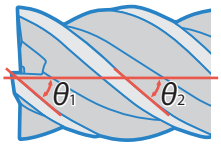
Unequal Spacing of Teeth



Cutting force distribution varies due to variable flute width, which prevents periodical vibration during machining

$$\alpha \neq \beta$$

Variable Helix



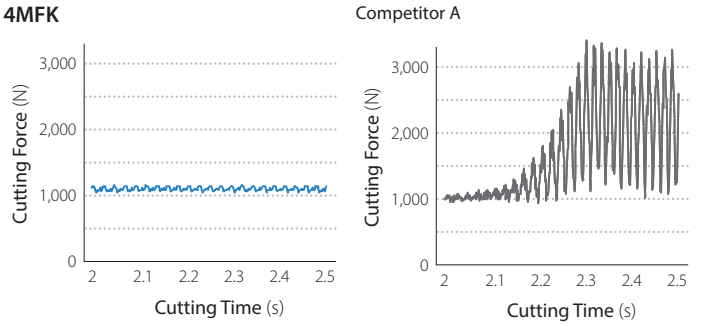
Each flute contains optimized helix angle (lead angleθ), which prevents vibration and achieves a clean surface finish

$$\theta_1 \neq \theta_2$$

Cutting Force Comparison

Drastically Reduced Vibration for Stable Machining

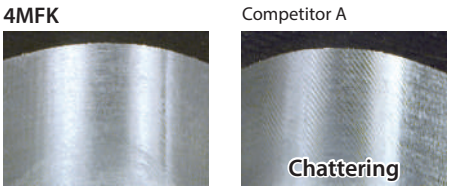
(In-house Evaluation)



Cutting Conditions: n = 2,650 min^{-1}, Vf = 300 mm/min, ap × ae = 10 × 8 mm, Cutter Dia. ø8, Slotting Wet Workpiece: SCM440

Surface Comparison

(In-house Evaluation)

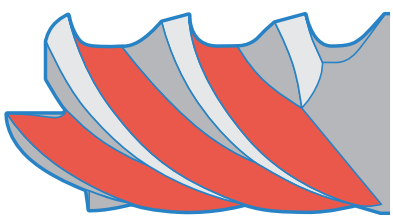


Cutting Conditions: n = 6,000 min^{-1}, Vf = 1,500 mm/min, ap × ae = 8 × 2 mm, Cutter Dia. ø8, Shouldering Wet Workpiece: S45C

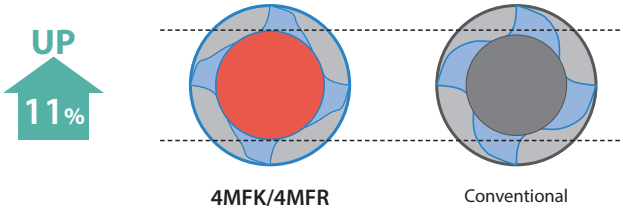
2 Good Chip Evacuation

Unique Flute Design for Smooth Chip Evacuation Even in Slotting and High Feed Machining Applications

Wide Chip Pocket



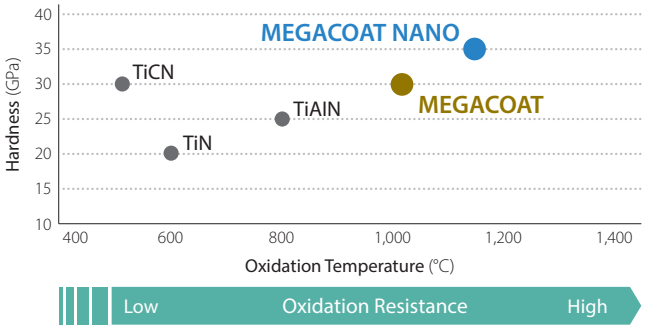
Core Thickness Comparison



3 Achieves Long Tool Life and Stable Machining

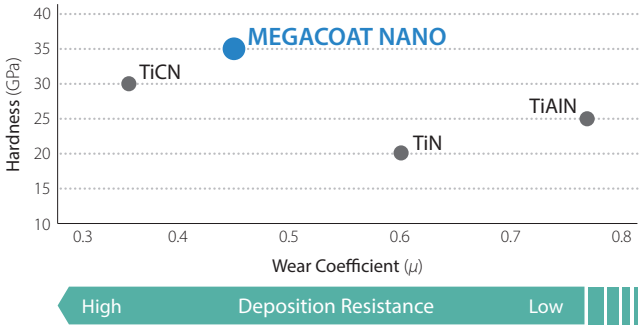
Special Nano-layer Coating MEGACOAT NANO controls wear progress and improves chipping resistance

