DIA EDGE
TOOL NEWS
2022.9 Update
B197G

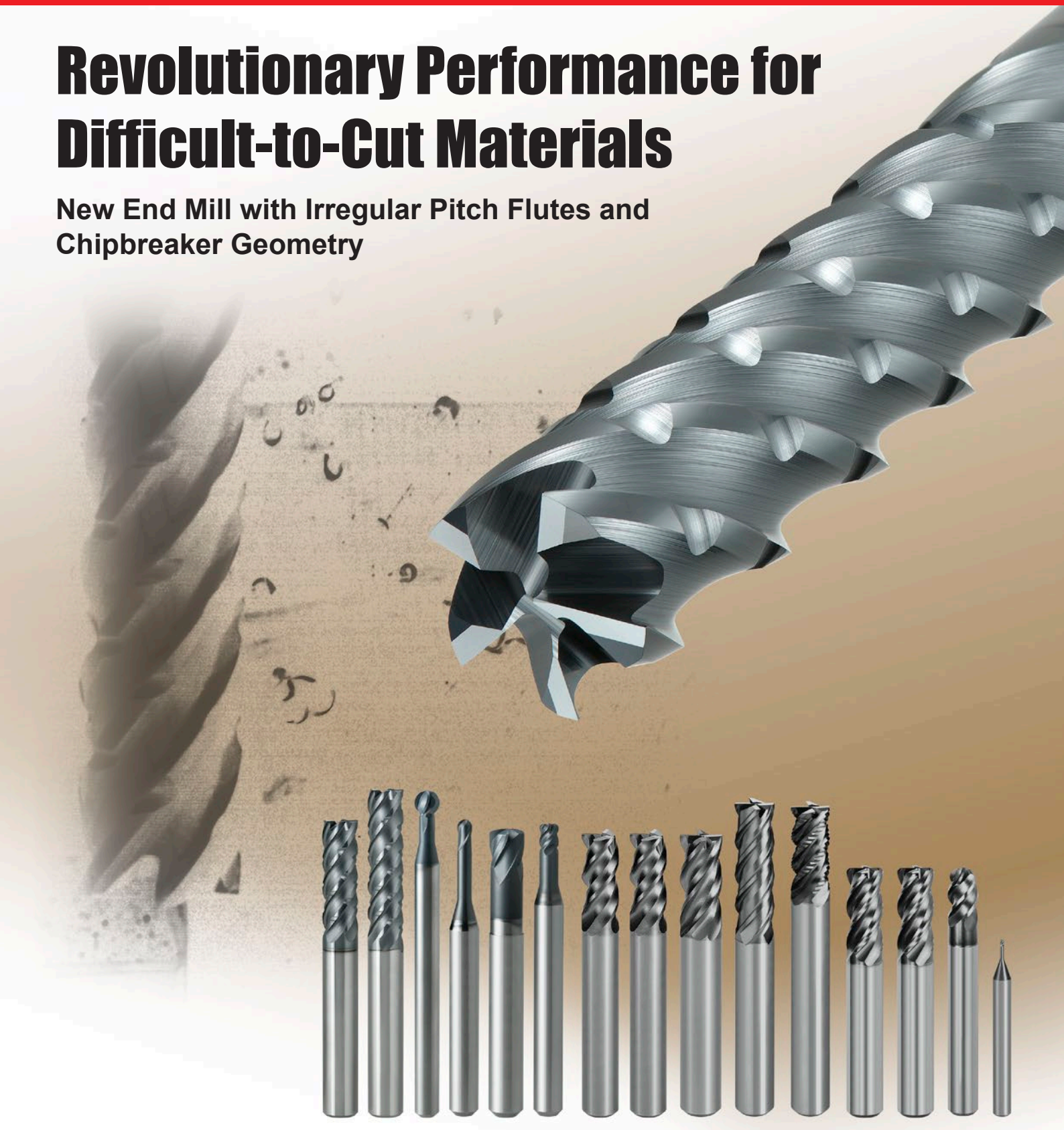
Vibration Control End Mills for Machining Difficult-to-Cut Materials

SMART MIRACLE

Series Expansion

Revolutionary Performance for Difficult-to-Cut Materials

New End Mill with Irregular Pitch Flutes and Chipbreaker Geometry

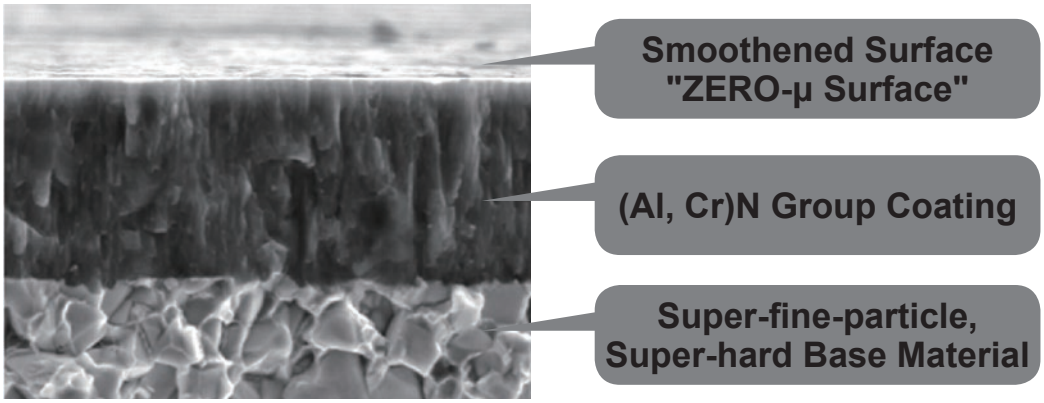


MITSUBISHI MATERIALS CORPORATION

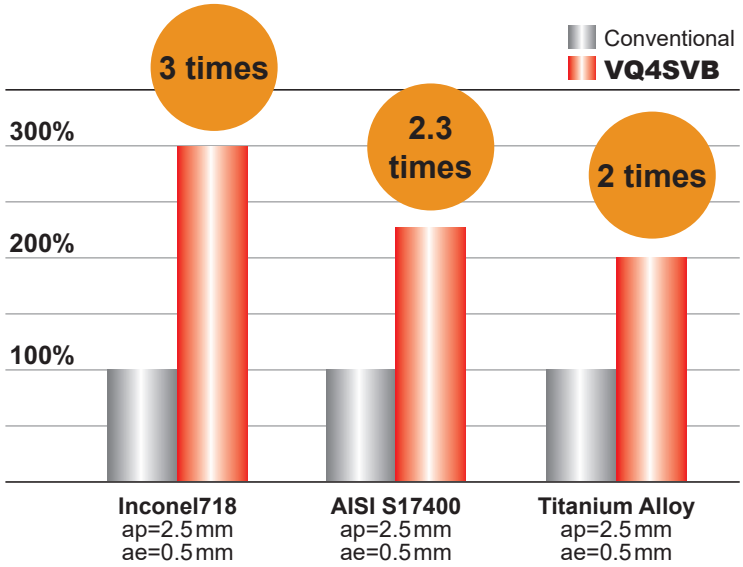
SMART MIRACLE

SMART MIRACLE Coating

SMART MIRACLE end mills have been treated with a (Al, Cr)N group coating which delivers substantially better wear resistance. The surface of the coating has been given a smoothening treatment resulting in better machined surfaces, reduced cutting resistance and improved chip discharge. These coated end mills deliver long tool life when machining stainless steels and other difficult-to-cut materials.



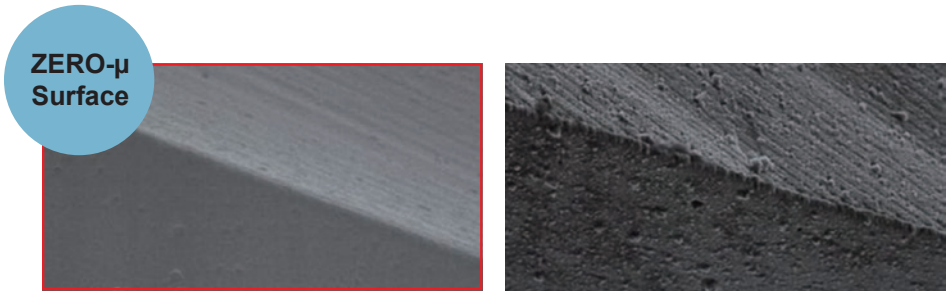
VQ4SVB achieves double tool life when machining difficult-to-cut materials.



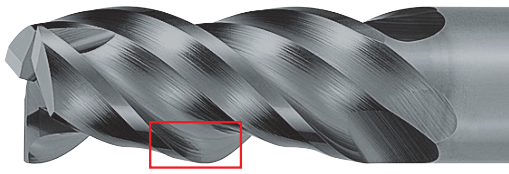
See page 70 for test data details.

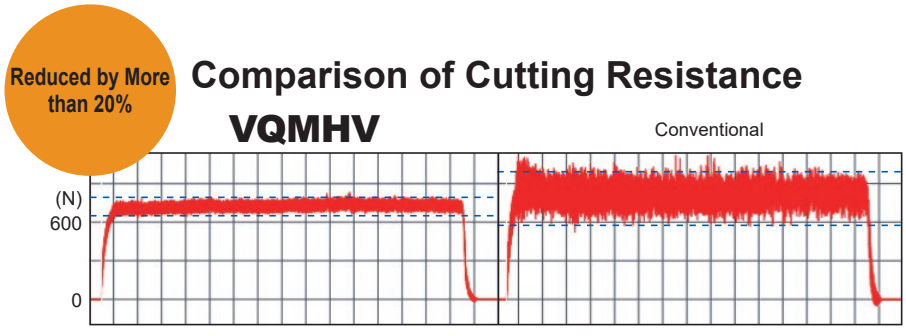
ZERO-μ Surface

With the unique ZERO-μ Surface, the cutting edge retains its sharpness. While previous technologies often resulted in diminished sharpness, the ZERO-μ Surface achieves both smoothness and sharpness, as well as longer tool life.



SMART MIRACLE Coating | Conventional Coating





<Cutting Conditions>

Work Material	: AISI 304
End Mill	: VQMHVD0600 (DC=6mm)
Revolution	: 2650min^{-1}
Cutting Speed	: 50m/min
Feed Rate	: 320mm/min (0.03mm/t.)
Depth of Cut	: ap=6mm
Overhang Length	: 20mm
Cutting Mode	: Down (Climb) Cut External Coolant (Emulsion)
Machine	: Vertical M/C (BT50)

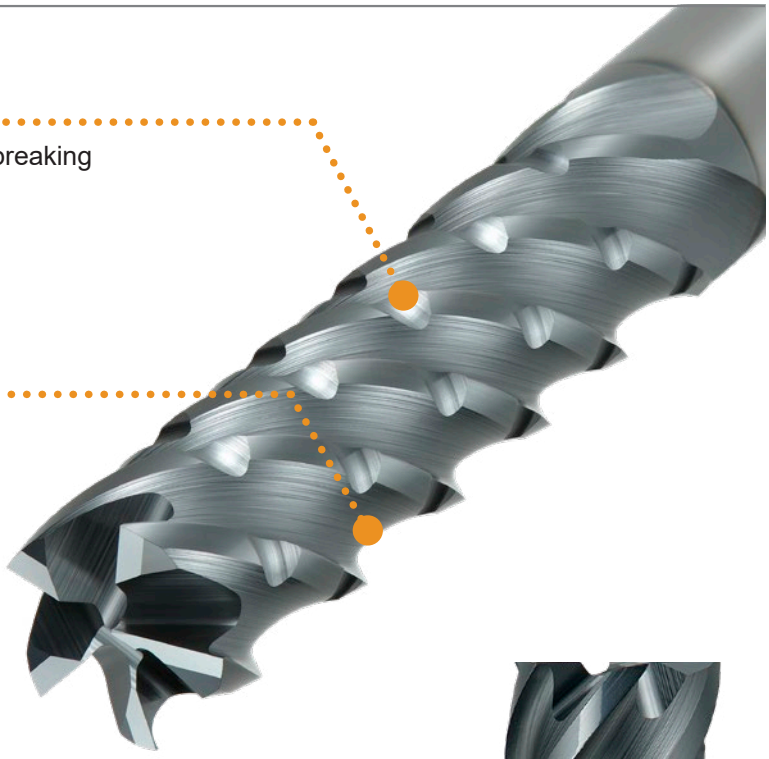
New Line-up

End mill, 5 flute, Irregular pitch flutes, Chip breaker

VQJCS/VQLCS

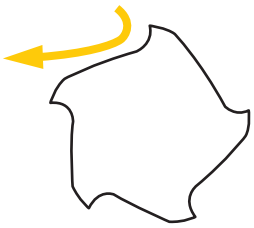
Chip Breaker Function

Prevents chip problems by combining great chip breaking capabilities and fracture resistance.



Chip Pocket Geometry for High Efficiency Machining

The rigid cross-sectional geometry with excellent chip evacuation properties is ideal for high efficiency machining such as trochoidal milling.



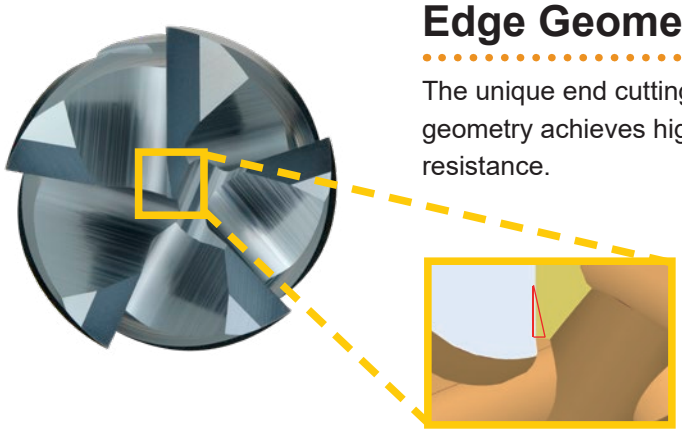
Ideal chip pocket geometry

Irregular Pitch Flutes and Micro Clearance Angle of the Peripheral Cutting Edge

Due to its excellent vibration damping properties, chatter and vibration are suppressed making stable machining possible.

Unique End Cutting Edge Geometry

The unique end cutting edge geometry achieves high chipping resistance.

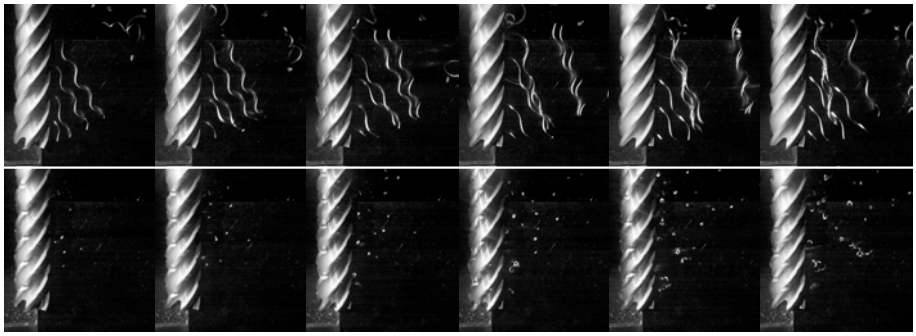


Chip Breaker Function : High-Speed Camera Comparison

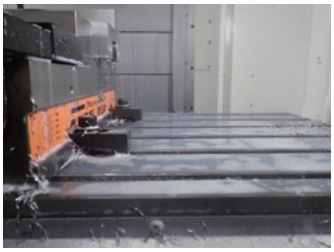
The excellent chip breaking properties reduce chip clogging and remove chips efficiently also suppressing chip pilling on the machine.

Conventional

VQLCS



After Machining with Conventional



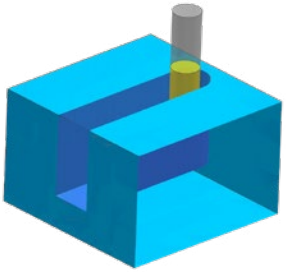
After Machining with **VQLCS**

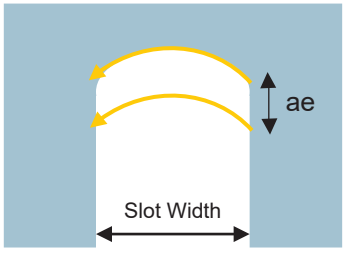
YouTube

Evaluation of Trochoidal Milling

	ae=1.8 mm	ae=2.4 mm	ae=3.0 mm	ae=3.6 mm	ae=6.0mm
VQLCS	YES	YES	YES	YES	YES
Conventional A	YES	YES	YES	NO	
Conventional B	YES	NO			

YES : Achieves Stable Machining
NO : Problems Caused by Chips





<Cutting Conditions>

Work Material	: JIS SUS304
Tool	: DC=Ø12mm
Cutting Speed	: vc=100m/min
Feed Rate	: ft=0.05mm/t.
Depth of Cut	: ap=24mm, DCx2 ae(Pitch)=1.8 - 6.0 mm Slot Width=18mm (DCx1.5)
Overhang Length	: 60mm (DCx5)
Cutting Mode	: Trochoidal Milling External Coolant(Emulsion)

SERIES SELECTION CHART

(mm)

Figure	No. of Flutes	Type	Specifications	Shape	Coolant (Int, Ext)	Dia. DC Min.	Dia. DC Max.	APMX Max. DC	Size	Workpiece Material P: Carbon Steel	P: Tool Steel	M: Stainless Steel	S: Titanium Alloy, Heat Resistant Alloy	N: Copper Alloy	Page	Features
SQUARE	3	VQMHZV	Irregular helix Slotting		Ext	1	20	32	50	◎	◎	◎	◎	○	P.7	P.64
SQUARE	3	VQMHZVOH	Irregular helix Slotting		Int	6	16	30	5	◎	◎	◎	◎	○	P.13	P.64
SQUARE	4	VQMHV	Irregular helix Slim shank type available		Ext	1	25	55	28	◎	◎	◎	◎	○	P.17	P.67
SQUARE	4	VQJHV	Irregular helix		Ext	1	20	70	17	◎	◎	◎	◎	○	P.21	P.67
SQUARE	5	NEW VQJCS	Irregular pitch Chip breaker		Ext	6	20	60	6	◎	◎	◎	◎	○	P.23	P.3
SQUARE	5	NEW VQLCS	Irregular pitch Chip breaker		Ext	6	12	48	4	◎	◎	◎	◎	○	P.25	P.3
SQUARE	6	VQ6MHVCH	**CoolStar** Irregular helix		Int	10	20	38	4	○	○	◎	◎	○	P.27	P.56
LONG NECK SQUARE	3-4	VQXL	Small diameter Multi-cutters		Ext	0.2	1	1.5	14	◎	◎	◎	◎	○	P.28	P.6
RADIUS	4	VQMHVRB	Irregular helix		Ext	2	20	45	45	◎	◎	◎	◎	○	P.40	P.67
RADIUS	4	VQMHVRBF	Irregular helix Finishing		Ext	6	16	35	14	◎	◎	◎	◎	○	P.45	P.67
RADIUS	4	VQHVRB	Irregular helix		Ext	1	4	4	8				◎		P.47	P.58
RADIUS	4	VQFDRB	Duplex corner radius		Ext	3	6	0.36	5				◎		P.49	P.57
RADIUS	6	VQ6MHVRBCH	**CoolStar** Irregular helix		Int	10	20	38	10	○	○	◎	◎		P.51	P.56
ROUGHING	3-4	VQSVR	Irregular helix		Ext	3	20	38	15	◎	◎	◎	◎	○	P.53	P.65

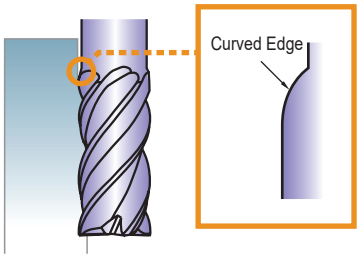
(mm)

Figure	No. of Flutes	Type	Specifications	Shape	Coolant (Int, Ext)	Corner R RE Min.	Corner R RE Max.	APMX Max. RE	Size	Workpiece Material P Carbon Steel	P Tool Steel	M Stainless Steel	S Titanium Alloy, Heat Resistant Alloy	N Copper Alloy	Page	Features
BALL	4	VQ4SVB	Irregular pitch		Ext	1	6	18	8	◎	◎	◎	◎	○	P.35	P.63
LONG NECK BALL	2	VQ2XLB	Reinforced cutting edge		Ext	0.5	1.5	2.3	14				◎		P.33	P.59
LOLLIPOP	4	VQ4WB	Multi-functional		Ext	0.5	3	5.29	11	◎	◎	◎	◎	○	P.37	P.60

VQMHV Undercut Size

Curved Edge

A curved edge at the shank side of the flute is used in the undercut shank type 4 flute VQMHV end mills with irregular helix flutes.
Achieves good surface finishes because undercut size allows deep faces to be finished in steps and minimizes the blend mark between steps.

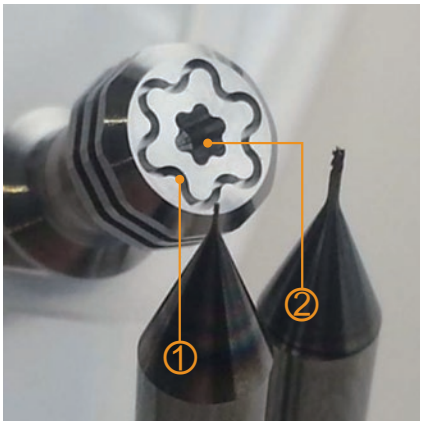


VQXL Application Example

<Cutting Conditions>
Work Material : Ti-6Al-4V ELV
Cutting Mode : External Coolant (Emulsion)
Machining : CNC Automatic Lathe

①
Tool Size : DC=0.2mm 3 flutes
Revolution : 17000min^{-1}
Feed Rate : 50−80mm/min
Depth of Cut : ap=0.025mm

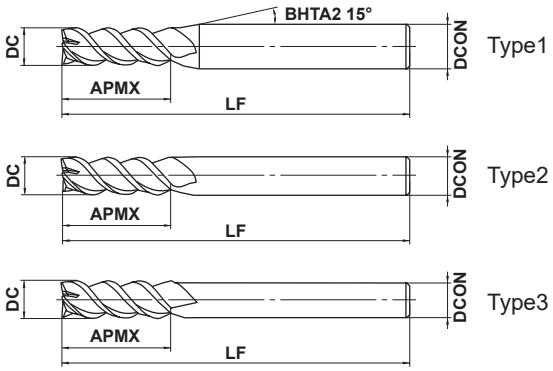
②
Tool Size : DC=0.4mm 4 flutes
Revolution : 17000min^{-1}
Feed Rate : 100mm/min
Depth of Cut : ap=0.05mm
Cutting Method : Machining of TORX There is a Pre-hole



VQMHZV

End mill, Medium cutting length, 3 flute for drilling and slotting

Carbon Steel, Alloy Steel, Cast Iron (<30HRC)	Tool Steel, Pre-hardened Steel,Hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Hardened Steel (>55HRC)	Austenitic Stainless Steel	Titanium Alloy, Heat Resistant Alloy	Copper Alloy	Aluminium Alloy
◎	◎			◎	◎	○	



DC≤12	DC>12			
0 - 0.02	0 - 0.03			
4≤DCON≤6	8≤DCON≤10	12≤DCON≤16	DCON=20	
0 - 0.008	0 - 0.009	0 - 0.011	0 - 0.013	

●A single end mill for both plunging and slotting.
●Irregular helical geometry controls the vibration.

(mm)

Order Number	DC	APMX	LF	DCON	No. of Flutes	Stock	Type
VQMHZVD0100	1	2	45	4	3	●	1
VQMHZVD0110	1.1	2.2	45	4	3	●	1
VQMHZVD0120	1.2	2.4	45	4	3	●	1
VQMHZVD0130	1.3	2.6	45	4	3	●	1
VQMHZVD0140	1.4	2.8	45	4	3	●	1
VQMHZVD0150	1.5	3	45	4	3	●	1
VQMHZVD0160	1.6	3.2	45	4	3	●	1
VQMHZVD0170	1.7	3.4	45	4	3	●	1
VQMHZVD0180	1.8	3.6	45	4	3	●	1
VQMHZVD0190	1.9	3.8	45	4	3	●	1
VQMHZVD0200	2	4	50	6	3	●	1
VQMHZVD0210	2.1	4.2	50	6	3	●	1
VQMHZVD0220	2.2	4.4	50	6	3	●	1
VQMHZVD0230	2.3	4.6	50	6	3	●	1
VQMHZVD0240	2.4	4.8	50	6	3	●	1
VQMHZVD0250	2.5	5	50	6	3	●	1
VQMHZVD0260	2.6	5.2	50	6	3	●	1
VQMHZVD0270	2.7	5.4	50	6	3	●	1
VQMHZVD0280	2.8	5.6	50	6	3	●	1
VQMHZVD0290	2.9	5.8	50	6	3	●	1
VQMHZVD0300	3	6	50	6	3	●	1
VQMHZVD0310	3.1	7	50	6	3	●	1
VQMHZVD0320	3.2	7	50	6	3	●	1
VQMHZVD0330	3.3	7	50	6	3	●	1
VQMHZVD0340	3.4	7	50	6	3	●	1
VQMHZVD0350	3.5	8	50	6	3	●	1
VQMHZVD0360	3.6	8	50	6	3	●	1
VQMHZVD0370	3.7	8	50	6	3	●	1
VQMHZVD0380	3.8	8	50	6	3	●	1
VQMHZVD0390	3.9	8	50	6	3	●	1
VQMHZVD0400	4	8	50	6	3	●	1
VQMHZVD0450	4.5	10	50	6	3	●	1

Note 1) SMART MIRACLE Coating is not energized because of its nature. Therefore, an external contact (voltaic type) tool setter cannot be used. An internal contact (non-voltaic) type or laser type tool setter is recommended to measure the length of the tool.

