Cutting Conditions (Guide) :
● : Stable Cutting ◔ : General Cutting ✲ : Unstable Cutting

Chip Breaker Recommendation

■ Chip Breaker Selection Table

	Workpiece Material	Properties	Cutting Conditions	Chip Breaker		Grade	
				1st Recommended	2nd Recommended	1st Recommended	2nd Recommended
P	Mild Steels	Hardness ≤180HB	● ◔	L	M	MP6120	VP15TF
			✲	M	L	MP6130	—
	Carbon Steels Alloy Steels Alloy Tool Steels	Hardness 180-350HB ≤350HB (Annealing)	●	L	M	MP6120	VP15TF
			◔	M	L	MP6120	VP15TF
			✲	M	L	MP6130	—
	Pre-hardened Steels	Hardness 35—45HRC	● ◔	M	L	MP6120	VP15TF
			✲	M	L	MP6130	—
M	Austenitic Stainless Steels	Hardness ≤280HB	● ◔	L	M	MP7130	VP15TF
			✲	M	L	MP7130	—
		Hardness >200HB	● ◔	L	M	MP7130	VP15TF
			✲	M	L	MP7130	—
	Duplex Stainless Steels	Hardness ≤280HB	● ◔	L	M	MP7130	VP15TF
			✲	M	L	MP7130	—
	Ferritic and Martensitic Stainless Steels	—	● ◔	L	M	MP7130	VP15TF
			✲	M	L	MP7130	—
	Precipitation Hardening Stainless Steels	Hardness <450HB	● ◔	L	M	MP7130	VP15TF
			✲	M	L	MP7130	—
K	Gray Cast Irons	Tensile Strength ≤350MPa	● ◔	M	L	MC5020	VP15TF
			✲	M	L	VP15TF	—
	Ductile Cast Irons	Tensile Strength ≤800MPa	● ◔	M	L	MC5020	VP15TF
			✲	M	L	VP15TF	—
N	Aluminum Alloys	Content Si<5%	● ◔	L	M	TF15	—
			✲	M	L	TF15	—
S	Titanium Alloys (Ti-6Al-4V,etc.)	—	● ◔	L	M	MP9120	VP15TF
			✲	M	L	MP9130	—
	Titanium Alloys (Ti-5Al-5V-5Mo-3Cr,etc.)	—	● ◔	L	M	MP9120	VP15TF
			✲	M	L	MP9130	—
	Heat Resistant Alloys	—	● ◔	M	L	MP9120	VP15TF
			✲	M	L	MP9130	—
H	Hardened Steels	Hardness 40—55HRC	● ◔ ✲	M	—	VP15TF	—

Recommended Cutting Conditions

■ Dry Cutting

Cutting Speed

(inch)

	Workpiece Material	Properties	Cutting Conditions	Grade	Cutting Width **ae** ≤.25DC	.25—.5DC	.5—.75DC	DC(Slot)
					Cutting Speed **vc** (SFM)			
P	Mild Steels	Hardness ≤180HB	● ●	MP6120,VP15TF	755 (590—885)	720 (560—850)	590 (460—690)	590 (460—690)
			✻	MP6130	655 (490—785)	620 (460—755)	490 (360—590)	490 (360—590)
	Carbon Steels Alloy Steels Alloy Tool Steels	Hardness 180—350HB ≤350HB (Annealing)	● ●	MP6120,VP15TF	590 (460—690)	560 (425—655)	460 (360—525)	460 (360—525)
			✻	MP6130	490 (360—590)	460 (330—560)	360 (260—425)	360 (260—425)
	Pre-hardened Steels	Hardness 35—45HRC	● ●	MP6120,VP15TF	395 (295—460)	360 (260—425)	330 (230—395)	330 (230—395)
			✻	MP6130	330 (260—395)	295 (230—360)	260 (195—330)	260 (195—330)
M	Austenitic Stainless Steels	Hardness ≤200HB	● ● ✻	MP7130,VP15TF	590 (460—690)	560 (425—655)	460 (360—525)	460 (360—525)
		Hardness >200HB	● ● ✻	MP7130,VP15TF	490 (360—590)	460 (330—525)	360 (260—425)	360 (260—425)
	Duplex Stainless Steels	Hardness ≤280HB	● ● ✻	MP7130,VP15TF	460 (360—560)	425 (295—490)	330 (230—395)	330 (230—395)
	Ferritic and Martensitic Stainless Steels	—	● ● ✻	MP7130,VP15TF	590 (460—690)	560 (425—655)	460 (360—525)	460 (360—525)
	Precipitation Hardening Stainless Steels	Hardness <450HB	● ● ✻	MP7130,VP15TF	425 (330—525)	395 (260—460)	295 (195—360)	295 (195—360)
K	Gray Cast Irons	Tensile Strength ≤350MPa	● ●	MC5020	820 (655—985)	785 (620—950)	690 (525—850)	690 (525—850)
			● ● ✻	VP15TF	655 (490—820)	620 (460—785)	525 (360—690)	525 (360—690)
	Ductile Cast Irons	Tensile Strength ≤800MPa	● ●	MC5020	590 (490—655)	560 (460—620)	490 (395—560)	490 (395—560)
			● ● ✻	VP15TF	425 (330—490)	395 (295—460)	330 (260—395)	330 (260—395)
N	Aluminum Alloys	Content Si<5%	● ● ✻	TF15	1970 (1310—3280)	1970 (1310—3280)	1970 (1310—3280)	1970 (1310—3280)
H	Hardened Steels	Hardness 40—55HRC	● ● ✻	VP15TF	295 (230—330)	280 (195—330)	230 (165—260)	230 (165—260)

Note 1) These cutting conditions should be referenced for standard shank types (last letter in designation is S) and arbor shank types. If there is chatter, insert chipping, etc. during machining, alter conditions accordingly.