Coating Properties (Abrasion Resistance)



Achieve long tool life with the combination of a tough substrate and a special Nano coating layer

Coating Properties (Deposition Resistance)

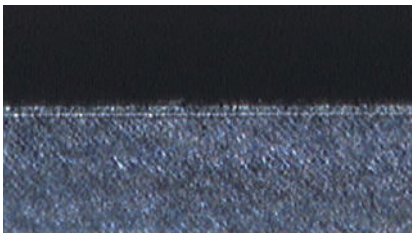


Stable Machining with Excellent Wear Resistance

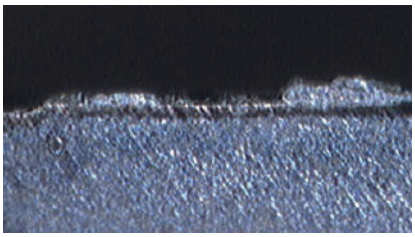
Abrasion Resistance Comparison

(In-house Evaluation)

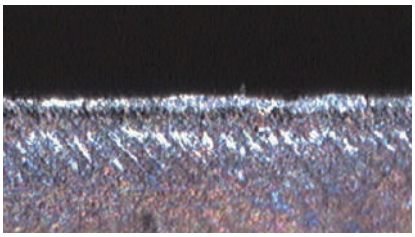
4MFK



Competitor B



Competitor C



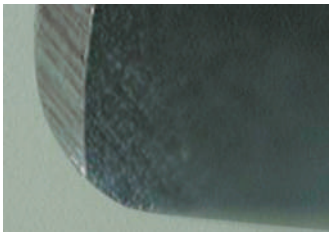
Edge Conditions after 140m Cutting

Cutting Conditions: n = 6,000 min^{-1}, Vf = 1,100 mm/min, ap × ae = 5.0 × 0.8 mm, Cutter Dia. ø8, Shouldering, Wet Workpiece: SCM440

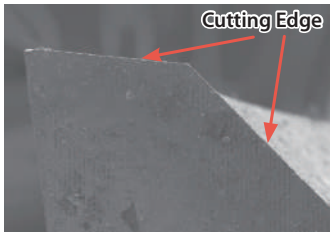
4 High Quality Sharp Edge

High Quality Sharp Edge with Advanced Grinding Technology Enables Excellent Surface Finish

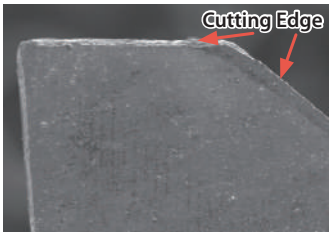
4MFR Corner Radius Type



Smooth and Sharp Cutting Edge Up to the Tip **Preventing Burrs**

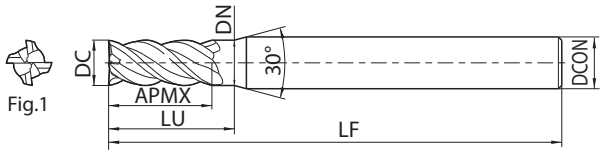


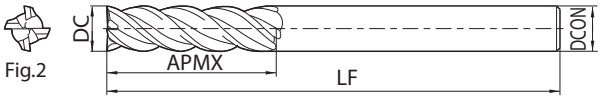
4MFK

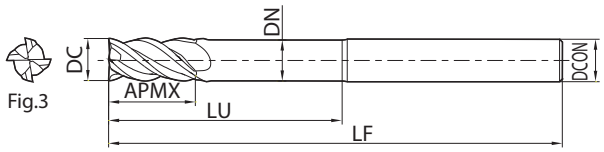


Competitor D

4MFK (Square Type)







Helix Angle : 42° / 44°

(Unit : mm)