● : Inventory maintained in Japan.

(mm)

Order Number	DC	APMX	LF	DCON	No. of Flutes	Stock	Type
VQMHZVD0500	5	10	50	6	3	●	1
VQMHZVD0550	5.5	13	50	6	3	●	1
VQMHZVD0600	6	13	60	6	3	●	2
VQMHZVD0650	6.5	16	60	8	3	●	1
VQMHZVD0700	7	16	60	8	3	●	1
VQMHZVD0750	7.5	16	60	8	3	●	1
VQMHZVD0800	8	19	70	8	3	●	2
VQMHZVD0850	8.5	19	70	10	3	●	1
VQMHZVD0900	9	19	70	10	3	●	1
VQMHZVD0950	9.5	19	70	10	3	●	1
VQMHZVD1000	10	22	80	10	3	●	2
VQMHZVD1100	11	22	80	12	3	●	1
VQMHZVD1200	12	26	90	12	3	●	2
VQMHZVD1300	13	26	90	12	3	●	3
VQMHZVD1400	14	26	90	12	3	●	3
VQMHZVD1500	15	26	110	16	3	●	1
VQMHZVD1600	16	30	110	16	3	●	2
VQMHZVD2000	20	32	140	20	3	●	2

Note 1) SMART MIRACLE Coating is not energized because of its nature. Therefore, an external contact (voltaic type) tool setter cannot be used. An internal contact (non-voltaic) type or laser type tool setter is recommended to measure the length of the tool.

DC = Cutting dia. **LF** = Functional length
APMX = Depth of cut max. **DCON** = Connection dia.

VQMHZV

End mill, Medium cutting length, 3 flute for drilling and slotting

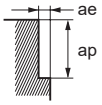
RECOMMENDED CUTTING CONDITIONS

■ Side milling

Select the high efficiency condition if the mechanical rigidity, the rigidity of the work material, and the chip evacuation are sufficient, and select the general-purpose condition if any of them is insufficient.

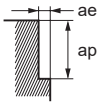
High efficiency conditions

(mm)

Work Material	Carbon steel, Alloy steel, Mild steel AISI 1045, AISI 4140, ASTM A36, AISI 1010					Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel AISI P21, AISI P20, AISI 4340, SKD, SKT					Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys AISI 304, AISI 316, Ti-6Al-4V					Hardened stainless steels, Cobaly chromium alloy AISI 630, AISI 631 15-5PH, 17-4PH				
Dia. DC	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae
1	100	32000	720	1.5	0.2	80	25000	530	1.5	0.2	60	19000	430	1.5	0.2	50	16000	340	1.5	0.1
1.5	130	28000	1300	2.25	0.3	100	21000	630	2.25	0.3	85	18000	540	2.25	0.3	65	14000	420	2.25	0.15
2	150	24000	1800	3	0.6	120	19000	860	3	0.6	100	16000	620	3	0.6	75	12000	540	3	0.4
3	150	16000	1900	4.5	0.9	120	13000	940	4.5	0.9	100	11000	660	4.5	0.9	75	8000	580	4.5	0.6
4	150	12000	2000	6	1.2	120	9500	940	6	1.2	100	8000	670	6	1.2	75	6000	590	6	0.8
5	150	9500	1900	7.5	1.5	120	7600	960	7.5	1.5	100	6400	670	7.5	1.5	75	4800	600	7.5	1
6	150	8000	1900	9	1.8	120	6400	960	9	1.8	100	5300	830	9	1.8	75	4000	600	9	1.2
8	150	6000	1900	12	2.4	120	4800	1000	12	2.4	100	4000	900	12	2.4	75	3000	630	12	1.6
10	150	4800	1700	15	3	120	3800	910	15	3	100	3200	960	15	3	75	2400	580	15	2
12	150	4000	1400	18	3.6	120	3200	860	18	3.6	100	2700	890	18	3.6	75	2000	540	18	2.4
16	150	3000	1200	24	4.8	120	2400	720	24	4.8	100	2000	720	24	4.8	75	1500	450	24	3.2
20	150	2400	970	30	6	120	1900	570	30	6	100	1600	580	30	6	75	1200	360	30	4
Depth of cut																				

General-purpose conditions

(mm)

Work Material	Carbon steel, Alloy steel, Mild steel AISI 1045, AISI 4140, ASTM A36, AISI 1010					Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel AISI P21, AISI P20, AISI 4340, SKD, SKT					Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys AISI 304, AISI 316, Ti-6Al-4V					Hardened stainless steels, Cobaly chromium alloy AISI 630, AISI 631 15-5PH, 17-4PH				
Dia. DC	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae
1	100	32000	480	1.5	0.2	80	25000	350	1.5	0.2	60	19000	280	1.5	0.2	50	16000	220	1.5	0.1
1.5	120	25000	740	2.25	0.3	100	21000	420	2.25	0.3	80	17000	340	2.25	0.3	65	14000	280	2.25	0.15
2	120	19000	940	3	0.6	100	16000	480	3	0.6	80	13000	340	3	0.6	70	11000	330	3	0.4
3	120	13000	1000	4.5	0.9	100	11000	520	4.5	0.9	80	8500	340	4.5	0.9	70	7400	350	4.5	0.6
4	120	9500	1000	6	1.2	100	8000	520	6	1.2	80	6400	350	6	1.2	70	5600	370	6	0.8
5	120	7600	980	7.5	1.5	100	6400	530	7.5	1.5	80	5100	350	7.5	1.5	70	4500	370	7.5	1
6	120	6400	1000	9	1.8	100	5300	540	9	1.8	80	4200	400	9	1.8	70	3700	370	9	1.2
8	120	4800	1000	12	2.4	100	4000	550	12	2.4	80	3200	430	12	2.4	70	2800	390	12	1.6
10	120	3800	900	15	3	100	3200	510	15	3	80	2500	450	15	3	70	2200	350	15	2
12	120	3200	760	18	3.6	100	2700	480	18	3.6	80	2100	420	18	3.6	70	1900	340	18	2.4
16	120	2400	640	24	4.8	100	2000	400	24	4.8	80	1600	340	24	4.8	70	1400	280	24	3.2
20	120	1900	510	30	6	100	1600	320	30	6	80	1300	270	30	6	70	1100	220	30	4
Depth of cut																				

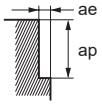
Note 1) SMART MIRACLE Coating is not energized because of its nature. Therefore, an external contact (voltaic type) tool setter cannot be used. An internal contact (non-voltaic) type or laser type tool setter is recommended to measure the length of the tool.
Note 2) Effective cutting of stainless steel, titanium alloys and heat resistant alloys etc. can be achieved with the use of emulsion.
Note 3) Vibration damping end mills are more effective in suppressing chatter and vibration compared to general end mills, but these may still occur if the rigidity of the machine or the workpiece material is low.
Note 4) When the depth of cut is smaller than shown the feed rate can be increased.

■ Side milling

Select the high efficiency condition if the mechanical rigidity, the rigidity of the work material, and the chip evacuation are sufficient, and select the general-purpose condition if any of them is insufficient.

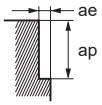
High efficiency cutting conditions

(mm)

Work Material	Copper, Copper alloy					Heat resistant alloys Inconel718				
Dia. DC	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae
1	120	38000	860	1.5	0.2	40	13000	160	1.5	0.05
1.5	150	32000	1400	2.25	0.3	40	8500	170	2.25	0.08
2	180	29000	2200	3	0.6	40	6400	170	3	0.2
3	180	19000	2300	4.5	0.9	40	4200	180	4.5	0.3
4	180	14000	2300	6	1.2	40	3200	180	6	0.4
5	180	11000	2300	7.5	1.5	40	2500	180	7.5	0.5
6	180	9500	2300	9	1.8	40	2100	190	9	0.6
8	180	7200	2300	12	2.4	40	1600	190	12	0.8
10	180	5700	2100	15	3	40	1300	220	15	1
12	180	4800	1700	18	3.6	40	1100	210	18	1.2
16	180	3600	1500	24	4.8	40	800	150	24	1.6
20	180	2900	1200	30	6	40	640	120	30	2
Depth of cut										

General-purpose conditions

(mm)

Work Material	Copper, Copper alloy					Heat resistant alloys Inconel718				
Dia. DC	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae
1	120	38000	560	1.5	0.2	30	9500	75	1.5	0.05
1.5	140	30000	890	2.25	0.3	30	6400	82	2.25	0.07
2	140	22000	1100	3	0.6	30	4800	86	3	0.2
3	140	15000	1200	4.5	0.9	30	3200	89	4.5	0.3
4	140	11000	1200	6	1.2	30	2400	90	6	0.4
5	140	8900	1200	7.5	1.5	30	1900	90	7.5	0.5
6	140	7400	1200	9	1.8	30	1600	95	9	0.6
8	140	5600	1200	12	2.4	30	1200	95	12	0.8
10	140	4500	1100	15	3	30	950	110	15	1
12	140	3700	880	18	3.6	30	800	100	18	1.2
16	140	2800	750	24	4.8	30	600	76	24	1.6
20	140	2200	590	30	6	30	480	61	30	2
Depth of cut										

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Note 3) Vibration damping end mills are more effective in suppressing chatter and vibration compared to general end mills, but these may still occur if the rigidity of the machine or the workpiece material is low.
Note 4) When the depth of cut is smaller than shown the revolution and feed rate can be increased.

VQMHZV

End mill, Medium cutting length, 3 flute for drilling and slotting

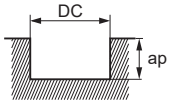
RECOMMENDED CUTTING CONDITIONS

■Slotting

Select the high efficiency condition if the mechanical rigidity, the rigidity of the work material, and the chip evacuation are sufficient, and select the general-purpose condition if any of them is insufficient.

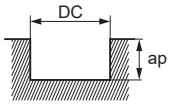
High efficiency conditions

(mm)

Work Material	Carbon steel, Alloy steel, Mild steel AISI 1045, AISI 4140, ASTM A36, AISI 1010				Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel AISI P21, AISI P20, AISI 4340, SKD, SKT				Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys AISI 304, AISI 316, Ti-6Al-4V				Hardened stainless steels, Cobaly chromium alloy AISI 630, AISI 631 15-5PH, 17-4PH				Copper, Copper alloy				Heat resistant alloys Inconel718			
Dia. DC	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap
1	100	32000	380	0.5	80	25000	150	0.5	60	19000	100	0.5	45	14000	80	0.3	120	38000	460	0.5	30	9500	60	0.2
1.5	130	28000	590	0.75	100	21000	250	0.75	85	18000	220	0.75	60	12000	140	0.4	150	32000	670	0.75	30	6400	80	0.3
2	150	24000	940	2	120	19000	460	2	100	16000	480	2	60	9500	230	1	180	29000	1100	2	30	4800	100	0.6
3	150	16000	1100	3	120	13000	550	3	100	11000	500	3	60	6400	270	1.5	180	19000	1300	3	30	3200	120	0.9
4	150	12000	1400	4	120	9500	680	4	100	8000	530	4	60	4800	350	2	180	14000	1700	4	30	2400	130	1.2
5	150	9500	1400	5	120	7600	680	5	100	6400	540	5	60	3800	350	2.5	180	11000	1700	5	30	1900	130	1.5
6	150	8000	1400	6	120	6400	770	6	100	5300	560	6	60	3200	380	3	180	9500	1700	6	30	1600	130	1.8
8	150	6000	1300	8	120	4800	720	8	100	4000	600	8	60	2400	360	4	180	7200	1500	8	30	1200	140	2.4
10	150	4800	1200	10	120	3800	630	10	100	3200	670	10	60	1900	310	5	180	5700	1400	10	30	950	160	3
12	150	4000	960	12	120	3200	580	12	100	2700	650	12	60	1600	290	6	180	4800	1200	12	30	800	150	3.6
16	150	3000	810	12	120	2400	500	12	100	2000	480	12	60	1200	250	8	180	3600	970	12	30	600	120	4.8
20	150	2400	650	12	120	1900	400	12	100	1600	380	12	60	950	200	10	180	2900	780	12	30	480	90	6
Depth of cut	 DC:Dia.																							

General-purpose conditions

(mm)

Work Material	Carbon steel, Alloy steel, Mild steel AISI 1045, AISI 4140, ASTM A36, AISI 1010				Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel AISI P21, AISI P20, AISI 4340, SKD, SKT				Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys AISI 304, AISI 316, Ti-6Al-4V				Hardened stainless steels, Cobaly chromium alloy AISI 630, AISI 631 15-5PH, 17-4PH				Copper, Copper alloy				Heat resistant alloys Inconel718			
Dia. DC	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap
1	100	32000	250	0.5	80	25000	99	0.5	60	19000	80	0.5	45	14000	60	0.3	120	38000	300	0.5	25	8000	30	0.2
1.5	100	21000	290	0.75	80	17000	130	0.75	60	13000	100	0.75	50	11000	87	0.4	120	25000	350	0.75	25	5300	40	0.3
2	100	16000	410	2	80	13000	210	2	60	9500	190	2	50	8000	130	1	120	19000	490	2	25	4000	55	0.6
3	100	11000	500	3	80	8500	240	3	60	6400	190	3	50	5300	150	1.5	120	13000	590	3	25	2700	64	0.9
4	100	8000	630	4	80	6400	300	4	60	4800	210	4	50	4000	190	2	120	9500	750	4	25	2000	70	1.2
5	100	6400	630	5	80	5100	300	5	60	3800	210	5	50	3200	190	2.5	120	7600	750	5	25	1600	71	1.5
6	100	5300	630	6	80	4200	330	6	60	3200	220	6	50	2700	210	3	120	6400	760	6	25	1300	72	1.8
8	100	4000	550	8	80	3200	320	8	60	2400	240	8	50	2000	200	4	120	4800	670	8	25	990	78	2.4
10	100	3200	510	10	80	2500	270	10	60	1900	260	10	50	1600	170	5	120	3800	600	10	25	800	89	3
12	100	2700	430	12	80	2100	250	12	60	1600	250	12	50	1300	150	6	120	3200	510	12	25	660	84	3.6
16	100	2000	360	12	80	1600	220	12	60	1200	190	12	50	990	140	8	120	2400	430	12	25	500	63	4.8
20	100	1600	290	12	80	1300	180	12	60	950	150	12	50	800	110	10	120	1900	340	12	25	400	50	6
Depth of cut	 DC:Dia.																							

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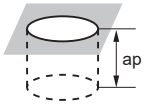
Note 4) When the depth of cut is smaller than shown the feed rate can be increased.

■ Plunging

Select the high efficiency condition if the mechanical rigidity, the rigidity of the work material, and the chip evacuation are sufficient, and select the general-purpose condition if any of them is insufficient.

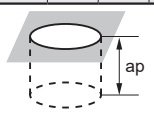
High efficiency conditions

(mm)

Work Material	Carbon steel, Alloy steel, Mild steel AISI 1045, AISI 4140, ASTM A36, AISI 1010					Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel AISI P21, AISI P20, AISI 4340, SKD, SKT					Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys AISI 304, AISI 316, Ti-6Al-4V					Hardened stainless steels, Cobaly chromium alloy AISI 630, AISI 631 15-5PH, 17-4PH					Copper, Copper alloy				
Dia. DC	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Step	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Step	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Step	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Step	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Step
1	65	20000	160	0.5	0.1	50	16000	100	0.5	0.1	50	16000	50	0.5	0.05	30	9500	30	0.5	0.05	75	24000	190	0.5	0.1
1.5	85	18000	270	0.75	0.3	60	13000	120	0.75	0.3	60	13000	80	0.75	0.1	35	7400	40	0.75	0.1	100	21000	320	0.75	0.3
2	100	16000	480	2	0.5	70	11000	200	2	0.4	60	9500	90	1	0.15	40	6400	60	1	0.1	120	19000	570	2	0.5
3	100	11000	660	3	1	70	7400	270	3	0.6	60	6400	100	1.5	0.2	40	4200	60	1.5	0.2	120	13000	780	3	1.0
4	100	8000	800	4	2	70	5600	340	4	0.8	60	4800	100	2	0.4	40	3200	60	2	0.4	120	9500	950	4	2
5	100	6400	960	5	2.5	70	4500	410	5	1	60	3800	100	2.5	0.5	40	2500	60	2.5	0.5	120	7600	1100	5	2.5
6	100	5300	950	6	3	70	3700	440	6	1.2	60	3200	100	3	0.6	40	2100	60	3	0.6	120	6400	1200	6	3
8	100	4000	720	8	4	70	2800	340	8	1.6	60	2400	70	4	0.6	40	1600	50	4	0.6	120	4800	860	8	4
10	100	3200	580	10	5	70	2200	260	10	2.5	60	1900	60	5	0.6	40	1300	40	5	0.6	120	3800	680	10	5
12	100	2700	490	12	5	70	1900	230	12	3	60	1600	50	6	0.6	40	1100	30	6	0.6	120	3200	580	12	5
16	100	2000	360	16	5	70	1400	170	16	4	60	1200	40	8	0.6	40	800	20	8	0.6	120	2400	430	16	5
20	100	1600	290	20	5	70	1100	130	20	5	60	950	30	10	0.6	40	640	20	10	0.6	120	1900	340	20	5
Depth of cut																									

General-purpose conditions

(mm)

Work Material	Carbon steel, Alloy steel, Mild steel AISI 1045, AISI 4140, ASTM A36, AISI 1010					Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel AISI P21, AISI P20, AISI 4340, SKD, SKT					Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys AISI 304, AISI 316, Ti-6Al-4V					Hardened stainless steels, Cobaly chromium alloy AISI 630, AISI 631 15-5PH, 17-4PH					Copper, Copper alloy				
Dia. DC	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Step	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Step	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Step	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Step	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Step
1	65	20000	160	0.5	0.05	50	16000	100	0.5	0.05	50	16000	50	0.5	0.05	30	9500	30	0.5	0.05	75	24000	190	0.5	0.05
1.5	85	18000	270	0.75	0.15	60	13000	120	0.75	0.1	60	13000	80	0.75	0.05	35	7400	40	0.75	0.05	100	21000	320	0.75	0.15
2	100	16000	480	2	0.25	70	11000	200	2	0.2	60	9500	90	1	0.05	40	6400	60	1	0.05	120	19000	570	2	0.25
3	100	11000	660	3	0.3	70	7400	270	3	0.3	60	6400	100	1.5	0.1	40	4200	60	1.5	0.1	120	13000	780	3	0.3
4	100	8000	800	4	0.4	70	5600	340	4	0.4	60	4800	100	2	0.2	40	3200	60	2	0.2	120	9500	950	4	0.4
5	100	6400	960	5	0.5	70	4500	410	5	0.5	60	3800	100	2.5	0.25	40	2500	60	2.5	0.25	120	7600	1100	5	0.5
6	100	5300	950	6	0.6	70	3700	440	6	0.6	60	3200	100	3	0.3	40	2100	60	3	0.3	120	6400	1200	6	0.6
8	100	4000	720	8	0.7	70	2800	340	8	0.7	60	2400	70	4	0.3	40	1600	50	4	0.3	120	4800	860	8	0.7
10	100	3200	580	10	0.75	70	2200	260	10	0.75	60	1900	60	5	0.3	40	1300	40	5	0.3	120	3800	680	10	0.75
12	100	2700	490	12	0.75	70	1900	230	12	0.75	60	1600	50	6	0.3	40	1100	30	6	0.3	120	3200	580	12	0.75
16	100	2000	360	16	0.75	70	1400	170	16	0.75	60	1200	40	8	0.3	40	800	20	8	0.3	120	2400	430	16	0.75
20	100	1600	290	20	0.75	70	1100	130	20	0.75	60	950	30	10	0.3	40	640	20	10	0.3	120	1900	340	20	0.75
Depth of cut																									

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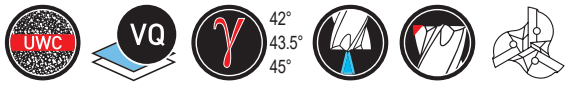
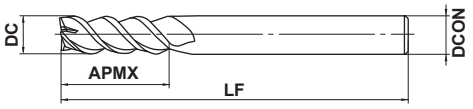
VQMHZVOH

End mill, Medium cutting length, 3 flute for drilling and slotting with internal through coolant holes



Carbon Steel, Alloy Steel, Cast Iron (<30HRC)	Tool Steel, Pre-hardened Steel,Hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Hardened Steel (>55HRC)	Austenitic Stainless Steel	Titanium Alloy, Heat Resistant Alloy	Copper Alloy	Aluminium Alloy
◎	◎			◎	◎	○	



Type1

DC≤12	DC=16			
0 - 0.02	0 - 0.03			
DCON=6	**8≤DCON≤10**	**12≤DCON≤16**		
0 - 0.008	0 - 0.009	0 - 0.011		

- A single end mill for both plunging and slotting.
- Excellent peformance in slotting and pocketing with oil supply from the end cutting edge.

(mm)

Order Number	DC	APMX	LF	DCON	No. of Flutes	Stock	Type
VQMHZVOHD0600	6	13	60	6	3	●	1
VQMHZVOHD0800	8	19	70	8	3	●	1
VQMHZVOHD1000	10	22	80	10	3	●	1
VQMHZVOHD1200	12	26	90	12	3	●	1
VQMHZVOHD1600	16	30	110	16	3	●	1

Note 1) SMART MIRACLE Coating is not energized because of its nature. Therefore, an external contact (voltaic type) tool setter cannot be used. An internal contact (non-voltaic) type or laser type tool setter is recommended to measure the length of the tool.

DC = Cutting dia. **LF** = Functional length
APMX = Depth of cut max. **DCON** = Connection dia.

● : **Inventory maintained in Japan.**

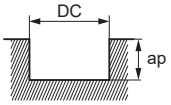
RECOMMENDED CUTTING CONDITIONS

■ Slotting

Select the high efficiency condition if the mechanical rigidity, the rigidity of the work material, and the chip evacuation are sufficient, and select the general-purpose condition if any of them is insufficient.

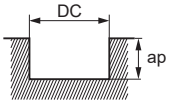
High efficiency conditions

(mm)

Work Material	Carbon steel, Alloy steel, Mild steel AISI 1045, AISI 4140, ASTM A36, AISI 1010				Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel AISI P21, AISI P20, AISI 4340, SKD, SKT				Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys AISI 304, AISI 316, Ti-6Al-4V				Hardened stainless steels, Cobaly chromium alloy AISI 630, AISI 631 15-5PH, 17-4PH				Copper, Copper alloy				Heat resistant alloys Inconel718			
Dia. DC	Cutting speed (m/min)	Revolution (min-1)	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min-1)	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min-1)	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min-1)	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min-1)	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min-1)	Feed rate (mm/min)	Depth of cut ap
6	150	8000	1400	6	120	6400	770	6	100	5300	560	6	60	3200	380	3	180	9500	1700	6	30	1600	130	1.8
8	150	6000	1300	8	120	4800	720	8	100	4000	600	8	60	2400	360	4	180	7200	1500	8	30	1200	140	2.4
10	150	4800	1200	10	120	3800	630	10	100	3200	670	10	60	1900	310	5	180	5700	1400	10	30	950	160	3
12	150	4000	960	12	120	3200	580	12	100	2700	650	12	60	1600	290	6	180	4800	1200	12	30	800	150	3.6
16	150	3000	810	12	120	2400	500	12	100	2000	480	12	60	1200	250	8	180	3600	970	12	30	600	120	4.8
Depth of cut	 DC:Dia.																							

General-purpose conditions

(mm)

Work Material	Carbon steel, Alloy steel, Mild steel AISI 1045, AISI 4140, ASTM A36, AISI 1010				Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel AISI P21, AISI P20, AISI 4340, SKD, SKT				Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys AISI 304, AISI 316, Ti-6Al-4V				Hardened stainless steels, Cobaly chromium alloy AISI 630, AISI 631 15-5PH, 17-4PH				Copper, Copper alloy				Heat resistant alloys Inconel718			
Dia. DC	Cutting speed (m/min)	Revolution (min-1)	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min-1)	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min-1)	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min-1)	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min-1)	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min-1)	Feed rate (mm/min)	Depth of cut ap
6	100	5300	630	6	80	4200	330	6	60	3200	220	6	50	2700	210	3	120	6400	760	6	25	1300	72	1.8
8	100	4000	550	8	80	3200	320	8	60	2400	240	8	50	2000	200	4	120	4800	670	8	25	990	78	2.4
10	100	3200	510	10	80	2500	270	10	60	1900	260	10	50	1600	170	5	120	3800	600	10	25	800	89	3
12	100	2700	430	12	80	2100	250	12	60	1600	250	12	50	1300	150	6	120	3200	510	12	25	660	84	3.6
16	100	2000	360	12	80	1600	220	12	60	1200	190	12	50	990	140	8	120	2400	430	12	25	500	63	4.8
Depth of cut	 DC:Dia.																							