Note 2) Chattering vibration is more likely under the following circumstances. Use a cut and feed per tooth that are at minimum recommended conditions or below.
- When tool overhang is long (using a long shank, screw-in type, etc.)
- Rigidity of machine, workpiece material or attachment of workpiece material is low
- Corner radius during pocket milling

Note 3) A type with fewer teeth is recommended when the depth of cut in the radius direction (ae) is .5 DC or more.

Note 4) Wet cutting is recommended, when focusing on the surface finish. (Tool life is shorter than for dry cutting.)

Note 5) When using under higher than recommended cutting conditions, or for long periods of time, the clamp screw may become fatigued and break during machining. Please change out the clamp screw periodically.

Cutting Conditions (Guide) :
● : Stable Cutting ◔ : General Cutting ✲ : Unstable Cutting

Depth of Cut / Feed per Tooth

(inch)

Workpiece Material		Properties	Cutting Width **ae**	Cutting Conditions	Cutter Diameter **DC** ø.625-ø.750(ø16mm-ø18mm) Depth of Cut **ap**	ø.625-ø.750(ø16mm-ø18mm) Feed per Tooth **fz** (IPT)	ø.875-ø1.000(ø20mm-ø25mm) Depth of Cut **ap**	ø.875-ø1.000(ø20mm-ø25mm) Feed per Tooth **fz** (IPT)	ø1.125-ø2.500(ø28mm-ø63mm) Depth of Cut **ap**	ø1.125-ø2.500(ø28mm-ø63mm) Feed per Tooth **fz** (IPT)
P	Mild Steels	Hardness ≤180HB	≤.25DC	● ◔ ✲	≤.236	.004—.006	≤.315	.004—.008	≤.315	.004—.010
			.25—.5DC	● ◔ ✲	≤.197	.003—.005	≤.315	.004—.006	≤.315	.004—.008
			.5—.75DC	● ◔ ✲	≤.157	.003—.005	≤.236	.003—.005	≤.236	.004—.006
			DC(Slot)	● ◔ ✲	≤.079	.002—.004	≤.157	.002—.004	≤.157	.003—.005
	Carbon Steels Alloy Steels Alloy Tool Steels	Hardness 180—280HB	≤.25DC	● ◔ ✲	≤.236	.004—.006	≤.315	.004—.008	≤.315	.004—.010
			.25—.5DC	● ◔ ✲	≤.197	.003—.005	≤.315	.004—.006	≤.315	.004—.008
			.5—.75DC	● ◔ ✲	≤.157	.003—.005	≤.236	.003—.005	≤.236	.004—.006
			DC(Slot)	● ◔ ✲	≤.079	.002—.004	≤.157	.002—.004	≤.157	.003—.005
	Carbon Steels Alloy Steels Alloy Tool Steels	Hardness 280—350HB ≤350HB (Annealing)	≤.25DC	● ◔ ✲	≤.236	.004—.006	≤.315	.004—.006	≤.315	.004—.008
			.25—.5DC	● ◔ ✲	≤.197	.003—.005	≤.315	.003—.005	≤.315	.004—.006
			.5—.75DC	● ◔ ✲	≤.157	.003—.005	≤.236	.002—.004	≤.236	.003—.005
			DC(Slot)	● ◔ ✲	≤.079	.002—.004	≤.157	.002—.004	≤.157	.002—.004
	Pre-hardened Steels	Hardness 35—45HRC	≤.25DC	● ◔ ✲	≤.236	.004—.006	≤.315	.004—.006	≤.315	.004—.008
			.25—.5DC	● ◔ ✲	≤.197	.003—.005	≤.315	.003—.005	≤.315	.004—.006
			.5—.75DC	● ◔ ✲	≤.157	.003—.005	≤.236	.002—.004	≤.236	.003—.005
			DC(Slot)	● ◔ ✲	≤.079	.002—.004	≤.157	.002—.004	≤.157	.002—.004
M	Austenitic Stainless Steels	—	≤.25DC	● ◔	≤.236	.004—.006	≤.315	.004—.008	≤.315	.004—.008
				✲	≤.236	.003—.005	≤.315	.003—.006	≤.315	.003—.006
			.25—.5DC	● ◔	≤.197	.003—.005	≤.315	.003—.006	≤.315	.003—.006
				✲	≤.197	.002—.004	≤.315	.003—.005	≤.315	.003—.005
			.5—.75DC	● ◔	≤.157	.002—.004	≤.236	.003—.005	≤.236	.003—.005
				✲	≤.157	.002—.003	≤.236	.002—.004	≤.236	.002—.004
			DC(Slot)	● ◔	≤.079	.002—.004	≤.157	.002—.004	≤.157	.002—.004
				✲	≤.079	.002—.003	≤.157	.002—.003	≤.157	.002—.003
	Duplex Stainless Steels	Hardness ≤280HB	≤.25DC	● ◔	≤.236	.004—.006	≤.315	.004—.008	≤.315	.004—.008
				✲	≤.236	.003—.005	≤.315	.003—.006	≤.315	.003—.006
			.25—.5DC	● ◔	≤.197	.003—.005	≤.315	.003—.006	≤.315	.003—.006
				✲	≤.197	.002—.004	≤.315	.003—.005	≤.315	.003—.005
			.5—.75DC	● ◔	≤.157	.002—.004	≤.236	.003—.005	≤.236	.003—.005
				✲	≤.157	.002—.003	≤.236	.002—.004	≤.236	.002—.004
			DC(Slot)	● ◔	≤.079	.002—.004	≤.157	.002—.004	≤.157	.002—.004
				✲	≤.079	.002—.003	≤.157	.002—.003	≤.157	.002—.003
	Ferritic and Martensitic Stainless Steels	—	≤.25DC	● ◔	≤.236	.004—.006	≤.315	.004—.008	≤.315	.004—.008
				✲	≤.236	.003—.005	≤.315	.003—.006	≤.315	.003—.006
			.25—.5DC	● ◔	≤.197	.003—.005	≤.315	.003—.006	≤.315	.003—.006
				✲	≤.197	.002—.004	≤.315	.003—.005	≤.315	.003—.005
			.5—.75DC	● ◔	≤.157	.002—.004	≤.236	.003—.005	≤.236	.003—.005
				✲	≤.157	.002—.003	≤.236	.002—.004	≤.236	.002—.004
			DC(Slot)	● ◔	≤.079	.002—.004	≤.157	.002—.004	≤.157	.002—.004
				✲	≤.079	.002—.003	≤.157	.002—.003	≤.157	.002—.003
	Precipitation Hardening Stainless Steels	Hardness <450HB	≤.25DC	● ◔	≤.236	.004—.006	≤.315	.004—.006	≤.315	.004—.006
				✲	≤.236	.003—.005	≤.315	.003—.005	≤.315	.003—.005
			.25—.5DC	● ◔	≤.197	.003—.005	≤.315	.003—.005	≤.315	.003—.005
				✲	≤.197	.002—.004	≤.315	.003—.005	≤.315	.003—.005
			.5—.75DC	● ◔	≤.157	.002—.004	≤.236	.002—.004	≤.236	.002—.004
				✲	≤.157	.002—.003	≤.236	.002—.003	≤.236	.002—.003
			DC(Slot)	● ◔	≤.079	.002—.004	≤.157	.002—.004	≤.157	.002—.004
				✲	≤.079	.002—.003	≤.157	.002—.003	≤.157	.002—.003