Description	Stock	Cutter Dia. DC	Outside Dia. Tolerance	Length of cut APMX	Flute Length* Type	Neck Dia. DN	Under Neck Length LU	Shank Dia. DCON	Overall Length LF	Number of Flutes ZEFP	Shape
4MFK030-045	●	3.0	0 -0.015	4.5	S	3.15	5.4	6	60	4	Fig.1
4MFK030-080	●			8	M		9.6				
4MFK030-120	●			12	L		14.4				
4MFK035-050	●	3.5	0 -0.015	5	S	3.7	6.0	6	60	4	
4MFK035-095	●			9.5	M		11.4				
4MFK035-140	●			14	L		16.8				
4MFK040-060	●	4.0	0 -0.015	6	S	4.2	7.2	6	60	4	
4MFK040-110	●			11	M		13.2				
4MFK040-120	●			12	M (3D)		14.4				
4MFK040-160	●			16	L		19.2				
4MFK045-065	●	4.5	0 -0.015	6.5	S	4.7	7.8	6	60	4	
4MFK045-120	●			12	M		14.4				
4MFK045-180	●			18	L		21.6				
4MFK050-075	●	5.0	0 -0.015	7.5	S	5.2	9.0	6	60	4	
4MFK050-130	●			13	M		15.6				
4MFK050-200	●			20	L		24.0				
4MFK055-080	●	5.5	0 -0.015	8	S	5.7	9.6	6	60	4	
4MFK055-130	●			13	M		15.6				
4MFK055-210	●			21	L		25.2				
4MFK060-090	●	6.0	0 -0.020	9	S	–	–	6	60	4	Fig.2
NEW 4MFK060-090-180	●			9	S - L	5.8	18.0	6	60	4	Fig.3
NEW 4MFK060-090-300	●			9	S - L		30.0		70		
4MFK060-130	●			13	M	–	–	6	60	4	Fig.2
4MFK060-150	●			15	M (2.5D)						
4MFK060-220	●			22	L						
NEW 4MFK065-160	●	6.5	0 -0.020	16	M	6.7	19.2	8	70	4	Fig.1
4MFK070-105	●	7.0	0 -0.020	10.5	S	7.2	12.6	8	70	4	
4MFK070-160	●			16	M		19.2				
4MFK070-250	●			25	L		30.0				
NEW 4MFK075-190	●	7.5	0 -0.020	19	M	7.7	22.8	8	70	4	
4MFK080-120	●	8.0	-0.005 -0.025	12	S	–	–	8	70	4	Fig.2
NEW 4MFK080-120-240	●				S - L	7.7	24.0	8	70	4	Fig.3
NEW 4MFK080-120-400	●				S - L		40.0		80		
4MFK080-190	●			19	M	–	–	8	70	4	Fig.2
4MFK080-200	●			20	M (2.5D)						
4MFK080-280	●			28	L						
NEW 4MFK085-190	●	8.5	-0.005 -0.025	19	M	8.7	22.8	10	80	4	Fig.1
4MFK090-135	●	9.0	-0.005 -0.025	13.5	S	9.2	16.2				
4MFK090-205	●			20.5	M		24.6				

*Flute Length Type : S (Short), S - L (Short / Long Shank), M (Medium), L (Long)

● : Standard Stock

4MFK (Square Type)

(Unit : mm)

Description	Stock	Cutter Dia. DC	Outside Dia. Tolerance	Length of cut APMX	Flute Length Type *	Neck Dia. DN	Under Neck Length LU	Shank Dia. DCON	Overall Length LF	Number of Flutes ZEFP	Shape
NEW 4MFK095-220	●	9.5	-0.005 -0.025	22	M	9.7	26.4	10	80	4	Fig.1
4MFK100-150	●	10.0	-0.005 -0.025	15	S	–	–	10	80	4	Fig.2
NEW 4MFK100-150-300	●				S - L	9.7	30.0				Fig.3
NEW 4MFK100-150-500	●				S - L		50.0		100		
4MFK100-220	●			22	M	–	–		80		Fig.2
4MFK100-250	●			25	M (2.5D)						
4MFK100-330	●			33	L						
NEW 4MFK110-260	●	11.0	-0.010 -0.030	26	M	11.2	31.2	12	100	4	Fig.1
4MFK120-180	●	12.0	-0.010 -0.030	18	S	–	–	12	100	4	Fig.2
NEW 4MFK120-180-360	●				S - L	11.7	36.0				Fig.3
NEW 4MFK120-180-600	●				S - L		60.0		110		
4MFK120-260	●			26	M	–	–		100		Fig.2
4MFK120-360	●			36	L						
4MFK160-240	●	16.0	-0.010 -0.030	24	S	–	–	16	110	4	Fig.2
4MFK160-350	●			35	M						
4MFK160-480	●			48	L						