Note 1) SMART MIRACLE Coating is not energized because of its nature. Therefore, an external contact (voltaic type) tool setter cannot be used. An internal contact (non-voltaic) type or laser type tool setter is recommended to measure the length of the tool.
Note 2) Effective cutting of stainless steel, titanium alloys and heat resistant alloys etc. can be achieved with the use of emulsion.
Note 3) Vibration damping end mills are more effective in suppressing chatter and vibration compared to general end mills, but these may still occur if the rigidity of the machine or the workpiece material is low.
Note 4) When the depth of cut is smaller than shown the feed rate can be increased.

VQMHZVOH

End mill, Medium cutting length, 3 flute for drilling and slotting with internal through coolant holes

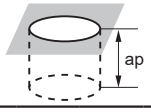
RECOMMENDED CUTTING CONDITIONS

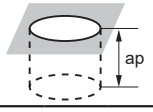
■ Plunging

Select the high efficiency condition if the mechanical rigidity, the rigidity of the work material, and the chip evacuation are sufficient, and select the general-purpose condition if any of them is insufficient.

High efficiency conditions

(mm)

Work Material	Carbon steel, Alloy steel, Mild steel AISI 1045, AISI 4140, ASTM A36, AISI 1010					Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel AISI P21, AISI P20, AISI 4340, SKD, SKT					Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys AISI 304, AISI 316, Ti-6Al-4V					Hardened stainless steels, Cobaly chromium alloy AISI 630, AISI 631 15-5PH, 17-4PH				
Dia. DC	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Step	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Step	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Step	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Step
6	100	5300	950	9	3	70	3700	440	9	1.2	60	3200	100	6	0.6	40	2100	60	6	0.6
8	100	4000	720	12	4	70	2800	340	12	1.6	60	2400	70	8	0.6	40	1600	50	8	0.6
10	100	3200	580	15	5	70	2200	260	15	2.5	60	1900	60	10	0.6	40	1300	40	10	0.6
12	100	2700	490	18	5	70	1900	230	18	3	60	1600	50	12	0.6	40	1100	30	12	0.6
16	100	2000	360	24	5	70	1400	170	24	4	60	1200	40	16	0.6	40	800	20	16	0.6
Depth of cut																				

Work Material	Copper, Copper alloy				
Dia. DC	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Step
6	120	6400	1200	9	3
8	120	4800	860	12	4
10	120	3800	680	15	5
12	120	3200	580	18	5
16	120	2400	430	24	5
Depth of cut					

Note 1) SMART MIRACLE Coating is not energized because of its nature. Therefore, an external contact (voltaic type) tool setter cannot be used. An internal contact (non-voltaic) type or laser type tool setter is recommended to measure the length of the tool.

Note 2) Effective cutting of stainless steel, titanium alloys and heat resistant alloys etc. can be achieved with the use of emulsion.

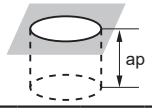
Note 3) Vibration damping end mills are more effective in suppressing chatter and vibration compared to general end mills, but these may still occur if the rigidity of the machine or the workpiece material is low.

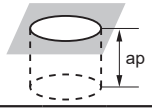
■ Plunging

Select the high efficiency condition if the mechanical rigidity, the rigidity of the work material, and the chip evacuation are sufficient, and select the general-purpose condition if any of them is insufficient.

General-purpose conditions

(mm)

Work Material	Carbon steel, Alloy steel, Mild steel AISI 1045, AISI 4140, ASTM A36, AISI 1010					Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel AISI P21, AISI P20, AISI 4340, SKD, SKT					Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys AISI 304, AISI 316, Ti-6Al-4V					Hardened stainless steels, Cobaly chromium alloy AISI 630, AISI 631 15-5PH, 17-4PH				
Dia. DC	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Step	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Step	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Step	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Step
6	100	5300	950	9	0.6	70	3700	440	9	0.6	60	3200	100	6	0.3	40	2100	60	6	0.3
8	100	4000	720	12	0.7	70	2800	340	12	0.7	60	2400	70	8	0.3	40	1600	50	8	0.3
10	100	3200	580	15	0.75	70	2200	260	15	0.75	60	1900	60	10	0.3	40	1300	40	10	0.3
12	100	2700	490	18	0.75	70	1900	230	18	0.75	60	1600	50	12	0.3	40	1100	30	12	0.3
16	100	2000	360	24	0.75	70	1400	170	24	0.75	60	1200	40	16	0.3	40	800	20	16	0.3
Depth of cut																				

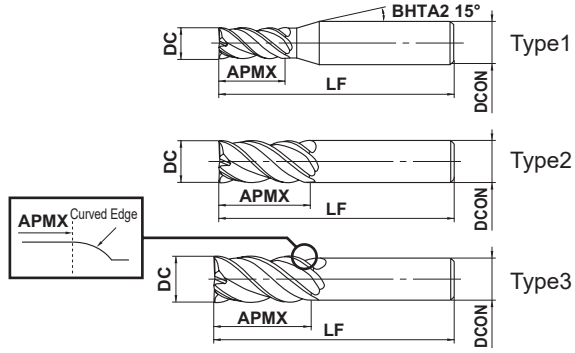
Work Material	Copper, Copper alloy				
Dia. DC	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Step
6	120	6400	1200	9	0.6
8	120	4800	860	12	0.7
10	120	3800	680	15	0.75
12	120	3200	580	18	0.75
16	120	2400	430	24	0.75
Depth of cut					

Note 1) SMART MIRACLE Coating is not energized because of its nature. Therefore, an external contact (voltaic type) tool setter cannot be used. An internal contact (non-voltaic) type or laser type tool setter is recommended to measure the length of the tool.
Note 2) Effective cutting of stainless steel, titanium alloys and heat resistant alloys etc. can be achieved with the use of emulsion.
Note 3) Vibration damping end mills are more effective in suppressing chatter and vibration compared to general end mills, but these may still occur if the rigidity of the machine or the workpiece material is low.

VQMHV

End mill, Medium cutting length, 4 flute, Irregular helix flutes

Carbon Steel, Alloy Steel, Cast Iron (<30HRC)	Tool Steel, Pre-hardened Steel,Hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Hardened Steel (>55HRC)	Austenitic Stainless Steel	Titanium Alloy, Heat Resistant Alloy	Copper Alloy	Aluminium Alloy
◎	◎			◎	◎	○	



DC≤12	DC>12			
0 - 0.020	0 - 0.030			
4≤DCON≤6	8≤DCON≤10	12≤DCON≤16	20≤DCON≤25	
0 - 0.008	0 - 0.009	0 - 0.011	0 - 0.013	

● Smart Miracle vibration control end mill achieving stable machining of difficult-to-cut materials and for long overhang applications.

(mm)

Order Number	DC	APMX	LF	DCON	No. of Flutes	Stock	Type
VQMHVD0100	1	2	45	4	4	●	1
VQMHVD0150	1.5	3	45	4	4	●	1
VQMHVD0200	2	4	45	4	4	●	1
VQMHVD0250	2.5	5	45	4	4	●	1
VQMHVD0300	3	8	45	6	4	●	1
VQMHVD0350	3.5	8	45	6	4	●	1
VQMHVD0400	4	11	45	6	4	●	1
VQMHVD0500	5	13	50	6	4	●	1
VQMHVD0600	6	13	50	6	4	●	2
VQMHVD0700	7	19	60	8	4	●	1
VQMHVD0800	8	19	60	8	4	●	2
VQMHVD0900	9	22	70	10	4	●	1
VQMHVD0900S08	9	22	75	8	4	●	3
VQMHVD1000	10	22	70	10	4	●	2
VQMHVD1000S08	10	22	100	8	4	●	3
VQMHVD1100	11	26	75	12	4	●	1
VQMHVD1100S10	11	26	100	10	4	●	3
VQMHVD1200	12	26	75	12	4	●	2
VQMHVD1200S10	12	26	110	10	4	●	3
VQMHVD1300	13	26	75	12	4	●	3
VQMHVD1300S12	13	26	110	12	4	●	3
VQMHVD1400	14	30	90	16	4	●	1
VQMHVD1400S12	14	32	130	12	4	●	3
VQMHVD1600	16	35	90	16	4	●	2
VQMHVD1800	18	40	100	16	4	●	3
VQMHVD1800S16	18	42	150	16	4	●	3
VQMHVD2000	20	45	110	20	4	●	2
VQMHVD2500	25	55	125	25	4	●	2

Note 1) SMART MIRACLE Coating is not energized because of its nature. Therefore, an external contact (voltaic type) tool setter cannot be used. An internal contact (non-voltaic) type or laser type tool setter is recommended to measure the length of the tool.

DC = Cutting dia. **LF** = Functional length
APMX = Depth of cut max. **DCON** = Connection dia.

● : **Inventory maintained in Japan.**

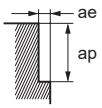
RECOMMENDED CUTTING CONDITIONS

■ Side milling

Select the high efficiency condition if the mechanical rigidity, the rigidity of the work material, and the chip evacuation are sufficient, and select the general-purpose condition if any of them is insufficient.

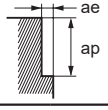
High efficiency conditions

(mm)

Work Material	Carbon steel, Alloy steel, Mild steel AISI 1045, AISI 4140, ASTM A36, AISI 1010					Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel AISI P21, AISI P20, AISI 4340, SKD, SKT					Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys AISI 304, AISI 316, Ti-6Al-4V					Hardened stainless steels, Cobaly chromium alloy AISI 630, AISI 631 15-5PH,17-4PH				
Dia. DC	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae
1	130	40000	1800	1.5	0.3	120	38000	910	1.5	0.3	80	25000	500	1.5	0.2	75	24000	580	1.5	0.2
2	150	24000	2400	3	0.6	120	19000	1100	3	0.6	100	16000	830	3	0.6	75	12000	720	3	0.4
3	150	16000	2600	4.5	0.9	120	13000	1200	4.5	0.9	100	11000	880	4.5	0.9	75	8000	770	4.5	0.6
4	150	12000	2600	6	1.2	120	9500	1300	6	1.2	100	8000	900	6	1.2	75	6000	790	6	0.8
5	150	9500	2600	7.5	1.5	120	7600	1300	7.5	1.5	100	6400	900	7.5	1.5	75	4800	810	7.5	1
6	150	8000	2600	9	1.8	120	6400	1300	9	1.8	100	5300	1100	9	1.8	75	4000	810	9	1.2
8	150	6000	2500	12	2.4	120	4800	1300	12	2.4	100	4000	1200	12	2.4	75	3000	840	12	1.6
10	150	4800	2300	15	3	120	3800	1200	15	3	100	3200	1300	15	3	75	2400	770	15	2
12	150	4000	1900	18	3.6	120	3200	1200	18	3.6	100	2700	1200	18	3.6	75	2000	720	18	2.4
16	150	3000	1600	24	4.8	120	2400	960	24	4.8	100	2000	960	24	4.8	75	1500	600	24	3.2
20	150	2400	1300	30	6	120	1900	760	30	6	100	1600	770	30	6	75	1200	480	30	4
25	150	1900	1100	37.5	7.5	120	1500	600	37.5	7.5	100	1300	620	37.5	7.5	75	950	380	37.5	5
Depth of cut																				

General-purpose conditions

(mm)

Work Material	Carbon steel, Alloy steel, Mild steel AISI 1045, AISI 4140, ASTM A36, AISI 1010					Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel AISI P21, AISI P20, AISI 4340, SKD, SKT					Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys AISI 304, AISI 316, Ti-6Al-4V					Hardened stainless steels, Cobaly chromium alloy AISI 630, AISI 631 15-5PH,17-4PH				
Dia. DC	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae
1	120	38000	1000	1.5	0.3	100	32000	560	1.5	0.3	80	25000	400	0.75	0.1	70	22000	390	1.5	0.2
2	120	19000	1300	3	0.6	100	16000	630	3	0.6	80	13000	450	1.5	0.2	70	11000	440	3	0.4
3	120	13000	1400	4.5	0.9	100	11000	700	4.5	0.9	80	8500	450	2.2	0.3	70	7400	470	4.5	0.6
4	120	9500	1400	6	1.2	100	8000	700	6	1.2	80	6400	470	3	0.6	70	5600	490	6	0.8
5	120	7600	1400	7.5	1.5	100	6400	710	7.5	1.5	80	5100	470	4.5	0.9	70	4500	500	7.5	1
6	120	6400	1400	9	1.8	100	5300	710	9	1.8	80	4200	580	6	1.2	70	3700	500	9	1.2
8	120	4800	1300	12	2.4	100	4000	740	12	2.4	80	3200	630	7.5	1.5	70	2800	520	12	1.6
10	120	3800	1200	15	3	100	3200	680	15	3	80	2500	660	9	1.8	70	2200	460	15	2
12	120	3200	1000	18	3.6	100	2700	640	18	3.6	80	2100	610	12	2.4	70	1900	450	18	2.4
16	120	2400	860	24	4.8	100	2000	530	24	4.8	80	1600	510	15	3	70	1400	370	24	3.2
20	120	1900	680	30	6	100	1600	420	30	6	80	1300	410	18	3.6	70	1100	290	30	4
25	120	1500	390	37.5	7.5	100	1300	340	37.5	7.5	80	1000	210	24	4.8	70	890	230	37.5	5
Depth of cut																				

Note 1) SMART MIRACLE Coating is not energized because of its nature. Therefore, an external contact (voltaic type) tool setter cannot be used. An internal contact (non-voltaic) type or laser type tool setter is recommended to measure the length of the tool.
Note 2) Effective cutting of stainless steel, titanium alloys and heat resistant alloys etc. can be achieved with the use of emulsion.
Note 3) Vibration damping end mills are more effective in suppressing chatter and vibration compared to general end mills, but these may still occur if the rigidity of the machine or the workpiece material is low.
Note 4) When the depth of cut is smaller than shown the revolution and feed rate can be increased.

VQMHV

End mill, Medium length of cut, 4 flute, Irregular helix flutes

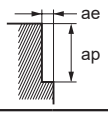
RECOMMENDED CUTTING CONDITIONS

■ Side milling

Select the high efficiency condition if the mechanical rigidity, the rigidity of the work material, and the chip evacuation are sufficient, and select the general-purpose condition if any of them is insufficient.

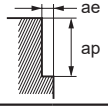
High efficiency conditions

(mm)

Work Material	Copper, Copper alloy					Heat resistant alloys Inconel718				
Dia. DC	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae
1	130	40000	1800	1.5	0.3	40	13000	210	1.5	0.1
2	180	29000	2900	3	0.6	40	6400	230	3	0.2
3	180	19000	3000	4.5	0.9	40	4200	240	4.5	0.3
4	180	14000	3000	6	1.2	40	3200	240	6	0.4
5	180	11000	3000	7.5	1.5	40	2500	240	7.5	0.5
6	180	9500	3000	9	1.8	40	2100	250	9	0.6
8	180	7200	3000	12	2.4	40	1600	260	12	0.8
10	180	5700	2700	15	3	40	1300	290	15	1
12	180	4800	2300	18	3.6	40	1100	280	18	1.2
16	180	3600	1900	24	4.8	40	800	200	24	1.6
20	180	2900	1600	30	6	40	640	160	30	2
25	180	2300	1300	37.5	7.5	40	510	130	37.5	2.5
Depth of cut										

General-purpose conditions

(mm)

Work Material	Copper, Copper alloy					Heat resistant alloys Inconel718				
Dia. DC	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae
1	130	40000	1300	1.5	0.3	30	9600	92	1.5	0.1
2	140	22000	1500	3	0.6	30	4800	110	3	0.2
3	140	15000	1600	4.5	0.9	30	3200	120	4.5	0.3
4	140	11000	1600	6	1.2	30	2400	120	6	0.4
5	140	8900	1600	7.5	1.5	30	1900	120	7.5	0.5
6	140	7400	1600	9	1.8	30	1600	130	9	0.6
8	140	5600	1600	12	2.4	30	1200	130	12	0.8
10	140	4500	1400	15	3	30	950	140	15	1
12	140	3700	1200	18	3.6	30	800	140	18	1.2
16	140	2800	1000	24	4.8	30	600	100	24	1.6
20	140	2200	780	30	6	30	480	81	30	2
25	140	1800	670	37.5	7.5	30	380	64	37.5	2.5
Depth of cut										

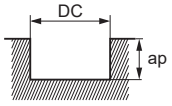
Note 1) SMART MIRACLE Coating is not energized because of its nature. Therefore, an external contact (voltaic type) tool setter cannot be used. An internal contact (non-voltaic) type or laser type tool setter is recommended to measure the length of the tool.
Note 2) Effective cutting of stainless steel, titanium alloys and heat resistant alloys etc. can be achieved with the use of emulsion.
Note 3) Vibration damping end mills are more effective in suppressing chatter and vibration compared to general end mills, but these may still occur if the rigidity of the machine or the workpiece material is low.
Note 4) When the depth of cut is smaller than shown the revolution and feed rate can be increased.

■ Slotting

Select the high efficiency condition if the mechanical rigidity, the rigidity of the work material, and the chip evacuation are sufficient, and select the general-purpose condition if any of them is insufficient.

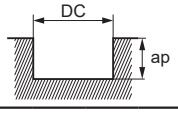
High efficiency conditions

(mm)

Work Material	Carbon steel, Alloy steel, Mild steel AISI 1045, AISI 4140, ASTM A36, AISI 1010				Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel AISI P21, AISI P20, AISI 4340, SKD, SKT				Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys AISI 304, AISI 316, Ti-6Al-4V				Hardened stainless steels, Cobaly chromium alloy AISI 630, AISI 631 15-5PH, 17-4PH				Copper, Copper alloy				Heat resistant alloys Inconel718			
Dia. DC	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap
2	150	24000	1200	2	120	19000	610	2	100	16000	640	2	60	9500	300	1	180	29000	1500	2	30	4800	130	0.6
3	150	16000	1500	3	120	13000	730	3	100	11000	660	3	60	6400	360	1.5	180	19000	1700	3	30	3200	150	0.9
4	150	12000	1900	4	120	9500	910	4	100	8000	700	4	60	4800	460	2	180	14000	2200	4	30	2400	170	1.2
5	150	9500	1900	5	120	7600	910	5	100	6400	720	5	60	3800	460	2.5	180	11000	2200	5	30	1900	170	1.5
6	150	8000	1900	6	120	6400	1000	6	100	5300	740	6	60	3200	510	3	180	9500	2300	6	30	1600	180	1.8
8	150	6000	1700	8	120	4800	960	8	100	4000	800	8	60	2400	480	4	180	7200	2000	8	30	1200	190	2.4
10	150	4800	1500	10	120	3800	840	10	100	3200	900	10	60	1900	420	5	180	5700	1800	10	30	950	210	3
12	150	4000	1300	12	120	3200	770	12	100	2700	860	12	60	1600	380	6	180	4800	1500	12	30	800	200	3.6
16	150	3000	1100	12	120	2400	670	12	100	2000	640	12	60	1200	340	8	180	3600	1300	12	30	600	150	4.8
20	150	2400	860	12	120	1900	530	12	100	1600	510	12	60	950	270	10	180	2900	1000	12	30	480	120	6
25	150	1900	760	12	120	1500	420	12	100	1300	420	12	60	760	210	12	180	2300	920	12	30	380	100	7.5
Depth of cut	 DC:Dia.																							

General-purpose conditions

(mm)

Work Material	Carbon steel, Alloy steel, Mild steel AISI 1045, AISI 4140, ASTM A36, AISI 1010				Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel AISI P21, AISI P20, AISI 4340, SKD, SKT				Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys AISI 304, AISI 316, Ti-6Al-4V				Hardened stainless steels, Cobaly chromium alloy AISI 630, AISI 631 15-5PH, 17-4PH				Copper, Copper alloy				Heat resistant alloys Inconel718			
Dia. DC	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap
1	100	32000	500	1	80	25000	250	1	80	25000	300	1	50	16000	150	0.5	120	38000	590	1	25	8000	67	0.3
2	100	16000	550	2	80	13000	270	2	60	9500	250	2	50	8000	170	1	120	19000	650	2	25	4000	74	0.6
3	100	11000	670	3	80	8500	310	3	60	6400	250	3	50	5300	200	1.5	120	13000	790	3	25	2700	86	0.9
4	100	8000	840	4	80	6400	410	4	60	4800	280	4	50	4000	250	2	120	9500	1000	4	25	2000	93	1.2
5	100	6400	840	5	80	5100	410	5	60	3800	280	5	50	3200	250	2.5	120	7600	1000	5	25	1600	95	1.5
6	100	5300	840	6	80	4200	440	6	60	3200	300	6	50	2700	290	3	120	6400	1000	6	25	1300	96	1.8
8	100	4000	740	8	80	3200	420	8	60	2400	320	8	50	2000	260	4	120	4800	890	8	25	990	100	2.4
10	100	3200	680	10	80	2500	360	10	60	1900	350	10	50	1600	230	5	120	3800	800	10	25	800	120	3
12	100	2700	570	12	80	2100	330	12	60	1600	340	12	50	1300	210	6	120	3200	680	12	25	660	110	3.6
16	100	2000	480	12	80	1600	300	12	60	1200	250	12	50	990	180	8	120	2400	570	12	25	500	84	4.8
20	100	1600	380	12	80	1300	240	12	60	950	200	12	50	800	150	10	120	1900	450	12	25	400	68	6
25	100	1300	340	12	80	1000	180	12	60	760	160	12	50	640	120	12	120	1500	400	12	25	320	50	7.5
Depth of cut	 DC:Dia.																							

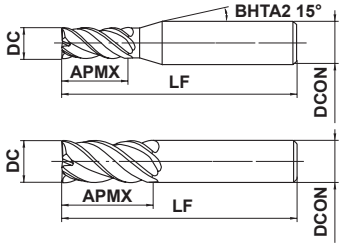
Note 1) SMART MIRACLE Coating is not energized because of its nature. Therefore, an external contact (voltaic type) tool setter cannot be used. An internal contact (non-voltaic) type or laser type tool setter is recommended to measure the length of the tool.
Note 2) Effective cutting of stainless steel, titanium alloys and heat resistant alloys etc. can be achieved with the use of emulsion.
Note 3) Vibration damping end mills are more effective in suppressing chatter and vibration compared to general end mills, but these may still occur if the rigidity of the machine or the workpiece material is low.
Note 4) When the depth of cut is smaller than shown the revolution and feed rate can be increased.

VQJHV

End mill, Medium cut length, 4 flute, Irregular helix flutes

UWC VQ 38° 40° DC≤6 37.5° 40° DC>6

Carbon Steel, Alloy Steel, Cast Iron (<30HRC)	Tool Steel, Pre-hardened Steel,Hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Hardened Steel (>55HRC)	Austenitic Stainless Steel	Titanium Alloy, Heat Resistant Alloy	Copper Alloy	Aluminium Alloy
◎	◎			◎	◎	○	



DC≤12	DC>12			
0 - 0.020	0 - 0.030			
4≤DCON≤6	8≤DCON≤10	12≤DCON≤16	DCON=20	
0 - 0.008	0 - 0.009	0 - 0.011	0 - 0.013	

● Smart Miracle vibration control end mill achieving stable machining of difficult-to-cut materials and for long overhang applications.

(mm)

Order Number	DC	APMX	LF	DCON	No. of Flutes	Stock	Type
VQJHVD0100	1	4	45	4	4	●	1
VQJHVD0150	1.5	6	45	4	4	●	1
VQJHVD0200	2	8	60	6	4	●	1
VQJHVD0250	2.5	10	60	6	4	●	1
VQJHVD0300	3	12	60	6	4	●	1
VQJHVD0350	3.5	14	60	6	4	●	1
VQJHVD0400	4	16	60	6	4	●	1
VQJHVD0450	4.5	18	60	6	4	●	1
VQJHVD0500	5	20	60	6	4	●	1
VQJHVD0600	6	24	60	6	4	●	2
VQJHVD0700	7	25	80	8	4	●	1
VQJHVD0800	8	28	80	8	4	●	2
VQJHVD0900	9	32	90	10	4	●	1
VQJHVD1000	10	35	90	10	4	●	2
VQJHVD1200	12	40	100	12	4	●	2
VQJHVD1600	16	55	125	16	4	●	2
VQJHVD2000	20	70	140	20	4	●	2

Note 1) SMART MIRACLE Coating is not energized because of its nature. Therefore, an external contact (voltaic type) tool setter cannot be used. An internal contact (non-voltaic) type or laser type tool setter is recommended to measure the length of the tool.

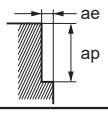
DC = Cutting dia. **LF** = Functional length
APMX = Depth of cut max. **DCON** = Connection dia.