Note 1) These cutting conditions should be referenced for standard shank types (last letter in designation is S) and arbor shank types. If there is chatter, insert chipping, etc. during machining, alter conditions accordingly.
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Note 3) A type with fewer teeth is recommended when the depth of cut in the radius direction (ae) is .5 DC or more.
Note 4) Wet cutting is recommended, when focusing on the surface finish. (Tool life is shorter than for dry cutting.)
Note 5) When using under higher than recommended cutting conditions, or for long periods of time, the clamp screw may become fatigued and break during machining. Please change out the clamp screw periodically.

Recommended Cutting Conditions

■ Dry Cutting

Depth of Cut / Feed per Tooth

(inch)

	Workpiece Material	Properties	Cutting Width **ae**	Cutting Conditions	Cutter Diameter **DC** ø.625-ø.750(ø16mm-ø18mm) Depth of Cut **ap**	ø.625-ø.750(ø16mm-ø18mm) Feed per Tooth **fz** (IPT)	ø.875-ø1.000(ø20mm-ø25mm) Depth of Cut **ap**	ø.875-ø1.000(ø20mm-ø25mm) Feed per Tooth **fz** (IPT)	ø1.125-ø2.500(ø28mm-ø63mm) Depth of Cut **ap**	ø1.125-ø2.500(ø28mm-ø63mm) Feed per Tooth **fz** (IPT)
K	Gray Cast Irons	Tensile Strength ≤350MPa	≤.25DC	● ●	≤.236	.004—.006	≤.315	.004—.008	≤.315	.004—.010
				✱	≤.236	.003—.005	≤.315	.003—.006	≤.315	.004—.008
			.25—.5DC	● ●	≤.197	.003—.005	≤.315	.003—.006	≤.315	.004—.008
				✱	≤.197	.002—.004	≤.315	.003—.005	≤.315	.004—.006
			.5—.75DC	● ●	≤.157	.003—.005	≤.236	.003—.005	≤.236	.004—.006
				✱	≤.157	.003—.005	≤.236	.002—.004	≤.236	.003—.005
			DC(Slot)	● ●	≤.079	.002—.004	≤.157	.002—.004	≤.157	.003—.006
				✱	≤.079	.002—.003	≤.157	.002—.003	≤.157	.003—.004
	Ductile Cast Irons	Tensile Strength ≤800MPa	≤.25DC	● ●	≤.236	.004—.006	≤.315	.004—.008	≤.315	.004—.008
				✱	≤.236	.003—.005	≤.315	.004—.006	≤.315	.004—.006
			.25—.5DC	● ●	≤.197	.003—.005	≤.315	.004—.006	≤.315	.004—.006
				✱	≤.197	.002—.004	≤.315	.003—.005	≤.315	.003—.005
			.5—.75DC	● ●	≤.157	.003—.005	≤.236	.003—.005	≤.236	.003—.005
				✱	≤.157	.003—.005	≤.236	.002—.004	≤.236	.002—.004
			DC(Slot)	● ●	≤.079	.002—.004	≤.157	.002—.004	≤.157	.002—.004
				✱	≤.079	.002—.003	≤.157	.002—.003	≤.157	.002—.003
N	Aluminum Alloys	Content Si< 5%	≤.25DC	● ●	≤.236	.004—.008	≤.315	.004—.010	≤.315	.004—.010
				✱	≤.236	.004—.006	≤.315	.004—.008	≤.315	.004—.008
			.25—.5DC	● ●	≤.197	.004—.006	≤.315	.004—.008	≤.315	.004—.008
				✱	≤.197	.003—.005	≤.315	.004—.006	≤.315	.004—.006
			.5—.75DC	● ●	≤.157	.003—.005	≤.236	.002—.006	≤.236	.003—.006
				✱	≤.157	.002—.004	≤.236	.002—.006	≤.236	.003—.006
			DC(Slot)	● ●	≤.079	.002—.004	≤.157	.002—.006	≤.157	.003—.006
				✱	≤.079	.002—.003	≤.157	.002—.005	≤.157	.003—.005
H	Hardened Steels	Hardness 40—55HRC	≤.25DC	● ●	≤.157	.003—.006	≤.157	.003—.006	≤.157	.003—.006
				✱	≤.157	.003—.005	≤.157	.003—.005	≤.157	.003—.005
			.25—.5DC	● ●	≤.118	.003—.005	≤.118	.003—.005	≤.118	.003—.005
				✱	≤.118	.002—.004	≤.118	.003—.004	≤.118	.002—.004
			.5—.75DC	● ●	≤.079	.002—.004	≤.079	.003—.004	≤.079	.002—.004
				✱	≤.079	.002—.003	≤.079	.002—.003	≤.079	.002—.003
			DC(Slot)	● ●	≤.039	.002—.004	≤.039	.002—.004	≤.039	.002—.004
				✱	≤.039	.002—.003	≤.039	.002—.003	≤.039	.002—.003

Note 1) These cutting conditions should be referenced for standard shank types (last letter in designation is S) and arbor shank types. If there is chatter, insert chipping, etc. during machining, alter conditions accordingly.