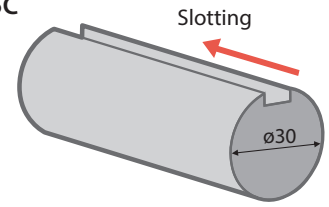
*Flute Length Type : S (Short), S - L (Short / Long Shank), M (Medium), L (Long)

●: Standard Stock

Case Studies

Automotive Parts S45C

n = 3,500 min^{-1} (Vc = 77 m/min)
Vf = 1,000 mm/min
(fz = 0.071 mm/t)
ap × ae = 5 × 7 mm, Wet
4MFK070-160



Tool Life

4MFK070-160 **255 pcs/edge** — Tool Life 5 Times, Efficiency 6.6 Times

Competitor E **50 pcs/edge**

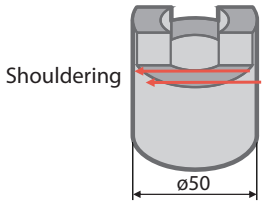
(Competitor E Cutting Conditions)
ø7 · 4 Flutes n = 2,000 min^{-1} (Vc = 44 m/min)
Vf = 150 mm/min (fz = 0.019 mm/t), ap × ae = 5 × 7mm, Wet

Kyocera showed 5 times longer tool life than Competitor E.
Compared to Competitor E, Kyocera increased the feed rate by 6.6 times.
No vibration occurred. Stable milling.

(User Evaluation)

Machine Parts SCr415

n = 1,400 min^{-1} (Vc = 53 m/min)
Vf = 280 mm/min (fz = 0.05 mm/t)
ap × ae = 12 × 5 mm, Wet
4MFK120-260



Tool Life

4MFK120-260 **700 pcs/edge and more** — Tool Life 3.5 Times

Competitor F **200 pcs/edge**

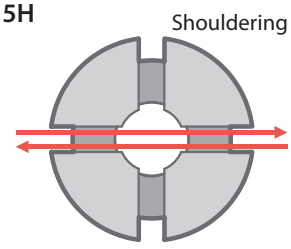
(Competitor F Cutting Conditions)
ø12 · 4 Flutes n = 1,400 min^{-1} (Vc = 53 m/min)
Vf = 280 mm/min (fz = 0.05 mm/t), ap × ae = 12 × 5mm, Wet

Reduced load on the tool, even after cutting 700 pieces. Regular cutting sounds, no chattering

(User Evaluation)

Automotive Parts SCM415H

n = 5,300 min^{-1} (Vc = 100 m/min)
Vf = 500 mm/min (0.09 mm/t)
ap × ae = 3.5 × 0.9 mm, Wet
4MFR060-130-R10



Tool Life

4MFR060-130-R10 **1,000 pcs/edge** — Tool Life 2 Times

Competitor G **500 pcs/edge**

The 4MFR End Mill machined 1,000 pieces and was available for further cutting, while Competitor G could not continue cutting because of chipping after processing 500 pieces.

(User Evaluation)

4MFR (Radius)

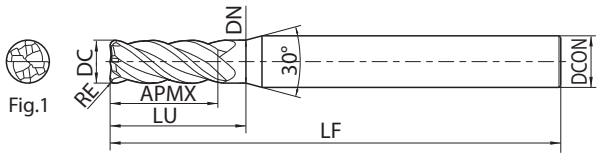


Fig.1

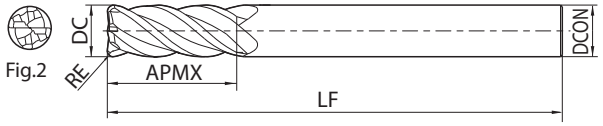


Fig.2

Helix Angle : 42° / 44°

(Unit : mm)