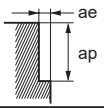
● : **Inventory maintained in Japan.**

RECOMMENDED CUTTING CONDITIONS

■Side milling

(mm)

Work Material	Carbon steel, Alloy steel, Mild steel AISI 1045, AISI 4140, ASTM A36, AISI 1010					Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel AISI P21, AISI P20, AISI 4340					Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys AISI 304, AISI 306, Ti-6Al-4V					Hardened stainless steels, Cobaly chromium alloy SUS630, SUS631, 15-5PH, 17-4PH				
Dia. **DC**	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae
1	130	40000	530	2.5	0.1	100	32000	410	2.5	0.1	80	25000	300	2.5	0.05	75	24000	290	2.5	0.05
2	130	21000	700	5	0.2	100	16000	510	5	0.2	80	13000	390	5	0.1	75	12000	360	5	0.1
3	130	14000	960	7.5	0.3	100	11000	680	7.5	0.3	80	8500	490	7.5	0.15	75	8000	460	7.5	0.15
4	130	10000	1000	10	0.4	100	8000	690	10	0.4	80	6400	540	10	0.2	75	6000	510	10	0.2
5	130	8300	1100	12.5	0.5	100	6400	730	12.5	0.5	80	5100	570	12.5	0.25	75	4800	540	12.5	0.25
6	130	6900	1200	15	0.6	100	5300	810	15	0.6	80	4200	630	15	0.3	75	4000	600	15	0.3
8	130	5200	1200	20	0.8	100	4000	840	20	0.8	80	3200	640	20	0.4	75	3000	600	20	0.4
10	130	4100	1100	25	1	100	3200	810	25	1	80	2500	590	25	0.5	75	2400	570	25	0.5
12	130	3400	1100	30	1.2	100	2700	780	30	1.2	80	2100	550	30	0.6	75	2000	520	30	0.6
16	130	2600	920	40	1.6	100	2000	640	40	1.6	80	1600	450	40	0.8	75	1500	420	40	0.8
20	130	2100	820	50	2	100	1600	570	50	2	80	1300	420	50	1	75	1200	390	50	1
Depth of cut																				

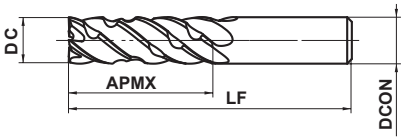
Work Material	Copper, Copper alloy					Heat resistant alloys Inconel718				
Dia. **DC**	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae
1	130	40000	530	2.5	0.1	40	13000	73	2.5	0.02
2	160	25000	830	5	0.2	40	6400	90	5	0.04
3	160	17000	1200	7.5	0.3	40	4200	130	7.5	0.06
4	160	13000	1300	10	0.4	40	3200	190	10	0.08
5	160	10000	1300	12.5	0.5	40	2500	180	12.5	0.1
6	160	8500	1500	15	0.6	40	2100	180	15	0.12
8	160	6400	1500	20	0.8	40	1600	170	20	0.16
10	160	5100	1300	25	1	40	1300	170	25	0.2
12	160	4200	1300	30	1.2	40	1100	140	30	0.24
16	160	3200	1100	40	1.6	40	800	110	40	0.32
20	160	2500	970	50	2	40	640	80	50	0.4
Depth of cut										

Note 1) SMART MIRACLE Coating is not energized because of its nature. Therefore, an external contact (voltaic type) tool setter cannot be used. An internal contact (non-voltaic) type or laser type tool setter is recommended to measure the length of the tool.
Note 2) Effective cutting of stainless steel, titanium alloys and heat resistant alloys etc. can be achieved with the use of emulsion.
Note 3) Vibration damping end mills are more effective in suppressing chatter and vibration compared to general end mills, but these may still occur if the rigidity of the machine or the workpiece material is low.
Note 4) When the depth of cut is smaller than shown the revolution and feed rate can be increased.

VQJCS NEW

End mill, Semi long cut length, 5 flute, Irregular pitch flutes, Chip breaker

Carbon Steel, Alloy Steel, Cast Iron (<30HRC)	Tool Steel, Pre-hardened Steel,Hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Hardened Steel (>55HRC)	Austenitic Stainless Steel	Titanium Alloy, Heat Resistant Alloy	Copper Alloy	Aluminium Alloy
◎	◎			◎	◎	○	



Type1

DC≤12	DC>12			
0 - 0.030	0 - 0.040			
DCON=6	8≤DCON≤10	12≤DCON≤16	DCON=20	
0 - 0.008	0 - 0.009	0 - 0.011	0 - 0.013	

- Chip breaker type end mill for efficient chip breaking capabilities that also provides good surface finishes.
- A high rigidity Smart Miracle vibration damping end mill for high efficiency trochoidal milling.

(mm)

Order Number	DC	APMX	LF	DCON	*1 No.F	Stock	Type
VQJCSD0600	6	18	70	6	5	●	1
VQJCSD0800	8	24	80	8	5	●	1
VQJCSD1000	10	30	90	10	5	●	1
VQJCSD1200	12	36	100	12	5	●	1
VQJCSD1600	16	48	110	16	5	●	1
VQJCSD2000	20	60	125	20	5	●	1

*1 Number of Flutes

Note 1) SMART MIRACLE coating has very low electrical conductivity; therefore, an electrical contact type of tool setter may not work. When measuring the tool length, please use a mechanical contact type or a laser tool setter.

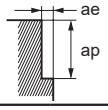
DC = Cutting dia. **LF** = Functional length
APMX = Depth of cut max. **DCON** = Connection dia.

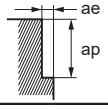
● : **Inventory maintained in Japan.**

RECOMMENDED CUTTING CONDITIONS

■Side milling

(mm)

Work Material	Carbon steel, Alloy steel, Mild steel AISI 1045, AISI 4140, ASTM A36, AISI 1010					Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel AISI P21, AISI P20, AISI 4340					Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys AISI 304, AISI 306, Ti-6Al-4V					Hardened stainless steels, Cobaly chromium alloy SUS630, SUS631, 15-5PH, 17-4PH				
Dia. DC	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae
6	200	10600	1800	18	0.9	180	9500	1500	18	0.9	120	6400	1000	18	0.45	100	5300	800	18	0.45
8	200	8000	1800	24	1.2	180	7200	1500	24	1.2	120	4800	1000	24	0.6	100	4000	800	24	0.6
10	200	6400	1700	30	1.5	180	5700	1400	30	1.5	120	3800	900	30	0.75	100	3200	800	30	0.75
12	200	5300	1700	36	1.8	180	4800	1400	36	1.8	120	3200	800	36	0.9	100	2700	700	36	0.9
16	200	4000	1400	48	2.4	180	3600	1200	48	2.4	120	2400	700	48	1.2	100	2000	600	48	1.2
20	200	3200	1200	60	3.0	180	2900	1000	60	3.0	120	1900	600	60	1.5	100	1600	500	60	1.5
Depth of cut																				

Work Material	Copper, Copper alloy					Heat resistant alloys Inconel718				
Dia. DC	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae
6	220	11700	2100	18	0.9	40	2100	200	18	0.18
8	220	8800	2100	24	1.2	40	1600	200	24	0.24
10	220	7000	1800	30	1.5	40	1300	200	30	0.3
12	220	5800	1800	36	1.8	40	1100	100	36	0.36
16	220	4400	1500	48	2.4	40	800	100	48	0.48
20	220	3500	1400	60	3.0	40	600	100	60	0.6
Depth of cut										

Note 1) SMART MIRACLE coating has very low electrical conductivity; therefore, an electrical contact type of tool setter may not work. When measuring the tool length, please use a mechanical contact type or a laser tool setter.

Note 2) The irregular pitch flute end mill has a larger effect on controlling vibration when compared to standard end mills. However, if the rigidity of the machine or the workpiece material installation is poor, vibration or abnormal sounds can occur. In that case, please adjust the revolution, feed rate and depth of cut.

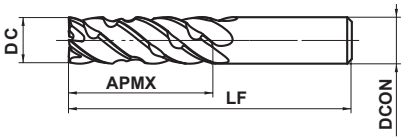
Note 3) The revolution and feed rate can be increased with a smaller depth of cut.

Note 4) For stainless steel, titanium alloys and heat resistant alloys, the use of water-soluble coolant is effective.

VQLCS NEW

End mill, Long cut length, 5 flute, Irregular pitch flutes, Chip breaker

Carbon Steel, Alloy Steel, Cast Iron (<30HRC)	Tool Steel, Pre-hardened Steel,Hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Hardened Steel (>55HRC)	Austenitic Stainless Steel	Titanium Alloy, Heat Resistant Alloy	Copper Alloy	Aluminium Alloy
◎	◎			◎	◎	○	



Type1

DC				
0 - 0.030				
DCON=6	8≤DCON≤10	DCON=12		
0 - 0.008	0 - 0.009	0 - 0.011		

- Chip breaker type end mill for efficient chip breaking capabilities that also provides good surface finishes.
- A high rigidity Smart Miracle vibration damping end mill for high efficiency trochoidal milling.

(mm)

Order Number	DC	APMX	LF	DCON	*1 No.F	Stock	Type
VQLCSD0600	6	24	70	6	5	●	1
VQLCSD0800	8	32	90	8	5	●	1
VQLCSD1000	10	40	100	10	5	●	1
VQLCSD1200	12	48	110	12	5	●	1

*1 Number of Flutes

Note 1) SMART MIRACLE coating has very low electrical conductivity; therefore, an electrical contact type of tool setter may not work. When measuring the tool length, please use a mechanical contact type or a laser tool setter.

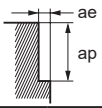
DC = Cutting dia. **LF** = Functional length
APMX = Depth of cut max. **DCON** = Connection dia.

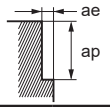
● : **Inventory maintained in Japan.**

RECOMMENDED CUTTING CONDITIONS

■Side milling

(mm)

Work Material	Carbon steel, Alloy steel, Mild steel AISI 1045, AISI 4140, ASTM A36, AISI 1010					Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel AISI P21, AISI P20, AISI 4340					Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys AISI 304, AISI 306, Ti-6Al-4V					Hardened stainless steels, Cobaly chromium alloy SUS630, SUS631, 15-5PH, 17-4PH				
Dia. **DC**	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae
6	180	9500	1600	24	0.6	160	8500	1200	24	0.6	100	5300	800	24	0.3	90	4800	700	24	0.3
8	180	7200	1600	32	0.8	160	6400	1300	32	0.8	100	4000	800	32	0.4	90	3600	700	32	0.4
10	180	5700	1500	40	1.0	160	5100	1200	40	1.0	100	3200	700	40	0.5	90	2900	700	40	0.5
12	180	4800	1500	48	1.2	160	4200	1200	48	1.2	100	2700	700	48	0.6	90	2400	600	48	0.6
Depth of cut																				

Work Material	Copper, Copper alloy					Heat resistant alloys Inconel718				
Dia. **DC**	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae
6	200	10600	1800	24	0.6	30	1600	100	24	0.12
8	200	8000	1800	32	0.8	30	1200	100	32	0.16
10	200	6400	1600	40	1.0	30	1000	100	40	0.2
12	200	5300	1600	48	1.2	30	800	100	48	0.24
Depth of cut										

Note 1) SMART MIRACLE coating has very low electrical conductivity; therefore, an electrical contact type of tool setter may not work. When measuring the tool length, please use a mechanical contact type or a laser tool setter.

Note 2) The irregular pitch flute end mill has a larger effect on controlling vibration when compared to standard end mills. However, if the rigidity of the machine or the workpiece material installation is poor, vibration or abnormal sounds can occur. In that case, please adjust the revolution, feed rate and depth of cut.

Note 3) The revolution and feed rate can be increased with a smaller depth of cut.

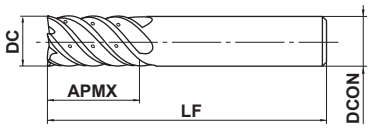
Note 4) For stainless steel, titanium alloys and heat resistant alloys, the use of water-soluble coolant is effective.

VQ6MHVCH

End mill, Medium cut length, 6 flute, Irregular helix flutes, With multiple internal through coolant

Carbon Steel, Alloy Steel, Cast Iron (<30HRC)	Tool Steel, Pre-hardened Steel,Hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Hardened Steel (>55HRC)	Austenitic Stainless Steel	Titanium Alloy, Heat Resistant Alloy	Copper Alloy	Aluminium Alloy
○	○			◎	◎	○	

CoolStar
END MILLS



Type1

DC≤12	DC>12			
0 - 0.020	0 - 0.030			
DCON=10	DCON=12	DCON=16	DCON=20	
0 - 0.009	0 - 0.011	0 - 0.011	0 - 0.013	

● Vibration control end mill with multiple internal through coolant holes ensures stable machining on difficult-to-cut materials and applications requiring long overhangs.

(mm)

Order Number	DC	APMX	LF	DCON	No. of Flutes	Stock	Type
VQ6MHVCHD1000	10	22	70	10	6	●	1
VQ6MHVCHD1200	12	26	75	12	6	●	1
VQ6MHVCHD1600	16	32	90	16	6	●	1
VQ6MHVCHD2000	20	38	100	20	6	●	1

RECOMMENDED CUTTING CONDITIONS

■Shoulder Milling

(mm)

Work Material	Alloy steel, Tool steel, Pre-hardened steel AISI H13, AISI W1-10, AISI P21		Austenitic Stainless Steel (≤200HB), Titanium Alloy AISI 304, AISI 316, Ti-6Al-4V		Copper, Copper alloy		Heat Resistant Alloys Inconel 718	
Dia. **DC** (mm)	Revolution (min^{-1})	Feed rate (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)
10	—	—	4800	2000	—	—	1300	260
12	—	—	4000	2000	—	—	1100	230
16	4000	2200	3000	1600	2400	1400	800	180
20	3200	1900	2400	1400	1900	1100	640	150
Depth of Cut	≤0.12DC, 0.5DC—1.5DC (DC:Dia.)						≤0.05DC, 0.5DC—1.5DC	

■Trochoid Milling

(mm)

Work Material	Alloy steel, Tool steel, Pre-hardened steel AISI H13, AISI W1-10, AISI P21		Austenitic Stainless Steel (≤200HB), Titanium Alloy AISI 304, AISI 316, Ti-6Al-4V	
Dia. **DC** (mm)	Revolution (min^{-1})	Feed rate (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)
10	—	—	4800	1400
12	—	—	4000	1200
16	4000	1600	3000	1100
20	3200	1400	2400	900
Depth of Cut	1.5DC≤, ≤0.12DC, 0.5DC—1.5DC (DC:Dia.)			

Note 1) If the depth of cut is shallow, the revolution and feed rate can be increased.

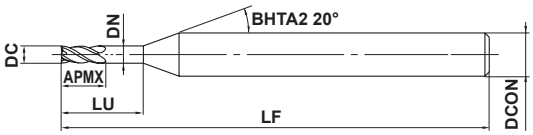
Note 2) Vibration damping end mills are more effective in suppressing chatter and vibration compared to general end mills, but these may still occur if the rigidity of the machine or the workpiece material is low.

● : **Inventory maintained in Japan.**

VQXL

End mill, Short cut length, 4 flute, Long neck

Carbon Steel, Alloy Steel, Cast Iron (<30HRC)	Tool Steel, Pre-hardened Steel,Hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Hardened Steel (>55HRC)	Austenitic Stainless Steel	Titanium Alloy, Heat Resistant Alloy	Copper Alloy	Aluminium Alloy
◎	◎			◎	◎	○	



Type1

DC				
0 - 0.010				
DCON				
0 - 0.005				

- The use of SMART MIRACLE Coating improves chip discharge dramatically.
- Multi-cutters at a small diameter of ϕ1 is realized.

(mm)

Order Number	DC	APMX	LU	DN	LF	DCON	No. of Flutes	Stock	Type
VQXLD0020N006	0.2	0.3	0.6	0.18	40	4	3	●	1
VQXLD0030N009	0.3	0.5	0.9	0.28	40	4	3	●	1
VQXLD0030N015	0.3	0.5	1.5	0.28	40	4	3	●	1
VQXLD0040N010	0.4	0.6	1	0.37	40	4	4	●	1
VQXLD0040N018	0.4	0.6	1.8	0.37	40	4	4	●	1
VQXLD0050N015	0.5	0.7	1.5	0.47	40	4	4	●	1
VQXLD0050N025	0.5	0.7	2.5	0.47	40	4	4	●	1
VQXLD0050N030	0.5	0.7	3	0.47	40	4	4	●	1
VQXLD0060N030	0.6	0.9	3	0.57	40	4	4	●	1
VQXLD0070N035	0.7	1	3.5	0.67	40	4	4	●	1
VQXLD0080N024	0.8	1.2	2.4	0.77	40	4	4	●	1
VQXLD0080N030	0.8	1.2	3	0.77	40	4	4	●	1
VQXLD0080N040	0.8	1.2	4	0.77	40	4	4	●	1
VQXLD0100N050	1	1.5	5	0.96	40	4	4	●	1

Note 1) SMART MIRACLE Coating is not energized because of its nature. Therefore, an external contact (voltaic type) tool setter cannot be used. An internal contact (non-voltaic) type or laser type tool setter is recommended to measure the length of the tool.

Torque chart

Order Number	ISO 10664
	Torque type
VQXLD0020N006	T4
VQXLD0030N009	T6
VQXLD0030N015	
VQXLD0040N010	T8
VQXLD0040N018	
VQXLD0050N015	T15
VQXLD0050N025	
VQXLD0050N030	
VQXLD0080N024	TS25
VQXLD0080N040	
VQXLD0100N050	T40

DC = Cutting dia. **DN** = Neck dia.
APMX = Depth of cut max. **LF** = Functional length
LU = Usable length **DCON** = Connection dia.

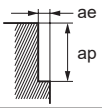
VQXL

End mill, Short cut length, 4 flute, Long neck

RECOMMENDED CUTTING CONDITIONS

■Side milling

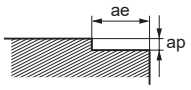
(mm)

Work Material		Carbon steel, Alloy steel, Austenitic stainless steels, Titanium alloys Cobaly chromium alloy, Copper, Copper alloy AISI 1045, AISI 4140, AISI 4340, AISI 304, AISI 316, AISI 304LN, AISI 316LN, Ti-6Al-4V					Heat resistant alloys, Pre-hardened steel, Hardened steel Inconel718, AISI P21, AISI P20, AISI H13, AISI L6, AISI 431, AISI 420				
Dia. **DC**	Neck Length **LU**	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae
0.2	**0.6**	25	40000	360	0.03	0.01	20	32000	290	0.03	0.01
0.3	**0.9**	40	40000	480	0.045	0.015	20	21000	250	0.045	0.015
0.3	**1.5**	40	40000	360	0.045	0.015	20	21000	190	0.045	0.015
0.4	**1**	50	40000	800	0.06	0.02	20	16000	320	0.06	0.02
0.4	**1.8**	50	40000	560	0.06	0.02	20	16000	220	0.06	0.025
0.5	**1.5**	60	38000	910	0.075	0.025	20	13000	310	0.075	0.025
0.5	**2.5**	60	38000	610	0.075	0.025	20	13000	210	0.075	0.025
0.5	**3**	60	38000	550	0.075	0.025	20	13000	180	0.075	0.025
0.6	**3**	60	32000	640	0.09	0.03	20	10500	210	0.09	0.03
0.7	**3.5**	60	27000	650	0.11	0.035	20	9100	200	0.11	0.035
0.8	**2.4**	60	24000	960	0.12	0.04	20	8000	260	0.12	0.04
0.8	**3**	60	24000	860	0.12	0.04	20	8000	230	0.12	0.04
0.8	**4**	60	24000	670	0.12	0.04	20	8000	190	0.12	0.04
1	**5**	60	20000	800	0.15	0.05	20	6500	210	0.15	0.05
Depth of cut											

Note 1) SMART MIRACLE Coating is not energized because of its nature. Therefore, an external contact (voltaic type) tool setter cannot be used. An internal contact (non-voltaic) type or laser type tool setter is recommended to measure the length of the tool.
Note 2) Effective cutting of stainless steel, titanium alloys and heat resistant alloys etc. can be achieved with the use of emulsion.
Note 3) When the depth of cut is smaller than shown the revolution and feed rate can be increased.

■Bottom face milling

(mm)

Work Material		Carbon steel, Alloy steel, Austenitic stainless steels, Titanium alloys Cobaly chromium alloy, Copper, Copper alloy AISI 1045, AISI 4140, AISI 4340, AISI 304, AISI 316, AISI 304LN, AISI 316LN, Ti-6Al-4V					Heat resistant alloys, Pre-hardened steel, Hardened steel Inconel718, AISI P21, AISI P20, AISI H13, AISI L6, AISI 431, AISI 420				
Dia. **DC**	Neck Length **LU**	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae
0.2	**0.6**	25	40000	360	0.015	≤0.2	20	32000	290	0.015	≤0.1
0.3	**0.9**	40	40000	480	0.025	≤0.3	20	21000	250	0.025	≤0.15
0.3	**1.5**	40	40000	360	0.02	≤0.3	20	21000	190	0.02	≤0.15
0.4	**1**	50	40000	800	0.03	≤0.4	20	16000	320	0.03	≤0.2
0.4	**1.8**	50	40000	560	0.02	≤0.4	20	16000	220	0.02	≤0.2
0.5	**1.5**	60	38000	910	0.04	≤0.5	20	13000	310	0.04	≤0.25
0.5	**2.5**	60	38000	610	0.03	≤0.5	20	13000	210	0.03	≤0.25
0.5	**3**	60	38000	550	0.03	≤0.5	20	13000	180	0.03	≤0.25
0.6	**3**	60	32000	640	0.035	≤0.6	20	10500	210	0.035	≤0.3
0.7	**3.5**	60	27000	640	0.035	≤0.7	20	9100	190	0.035	≤0.35
0.8	**2.4**	60	24000	960	0.06	≤0.8	20	8000	260	0.06	≤0.4
0.8	**3**	60	24000	840	0.05	≤0.8	20	8000	230	0.05	≤0.4
0.8	**4**	60	24000	670	0.04	≤0.8	20	8000	190	0.04	≤0.4
1	**5**	60	20000	800	0.05	≤1	20	6500	210	0.05	≤0.5
Depth of cut											

Note 1) SMART MIRACLE Coating is not energized because of its nature. Therefore, an external contact (voltaic type) tool setter cannot be used. An internal contact (non-voltaic) type or laser type tool setter is recommended to measure the length of the tool.
Note 2) Effective cutting of stainless steel, titanium alloys and heat resistant alloys etc. can be achieved with the use of emulsion.
Note 3) When the depth of cut is smaller than shown the revolution and feed rate can be increased.

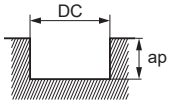
VQXL

End mill, Short cut length, 4 flute, Long neck

RECOMMENDED CUTTING CONDITIONS

■Slotting

(mm)

Work Material		Carbon steel, Alloy steel, Austenitic stainless steels, Titanium alloys Cobaly chromium alloy, Copper, Copper alloy AISI 1045, AISI 4140, AISI 4340, AISI 304, AISI 306, AISI 304LN, AISI 316LN, Ti-6Al-4V				Heat resistant alloys, Pre-hardened steel, Hardened steel Inconel718, AISI P21, AISI P20, AISI H13, AISI L6, AISI 431, AISI 420			
Dia. **DC**	Neck Length **LU**	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap
0.2	**0.6**	20	30000	270	0.03	15	24000	220	0.03
0.3	**0.9**	30	30000	360	0.045	14	15000	180	0.045
0.3	**1.5**	30	30000	270	0.045	14	15000	140	0.045
0.4	**1**	40	30000	600	0.06	15	12000	240	0.06
0.4	**1.8**	40	30000	420	0.06	15	12000	170	0.06
0.5	**1.5**	45	28000	670	0.075	15	9500	230	0.075
0.5	**2.5**	45	28000	450	0.075	15	9500	150	0.075
0.5	**3**	45	28000	390	0.075	15	9500	130	0.075
0.6	**3**	45	24000	480	0.09	15	7800	160	0.09
0.7	**3.5**	45	20000	480	0.11	15	6800	140	0.11
0.8	**2.4**	45	18000	720	0.12	15	6000	190	0.12
0.8	**3**	45	18000	650	0.12	15	6000	170	0.12
0.8	**4**	45	18000	500	0.12	15	6000	140	0.12
1	**5**	45	15000	600	0.15	15	4800	150	0.15
Depth of cut		 DC:Dia.							

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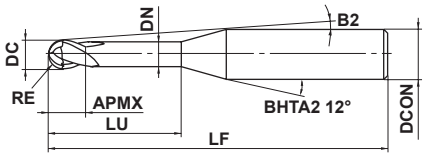
Note 2) Effective cutting of stainless steel, titanium alloys and heat resistant alloys etc. can be achieved with the use of emulsion.
Note 3) When the depth of cut is small, the feed rate can be increased.

Memo

VQ2XLB

Ball nose, Short cut length, 2 flute, Long neck

Carbon Steel, Alloy Steel, Cast Iron (<30HRC)	Tool Steel, Pre-hardened Steel,Hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Hardened Steel (>55HRC)	Austenitic Stainless Steel	Titanium Alloy, Heat Resistant Alloy	Copper Alloy	Aluminium Alloy
					◎	◎	



Type1

RE			
±0.005			
DCON			
0 - 0.005			

- Fracture resistance is improved by adopting a new S-shape, reinforced cutting edge geometry.
- SMART MIRACLE coating provides better wear resistance when machining difficult-to-cut materials.