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- Rigidity of machine, workpiece material or attachment of workpiece material is low
- Corner radius during pocket milling

Note 3) A type with fewer teeth is recommended when the depth of cut in the radius direction (ae) is .5 DC or more.

Note 4) Wet cutting is recommended, when focusing on the surface finish. (Tool life is shorter than for dry cutting.)

Note 5) When using under higher than recommended cutting conditions, or for long periods of time, the clamp screw may become fatigued and break during machining. Please change out the clamp screw periodically.

Cutting Conditions (Guide) :
● : Stable Cutting ◐ : General Cutting ✲ : Unstable Cutting

■ Wet Cutting
Cutting Speed

(inch)

	Workpiece Material	Properties	Cutting Conditions	Grade	Cutting Width **ae** ≤.25DC	.25—.5DC	.5—.75DC	DC(Slot)
					Cutting Speed **vc** (SFM)			
P	Mild Steels	Hardness ≤180HB	● ◐	MP6120	460 (330—620)	425 (295—590)	330 (230—395)	330 (230—395)
			● ◐	VP15TF				
			✲	MP6130				
	Carbon Steels Alloy Steels Alloy Tool Steels	Hardness 180—350HB ≤350HB (Annealing)	● ◐	MP6120	395 (295—460)	360 (260—425)	330 (230—395)	330 (230—395)
			● ◐	VP15TF				
			✲	MP6130				
	Pre-hardened Steels	Hardness 35—45HRC	● ◐	MP6120	330 (260—395)	295 (230—360)	260 (195—330)	260 (195—330)
			● ◐	VP15TF				
			✲	MP6130				
M	Austenitic Stainless Steels	Hardness ≤200HB	○ ◐ ✲	MP7130	395 (330—490)	360 (295—460)	295 (230—395)	295 (230—395)
			○ ◐	VP15TF				
		Hardness >200HB	○ ◐ ✲	MP7130	330 (260—425)	295 (230—360)	230 (165—330)	230 (165—330)
			○ ◐	VP15TF				
	Duplex Stainless Steels	Hardness ≤280HB	○ ◐ ✲	MP7130	330 (260—425)	295 (230—395)	230 (165—330)	230 (165—330)
			○ ◐	VP15TF				
	Ferritic and Martensitic Stainless Steels	—	○ ◐ ✲	MP7130	395 (330—490)	360 (295—460)	295 (230—395)	295 (230—395)
			○ ◐	VP15TF				
	Precipitation Hardening Stainless Steels	Hardness <450HB	○ ◐ ✲	MP7130	295 (230—395)	260 (195—360)	195 (130—295)	195 (130—295)
			○ ◐	VP15TF				
K	Gray Cast Irons	Tensile Strength ≤350MPa	● ◐	MC5020	590 (525—720)	560 (490—690)	490 (425—620)	490 (425—620)
			● ◐ ✲	VP15TF	425 (330—490)	395 (295—460)	330 (260—395)	330 (260—395)
	Ductile Cast Irons	Tensile Strength ≤800MPa	● ◐	MC5020	525 (460—590)	490 (425—560)	425 (360—490)	425 (360—490)
			● ◐ ✲	VP15TF	360 (260—460)	330 (230—425)	260 (195—395)	260 (195—395)
N	Aluminum Alloys	Content Si<5%	● ◐ ✲	TF15	1970 (1310—3280)	1970 (1310—3280)	1970 (1310—3280)	1970 (1310—3280)
S	Titanium Alloys (Ti-6Al-4V,etc.)	—	● ◐	MP9120	165 (130—230)	165 (130—230)	165 (130—230)	165 (130—230)
			● ◐	VP15TF	165 (130—230)	165 (130—230)	165 (130—230)	165 (130—230)
			✲	MP9130	130 (100—195)	130 (100—195)	130 (100—195)	130 (100—195)
	Titanium Alloys (Ti-5Al-5V-5Mo-3Cr,etc.)	—	● ◐	MP9120	100 (65—130)	100 (65—130)	100 (65—130)	100 (65—130)
			● ◐	VP15TF	100 (65—130)	100 (65—130)	100 (65—130)	100 (65—130)
			✲	MP9130	100 (65—130)	100 (65—130)	100 (65—130)	100 (65—130)
	Heat Resistant Alloys	—	● ◐	MP9120	130 (100—195)	130 (100—195)	130 (100—195)	130 (100—195)
			● ◐	VP15TF	130 (100—195)	130 (100—195)	130 (100—195)	130 (100—195)
			✲	MP9130	100 (65—130)	100 (65—130)	100 (65—130)	100 (65—130)
H	Hardened Steels	Hardness 40—55HRC	● ◐ ✲	VP15TF	295 (230—330)	280 (195—330)	230 (165—260)	230 (165—260)

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Recommended Cutting Conditions

■ Wet Cutting

Depth of Cut / Feed per Tooth

(inch)