Description	Stock	Cutter Dia.	Outside Dia. Tolerance	Corner R	Length of cut	Neck Dia.	Under Neck Length	Shank Dia.	Overall Length	Number of Flutes	Shape
		DC		RE	APMX	DN	LU	DCON	LF	ZEFP	
4MFR030-080-R02	●	3.0	0 -0.015	0.2	8	3.15	9.6	6	60	4	Fig.1
4MFR030-080-R03	●			0.3							
4MFR030-080-R05	●			0.5							
4MFR035-095-R02	●	3.5	0 -0.015	0.2	9.5	3.7	11.4	6	60	4	
4MFR035-095-R03	●			0.3							
4MFR035-095-R05	●			0.5							
4MFR040-110-R02	●	4.0	0 -0.015	0.2	11	4.2	13.2	6	60	4	
4MFR040-110-R03	●			0.3							
4MFR040-110-R05	●			0.5							
4MFR040-110-R10	●			1.0							
4MFR045-120-R02	●	4.5	0 -0.015	0.2	12	4.7	14.4	6	60	4	
4MFR045-120-R03	●			0.3							
4MFR045-120-R05	●			0.5							
4MFR045-120-R10	●			1.0							
4MFR050-130-R02	●	5.0	0 -0.015	0.2	13	5.2	15.6	6	60	4	
4MFR050-130-R03	●			0.3							
4MFR050-130-R05	●			0.5							
4MFR050-130-R10	●			1.0							
NEW 4MFR055-130-R02	●	5.5	0 -0.015	0.2	13	5.7	15.6	6	60	4	
4MFR055-130-R03	●			0.3							
4MFR055-130-R05	●			0.5							
4MFR055-130-R10	●			1.0							
NEW 4MFR060-130-R02	●	6.0	0 -0.020	0.2	13	–	–	6	60	4	Fig.2
4MFR060-130-R03	●			0.3							
4MFR060-130-R05	●			0.5							
4MFR060-130-R10	●			1.0							
4MFR060-130-R15	●			1.5							
NEW 4MFR080-190-R02	●	8.0	-0.005 -0.025	0.2	19	–	–	8	70	4	
4MFR080-190-R03	●			0.3							
4MFR080-190-R05	●			0.5							
4MFR080-190-R10	●			1.0							
4MFR080-190-R15	●			1.5							
4MFR080-190-R20	●			2.0							
4MFR080-190-R30	●			3.0							
NEW 4MFR100-220-R02	●	10.0	-0.005 -0.025	0.2	22	–	–	10	80	4	
4MFR100-220-R03	●			0.3							
4MFR100-220-R05	●			0.5							
4MFR100-220-R10	●			1.0							
4MFR100-220-R15	●			1.5							
4MFR100-220-R20	●			2.0							
4MFR100-220-R30	●			3.0							

● : Standard Stock

4MFR (Radius)

(Unit : mm)

Description	Stock	Cutter Dia. DC	Outside Dia. Tolerance	Corner R RE	Length of cut APMX	Neck Dia. DN	Under Neck Length LU	Shank Dia. DCON	Overall Length LF	Number of Flutes ZEFP	Shape
NEW 4MFR120-260-R03	●	12.0	-0.010 -0.030	0.3	26	–	–	12	100	4	Fig.2
4MFR120-260-R05	●			0.5							
4MFR120-260-R10	●			1.0							
4MFR120-260-R15	●			1.5							
4MFR120-260-R20	●			2.0							
4MFR120-260-R30	●			3.0							
4MFR160-350-R10	●	16.0	-0.010 -0.030	1.0	35	–	–	16	110	4	
4MFR160-350-R15	●			1.5							
4MFR160-350-R20	●			2.0							
4MFR160-350-R30	●			3.0							