(mm)

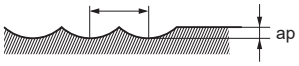
Order Number	RE	DC	APMX	LU	DN	B2	LF	DCON	No. of Flutes	Stock	Type
VQ2XLBR0050N080	0.5	1	0.75	8	0.94	6.4°	50	4	2	●	1
VQ2XLBR0050N100	0.5	1	0.75	10	0.94	5.6°	50	4	2	●	1
VQ2XLBR0050N080S06	0.5	1	0.75	8	0.94	8.3°	50	6	2	●	1
VQ2XLBR0050N100S06	0.5	1	0.75	10	0.94	7.5°	55	6	2	●	1
VQ2XLBR0050N120S06	0.5	1	0.75	12	0.94	6.8°	55	6	2	●	1
VQ2XLBR0075N100S06	0.75	1.5	1.1	10	1.44	7.2°	55	6	2	●	1
VQ2XLBR0075N120S06	0.75	1.5	1.1	12	1.44	6.5°	55	6	2	●	1
VQ2XLBR0100N100	1.0	2	1.5	10	1.9	4.5°	50	4	2	●	1
VQ2XLBR0100N100S06	1.0	2	1.5	10	1.9	6.9°	55	6	2	●	1
VQ2XLBR0100N120	1.0	2	1.5	12	1.9	3.9°	50	4	2	●	1
VQ2XLBR0100N120S06	1.0	2	1.5	12	1.9	6.1°	55	6	2	●	1
VQ2XLBR0150N120	1.5	3	2.3	12	2.9	5.3°	55	6	2	●	1
VQ2XLBR0150N140	1.5	3	2.3	14	2.9	4.7°	60	6	2	●	1
VQ2XLBR0150N160	1.5	3	2.3	16	2.9	4.3°	60	6	2	●	1

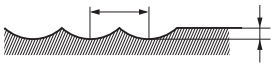
● : Inventory maintained in Japan.

RE = Ball nose
DC = Cutting dia.
APMX = Depth of cut max.
LU = Usable length
DN = Neck dia.
LF = Functional length
DCON = Connection dia.

RECOMMENDED CUTTING CONDITIONS

(mm)

Work Material		Titanium Alloys Ti-6Al-4V ELI, ASTM F136, etc.					Cobalt Chromium Alloys ASTM F75:Casting, F1537:Wrought Bar, F799:Forgings, etc.				
RE	**LU**	Revolution **n** (min^{-1})	Cutting Speed **vc** (m/min)	Feed Rate **vf** (mm/min)	Depth of cut **ap**	Width of cut **ae**	Revolution **n** (min^{-1})	Cutting Speed **vc** (m/min)	Feed Rate **vf** (mm/min)	Depth of cut **ap**	Width of cut **ae**
0.5	**8**	32000	100	2500	0.05	0.1	25000	80	2000	0.05	0.1
0.5	**10**	24000	75	1500	0.05	0.1	19000	60	1500	0.05	0.1
0.5	**12**	24000	75	1500	0.03	0.1	19000	60	1500	0.03	0.1
0.75	**10**	21000	100	2100	0.13	0.3	17000	80	1700	0.08	0.1
0.75	**12**	16000	75	1500	0.13	0.3	13000	60	1200	0.08	0.1
1	**10**	16000	100	1800	0.20	0.5	13000	80	1500	0.2	0.5
1	**12**	16000	100	1800	0.20	0.5	13000	80	1500	0.2	0.5
1.5	**12**	10000	100	1600	0.30	0.8	8500	80	1300	0.3	0.8
1.5	**14**	10000	100	1600	0.30	0.8	8500	80	1300	0.3	0.8
1.5	**16**	10000	100	1600	0.30	0.8	8500	80	1300	0.3	0.8
Depth of Cut		≤0.10RE (RE≤1) ≤0.20RE (RE>1)  RE : Radius									

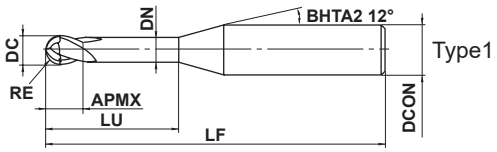
Work Material		Pure Titanium Ti etc.				
RE	**LU**	Revolution **n** (min^{-1})	Cutting Speed **vc** (m/min)	Feed Rate **vf** (mm/min)	Depth of cut **ap**	Width of cut **ae**
0.5	**8**	27000	80	1600	0.08	0.1
0.5	**10**	19000	60	1200	0.08	0.1
0.5	**12**	19000	60	1200	0.04	0.1
0.75	**10**	25000	120	2000	0.13	0.2
0.75	**12**	21000	100	1600	0.13	0.2
1	**10**	32000	200	2500	0.32	0.8
1	**12**	29000	180	1700	0.32	0.8
1.5	**12**	21000	200	1600	0.48	1.2
1.5	**14**	21000	200	1600	0.48	1.2
1.5	**16**	21000	200	1600	0.48	1.2
Depth of Cut		≤0.10RE (RE≤1) ≤0.20RE (RE>1)  RE : Radius				

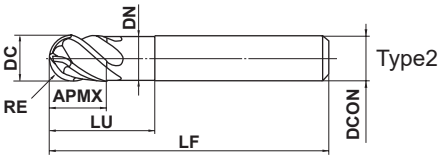
Note 1) The SMART MIRACLE coating has very low electrical conductivity; therefore, an external contact type of tool setter (electrically transmitted) may not work.
When measuring the tool length, please use an internal contact type (non-electrical type) or a laser tool setter.
Note 2) When cutting titanium alloys, the use of water-soluble cutting fluid is effective.
Note 3) If the depth of cut is shallow, the revolution and the feed rate can be increased.

VQ4SVB

Ball nose, Short cut length, 4 flute, Irregular pitch flutes

Carbon Steel, Alloy Steel, Cast Iron (<30HRC)	Tool Steel, Pre-hardened Steel,Hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Hardened Steel (>55HRC)	Austenitic Stainless Steel	Titanium Alloy, Heat Resistant Alloy	Copper Alloy	Aluminium Alloy
◎	◎			◎	◎	○	





RE				
±0.01				
DC				
0 - 0.02				
DCON=6	8≤DCON≤10	DCON=12		
0 - 0.008	0 - 0.009	0 - 0.011		

- 4 flute ball nose end mill
- With the special substrate, suitable for finishing of heat resistance alloy, etc.

(mm)

Order Number	RE	DC	APMX	LU	DN	LF	DCON	No. of Flutes	Stock	Type
VQ4SVBR0100	1	2	3	5	1.9	50	6	4	●	1
VQ4SVBR0150	1.5	3	4.5	7.5	2.9	50	6	4	●	1
VQ4SVBR0200	2	4	6	10	3.9	50	6	4	●	1
VQ4SVBR0250	2.5	5	7.5	12.5	4.9	50	6	4	●	1
VQ4SVBR0300	3	6	9	15	5.85	50	6	4	●	2
VQ4SVBR0400	4	8	12	20	7.85	60	8	4	●	2
VQ4SVBR0500	5	10	15	25	9.7	70	10	4	●	2
VQ4SVBR0600	6	12	18	30	11.7	75	12	4	●	2

Note 1) SMART MIRACLE Coating is not energized because of its nature. Therefore, an external contact (voltaic type) tool setter cannot be used. An internal contact (non-voltaic) type or laser type tool setter is recommended to measure the length of the tool.

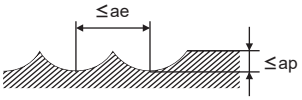
RE = Ball nose
DC = Cutting dia.
APMX = Depth of cut max.
LU = Usable length
DN = Neck dia.
LF = Functional length
DCON = Connection dia.

● : **Inventory maintained in Japan.**

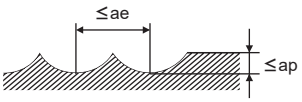
RECOMMENDED CUTTING CONDITIONS

■ Shoulder milling(Slotting)

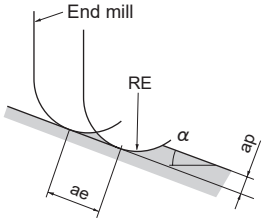
(mm)

Work Material	Carbon steel, Alloy steel, Mild steel, Pre-hardened steel AISI 1045, AISI 4140, ASTM A36, AISI 1010, AISI P21, AISI P20, AISI 4340								Austenitic stainless steel, Titanium alloy, Precipitation hardeningstainless steel, Cobalt chromium alloy, Ferritic, Precipitation hardeningstainless steel AISI 304, AISI 316, Ti-6Al-4V, AISI 630, AISI 631, 15-5PH, 17-4PH, AISI 431, AISI 420							
R **RE**	α≤15°			α>15°			Depth of cut ap	Depth of cut ae	α≤15°			α>15°			Depth of cut ap	Depth of cut ae
	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)			Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)		
R 1	250	40000	8000	200	32000	3800	0.17	0.5	230	36000	6500	150	24000	2900	0.17	0.5
R 1.5	300	32000	7700	200	21000	3200	0.25	0.75	230	24000	4800	150	16000	1900	0.25	0.75
R 2	300	24000	5800	200	16000	2800	0.33	1	230	18000	4000	150	12000	1700	0.33	1
R 2.5	300	19000	5300	200	12700	2600	0.42	1.25	230	14400	3500	150	9600	1500	0.42	1.25
R 3	300	16000	4800	200	10600	2100	0.5	1.5	230	12000	3200	150	8000	1400	0.5	1.5
R 4	300	12000	4300	200	8000	1900	0.8	2	230	9000	3200	150	6000	1400	0.8	2
R 5	300	9600	4100	200	6400	1800	1	2.5	230	7200	3000	150	4800	1300	1	2.5
R 6	300	8000	4000	200	5300	1800	1.2	3	230	6000	3000	150	4000	1300	1.2	3
Depth of cut																

(mm)

Work Material	Copper, Copper alloy								Heat Resistant Alloy Inconel718							
R **RE**	α≤15°			α>15°			Depth of cut ap	Depth of cut ae	α≤15°			α>15°			Depth of cut ap	Depth of cut ae
	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)			Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)		
R 1	250	40000	8000	240	38000	4500	0.17	0.5	60	9600	960	40	6400	510	0.08	0.2
R 1.5	360	38000	9100	240	25000	3800	0.25	0.7	60	6400	640	40	4200	340	0.13	0.3
R 2	360	29000	7000	240	19000	3300	0.33	1	60	4800	580	40	3200	260	0.17	0.4
R 2.5	360	23000	6400	240	15000	3100	0.42	1.2	60	3800	530	39	2500	250	0.21	0.5
R 3	360	19000	5700	240	13000	2600	0.5	1.5	60	3200	500	40	2100	210	0.25	0.6
R 4	360	14000	5000	240	9600	2300	0.8	2	60	2400	430	40	1600	190	0.4	0.8
R 5	360	12000	5100	240	7700	2200	1	2.5	63	2000	420	41	1300	180	0.5	1
R 6	360	9600	4800	240	6400	2200	1.2	3	64	1700	350	41	1100	150	0.6	1.2
Depth of cut																

Note 1) SMART MIRACLE Coating is not energized because of its nature. Therefore, an external contact (voltaic type) tool setter cannot be used. An internal contact (non-voltaic) type or laser type tool setter is recommended to measure the length of the tool.
Note 2) For stainless steel, titanium alloy and heat resistant alloy, the use of water-soluble coolant is effective.
Note 3) Vibration damping end mills are more effective in suppressing chatter and vibration compared to general end mills, but these may still occur if the rigidity of the machine or the workpiece material is low.
Note 4) If the depth of cut is shallow, the revolution and feed rate can be increased.
Note 5) α is the inclination angle of the machined surface.

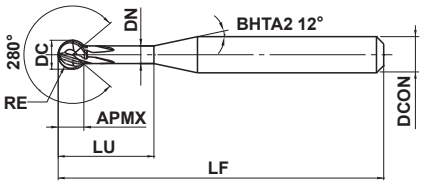


ae:Pick Feed

VQ4WB

Multi-functional lollipop, Short cut length, 4 flute

Carbon Steel, Alloy Steel, Cast Iron (<30HRC)	Tool Steel, Pre-hardened Steel,Hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Hardened Steel (>55HRC)	Austenitic Stainless Steel	Titanium Alloy, Heat Resistant Alloy	Copper Alloy	Aluminium Alloy
◎	◎			◎	◎	○	



RE				
±0.01				
DCON				
0 - 0.008				

●Multi-functional ball end mill with a lollipop shape for 5-axis machining. Optimal for back deburring undercutting, and inner curved surface machining.

(mm)

Order Number	RE	DC	APMX	LU	DN	LF	DCON	No. of Flutes	Stock
VQ4WBR0050N06E280	0.5	1.0	0.88	6	0.61	50	4	4	●
VQ4WBR0065N08E280	0.65	1.3	1.14	8	0.80	50	4	4	●
VQ4WBR0090N06E280	0.9	1.8	1.58	6	1.11	50	4	4	●
VQ4WBR0100N06E280	1.0	2.0	1.76	6	1.24	60	6	4	●
VQ4WBR0140N16E280	1.4	2.8	2.47	16	1.74	60	6	4	●
VQ4WBR0150N08E280	1.5	3.0	2.64	8	1.87	60	6	4	●
VQ4WBR0190N12E280	1.9	3.8	3.35	12	2.37	60	6	4	●
VQ4WBR0200N12E280	2.0	4.0	3.53	12	2.50	60	6	4	●
VQ4WBR0240N16E280	2.4	4.8	4.23	16	3.00	70	6	4	●
VQ4WBR0250N12E280	2.5	5.0	4.41	12	3.13	80	6	4	●
VQ4WBR0300N12E280	3.0	6.0	5.29	12	3.76	80	6	4	●

Note 1) SMART MIRACLE coating has very low electrical conductivity; therefore, an external contact type of tool setter (electrically transmitted) may not work.

<Special Orders>

For non standard products not shown above, please contact our sales department.

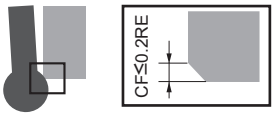
RE = Ball nose
DC = Cutting dia.
APMX = Depth of cut max.
LU = Usable length
DN = Neck dia.
LF = Functional length
DCON = Connection dia.

● : **Inventory maintained in Japan.**

RECOMMENDED CUTTING CONDITIONS

■ Chamfering (Debarring)

(mm)

Work Material		Mild Steels, Carbon Steels, Alloy steel Pre-hardened Steels, Alloy tool steel (–45HRC), Copper Alloys SS400, S10C, S45C, SCM440, SNCM439 NAK, SKD etc.			Austenitic, Ferritic and Martensitic Stainless Steels, Precipitation Hardening Stainless Steels, Cobalt Chromium Alloys, Titanium Alloys SUS304, SUS316L, SUS420J, SUS630, SU631, Ti-6Al-4V, CCM etc.		
DC	**RE**	Revolution **n** (min^{-1})	Feed Rate **vf** (mm/min)	Depth of Cut **Max. CF**	Revolution **n** (min^{-1})	Feed Rate **vf** (mm/min)	Depth of Cut **Max. CF**
1.0	**0.5**	19000	300	0.10	14000	220	0.10
1.3	**0.65**	15000	420	0.13	11000	310	0.13
1.8	**0.9**	11000	570	0.18	8000	420	0.18
2.0	**1.0**	9500	610	0.20	7200	460	0.20
2.8	**1.4**	6800	760	0.28	5100	570	0.28
3.0	**1.5**	6400	770	0.30	4800	580	0.30
3.8	**1.9**	5000	840	0.38	3800	640	0.38
4.0	**2.0**	4800	880	0.40	3600	660	0.40
4.8	**2.4**	4000	960	0.48	3000	720	0.48
5.0	**2.5**	3800	970	0.50	2900	740	0.50
6.0	**3.0**	3200	1000	0.60	2400	770	0.60
Depth of Cut		 RE : Radius					

■ Internal Profile / Undercut

(mm)

Work Material		Mild Steels, Carbon Steels, Alloy steel Pre-hardened Steels, Alloy tool steel (–45HRC), Copper Alloys SS400, S10C, S45C, SCM440, SNCM439 NAK, SKD etc.			Austenitic, Ferritic and Martensitic Stainless Steels, Precipitation Hardening Stainless Steels, Cobalt Chromium Alloys, Titanium Alloys SUS304, SUS316L, SUS420J, SUS630, SU631, Ti-6Al-4V, CCM etc.		
DC	**RE**	Revolution **n** (min^{-1})	Feed Rate **vf** (mm/min)	Depth of Cut **ae**	Revolution **n** (min^{-1})	Feed Rate **vf** (mm/min)	Depth of Cut **ae**
2.0	**1.0**	9500	460	0.03	7200	290	0.03
3.0	**1.5**	6400	560	0.10	4800	350	0.10
4.0	**2.0**	4800	650	0.14	3600	390	0.14
5.0	**2.5**	3800	730	0.18	2900	440	0.18
6.0	**3.0**	3200	770	0.22	2400	460	0.22
Depth of Cut		 RE : Radius					

Note 1) SMART MIRACLE coating has very low electrical conductivity; therefore, an external contact type of tool setter (electrically transmitted) may not work. When measuring the tool length, please use an internal contact type (non-electrical type) or a laser tool setter.

Note 2) If the depth of cut is smaller than this table, feed rate can be increased.

Note 3) Vibration may occur if the rigidity of machine or workpiece is low. In this case, please reduce the revolution and feed rate proportionately.

Note 4) For sizes RE 0.5, 0.65, 0.9, 1.4, 1.9 and RE 2.4, which have long neck lengths, internal profile milling and round shape slotting are not recommended.

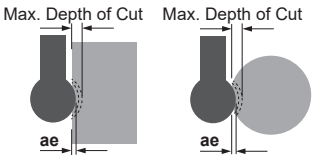
VQ4WB

Multi-functional lollipop, Short cut length, 4 flute

RECOMMENDED CUTTING CONDITIONS

■ Radiused Shape Slotting

(mm)

Work Material		Mild Steels, Carbon Steels, Alloy steel Pre-hardened Steels, Alloy tool steel (–45HRC), Copper Alloys SS400, S10C, S45C, SCM440, SNCM439 NAK, SKD etc.				Austenitic, Ferritic and Martensitic Stainless Steels, Precipitation Hardening Stainless Steels, Cobalt Chromium Alloys, Titanium Alloys SUS304, SUS316L, SUS420J, SUS630, SU631, Ti-6Al-4V, CCM etc.			
DC	**RE**	Revolution **n** (min^{-1})	Feed Rate **vf** (mm/min)	Depth of Cut **ae**	Depth of Cut **Max. ae**	Revolution **n** (min^{-1})	Feed Rate **vf** (mm/min)	Depth of Cut **ae**	Depth of Cut **Max. ae**
2.0	**1.0**	9500	300	0.03	0.06	7200	140	0.03	0.06
3.0	**1.5**	6400	380	0.10	0.20	4800	190	0.10	0.20
4.0	**2.0**	4800	440	0.14	0.28	3600	230	0.14	0.28
5.0	**2.5**	3800	490	0.18	0.54	2900	260	0.18	0.54
6.0	**3.0**	3200	510	0.22	0.88	2400	270	0.22	0.88
Depth of Cut									

Note 1) SMART MIRACLE coating has very low electrical conductivity; therefore, an external contact type of tool setter (electrically transmitted) may not work. When measuring the tool length, please use an internal contact type (non-electrical type) or a laser tool setter.

Note 2) If the depth of cut is smaller than this table, feed rate can be increased.

Note 3) Vibration may occur if the rigidity of machine or workpiece is low. In this case, please reduce the revolution and feed rate proportionately.

Note 4) For sizes RE 0.5, 0.65, 0.9, 1.4, 1.9 and RE 2.4, which have long neck lengths, internal profile milling and round shape slotting are not recommended.

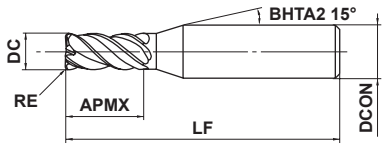
Note 5) The maximum allowed depth of cut (Max. ae) avoids interference between the workpiece and tool shank. It is recommended to machine up to the Max. ae in 2-4 passes.

VQMHVRB

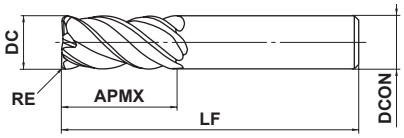
Corner radius end mill, Medium cutting length, 4 flute, Irregular helix flutes

UWC VQ 37° 40°

Carbon Steel, Alloy Steel, Cast Iron (<30HRC)	Tool Steel, Pre-hardened Steel,Hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Hardened Steel (>55HRC)	Austenitic Stainless Steel	Titanium Alloy, Heat Resistant Alloy	Copper Alloy	Aluminium Alloy
◎	◎			◎	◎	○	



Type1



Type2

RE				
±0.015				
DC≤12	DC>12			
0 - 0.02	0 - 0.03			
4≤DCON≤6	8≤DCON≤10	12≤DCON≤16	DCON=20	
0 - 0.008	0 - 0.009	0 - 0.011	0 - 0.013	

● Smart Miracle vibration control end mill achieving stable machining of difficult-to-cut materials and for long overhang applications.

(mm)

Order Number	DC	RE	APMX	LF	DCON	No. of Flutes	Stock	Type
VQMHVRBD0200R020	2	0.2	4	45	4	4	●	1
VQMHVRBD0200R030	2	0.3	4	45	4	4	●	1
VQMHVRBD0300R020	3	0.2	8	45	6	4	●	1
VQMHVRBD0300R030	3	0.3	8	45	6	4	●	1
VQMHVRBD0300R050	3	0.5	8	45	6	4	●	1
VQMHVRBD0400R020	4	0.2	11	45	6	4	●	1
VQMHVRBD0400R030	4	0.3	11	45	6	4	●	1
VQMHVRBD0400R050	4	0.5	11	45	6	4	●	1
VQMHVRBD0500R020	5	0.2	13	50	6	4	●	1
VQMHVRBD0500R030	5	0.3	13	50	6	4	●	1
VQMHVRBD0500R050	5	0.5	13	50	6	4	●	1
VQMHVRBD0500R100	5	1	13	50	6	4	●	1
VQMHVRBD0600R030	6	0.3	13	50	6	4	●	2
VQMHVRBD0600R050	6	0.5	13	50	6	4	●	2
VQMHVRBD0600R100	6	1	13	50	6	4	●	2
VQMHVRBD0800R030	8	0.3	19	60	8	4	●	2
VQMHVRBD0800R050	8	0.5	19	60	8	4	●	2
VQMHVRBD0800R100	8	1	19	60	8	4	●	2
VQMHVRBD0800R150	8	1.5	19	60	8	4	●	2
VQMHVRBD1000R030	10	0.3	22	70	10	4	●	2
VQMHVRBD1000R050	10	0.5	22	70	10	4	●	2
VQMHVRBD1000R100	10	1	22	70	10	4	●	2
VQMHVRBD1000R150	10	1.5	22	70	10	4	●	2
VQMHVRBD1000R200	10	2	22	70	10	4	●	2
VQMHVRBD1200R050	12	0.5	26	75	12	4	●	2
VQMHVRBD1200R100	12	1	26	75	12	4	●	2
VQMHVRBD1200R150	12	1.5	26	75	12	4	●	2
VQMHVRBD1200R200	12	2	26	75	12	4	●	2
VQMHVRBD1200R250	12	2.5	26	75	12	4	●	2
VQMHVRBD1200R300	12	3	26	75	12	4	●	2
VQMHVRBD1600R100	16	1	35	90	16	4	●	2
VQMHVRBD1600R150	16	1.5	35	90	16	4	●	2

Note 1) SMART MIRACLE Coating is not energized because of its nature. Therefore, an external contact (voltaic type) tool setter cannot be used. An internal contact (non-voltaic) type or laser type tool setter is recommended to measure the length of the tool.

● : **Inventory maintained in Japan.**

VQMHVRB

Corner radius end mill, Medium cutting length, 4 flute, Irregular helix flutes

Order Number	DC	RE	APMX	LF	DCON	No. of Flutes	Stock	Type
VQMHVRBD1600R200	16	2	35	90	16	4	●	2
VQMHVRBD1600R250	16	2.5	35	90	16	4	●	2
VQMHVRBD1600R300	16	3	35	90	16	4	●	2
VQMHVRBD1600R400	16	4	35	90	16	4	●	2
VQMHVRBD1600R500	16	5	35	90	16	4	●	2
VQMHVRBD2000R100	20	1	45	110	20	4	●	2
VQMHVRBD2000R150	20	1.5	45	110	20	4	●	2
VQMHVRBD2000R200	20	2	45	110	20	4	●	2
VQMHVRBD2000R250	20	2.5	45	110	20	4	●	2
VQMHVRBD2000R300	20	3	45	110	20	4	●	2
VQMHVRBD2000R400	20	4	45	110	20	4	●	2
VQMHVRBD2000R500	20	5	45	110	20	4	●	2
VQMHVRBD2000R635	20	6.35	45	110	20	4	●	2

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● : **Inventory maintained in Japan.**

DC = Cutting dia.
RE = Corner radius
APMX = Depth of cut max.
LF = Functional length
DCON = Connection dia.