Workpiece Material		Properties	Cutting Width **ae**	Cutting Conditions	Cutter Diameter **DC** ø.625-ø.750(ø16mm-ø18mm) Depth of Cut **ap**	ø.625-ø.750(ø16mm-ø18mm) Feed per Tooth **fz** (IPT)	ø.875-ø1.000(ø20mm-ø25mm) Depth of Cut **ap**	ø.875-ø1.000(ø20mm-ø25mm) Feed per Tooth **fz** (IPT)	ø1.125-ø2.500(ø28mm-ø63mm) Depth of Cut **ap**	ø1.125-ø2.500(ø28mm-ø63mm) Feed per Tooth **fz** (IPT)
P	Mild Steels	Hardness ≤180HB	≤.25DC	● ◐ ✲	≤.236	.004—.006	≤.315	.004—.008	≤.315	.004—.010
			.25—.5DC	● ◐ ✲	≤.197	.004—.006	≤.315	.004—.006	≤.315	.004—.008
			.5—.75DC	● ◐ ✲	≤.157	.003—.005	≤.236	.003—.005	≤.236	.004—.006
			DC(Slot)	● ◐ ✲	≤.079	.002—.004	≤.157	.002—.004	≤.157	.003—.005
	Carbon Steels Alloy Steels Alloy Tool Steels	Hardness 180—280HB	≤.25DC	● ◐ ✲	≤.236	.004—.006	≤.315	.004—.008	≤.315	.004—.010
			.25—.5DC	● ◐ ✲	≤.197	.003—.005	≤.315	.004—.006	≤.315	.004—.008
			.5—.75DC	● ◐ ✲	≤.157	.003—.005	≤.236	.003—.005	≤.236	.004—.006
			DC(Slot)	● ◐ ✲	≤.079	.002—.004	≤.157	.002—.004	≤.157	.003—.005
	Carbon Steels Alloy Steels Alloy Tool Steels	Hardness 280—350HB ≤350HB (Annealing)	≤.25DC	● ◐ ✲	≤.236	.004—.006	≤.315	.004—.006	≤.315	.004—.008
			.25—.5DC	● ◐ ✲	≤.197	.003—.005	≤.315	.003—.005	≤.315	.004—.006
			.5—.75DC	● ◐ ✲	≤.157	.003—.005	≤.236	.002—.004	≤.236	.003—.005
			DC(Slot)	● ◐ ✲	≤.079	.002—.004	≤.157	.002—.004	≤.157	.002—.004
	Pre-hardened Steels	Hardness 35—45HRC	≤.25DC	● ◐ ✲	≤.236	.004—.006	≤.315	.004—.006	≤.315	.004—.008
			.25—.5DC	● ◐ ✲	≤.197	.003—.005	≤.315	.003—.005	≤.315	.004—.006
			.5—.75DC	● ◐ ✲	≤.157	.003—.005	≤.236	.002—.004	≤.236	.003—.005
			DC(Slot)	● ◐ ✲	≤.079	.002—.004	≤.157	.002—.004	≤.157	.002—.004
M	Austenitic Stainless Steels	—	≤.25DC	○ ◔	≤.236	.004—.006	≤.315	.004—.008	≤.315	.004—.008
				✲	≤.236	.003—.005	≤.315	.003—.006	≤.315	.003—.006
			.25—.5DC	○ ◔	≤.197	.003—.005	≤.315	.003—.006	≤.315	.003—.006
				✲	≤.197	.002—.004	≤.315	.003—.005	≤.315	.003—.005
			.5—.75DC	○ ◔	≤.157	.002—.004	≤.236	.003—.005	≤.236	.003—.005
				✲	≤.157	.002—.003	≤.236	.002—.004	≤.236	.002—.004
			DC(Slot)	○ ◔	≤.079	.002—.004	≤.157	.002—.004	≤.157	.002—.004
				✲	≤.079	.002—.003	≤.157	.002—.003	≤.157	.002—.003
	Duplex Stainless Steels	Hardness ≤280HB	≤.25DC	○ ◔	≤.236	.004—.006	≤.315	.004—.008	≤.315	.004—.008
				✲	≤.236	.003—.005	≤.315	.003—.006	≤.315	.003—.006
			.25—.5DC	○ ◔	≤.197	.003—.005	≤.315	.003—.006	≤.315	.003—.005
				✲	≤.197	.002—.004	≤.315	.003—.005	≤.315	.003—.005
			.5—.75DC	○ ◔	≤.157	.002—.004	≤.236	.003—.005	≤.236	.003—.005
				✲	≤.157	.002—.003	≤.236	.002—.004	≤.236	.002—.004
			DC(Slot)	○ ◔	≤.079	.002—.004	≤.157	.002—.004	≤.157	.002—.004
				✲	≤.079	.002—.003	≤.157	.002—.003	≤.157	.002—.003
	Ferritic and Martensitic Stainless Steels	—	≤.25DC	○ ◔	≤.236	.004—.006	≤.315	.004—.008	≤.315	.004—.008
				✲	≤.236	.003—.005	≤.315	.003—.006	≤.315	.003—.006
			.25—.5DC	○ ◔	≤.197	.003—.005	≤.315	.003—.006	≤.315	.003—.006
				✲	≤.197	.002—.004	≤.315	.003—.005	≤.315	.003—.005
			.5—.75DC	○ ◔	≤.157	.002—.004	≤.236	.003—.005	≤.236	.003—.005
				✲	≤.157	.002—.003	≤.236	.002—.004	≤.236	.002—.004
			DC(Slot)	○ ◔	≤.079	.002—.004	≤.157	.002—.004	≤.157	.002—.004
				✲	≤.079	.002—.003	≤.157	.002—.003	≤.157	.002—.003
	Precipitation Hardening Stainless Steels	Hardness <450HB	≤.25DC	○ ◔	≤.236	.004—.006	≤.315	.004—.006	≤.315	.004—.006
				✲	≤.236	.003—.005	≤.315	.003—.005	≤.315	.003—.005
			.25—.5DC	○ ◔	≤.197	.003—.005	≤.315	.003—.005	≤.315	.003—.005
				✲	≤.197	.002—.004	≤.315	.003—.005	≤.315	.003—.005
			.5—.75DC	○ ◔	≤.157	.002—.004	≤.236	.002—.004	≤.236	.002—.004
				✲	≤.157	.002—.003	≤.236	.002—.003	≤.236	.002—.003
			DC(Slot)	○ ◔	≤.079	.002—.004	≤.157	.002—.004	≤.157	.002—.004
				✲	≤.079	.002—.003	≤.157	.002—.003	≤.157	.002—.003

Note 1) These cutting conditions should be referenced for standard shank types (last letter in designation is S) and arbor shank types. If there is chatter, insert chipping, etc. during machining, alter conditions accordingly.