● : Standard Stock

Cutting Conditions

4MFK (Short · Medium) / 4MFR

Workpiece Material	Application	Depth of Cut ap × ae (mm)	Cutter Dia. DC (mm)	ø 3	ø 4	ø 5	ø 6	ø 8	ø 10	ø 12	ø 16
Carbon Steel S45C	Shouldering	Short 1.2DC × 0.15DC Medium 1.5DC × 0.15DC	Number of Revolutions (min^{-1})	13,800	10,700	8,800	7,500	6,000	4,800	4,000	3,300
			Feed Rate (mm/min)	1,400	1,400	1,400	1,500	1,500	1,400	1,400	1,300
	Slotting	ap ≤ 1.0DC	Number of Revolutions (min^{-1})	13,800	10,700	8,800	7,500	6,000	4,800	4,000	3,300
			Feed Rate (mm/min)	620	700	750	780	830	850	800	750
Alloy Steel SCM, SNCM	Shouldering	Short 1.2DC × 0.1DC Medium 1.5DC × 0.1DC	Number of Revolutions (min^{-1})	10,600	9,300	8,300	7,400	6,000	4,700	3,800	2,800
			Feed Rate (mm/min)	1,000	1,000	1,000	1,100	1,100	1,000	1,000	900
	Slotting	ap ≤ 1.0DC	Number of Revolutions (min^{-1})	10,600	9,300	8,300	7,400	6,000	4,700	3,800	2,800
			Feed Rate (mm/min)	500	510	520	530	550	570	530	450
Pre-hardened Steel (30 ~ 45HRC)	Shouldering	Short 1.2DC × 0.07DC Medium 1.5DC × 0.07DC	Number of Revolutions (min^{-1})	8,700	6,800	5,500	4,600	3,500	2,800	2,300	1,700
			Feed Rate (mm/min)	670	730	790	840	900	810	770	630
	Slotting	ap ≤ 1.0DC	Number of Revolutions (min^{-1})	6,700	5,800	4,800	4,000	3,000	2,300	1,900	1,400
			Feed Rate (mm/min)	320	330	360	370	400	420	380	300
Stainless Steel SUS304	Shouldering	Short 1.2DC × 0.1DC Medium 1.5DC × 0.1DC	Number of Revolutions (min^{-1})	8,700	7,000	6,000	5,200	4,000	3,000	2,500	1,700
			Feed Rate (mm/min)	670	720	780	830	840	760	710	520
	Slotting	ap ≤ 0.3DC	Number of Revolutions (min^{-1})	6,800	6,000	5,100	4,300	3,400	2,600	2,000	1,400
			Feed Rate (mm/min)	190	220	240	250	250	240	230	190
Titanium Alloy	Shouldering	Short 1.2DC × 0.1DC Medium 1.5DC × 0.1DC	Number of Revolutions (min^{-1})	8,700	7,000	6,000	5,200	4,000	3,000	2,500	1,700
			Feed Rate (mm/min)	670	720	780	830	840	760	710	520
	Slotting	ap ≤ 0.3DC	Number of Revolutions (min^{-1})	6,800	6,000	5,100	4,300	3,400	2,600	2,000	1,400
			Feed Rate (mm/min)	190	220	240	250	250	240	230	190

Cutting with coolant is recommended for stainless steel, titanium alloy and heat-resistant alloy.

Cutting Conditions

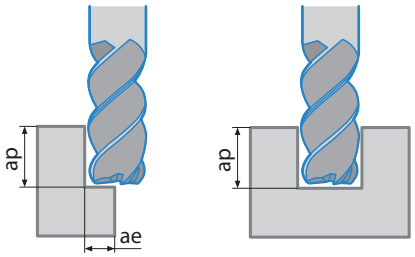
4MFK (Short / Long Shank · Long)

Workpiece Material	Application	Depth of Cut ap × ae (mm)	Cutter Dia. DC (mm)	ø 3	ø 4	ø 5	ø 6	ø 8	ø 10	ø 12	ø 16
Carbon Steel S45C	Shouldering	3DC × 0.02DC	Number of Revolutions (min^{-1})	11,000	8,500	7,000	6,000	4,800	3,800	3,200	2,600
			Feed Rate (mm/min)	910	910	910	970	970	910	910	840
Alloy Steel SCM, SNCM			Number of Revolutions (min^{-1})	6,500	5,700	5,100	4,500	3,700	2,900	2,300	1,700
			Feed Rate (mm/min)	540	540	540	600	600	540	540	490
Pre-hardened Steel (30 ~ 45HRC)			Number of Revolutions (min^{-1})	4,900	3,900	3,100	2,600	2,000	1,600	1,300	1,000
			Feed Rate (mm/min)	330	360	400	420	450	400	380	310
Stainless Steel SUS304			Number of Revolutions (min^{-1})	4,300	3,500	3,000	2,600	2,000	1,500	1,300	900
			Feed Rate (mm/min)	330	360	390	410	420	380	350	260
Titanium Alloy			Number of Revolutions (min^{-1})	4,300	3,500	3,000	2,600	2,000	1,500	1,300	900
			Feed Rate (mm/min)	330	360	390	410	420	380	350	260

Cutting with coolant is recommended for stainless steel, titanium alloy and heat-resistant alloy.

Slotting is not recommended

Application



Shouldering Slotting

Cutting with compressed air or coolant is recommended
Cutting with coolant is recommended for stainless steel and titanium alloy
Adjust ap to according to machine's rigidity
Use a chuck and a machine with as high a rigidity as possible

CP386-2 CAT/0T1911DNN