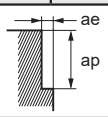
RECOMMENDED CUTTING CONDITIONS

■ Side milling

Select the high efficiency condition if the mechanical rigidity, the rigidity of the work material, and the chip evacuation are sufficient, and select the general-purpose condition if any of them is insufficient.

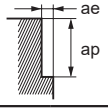
High efficiency conditions

(mm)

Work Material	Carbon steel, Alloy steel, Mild steel AISI 1045, AISI 4140, ASTM A36, AISI 1010					Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel AISI P21, AISI P20, AISI 4340, SKD, SKT					Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys AISI 304, AISI 316, Ti-6Al-4V					Hardened stainless steels, Cobaly chromium alloy AISI 630, AISI 631 15-5PH,17-4PH				
Dia. DC	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae
2	150	24000	2400	3	0.6	120	19000	1100	3	0.6	100	16000	830	3	0.6	75	12000	720	3	0.4
3	150	16000	2600	4.5	0.9	120	13000	1200	4.5	0.9	100	11000	880	4.5	0.9	75	8000	770	4.5	0.6
4	150	12000	2600	6	1.2	120	9500	1300	6	1.2	100	8000	900	6	1.2	75	6000	790	6	0.8
5	150	9500	2600	7.5	1.5	120	7600	1300	7.5	1.5	100	6400	900	7.5	1.5	75	4800	810	7.5	1
6	150	8000	2600	9	1.8	120	6400	1300	9	1.8	100	5300	1100	9	1.8	75	4000	810	9	1.2
8	150	6000	2500	12	2.4	120	4800	1300	12	2.4	100	4000	1200	12	2.4	75	3000	840	12	1.6
10	150	4800	2300	15	3	120	3800	1200	15	3	100	3200	1300	15	3	75	2400	770	15	2
12	150	4000	1900	18	3.6	120	3200	1200	18	3.6	100	2700	1200	18	3.6	75	2000	720	18	2.4
16	150	3000	1600	24	4.8	120	2400	960	24	4.8	100	2000	960	24	4.8	75	1500	600	24	3.2
20	150	2400	1300	30	6	120	1900	760	30	6	100	1600	770	30	6	75	1200	480	30	4
Depth of cut																				

General-purpose conditions

(mm)

Work Material	Carbon steel, Alloy steel, Mild steel AISI 1045, AISI 4140, ASTM A36, AISI 1010					Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel AISI P21, AISI P20, AISI 4340, SKD, SKT					Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys AISI 304, AISI 316, Ti-6Al-4V					Hardened stainless steels, Cobaly chromium alloy AISI 630, AISI 631 15-5PH,17-4PH				
Dia. DC	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae
2	120	19000	1300	3	0.6	100	16000	630	3	0.6	80	13000	450	1.5	0.2	70	11000	440	3	0.4
3	120	13000	1400	4.5	0.9	100	11000	700	4.5	0.9	80	8500	450	2.2	0.3	70	7400	470	4.5	0.6
4	120	9500	1400	6	1.2	100	8000	700	6	1.2	80	6400	470	3	0.6	70	5600	490	6	0.8
5	120	7600	1400	7.5	1.5	100	6400	710	7.5	1.5	80	5100	470	4.5	0.9	70	4500	500	7.5	1
6	120	6400	1400	9	1.8	100	5300	710	9	1.8	80	4200	580	6	1.2	70	3700	500	9	1.2
8	120	4800	1300	12	2.4	100	4000	740	12	2.4	80	3200	630	7.5	1.5	70	2800	520	12	1.6
10	120	3800	1200	15	3	100	3200	680	15	3	80	2500	660	9	1.8	70	2200	460	15	2
12	120	3200	1000	18	3.6	100	2700	640	18	3.6	80	2100	610	12	2.4	70	1900	450	18	2.4
16	120	2400	860	24	4.8	100	2000	530	24	4.8	80	1600	510	15	3	70	1400	370	24	3.2
20	120	1900	680	30	6	100	1600	420	30	6	80	1300	410	18	3.6	70	1100	290	30	4
Depth of cut																				

Note 1) SMART MIRACLE Coating is not energized because of its nature. Therefore, an external contact (voltaic type) tool setter cannot be used. An internal contact (non-voltaic) type or laser type tool setter is recommended to measure the length of the tool.
Note 2) Effective cutting of stainless steel, titanium alloys and heat resistant alloys etc. can be achieved with the use of emulsion.
Note 3) Vibration damping end mills are more effective in suppressing chatter and vibration compared to general end mills, but these may still occur if the rigidity of the machine or the workpiece material is low.
Note 4) When the depth of cut is smaller than shown the revolution and feed rate can be increased.

VQMHVRB

Corner radius end mill, Medium cutting length, 4 flute, Irregular helix flutes

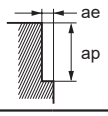
RECOMMENDED CUTTING CONDITIONS

■ Side milling

Select the high efficiency condition if the mechanical rigidity, the rigidity of the work material, and the chip evacuation are sufficient, and select the general-purpose condition if any of them is insufficient.

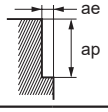
High efficiency conditions

(mm)

Work Material	Copper, Copper alloy					Heat resistant alloys Inconel718				
Dia. **DC** (mm)	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae
2	180	29000	2900	3	0.6	40	6400	230	3	0.2
3	180	19000	3000	4.5	0.9	40	4200	240	4.5	0.3
4	180	14000	3000	6	1.2	40	3200	240	6	0.4
5	180	11000	3000	7.5	1.5	40	2500	240	7.5	0.5
6	180	9500	3000	9	1.8	40	2100	250	9	0.6
8	180	7200	3000	12	2.4	40	1600	260	12	0.8
10	180	5700	2700	15	3	40	1300	290	15	1
12	180	4800	2300	18	3.6	40	1100	280	18	1.2
16	180	3600	1900	24	4.8	40	800	200	24	1.6
20	180	2900	1600	30	6	40	640	160	30	2
Depth of cut										

General-purpose conditions

(mm)

Work Material	Copper, Copper alloy					Heat resistant alloys Inconel718				
Dia. **DC** (mm)	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae
2	140	22000	1500	3	0.6	30	4800	110	3	0.2
3	140	15000	1600	4.5	0.9	30	3200	120	4.5	0.3
4	140	11000	1600	6	1.2	30	2400	120	6	0.4
5	140	8900	1600	7.5	1.5	30	1900	120	7.5	0.5
6	140	7400	1600	9	1.8	30	1600	130	9	0.6
8	140	5600	1600	12	2.4	30	1200	130	12	0.8
10	140	4500	1400	15	3	30	950	140	15	1
12	140	3700	1200	18	3.6	30	800	140	18	1.2
16	140	2800	1000	24	4.8	30	600	100	24	1.6
20	140	2200	780	30	6	30	480	81	30	2
Depth of cut										

Note 1) SMART MIRACLE Coating is not energized because of its nature. Therefore, an external contact (voltaic type) tool setter cannot be used. An internal contact (non-voltaic) type or laser type tool setter is recommended to measure the length of the tool.
Note 2) Effective cutting of stainless steel, titanium alloys and heat resistant alloys etc. can be achieved with the use of emulsion.
Note 3) Vibration damping end mills are more effective in suppressing chatter and vibration compared to general end mills, but these may still occur if the rigidity of the machine or the workpiece material is low.
Note 4) When the depth of cut is smaller than shown the revolution and feed rate can be increased.

■ Slotting

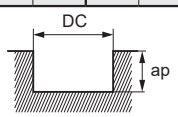
Select the high efficiency condition if the mechanical rigidity, the rigidity of the work material, and the chip evacuation are sufficient, and select the general-purpose condition if any of them is insufficient.

High efficiency conditions

(mm)

Work Material	Carbon steel, Alloy steel, Mild steel AISI 1045, AISI 4140, ASTM A36, AISI 1010				Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel AISI P21, AISI P20, AISI 4340, SKD, SKT				Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys AISI 304, AISI 316, Ti-6Al-4V				Hardened stainless steels, Cobaly chromium alloy AISI 630, AISI 631 15-5PH, 17-4PH				Copper, Copper alloy				Heat resistant alloys Inconel718			
Dia. **DC** (mm)	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap
2	150	24000	1200	2	120	19000	610	2	100	16000	640	2	60	9500	300	1	180	29000	1500	2	30	4800	130	0.6
3	150	16000	1500	3	120	13000	730	3	100	11000	660	3	60	6400	360	1.5	180	19000	1700	3	30	3200	150	0.9
4	150	12000	1900	4	120	9500	910	4	100	8000	700	4	60	4800	460	2	180	14000	2200	4	30	2400	170	1.2
5	150	9500	1900	5	120	7600	910	5	100	6400	720	5	60	3800	460	2.5	180	11000	2200	5	30	1900	170	1.5
6	150	8000	1900	6	120	6400	1000	6	100	5300	740	6	60	3200	510	3	180	9500	2300	6	30	1600	180	1.8
8	150	6000	1700	8	120	4800	960	8	100	4000	800	8	60	2400	480	4	180	7200	2000	8	30	1200	190	2.4
10	150	4800	1500	10	120	3800	840	10	100	3200	900	10	60	1900	420	5	180	5700	1800	10	30	950	210	3
12	150	4000	1300	12	120	3200	770	12	100	2700	860	12	60	1600	380	6	180	4800	1500	12	30	800	200	3.6
16	150	3000	1100	12	120	2400	670	12	100	2000	640	12	60	1200	340	8	180	3600	1300	12	30	600	150	4.8
20	150	2400	860	12	120	1900	530	12	100	1600	510	12	60	950	270	10	180	2900	1000	12	30	480	120	6

Depth of cut



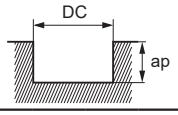
DC:Dia.

General-purpose conditions

(mm)

Work Material	Carbon steel, Alloy steel, Mild steel AISI 1045, AISI 4140, ASTM A36, AISI 1010				Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel AISI P21, AISI P20, AISI 4340, SKD, SKT				Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys AISI 304, AISI 316, Ti-6Al-4V				Hardened stainless steels, Cobaly chromium alloy AISI 630, AISI 631 15-5PH, 17-4PH				Copper, Copper alloy				Heat resistant alloys Inconel718			
Dia. **DC** (mm)	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap
2	100	16000	550	2	80	13000	270	2	60	9500	250	2	50	8000	170	1	120	19000	650	2	25	4000	74	0.6
3	100	11000	670	3	80	8500	310	3	60	6400	250	3	50	5300	200	1.5	120	13000	790	3	25	2700	86	0.9
4	100	8000	840	4	80	6400	410	4	60	4800	280	4	50	4000	250	2	120	9500	1000	4	25	2000	93	1.2
5	100	6400	840	5	80	5100	410	5	60	3800	280	5	50	3200	250	2.5	120	7600	1000	5	25	1600	95	1.5
6	100	5300	840	6	80	4200	440	6	60	3200	300	6	50	2700	290	3	120	6400	1000	6	25	1300	96	1.8
8	100	4000	740	8	80	3200	420	8	60	2400	320	8	50	2000	260	4	120	4800	890	8	25	990	100	2.4
10	100	3200	680	10	80	2500	360	10	60	1900	350	10	50	1600	230	5	120	3800	800	10	25	800	120	3
12	100	2700	570	12	80	2100	330	12	60	1600	340	12	50	1300	210	6	120	3200	680	12	25	660	110	3.6
16	100	2000	480	12	80	1600	300	12	60	1200	250	12	50	990	180	8	120	2400	570	12	25	500	84	4.8
20	100	1600	380	12	80	1300	240	12	60	950	200	12	50	800	150	10	120	1900	450	12	25	400	68	6

Depth of cut



DC:Dia.

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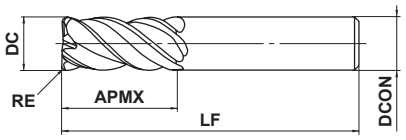
Note 3) Vibration damping end mills are more effective in suppressing chatter and vibration compared to general end mills, but these may still occur if the rigidity of the machine or the workpiece material is low.
Note 4) When the depth of cut is smaller than shown the feed rate can be increased.

VQMHVRBF

Corner radius end mill, Medium cutting length, 4 flute, Irregular helix flutes (for finishing)

Carbon Steel, Alloy Steel, Cast Iron (<30HRC)	Tool Steel, Pre-hardened Steel,Hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Hardened Steel (>55HRC)	Austenitic Stainless Steel	Titanium Alloy, Heat Resistant Alloy	Copper Alloy	Aluminium Alloy
◎	◎			◎	◎	○	



Type1

RE				
±0.015				
DC≤12	DC>12			
0 - 0.02	0 - 0.03			
DCON=6	8≤DCON≤10	12≤DCON≤16		
0 - 0.008	0 - 0.009	0 - 0.011		

- Smart Miracle vibration control end mill achieving stable machining of difficult-to-cut materials.
- With the special substrate, suitable for finishing of heat resistance alloy, etc.

(mm)

Order Number	DC	RE	APMX	LF	DCON	No. of Flutes	Stock	Type
VQMHVRBFD0600R030	6	0.3	13	50	6	4	●	1
VQMHVRBFD0600R050	6	0.5	13	50	6	4	●	1
VQMHVRBFD0600R100	6	1	13	50	6	4	●	1
VQMHVRBFD0800R050	8	0.5	19	60	8	4	●	1
VQMHVRBFD0800R100	8	1	19	60	8	4	●	1
VQMHVRBFD1000R030	10	0.3	22	70	10	4	●	1
VQMHVRBFD1000R050	10	0.5	22	70	10	4	●	1
VQMHVRBFD1000R100	10	1	22	70	10	4	●	1
VQMHVRBFD1000R200	10	2	22	70	10	4	●	1
VQMHVRBFD1200R100	12	1	26	75	12	4	●	1
VQMHVRBFD1200R200	12	2	26	75	12	4	●	1
VQMHVRBFD1200R300	12	3	26	75	12	4	●	1
VQMHVRBFD1600R100	16	1	35	90	16	4	●	1
VQMHVRBFD1600R200	16	2	35	90	16	4	●	1

Note 1) SMART MIRACLE Coating is not energized because of its nature. Therefore, an external contact (voltaic type) tool setter cannot be used. An internal contact (non-voltaic) type or laser type tool setter is recommended to measure the length of the tool.

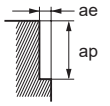
● : **Inventory maintained in Japan.**

DC = Cutting dia.
RE = Corner radius
APMX = Depth of cut max.
LF = Functional length
DCON = Connection dia.

RECOMMENDED CUTTING CONDITIONS

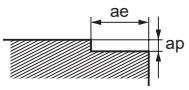
■Side milling

(mm)

Work Material	Carbon steel, Alloy steel, Mild steel AISI 1045, AISI 4140, ASTM A36, AISI 1010					Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel AISI P21, AISI P20, AISI 4340, SKD, SKT					Hardened stainless steels, Cobaly chromium alloy AISI 630, AISI 631, 15-5PH, 17-4PH					Copper, Copper alloy					Heat resistant alloys Inconel718				
Dia. DC	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae
6	150	8000	2600	9	0.3	120	6400	1300	9	0.3	75	4000	800	9	0.3	180	9500	3000	9	0.3	40	2100	250	9	0.18
8	150	6000	2500	12	0.4	120	4800	1300	12	0.4	75	3000	840	12	0.4	180	7200	3000	12	0.4	40	1600	260	12	0.24
10	150	4800	2300	15	0.5	120	3800	1200	15	0.5	75	2400	770	15	0.5	180	5700	2700	15	0.5	41	1300	290	15	0.3
12	150	4000	1900	18	0.6	120	3200	1200	18	0.6	75	2000	720	18	0.6	180	4800	2300	18	0.6	41	1100	280	18	0.36
16	150	3000	1600	24	0.8	120	2400	960	24	0.8	75	1500	600	24	0.8	180	3600	1900	24	0.8	40	800	200	24	0.48
Depth of cut																									

■Bottom face milling

(mm)

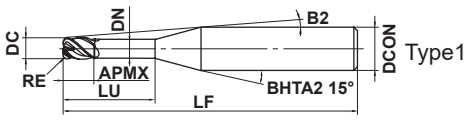
Work Material	Carbon steel, Alloy steel, Mild steel AISI 1045, AISI 4140, ASTM A36, AISI 1010					Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel AISI P21, AISI P20, AISI 4340, SKD, SKT					Hardened stainless steels, Cobaly chromium alloy AISI 630, AISI 631, 15-5PH, 17-4PH					Copper, Copper alloy					Heat resistant alloys Inconel718				
Dia. DC	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae	Cutting speed (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae
6	110	5800	1400	0.3	4.8	90	4800	770	0.3	4.8	55	2900	460	0.3	4.8	130	6900	1700	0.3	4.8	30	1600	180	0.18	4.8
8	110	4400	1200	0.4	6.4	90	3600	720	0.4	6.4	55	2200	440	0.4	6.4	130	5200	1500	0.4	6.4	30	1200	190	0.24	6.4
10	110	3500	1100	0.5	8	90	2900	640	0.5	8	55	1800	400	0.5	8	130	4100	1300	0.5	8	30	950	210	0.3	8
12	110	2900	930	0.6	9.6	90	2400	580	0.6	9.6	55	1500	360	0.6	9.6	130	3400	1100	0.6	9.6	30	800	200	0.36	9.6
16	110	2200	790	0.8	12.8	90	1800	500	0.8	12.8	55	1100	310	0.8	12.8	130	2600	940	0.8	12.8	30	600	150	0.48	12.8
Depth of cut																									

Note 1) SMART MIRACLE Coating is not energized because of its nature. Therefore, an external contact (voltaic type) tool setter cannot be used. An internal contact (non-voltaic) type or laser type tool setter is recommended to measure the length of the tool.
Note 2) Effective cutting of stainless steel, titanium alloys and heat resistant alloys etc. can be achieved with the use of emulsion.
Note 3) Vibration damping end mills are more effective in suppressing chatter and vibration compared to general end mills, but these may still occur if the rigidity of the machine or the workpiece material is low.
Note 4) When the depth of cut is smaller than shown the feed rate can be increased.

VQHVRB

Corner radius, Short cut length, 4 flute, Irregular helix flutes

Carbon Steel, Alloy Steel, Cast Iron (<30HRC)	Tool Steel, Pre-hardened Steel,Hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Hardened Steel (>55HRC)	Austenitic Stainless Steel	Titanium Alloy, Heat Resistant Alloy	Copper Alloy	Aluminium Alloy
					◎	○	



RE			
±0.01			
DC			
0 - 0.02			
DCON			
0 - 0.005			

● SMART MIRACLE corner radius end mill for high feed rates and efficient machining.

(mm)

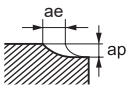
Order Number	DC	RE	APMX	LU	DN	B2	LF	DCON	No. of Flutes	Stock	Type
VQHVRBD0100R01N080	1	0.1	1	8	0.94	8.2°	50	6	4	●	1
VQHVRBD0100R01N120	1	0.1	1	12	0.94	6.7°	55	6	4	●	1
VQHVRBD0200R02N120	2	0.2	2	12	1.9	5.9°	55	6	4	●	1
VQHVRBD0200R02N160	2	0.2	2	16	1.9	4.9°	60	6	4	●	1
VQHVRBD0300R05N100	3	0.5	3	10	2.9	5.6°	55	6	4	●	1
VQHVRBD0300R05N180	3	0.5	3	18	2.9	3.7°	60	6	4	●	1
VQHVRBD0400R10N120	4	1.0	4	12	3.9	3.9°	55	6	4	●	1
VQHVRBD0400R10N200	4	1.0	4	20	3.9	2.5°	60	6	4	●	1

DC = Cutting dia.
RE = Corner radius
APMX = Depth of cut max.
LU = Usable length
DN = Neck dia.
LF = Functional length
DCON = Connection dia.

● : **Inventory maintained in Japan.**

RECOMMENDED CUTTING CONDITIONS

(mm)

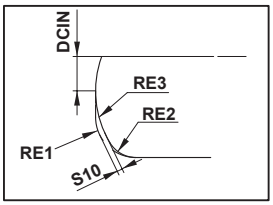
Work Material		Titanium Alloys Ti-6Al-4V ELI etc.					Cobalt Chromium Alloys Precipitation Hardening Stainless Steels Co-Cr-Mo, SUS630, SUS631, 15-5PH, 17-4PH etc.				
DC	**LU**	Revolution **n** (min^{-1})	Cutting Speed **vc** (m/min)	Feed Rate **vf** (mm/min)	Depth of cut **ap**	Width of cut **ae**	Revolution **n** (min^{-1})	Cutting Speed **vc** (m/min)	Feed Rate **vf** (mm/min)	Depth of cut **ap**	Width of cut **ae**
1	**8**	2500	8	500	0.030	0.1	2500	8	500	0.030	0.1
1	**12**	2500	8	350	0.030	0.1	2500	8	350	0.030	0.1
2	**12**	4800	30	600	0.075	0.3	4800	30	600	0.075	0.3
2	**16**	4800	30	340	0.075	0.3	4800	30	350	0.075	0.3
3	**10**	8500	80	2400	0.190	1.3	6400	60	2200	0.170	1.3
3	**18**	8500	80	2000	0.190	1.3	6400	60	1600	0.170	1.3
4	**12**	6400	80	2000	0.250	1.7	4800	60	1800	0.220	1.7
4	**20**	6400	80	2000	0.250	1.7	4800	60	1800	0.220	1.7
Depth of Cut											

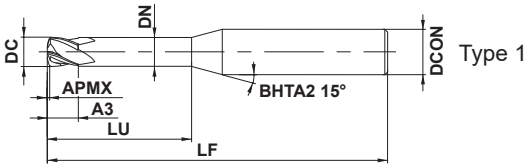
Note 1) The SMART MIRACLE coating has very low electrical conductivity; therefore, an external contact type of tool setter (electrically transmitted) may not work.
When measuring the tool length, please use an internal contact type (non-electrical type) or a laser tool setter.
Note 2) When cutting titanium alloys, the use of water-soluble cutting fluid is effective.
Note 3) Vibration damping end mills are more effective in suppressing chatter and vibration compared to general end mills, but these may still occur if the rigidity of the machine or the workpiece material is low.
Note 4) If the depth of cut is shallow, the revolution and the feed rate can be increased.

VQFDRB

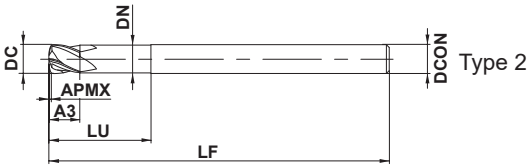
Duplex corner radius end mill for high-speed cutting

Carbon Steel, Alloy Steel, Cast Iron (<30HRC)	Tool Steel, Pre-hardened Steel,Hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Hardened Steel (>55HRC)	Austenitic Stainless Steel	Titanium Alloy, Heat Resistant Alloy	Copper Alloy	Aluminium Alloy
					◎	○	





Type 1



Type 2

DC				
0 - 0.020				
DCON				
0 - 0.005				

- Duplex corner radius type allows a more efficient, higher feed.
- High feed cutting realized through the use of multiple cuts.

(mm)

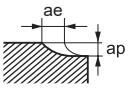
Order Number	DC	RE1	APMX	A3	LU	DN	LF	DCON	No. F	Multi-task radius part				RMPX	Stock	Type
										S10	DCIN	RE2	RE3			
VQFDRBD0300N080	3	0.64	0.18	3	8	2.8	50	6	4	0.08	0.75	0.5	2	2.1°	●	1
VQFDRBD0300N120	3	0.64	0.18	3	12	2.8	55	6	4	0.08	0.75	0.5	2	2.1°	●	1
VQFDRBD0400N120	4	0.71	0.25	4	12	3.8	55	6	4	0.13	1.0	0.5	3	1.9°	●	1
VQFDRBD0400N160	4	0.71	0.25	4	16	3.8	60	6	4	0.13	1.0	0.5	3	1.9°	●	1
VQFDRBD0600N180	6	0.92	0.36	6	18	5.6	60	6	4	0.21	1.5	0.6	5	1.7°	●	2

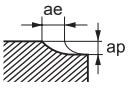
DC = Cutting dia.
RE1 = Approx. R
APMX = Depth of cut max.
A3 = Cutting edge effective length
LU = Usable length
DN = Neck dia.
LF = Functional length
DCON = Connection dia.
DCIN = Cutting dia. internal
RMPX = Ramping angle max.