Note 2) Chattering vibration is more likely under the following circumstances. Use a cut and feed per tooth that are at minimum recommended conditions or below.
- When tool overhang is long (using a long shank, screw-in type, etc.)
- Rigidity of machine, workpiece material or attachment of workpiece material is low
- Corner radius during pocket milling

Note 3) A type with fewer teeth is recommended when the depth of cut in the radius direction (ae) is .5 DC or more.

Note 4) Wet cutting is recommended, when focusing on the surface finish. (Tool life is shorter than for dry cutting.)

Note 5) When using under higher than recommended cutting conditions, or for long periods of time, the clamp screw may become fatigued and break during machining. Please change out the clamp screw periodically.

Cutting Conditions (Guide) :
● : Stable Cutting ◔ : General Cutting ✲ : Unstable Cutting

(inch)

Workpiece Material		Properties	Cutting Width **ae**	Cutting Conditions	Cutter Diameter **DC** ø.625-ø.750(ø16mm-ø18mm) Depth of Cut **ap**	ø.625-ø.750(ø16mm-ø18mm) Feed per Tooth **fz** (IPT)	ø.875-ø1.000(ø20mm-ø25mm) Depth of Cut **ap**	ø.875-ø1.000(ø20mm-ø25mm) Feed per Tooth **fz** (IPT)	ø1.125-ø2.500(ø28mm-ø63mm) Depth of Cut **ap**	ø1.125-ø2.500(ø28mm-ø63mm) Feed per Tooth **fz** (IPT)
K	Gray Cast Irons	Tensile Strength ≤350MPa	≤.25DC	● ◔	≤.236	.004—.006	≤.315	.004—.008	≤.315	.004—.010
				✲	≤.236	.003—.005	≤.315	.003—.006	≤.315	.004—.008
			.25—.5DC	● ◔	≤.197	.003—.005	≤.315	.003—.006	≤.315	.004—.008
				✲	≤.197	.002—.004	≤.315	.003—.005	≤.315	.004—.006
			.5—.75DC	● ◔	≤.157	.003—.005	≤.236	.002—.004	≤.236	.004—.006
				✲	≤.157	.003—.005	≤.236	.002—.004	≤.236	.003—.005
			DC(Slot)	● ◔	≤.079	.002—.004	≤.157	.002—.004	≤.157	.003—.006
				✲	≤.079	.002—.003	≤.157	.002—.003	≤.157	.002—.004
	Ductile Cast Irons	Tensile Strength ≤800MPa	≤.25DC	● ◔	≤.236	.004—.006	≤.315	.004—.008	≤.315	.004—.008
				✲	≤.236	.003—.005	≤.315	.004—.006	≤.315	.004—.006
			.25—.5DC	● ◔	≤.197	.003—.005	≤.315	.004—.006	≤.315	.004—.006
				✲	≤.197	.002—.004	≤.315	.003—.005	≤.315	.003—.005
			.5—.75DC	● ◔	≤.157	.003—.005	≤.236	.003—.005	≤.236	.003—.005
				✲	≤.157	.003—.005	≤.236	.003—.005	≤.236	.002—.004
			DC(Slot)	● ◔	≤.079	.002—.004	≤.157	.002—.004	≤.157	.002—.004
				✲	≤.079	.002—.003	≤.157	.002—.003	≤.157	.002—.003
N	Aluminum Alloys	Content Si< 5%	≤.25DC	● ◔	≤.236	.004—.008	≤.315	.004—.010	≤.315	.004—.010
				✲	≤.236	.004—.006	≤.315	.004—.008	≤.315	.004—.008
			.25—.5DC	● ◔	≤.197	.004—.006	≤.315	.004—.008	≤.315	.004—.008
				✲	≤.197	.003—.005	≤.315	.004—.006	≤.315	.004—.006
			.5—.75DC	● ◔	≤.157	.003—.005	≤.236	.002—.006	≤.236	.003—.006
				✲	≤.157	.002—.004	≤.236	.002—.006	≤.236	.003—.006
			DC(Slot)	● ◔	≤.079	.002—.004	≤.157	.002—.006	≤.157	.003—.006
				✲	≤.079	.002—.003	≤.157	.002—.005	≤.157	.003—.005
S	Titanium Alloys (Ti-6Al-4V,etc.)	—	≤.25DC	● ◔ ✲	≤.236	.003—.006	≤.315	.003—.006	≤.315	.003—.006
			.25—.5DC	● ◔ ✲	≤.197	.003—.005	≤.315	.003—.005	≤.315	.003—.005
			.5—.75DC	● ◔ ✲	≤.157	.002—.004	≤.236	.002—.004	≤.236	.002—.004
			DC(Slot)	● ◔ ✲	≤.079	.002—.004	≤.157	.002—.004	≤.157	.002—.004
	Titanium Alloys (Ti-5Al-5V-5Mo-3Cr,etc.)	—	≤.25DC	● ◔ ✲	≤.236	.003—.005	≤.315	.003—.005	≤.315	.003—.005
			.25—.5DC	● ◔ ✲	≤.197	.003—.005	≤.315	.003—.005	≤.315	.003—.005
			.5—.75DC	● ◔ ✲	≤.157	.002—.004	≤.236	.002—.004	≤.236	.002—.004
			DC(Slot)	● ◔ ✲	≤.079	.002—.004	≤.157	.002—.004	≤.157	.002—.004
	Heat Resistant Alloys	—	≤.25DC	● ◔ ✲	≤.236	.003—.005	≤.315	.003—.005	≤.315	.003—.005
			.25—.5DC	● ◔ ✲	≤.197	.003—.005	≤.315	.003—.005	≤.315	.003—.005
			.5—.75DC	● ◔ ✲	≤.157	.002—.004	≤.236	.002—.004	≤.236	.002—.004
			DC(Slot)	● ◔ ✲	≤.079	.002—.004	≤.157	.002—.004	≤.157	.002—.004
H	Hardened Steels	Hardness 40—55HRC	≤.25DC	● ◔	≤.157	.003—.006	≤.157	.003—.006	≤.157	.003—.006
				✲	≤.157	.003—.005	≤.157	.003—.005	≤.157	.003—.005
			.25—.5DC	● ◔	≤.118	.003—.005	≤.118	.003—.005	≤.118	.003—.005
				✲	≤.118	.002—.004	≤.118	.002—.004	≤.118	.002—.004
			.5—.75DC	● ◔	≤.079	.002—.004	≤.079	.002—.004	≤.079	.002—.004
				✲	≤.079	.002—.004	≤.079	.002—.004	≤.079	.002—.004
			DC(Slot)	● ◔	≤.039	.002—.004	≤.039	.002—.004	≤.039	.002—.004
				✲	≤.039	.002—.004	≤.039	.002—.004	≤.039	.002—.004

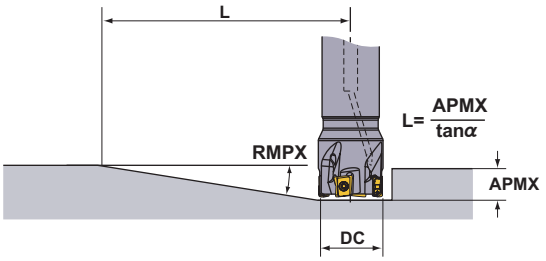
Note 1) These cutting conditions should be referenced for standard shank types (last letter in designation is S) and arbor shank types. If there is chatter, insert chipping, etc. during machining, alter conditions accordingly.
Note 2) Chattering vibration is more likely under the following circumstances. Use a cut and feed per tooth that are at minimum recommended conditions or below.
- When tool overhang is long (using a long shank, screw-in type, etc.)
- Rigidity of machine, workpiece material or attachment of workpiece material is low
- Corner radius during pocket milling

Note 3) A type with fewer teeth is recommended when the depth of cut in the radius direction (ae) is .5 DC or more.
Note 4) Wet cutting is recommended, when focusing on the surface finish. (Tool life is shorter than for dry cutting.)
Note 5) When using under higher than recommended cutting conditions, or for long periods of time, the clamp screw may become fatigued and break during machining. Please change out the clamp screw periodically.

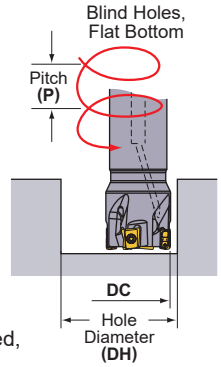
Recommended Cutting Conditions

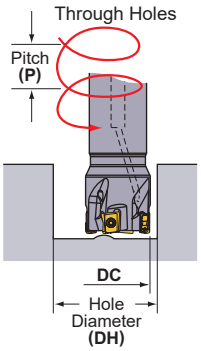
Ramping / Helical Milling

● **Ramping**



● **Helical Milling**





Refer to the table below for cutting conditions. For feed per tooth and cutting speed, follow the cutting conditions for slot milling.

(inch)

Cutting Edge Diameter **DC**	**RE**	Ramping		Helical Milling (Blind Hole, Flat Bottom)				Helical Milling (Through Hole)	
		Maximum Ramping Angle **RMPX**	Minimum * Distance **L**	Maximum Hole Diameter **DH max.**	Maximum Pitch **P max.**	Minimum Hole Diameter **DH min.**	Maximum Pitch **P max.**	Minimum Hole Diameter **DH min.**	Maximum Pitch **P max.**
.625	.008	1.87°	9.7	1.213	.060	1.072	.046	.942	.032
	.016	1.87°	9.7	1.197	.059	1.073	.046	.942	.032
	.031	1.87°	9.7	1.165	.055	1.073	.046	.942	.032
	.039	1.87°	9.7	1.150	.054	1.073	.046	.942	.032
	.047	1.87°	9.7	1.134	.052	1.073	.046	.942	.032
	.063	1.87°	9.7	1.102	.049	1.073	.046	.942	.032
.750	.008	1.43°	12.6	1.463	.056	1.323	.045	1.187	.034
	.016	1.43°	12.6	1.447	.055	1.323	.045	1.187	.034
	.031	1.43°	12.6	1.415	.052	1.323	.045	1.187	.034
	.039	1.43°	12.6	1.400	.051	1.323	.045	1.187	.034
	.047	1.43°	12.6	1.384	.050	1.323	.045	1.187	.034
	.063	1.43°	12.6	1.352	.047	1.323	.045	1.187	.034
.875	.008	1.14°	15.9	1.713	.052	1.574	.044	1.435	.035
	.016	1.14°	15.9	1.697	.051	1.574	.044	1.435	.035
	.031	1.14°	15.9	1.665	.049	1.574	.044	1.435	.035
	.039	1.14°	15.9	1.650	.048	1.574	.044	1.435	.035
	.047	1.14°	15.9	1.634	.047	1.574	.044	1.435	.035
	.063	1.14°	15.9	1.602	.045	1.575	.044	1.435	.035
1.000	.008	0.95°	19.0	1.963	.050	1.824	.043	1.685	.036
	.016	0.95°	19.0	1.947	.049	1.824	.043	1.685	.036
	.031	0.95°	19.0	1.915	.048	1.824	.043	1.685	.036
	.039	0.95°	19.0	1.900	.047	1.824	.043	1.685	.036
	.047	0.95°	19.0	1.884	.046	1.824	.043	1.685	.036
	.063	0.95°	19.0	1.852	.044	1.825	.043	1.685	.036
1.125	.008	0.82°	22.0	2.213	.049	2.074	.043	1.935	.036
	.016	0.82°	22.0	2.197	.048	2.074	.043	1.935	.036
	.031	0.82°	22.0	2.165	.047	2.074	.043	1.935	.036
	.039	0.82°	22.0	2.150	.046	2.074	.043	1.935	.036
	.047	0.82°	22.0	2.134	.045	2.074	.043	1.935	.036
	.063	0.82°	22.0	2.102	.044	2.075	.043	1.935	.036
1.250	.008	0.71°	25.4	2.463	.047	2.320	.042	2.183	.036
	.016	0.71°	25.4	2.447	.047	2.320	.042	2.183	.036
	.031	0.71°	25.4	2.415	.045	2.320	.042	2.183	.036
	.039	0.71°	25.4	2.400	.045	2.320	.042	2.183	.036
	.047	0.71°	25.4	2.384	.044	2.320	.042	2.183	.036
	.063	0.71°	25.4	2.352	.043	2.321	.042	2.183	.036