● : **Inventory maintained in Japan.**

RECOMMENDED CUTTING CONDITIONS

(mm)

Work Material	Titanium Alloys Ti-6Al-4V ELI etc.					Cobalt Chromium Alloys Precipitation Hardening Stainless Steels Co-Cr-Mo, SUS630, SUS631, 15-5PH, 17-4PH etc.				
DC	Revolution **n** (min^{-1})	Cutting Speed **vc** (m/min)	Feed Rate **vf** (mm/min)	Depth of cut **ap**	Width of cut **ae**	Revolution **n** (min^{-1})	Cutting Speed **vc** (m/min)	Feed Rate **vf** (mm/min)	Depth of cut **ap**	Width of cut **ae**
3	8500	80	2100	0.2	1.3	6400	60	3000	0.2	1.3
4	6400	80	2200	0.2	1.7	4800	60	2700	0.2	1.7
6	4200	80	1400	0.3	2.0	3200	60	2100	0.3	2.6
Depth of Cut										

Work Material	Heat Resistant Alloys Inconel 718 etc.				
DC	Revolution **n** (min^{-1})	Cutting Speed **vc** (m/min)	Feed Rate **vf** (mm/min)	Depth of cut **ap**	Width of cut **ae**
3	3200	30	770	0.2	0.6
4	2400	30	770	0.2	0.8
6	1600	30	520	0.3	1.3
Depth of Cut					

Note 1) The SMART MIRACLE coating has very low electrical conductivity; therefore, an external contact type of tool setter (electrically transmitted) may not work.
When measuring the tool length, please use an internal contact type (non-electrical type) or a laser tool setter.
Note 2) When cutting titanium alloys, the use of water-soluble cutting fluid is effective.
Note 3) If the depth of cut is shallow, the revolution and the feed rate can be increased.

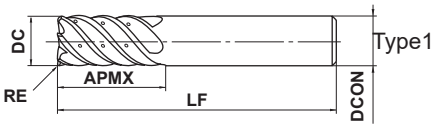
VQ6MHVRBCH

Corner radius end mill, Medium cut length, 6 flute, Irregular helix flutes, With multiple internal through coolant

Carbon Steel, Alloy Steel, Cast Iron (<30HRC)	Tool Steel, Pre-hardened Steel,Hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Hardened Steel (>55HRC)	Austenitic Stainless Steel	Titanium Alloy, Heat Resistant Alloy	Copper Alloy	Aluminium Alloy
○	○			◎	◎	○	

CoolStar

END MILLS



RE				
±0.015				
DC≤12	DC>12			
0 - 0.020	0 - 0.030			
DCON=10	DCON=12	DCON=16	DCON=20	
0 - 0.009	0 - 0.011	0 - 0.011	0 - 0.013	

● Vibration control corner radius end mill with multiple internal through coolant holes ensures stable machining on difficult-to-cut materials and applications requiring long overhangs.

(mm)

Order Number	DC	RE	APMX	LF	DCON	No. of Flutes	Stock	Type
VQ6MHVRBCHD1000R050	10	0.5	22	70	10	6	●	1
VQ6MHVRBCHD1000R100	10	1	22	70	10	6	●	1
VQ6MHVRBCHD1200R050	12	0.5	26	75	12	6	●	1
VQ6MHVRBCHD1200R100	12	1	26	75	12	6	●	1
VQ6MHVRBCHD1600R100	16	1	32	90	16	6	●	1
VQ6MHVRBCHD1600R300	16	3	32	90	16	6	●	1
VQ6MHVRBCHD1600R400	16	4	32	90	16	6	●	1
VQ6MHVRBCHD2000R100	20	1	38	100	20	6	●	1
VQ6MHVRBCHD2000R300	20	3	38	100	20	6	●	1
VQ6MHVRBCHD2000R400	20	4	38	100	20	6	●	1

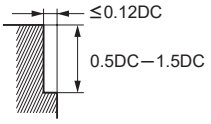
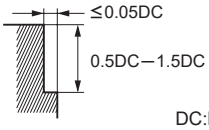
● : **Inventory maintained in Japan.**

DC = Cutting dia.
RE = Corner radius
APMX = Depth of cut max.
LF = Functional length
DCON = Connection dia.

RECOMMENDED CUTTING CONDITIONS

■Side milling

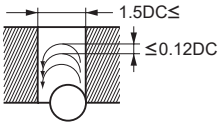
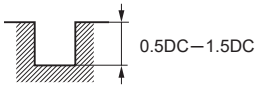
(mm)

Work Material	Alloy steel, Tool steel, Pre-hardened steel AISI H13, AISI W1-10, AISI P21		Austenitic Stainless Steel (≤200HB), Titanium Alloy AISI 304, AISI 316, Ti-6Al-4V		Copper, Copper alloy		Heat Resistant Alloys Inconel 718	
Dia. **DC**	Revolution (min^{-1})	Feed rate (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)
10	—	—	4800	2000	—	—	1300	260
12	—	—	4000	2000	—	—	1100	230
16	4000	2200	3000	1600	2400	1400	800	180
20	3200	1900	2400	1400	1900	1100	640	150
Depth of Cut								

DC:Dia.

■Trochoidal slotting

(mm)

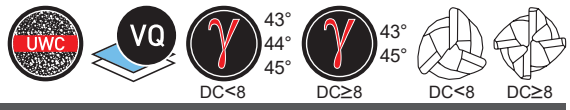
Work Material	Alloy steel, Tool steel, Pre-hardened steel AISI H13, AISI W1-10, AISI P21		Austenitic stainless steel (≤200HB), Titanium alloy AISI 304, AISI 306, Ti-6Al-4V	
Dia. **DC**	Revolution (min^{-1})	Feed rate (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)
10	—	—	4800	1400
12	—	—	4000	1200
16	4000	1600	3000	1100
20	3200	1400	2400	900
Depth of cut				

DC:Dia.

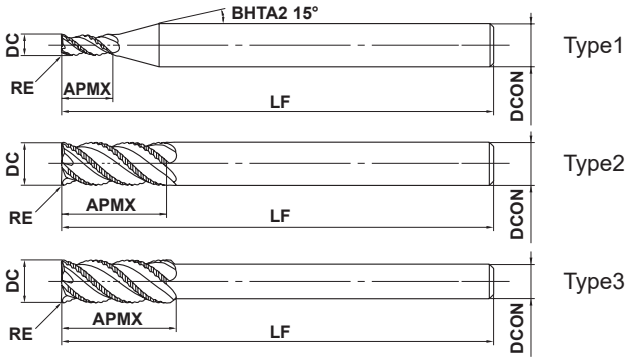
Note 1) If the depth of cut is shallow, the revolution and feed rate can be increased.
Note 2) Vibration damping end mills are more effective in suppressing chatter and vibration compared to general end mills, but these may still occur if the rigidity of the machine or the workpiece material is low.

VQSVR

Roughing end mill, Short cut length, 4 flute, Irregular helix flutes



Carbon Steel, Alloy Steel, Cast Iron (<30HRC)	Tool Steel, Pre-hardened Steel,Hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Hardened Steel (>55HRC)	Austenitic Stainless Steel	Titanium Alloy, Heat Resistant Alloy	Copper Alloy	Aluminium Alloy
◎	◎			◎	◎	○	



h6

DCON=6	8≤DCON≤10	12≤DCON≤16	DCON=20
0 - 0.008	0 - 0.009	0 - 0.011	0 - 0.013

- Achieving an excellent vibration resistance due to the adoption of irregular helix.
- Use of an asymmetric chip breaker improves fracture resistance substantially. (Compared to a conventional roughing end mill)

(mm)

Order Number	DC	RE	APMX	LF	DCON	No. of Flutes	Stock	Type
VQSVRD0300	3	0.2	6	60	6	3	●	1
VQSVRD0400	4	0.2	8	60	6	3	●	1
VQSVRD0500	5	0.3	10	60	6	3	●	1
VQSVRD0600	6	0.3	12	70	6	3	●	2
VQSVRD0700	7	0.3	17	80	8	3	●	1
VQSVRD0800	8	0.5	17	80	8	4	●	2
VQSVRD0900	9	0.5	22	90	10	4	●	1
VQSVRD1000	10	0.5	22	90	10	4	●	2
VQSVRD1000S08	10	0.5	22	90	8	4	●	3
VQSVRD1200	12	0.5	27	100	12	4	●	2
VQSVRD1200S10	12	0.5	27	100	10	4	●	3
VQSVRD1400	14	0.5	27	130	12	4	●	3
VQSVRD1600	16	0.5	33	125	16	4	●	2
VQSVRD1800	18	0.5	33	150	16	4	●	3
VQSVRD2000	20	0.5	38	140	20	4	●	2

Note 1) SMART MIRACLE Coating is not energized because of its nature. Therefore, an external contact (voltaic type) tool setter cannot be used. An internal contact (non-voltaic) type or laser type tool setter is recommended to measure the length of the tool.

● : **Inventory maintained in Japan.**

DC = Cutting dia.
RE = Corner radius
APMX = Depth of cut max.
LF = Functional length
DCON = Connection dia.

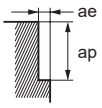
RECOMMENDED CUTTING CONDITIONS

■ Side milling

Select the high efficiency condition if the mechanical rigidity, the rigidity of the work material, and the chip evacuation are sufficient, and select the general-purpose condition if any of them is insufficient.

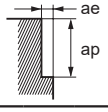
High efficiency conditions

(mm)

Work Material	Carbon steel, Alloy steel, Mild steel AISI 1045, AISI 4140, ASTM A36, AISI 1010					Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel AISI P21, AISI P20, AISI 4340					Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys AISI 304, AISI 316, Ti-6Al-4V					Hardened stainless steels, Cobaly chromium alloy AISI 630, AISI 631, 15-5PH, 17-4PH					Copper, Copper alloy				
Dia. DC	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Hole Depth ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Hole Depth ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Hole Depth ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Hole Depth ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Hole Depth ae
3	150	16000	960	4.5	1.5	120	13000	640	4.5	1.5	100	11000	450	4.5	1.5	75	8000	330	4.5	0.9	180	19000	1100	4.5	1.5
4	150	12000	960	6	2	120	9500	640	6	2	100	8000	430	6	2	75	6000	330	6	1.2	180	14000	1100	6	2
5	150	9500	960	7.5	2.5	120	7600	640	7.5	2.5	100	6400	440	7.5	2.5	75	4800	330	7.5	1.5	180	11000	1100	7.5	2.5
6	150	8000	960	9	3	120	6400	680	9	3	100	5300	480	9	3	75	4000	360	9	1.8	180	9500	1100	9	3
7	150	6800	950	10.5	3.5	120	5500	700	10.5	3.5	100	4500	500	10.5	3.5	75	3400	380	10.5	2.1	180	8200	1100	10.5	3.5
8	150	6000	1100	12	4	120	4800	800	12	4	100	4000	570	12	4	75	3000	430	12	2.4	180	7200	1300	12	4
9	150	5300	1100	13.5	4.5	120	4200	760	13.5	4.5	100	3500	570	13.5	4.5	75	2700	430	13.5	2.7	180	6400	1300	13.5	4.5
10	150	4800	1100	15	5	120	3800	760	15	5	100	3200	570	15	5	75	2400	430	15	3	180	5700	1200	15	5
12	150	4000	960	18	6	120	3200	700	18	6	100	2700	540	18	6	75	2000	400	18	3.6	180	4800	1200	18	6
14	150	3400	880	21	7	120	2700	650	21	7	100	2300	510	21	7	75	1700	380	21	4.2	180	4100	1100	21	7
16	150	3000	840	24	8	120	2400	620	24	8	100	2000	500	24	8	75	1500	380	24	4.8	180	3600	1000	24	8
18	150	2700	810	27	9	120	2100	590	27	9	100	1800	500	27	9	75	1300	360	27	5.4	180	3200	960	27	9
20	150	2400	760	30	10	120	1900	560	30	10	100	1600	500	30	10	75	1200	360	30	6	180	2900	920	30	10
Depth of cut																									

General-purpose conditions

(mm)

Work Material	Carbon steel, Alloy steel, Mild steel AISI 1045, AISI 4140, ASTM A36, AISI 1010					Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel AISI P21, AISI P20, AISI 4340					Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys AISI 304, AISI 306, Ti-6Al-4V					Hardened stainless steels, Cobaly chromium alloy AISI 630, AISI 631, 15-5PH, 17-4PH					Copper, Copper alloy				
Dia. DC	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Hole Depth ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Hole Depth ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Hole Depth ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Hole Depth ae	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Hole Depth ap	Hole Depth ae
3	120	13000	610	4.5	1.5	100	11000	430	4.5	1.5	80	8500	280	4.5	1.5	70	7400	240	4.5	0.9	140	15000	700	4.5	1.5
4	120	9500	610	6	2	100	8000	430	6	2	80	6400	280	6	2	70	5600	240	6	1.2	140	11000	700	6	2
5	120	7600	610	7.5	2.5	100	6400	430	7.5	2.5	80	5100	280	7.5	2.5	70	4500	250	7.5	1.5	140	8900	720	7.5	2.5
6	120	6400	610	9	3	100	5300	450	9	3	80	4200	300	9	3	70	3700	270	9	1.8	140	7400	720	9	3
7	120	5500	620	10.5	3.5	100	4500	480	10.5	3.5	80	3600	320	10.5	3.5	70	3200	290	10.5	2.1	140	6400	720	10.5	3.5
8	120	4800	720	12	4	100	4000	570	12	4	80	3200	380	12	4	70	2800	340	12	2.4	140	5600	840	12	4
9	120	4200	670	13.5	4.5	100	3500	510	13.5	4.5	80	2800	360	13.5	4.5	70	2500	320	13.5	2.7	140	5000	800	13.5	4.5
10	120	3800	670	15	5	100	3200	510	15	5	80	2500	360	15	5	70	2200	310	15	3	140	4500	790	15	5
12	120	3200	610	18	6	100	2700	470	18	6	80	2100	340	18	6	70	1900	300	18	3.6	140	3700	710	18	6
14	120	2700	560	21	7	100	2300	440	21	7	80	1800	320	21	7	70	1600	280	21	4.2	140	3200	670	21	7
16	120	2400	540	24	8	100	2000	410	24	8	80	1600	320	24	8	70	1400	280	24	4.8	140	2800	630	24	8
18	120	2100	500	27	9	100	1800	400	27	9	80	1400	310	27	9	70	1200	270	27	5.4	140	2500	600	27	9
20	120	1900	480	30	10	100	1600	380	30	10	80	1300	310	30	10	70	1100	270	30	6	140	2200	560	30	10
Depth of cut																									

Note 1) SMART MIRACLE Coating is not energized because of its nature. Therefore, an external contact (voltaic type) tool setter cannot be used. An internal contact (non-voltaic) type or laser type tool setter is recommended to measure the length of the tool.
Note 2) Effective cutting of stainless steel, titanium alloys and heat resistant alloys etc. can be achieved with the use of emulsion.
Note 3) Vibration damping end mills are more effective in suppressing chatter and vibration compared to general end mills, but these may still occur if the rigidity of the machine or the workpiece material is low.
Note 4) When the depth of cut is smaller than shown the revolution and feed rate can be increased.

VQSVR

Roughing end mill, Short cut length, 4 flute, Irregular helix flutes

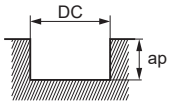
RECOMMENDED CUTTING CONDITIONS

■ Slotting

Select the high efficiency condition if the mechanical rigidity, the rigidity of the work material, and the chip evacuation are sufficient, and select the general-purpose condition if any of them is insufficient.

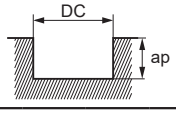
High efficiency conditions

(mm)

Work Material	Carbon steel, Alloy steel, Mild steel AISI 1045, AISI 4140, ASTM A36, AISI 1010				Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel AISI P21, AISI P20, AISI 4340				Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys AISI 304, AISI 306, Ti-6Al-4V				Hardened stainless steels, Cobaly chromium alloy AISI 630, AISI 631, 15-5PH, 17-4PH				Copper, Copper alloy			
Dia. DC	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap
3	120	13000	720	3	100	11000	440	3	80	8500	340	3	60	6400	250	1.5	150	16000	890	3
4	120	9500	720	4	100	8000	450	4	80	6400	340	4	60	4800	250	2	150	12000	900	4
5	120	7600	720	5	100	6400	460	5	80	5100	300	5	60	3800	230	2.5	150	9500	900	5
6	120	6400	720	6	100	5300	460	6	80	4200	310	6	60	3200	240	3	150	8000	900	6
7	120	5500	730	7	100	4500	470	7	80	3600	330	7	60	2700	250	3.5	150	6800	950	7
8	120	4800	840	8	100	4000	560	8	80	3200	400	8	60	2400	300	4	150	6000	1100	8
9	120	4200	810	9	100	3500	540	9	80	2800	350	9	60	2100	260	4.5	150	5300	1000	9
10	120	3800	800	10	100	3200	520	10	80	2500	340	10	60	1900	260	5	150	4800	1000	10
12	120	3200	750	12	100	2700	480	12	80	2100	340	12	60	1600	260	6	150	4000	940	12
14	120	2700	670	14	100	2300	420	14	80	1800	300	14	60	1400	240	7	150	3400	840	14
16	120	2400	620	16	100	2000	380	16	80	1600	290	16	60	1200	220	8	150	3000	780	16
18	120	2100	570	18	100	1800	380	18	80	1400	260	18	60	1100	210	9	150	2700	730	18
20	120	1900	540	20	100	1600	350	20	80	1300	260	20	60	950	190	10	150	2400	680	20
Depth of cut	 DC:Dia.																			

General-purpose conditions

(mm)

Work Material	Carbon steel, Alloy steel, Mild steel AISI 1045, AISI 4140, ASTM A36, AISI 1010				Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel AISI P21, AISI P20, AISI 4340				Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys AISI 304, AISI 306, Ti-6Al-4V				Hardened stainless steels, Cobaly chromium alloy AISI 630, AISI 631, 15-5PH, 17-4PH				Copper, Copper alloy			
Dia. DC	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Cutting speed (m/min)	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap
3	100	11000	490	3	80	8500	300	3	60	6400	200	3	50	5300	170	1.5	120	13000	580	3
4	100	8000	490	4	80	6400	310	4	60	4800	200	4	50	4000	170	2	120	9500	580	4
5	100	6400	490	5	80	5100	310	5	60	3800	200	5	50	3200	170	2.5	120	7600	580	5
6	100	5300	490	6	80	4200	310	6	60	3200	200	6	50	2700	170	3	120	6400	580	6
7	100	4500	500	7	80	3600	320	7	60	2700	200	7	50	2300	170	3.5	120	5500	620	7
8	100	4000	600	8	80	3200	380	8	60	2400	240	8	50	2000	200	4	120	4800	720	8
9	100	3500	540	9	80	2800	330	9	60	2100	210	9	50	1800	180	4.5	120	4200	650	9
10	100	3200	540	10	80	2500	330	10	60	1900	210	10	50	1600	180	5	120	3800	640	10
12	100	2700	510	12	80	2100	320	12	60	1600	210	12	50	1300	170	6	120	3200	600	12
14	100	2300	460	14	80	1800	300	14	60	1400	190	14	50	1100	150	7	120	2700	540	14
16	100	2000	410	16	80	1600	290	16	60	1200	170	16	50	990	140	8	120	2400	500	16
18	100	1800	390	18	80	1400	260	18	60	1100	170	18	50	880	130	9	120	2100	460	18
20	100	1600	360	20	80	1300	260	20	60	950	150	20	50	800	130	10	120	1900	430	20
Depth of cut	 DC:Dia.																			

Note 1) SMART MIRACLE Coating is not energized because of its nature. Therefore, an external contact (voltaic type) tool setter cannot be used. An internal contact (non-voltaic) type or laser type tool setter is recommended to measure the length of the tool.

Note 2) Effective cutting of stainless steel, titanium alloys and heat resistant alloys etc. can be achieved with the use of emulsion.

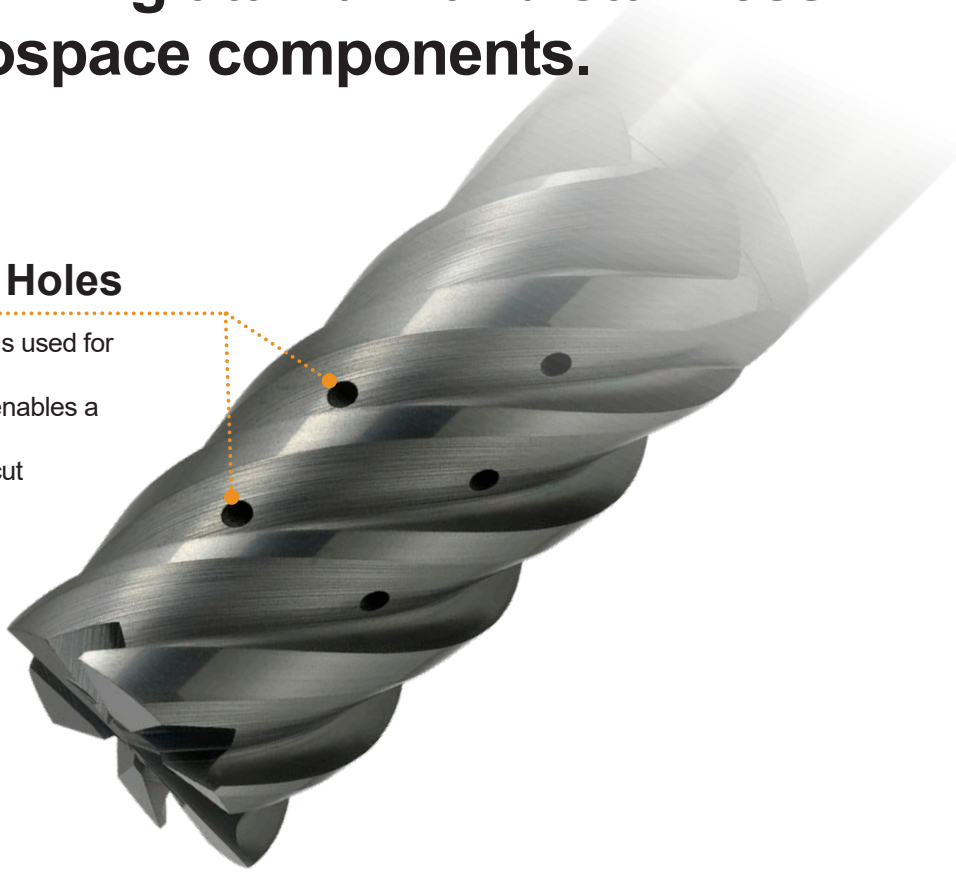
Note 3) Vibration damping end mills are more effective in suppressing chatter and vibration compared to general end mills, but these may still occur if the rigidity of the machine or the workpiece material is low.

Note 4) Finishing at a faster feedrate is possible when the depth of cut is small.

Vibration Control End Mills with Multiple Internal Through Coolant Holes for Difficult-to-cut Materials

CoolStar Series

Effective for machining titanium and stainless steel used in Aerospace components.



Multiple Internal Coolant Holes

The multiple internal through coolant system is used for improved welding resistance.
The spiral arrangement of the coolant holes enables a wide range of machining applications.
Especially suitable for machining difficult-to-cut materials, offering stable machining.

VQ6MHVCH

4 Sizes（DC=10mm, 12mm, 16mm, 20mm）

End mill, Medium cut length,
6 flute, Irregular helix flutes,
with multiple internal through coolant

VQ6MHVRBCH

10 Sizes（DC=10mm, 12mm, 16mm, 20mm）

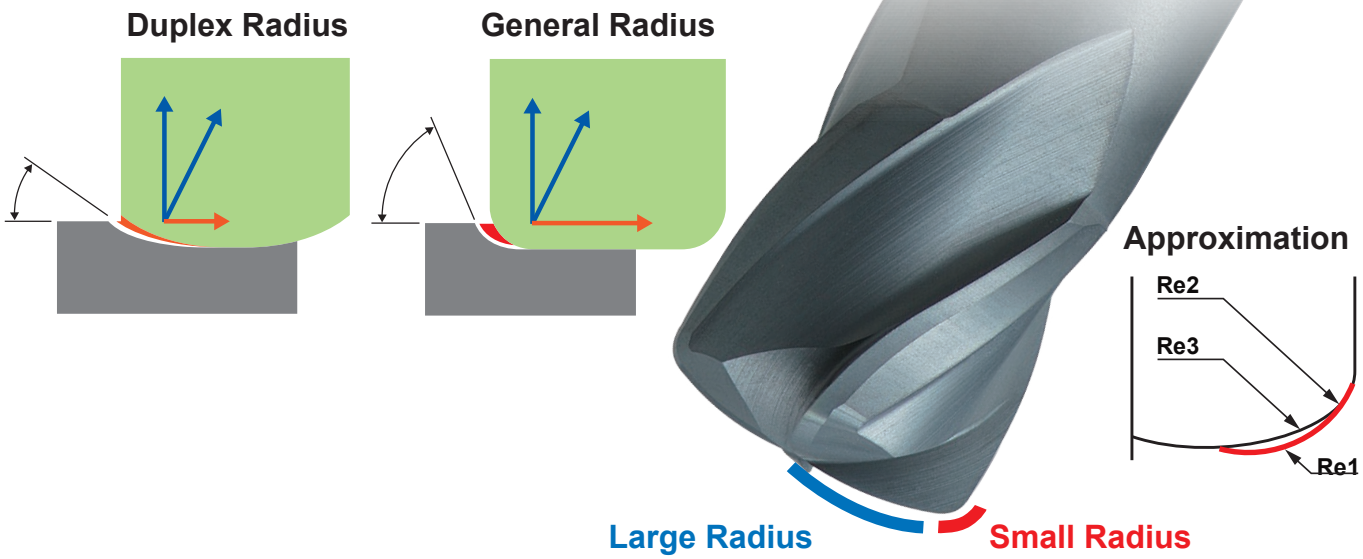
Corner radius end mill, Medium cut length,
6 flute, Irregular helix flutes,
with multiple internal through coolant

SMART MIRACLE End Mill Series for Difficult-to-Cut Materials

Duplex Radius End Mills VQFDRB

VQFDRB provides amazingly long tool life when machining Cobalt Chrome Alloy.