Note 1) When machining a highly ductile workpiece material with the ramping angles in the table above, chips may be elongated.
* Shows the distance until a maximum depth of cut of .315" is achieved at the maximum ramping angle L (= .315"/tan α).

(inch)

Cutting Edge Diameter **DC**	**RE**	Ramping		Helical Milling (Blind Hole, Flat Bottom)				Helical Milling (Through Hole)	
		Maximum Ramping Angle **RMPX**	Minimum * Distance **L**	Maximum Hole Diameter **DH max.**	Maximum Pitch **P max.**	Minimum Hole Diameter **DH min.**	Maximum Pitch **P max.**	Minimum Hole Diameter **DH min.**	Maximum Pitch **P max.**
1.375	.008	0.64°	28.2	2.713	.047	2.574	.042	2.435	.037
	.016	0.64°	28.2	2.697	.046	2.574	.042	2.435	.037
	.031	0.64°	28.2	2.665	.045	2.574	.042	2.435	.037
	.039	0.64°	28.2	2.650	.045	2.574	.042	2.435	.037
	.047	0.64°	28.2	2.634	.044	2.574	.042	2.435	.037
	.063	0.64°	28.2	2.602	.043	2.574	.042	2.435	.037
1.500	.008	0.57°	31.7	2.963	.046	2.820	.041	2.683	.037
	.016	0.57°	31.7	2.947	.045	2.820	.041	2.683	.037
	.031	0.57°	31.7	2.915	.044	2.820	.041	2.683	.037
	.039	0.57°	31.7	2.900	.044	2.820	.041	2.683	.037
	.047	0.57°	31.7	2.884	.043	2.820	.041	2.683	.037
	.063	0.57°	31.7	2.852	.042	2.821	.041	2.683	.037
2.000	.008	0.41°	44.0	3.963	.044	3.820	.041	3.683	.038
	.016	0.41°	44.0	3.947	.044	3.820	.041	3.683	.038
	.031	0.41°	44.0	3.915	.043	3.820	.041	3.683	.038
	.039	0.41°	44.0	3.900	.043	3.820	.041	3.683	.038
	.047	0.41°	44.0	3.884	.042	3.820	.041	3.683	.038
	.063	0.41°	44.0	3.852	.042	3.820	.041	3.683	.038
2.500	.008	0.32°	56.4	4.963	.043	4.820	.041	4.683	.038
	.016	0.32°	56.4	4.947	.043	4.820	.041	4.683	.038
	.031	0.32°	56.4	4.915	.042	4.820	.041	4.683	.038
	.039	0.32°	56.4	4.900	.042	4.820	.041	4.683	.038
	.047	0.32°	56.4	4.884	.042	4.820	.041	4.683	.038
	.063	0.32°	56.4	4.852	.041	4.820	.041	4.683	.038

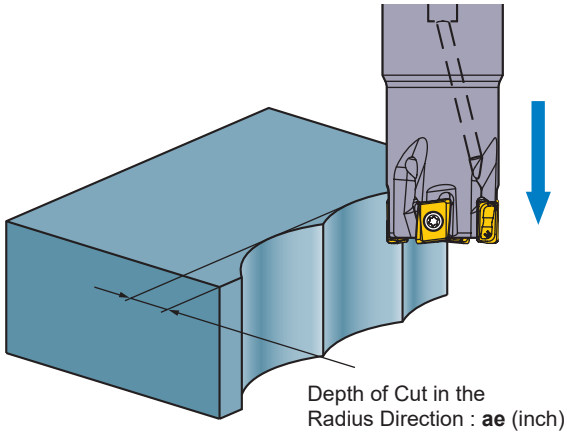
Note 1) When machining a highly ductile workpiece material with the ramping angles in the table above, chips may be elongated.
* Shows the distance until a maximum depth of cut of .315” is achieved at the maximum ramping angle L (= .315”/tan α).

Recommended Cutting Conditions

For Plunging and Drilling

See the tables to the right for cutting conditions. Follow the cutting conditions for slot milling regarding feed per tooth and cutting speed.

● **Plunging**

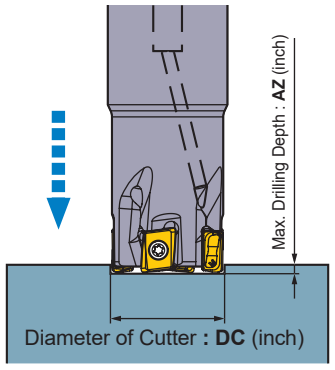


(inch)

DC	ae max.
.625	.154
.750	.154
.875	.157
1.000	.157
1.125	.157
1.250	.157
1.375	.157
1.500	.157
2.000	.157
2.500	.157

Note 1) No step feed necessary.

● **Drilling**



(inch)

DC	AZ max.
.625	.012
.750	.012
.875	.012
1.000	.012
1.125	.012
1.250	.012
1.375	.012
1.500	.012
2.000	.012
2.500	.012

Note 1) Exercise due caution as chips scatter easily.
Note 2) Use compressed air to eliminate chips (or coolant for when machining aluminum alloy).