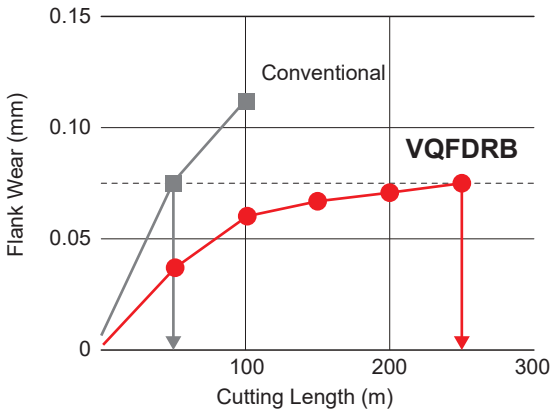
- Improved notch wear due to the reduced side contact of the duplex geometry.
- Reduced flank wear through the use of SMART MIRACLE coating and an ultra micro-grain cemented carbide.
- Provides stable machining with a low radial cutting force.



Cutting Performance

VQFDRB gave 5 times longer tool life than a conventional duplex radius end mill when machining cobalt chrome alloy.

<Cutting Conditions>
Workpiece Material : Co-Cr-Mo Alloy (ASTM F1537)
Tool : VQFDRBD0300N080 (DC=ø3mm)
Revolution : n=8600min-1(vc=80 m/min)
Feed Rate : vf=1300mm/min (0.038 mm/t.)
Depth of Cut : ap=0.2mm ae=1.3mm
Cutting Mode : External Coolant (Emulsion)

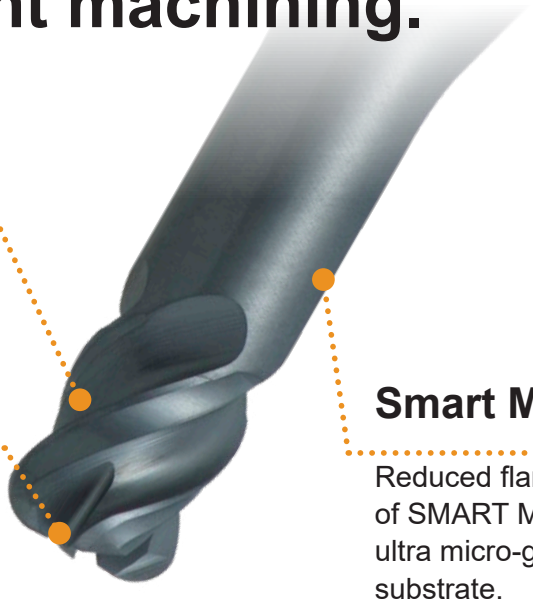


SMART MIRACLE End Mill Series for Difficult-to-Cut Materials

Vibration Control Corner Radius End Mills

VQHVRB

Increased feed rates and large depths of cut are achievable with VQHVRB, resulting in highly efficient machining.



Variable Helix

Vibration control geometry for smooth, stable cutting.

Special Gash

Good chip disposal enables both increased feed rates and large depths of cut.

Smart Miracle Coating

Reduced flank wear through the use of SMART MIRACLE coating and an ultra micro-grain cemented carbide substrate.

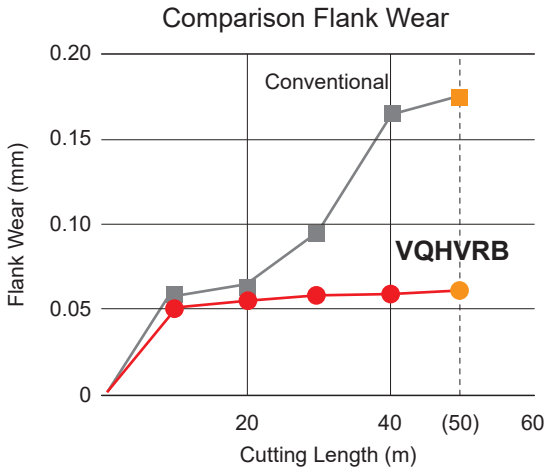
Cutting Performance

VQHRB wears less than the conventional end mill and provides a stable cutting action.

<Cutting Conditions>
Workpiece Material : Titanium Alloy
Tool : VQHVRBD0300R05N180 (DC=ø3mm)
Revolution : n=8600min-1(vc=80 m/min)
Feed Rate : vf=1300mm/min (0.05mm/t.)
Depth of Cut : ap=0.2mm ae=1.3mm
Cutting Mode : External Coolant (Emulsion)
Cutting Length : 50m
Machine : Vertical MC (BT30)

VQHVRB

Conventional



SMART MIRACLE End Mill Series for Difficult-to-Cut Materials

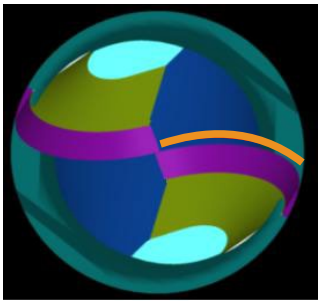
Long Neck Ball Nose End Mills VQ2XLB

VQ2XLB provides long tool life and stable cutting when machining cobalt chrome and titanium alloy.

- **A new cutting edge geometry provides improved resistance to chipping.**
- **SMART MIRACLE coating providing better wear resistance when machining difficult-to-cut materials.**

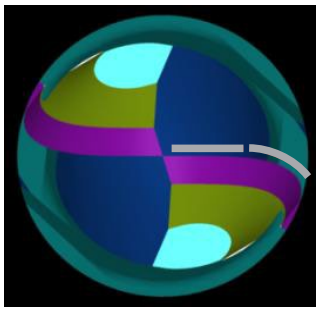
VQ2XLB

Strong S



General (For Moulds)

Normal Curve



Tooling Example

Workpiece Material : Co-Cr-Mo Alloys

Customer Comment

"Machined surface roughness is better than conventional tools under normal conditions"

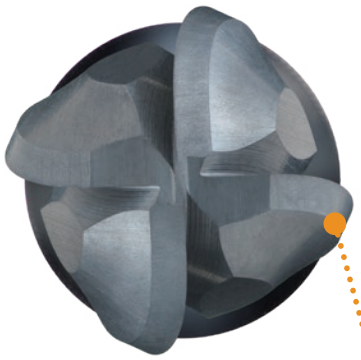
Process		Rough 1	Rough 2	Finish 1	Finish 2
Tool		VQ2XLBR0150N140 Ø3 (RE1.5)	VQ2XLBR0150N140 Ø3 (RE1.5)	VQ2XLBR0100N100S06 Ø2 (RE1.0)	VQ2XLBR0050N080N06 Ø1 (RE0.5)
Cutting Speed **vc** (m/min)		80	79.8	75.4	62.8
Revolution **n** (min^{-1})		6400	8500	12000	20000
Feed Rate **vf** (mm/min)		800	960	800	660
fz (mm/t.)		0.063	0.057	0.033	0.017
Depth of Cut	**ap** (mm)	0.15	0.12	0.1	0.05
	ae (mm)	1.0	0.3	0.2	0.08
Cutting Time (min)		400	60	90	150
Wear Condition		Good	Good	Good	Good

Multi-functional Lollipop End Mill for Difficult-to-Cut Materials

VQ4WB

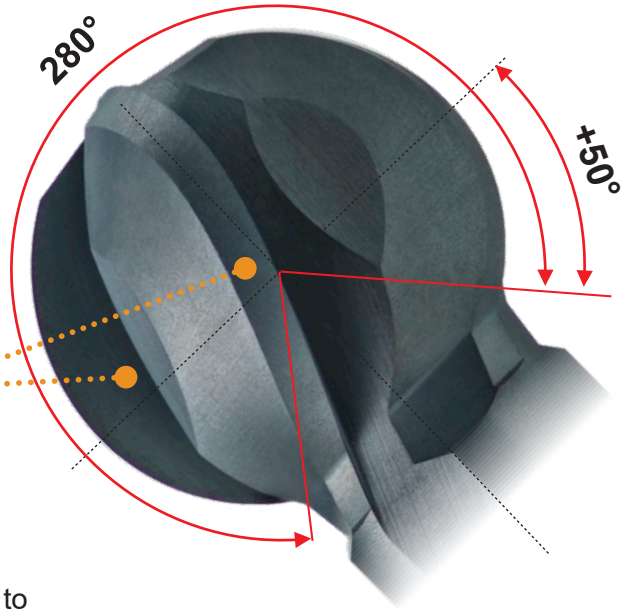
SMART MIRACLE End Mill Series

280º extended cutting edge and special geometry of the cutting edge & rake face realizes multi-functional machining and a wide range of applications. Optimal choice for machining undercut and complex shapes when using a 5-axis machine.



Multiple-Applications

True round ball cutting edge over the full 280º achieves stable cutting even during undercut machining.



High Efficiency

4 flutes, extended cutting edge, specialized geometry and long tool life make for a highly efficient tool.

Low Cutting Resistance

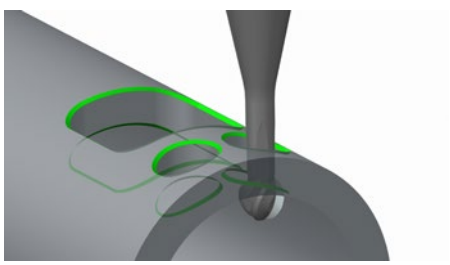
Constant edge and rake geometry helps to prevent burrs and chattering.

Long Tool Life

Long tool life when machining carbon steel through to difficult-to-cut materials enabled by the (Al,Cr)N based SMART MIRACLE coating.

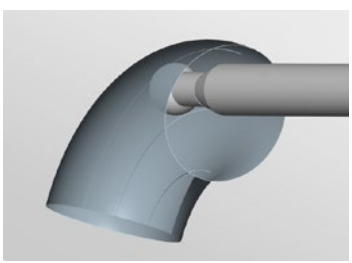
Multiple Applications

Deburring (Chamfering)

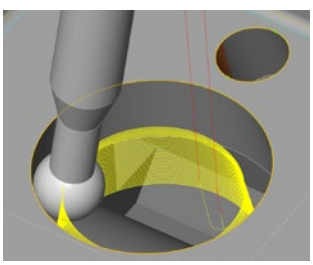


Size suitable for deburring.
DC = 1.3, 1.8, 2.8, 3.8 and 4.8 mm

Internal Profile Milling



Undercut Machining



Application Example

①Rounded Shape Slotting

②Deburring
(Top & Back Face)

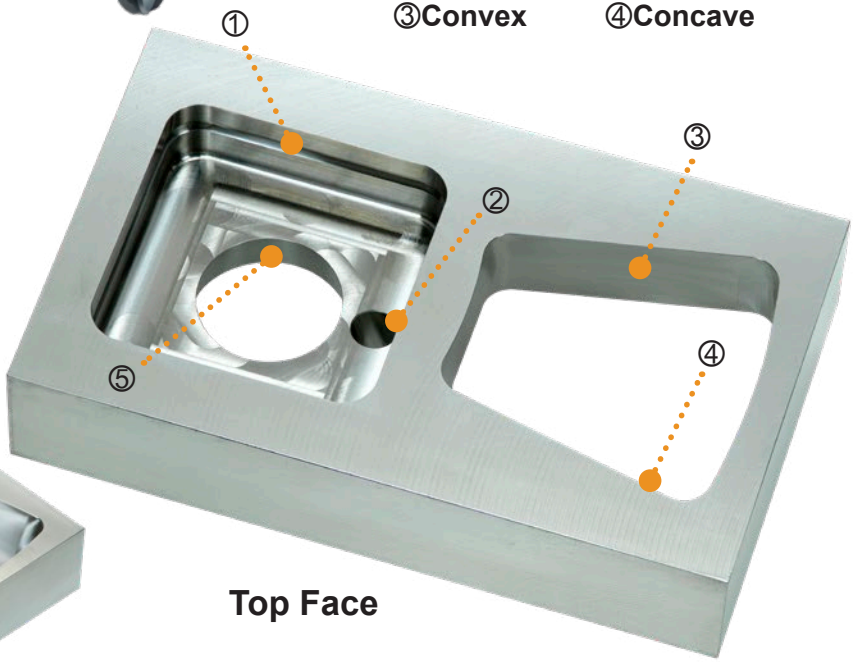
Internal Profile

③Convex

④Concave

⑤Undercut (Taper Hole)

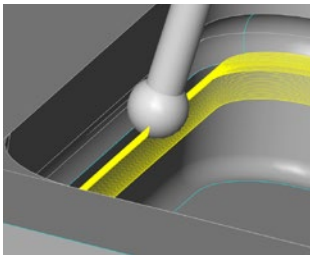
Back Face



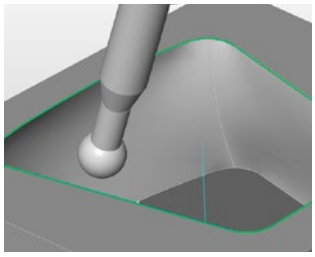
Top Face

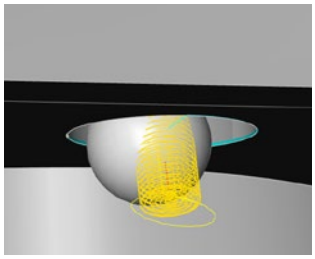
Multiple Applications

Rounded Shape Slotting

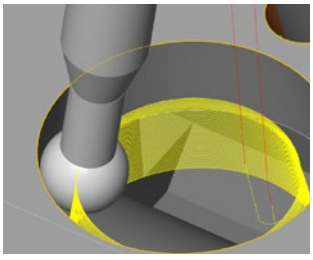


Deburring and Chamfering

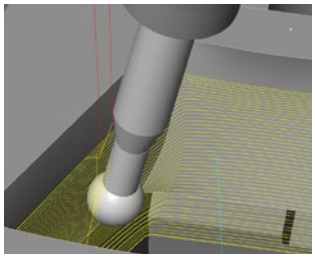


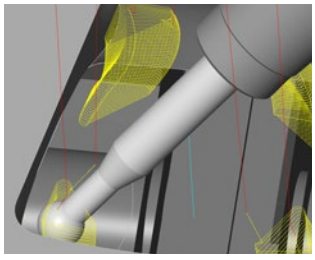


Under Cut (Taper Hole)



Internal Profile Milling





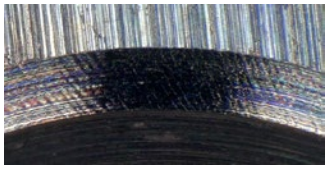
Cutting Performance

Comparison of Back Deburring on JIS SUS630

Significantly less burrs than the conventional lollipop end mills.

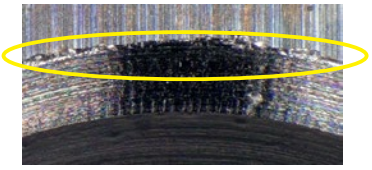
VQ4WB

Excellent Finish with No Burrs



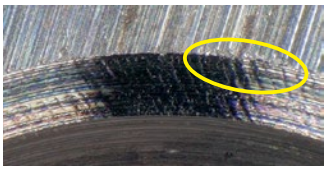
Conventional A

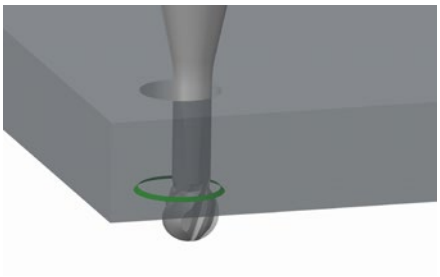
Heavy Burring Remains



Conventional B

Visible Burrs Persist



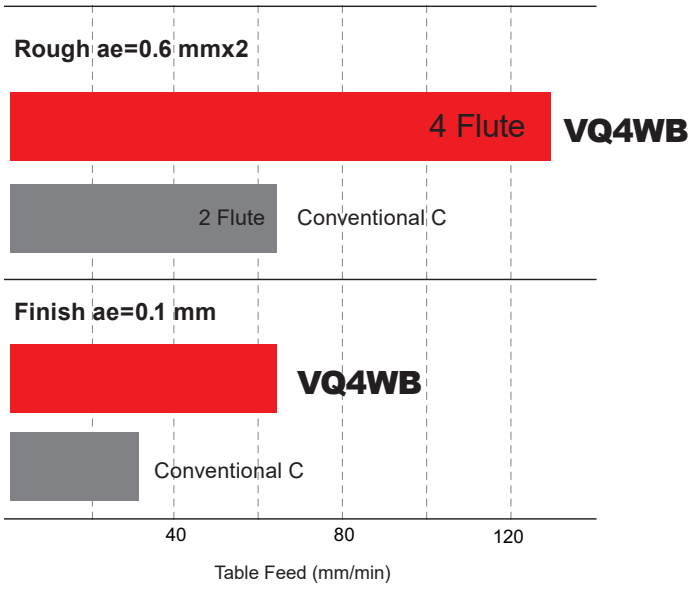


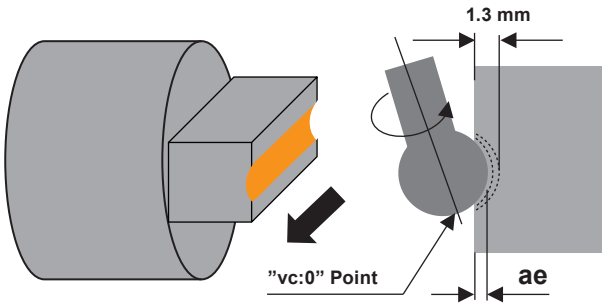
<Cutting Conditions>
Workpiece Material : JIS SUS630
Tool : VQ4WBR0150N08E280
DC = ø3.0 mm (RE 1.5)
Revolution : n = 3200 min^{-1}
Cutting Speed : vc = 30 m/min
Feed Rate : vf = 55 mm/min, fz = 0.04 mm/t.
Chamfer Width : cf = 0.2 mm
Cutting Mode : Hole Size 4.0 mm
External Coolant (Emulsion)
Machine : Vertical M/C (HSK-E25)

Rounded Shape Slotting in Ti-6Al-4V ELI

VQ4WB (4 flute) doubles efficiency compared to conventional 2 flute lollipop end mills.

After the same number of rough and finish machining cycles when a competitors tool was worn, the VQ4WB could continue machining.





<Cutting Conditions>
Workpiece Material : Ti-6Al-4V ELI
Tool : VQ4WBR0300N12E280
DC = ø6.0 mm (RE 3.0)
Revolution : n = 800 min^{-1}
Cutting Speed : vc = 15 m/min
Cutting Mode : External Coolant (Oil)
Machine : Multi-task Lathe

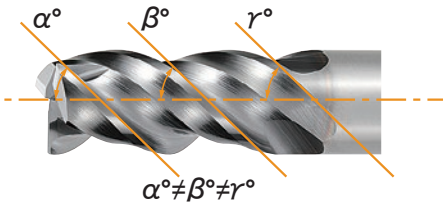
Features

Compared to conventional end mills, irregular helix flutes help prevent vibration.
Superior vibration resistance on difficult-to-cut materials and long overhang applications.
Newly developed coating gives long tool life and high efficiency machining.

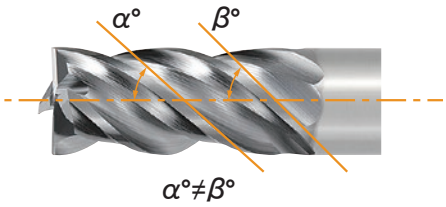
Geometry

Irregular Helical Flutes

No Vibration!



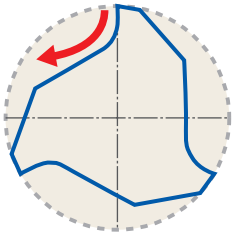
3 flute

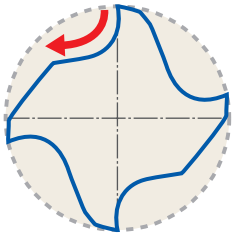


4 flute

Special Flute Geometry

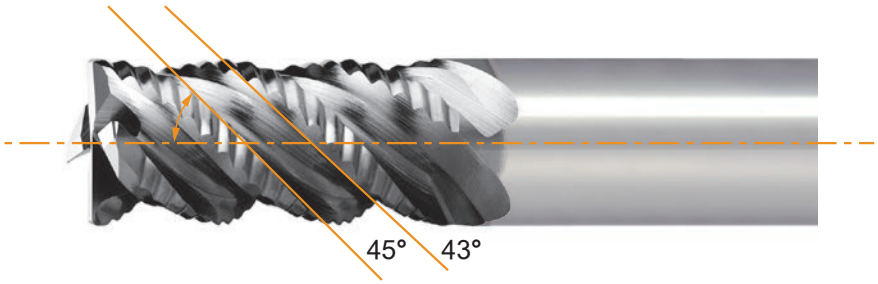
Improved Chip Disposal





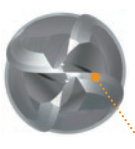
New flute geometry with low resistance for smooth chip evacuation.

VQSVR



Provides a long tool life without vibration, because of the efficiency of irregular helix asymmetrical nick geometry.

VQ4SVB



Irregular pitch flutes

4 flutes, Helix angle 45°
Dedicated carbide substrate gives excellent wear resistance.

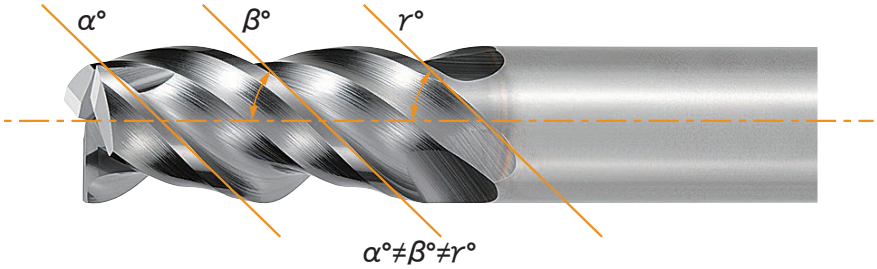
End Mill, 3 Flute for Drilling and Slotting

VQMHZV

Multi-functional machining with one end mill.
Drilling, slotting and shoulder milling.

VQMHZVOH

Stability and high efficiency achieved due to the through coolant holes.

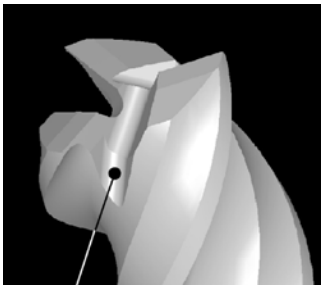


Unique geometry - 3 flute end mill with irregular helix flutes suppresses chatter for increased machining stability.
Optimised tool geometry and Miracle coating give excellent chip evacuation for higher efficiency.
The performance of VQMHZVOH when drilling is significantly improved on difficult-to-cut materials because of the through coolant holes.

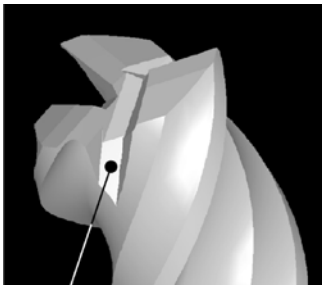
Improved Gash Shape

Improved Chip Evacuation

In addition to employing a conventional two-stage gash, the bottom of the gash has been rounded to avoid the concentration of stresses, thereby improving fracture resistance. Additionally, an optimised pocket size helps improve chip discharge performance.



2 stage gash with rounded geometry



Standard 2 stage gash shape

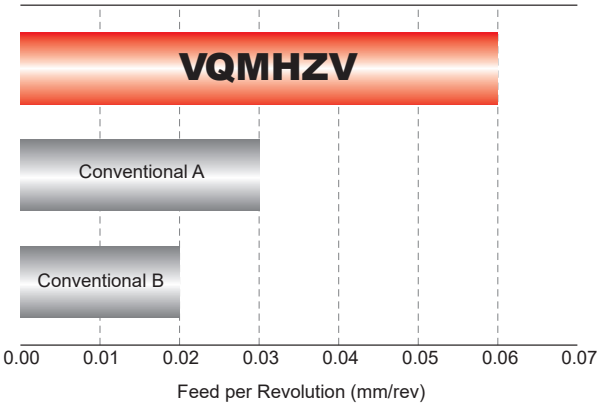
Effect of New Gash Geometry

Vertical feed performance has been greatly improved by the effect of the new geometry and SMART MIRACLE coating. Due to the stable chip evacuation, vertical feed rates can be doubled compared to conventional product.

<Cutting Conditions>

Work Material	: AISI 304
End Mill	: VQMHZVD0600(DC=6mm)
Revolution	: 3200 min^{-1}
Cutting Speed	: 60m/min
Feed Rate	: 32-192mm/min
Depth of Cut	: ap=3mm
Overhang Length	: 20mm
Cutting Mode	: Down (Climb) Cut External Coolant (Emulsion)
Machine	: Vertical M/C (BT50)

AISI 304 DC x 0.5 Vertical Feed Limit



Roughing End Mill, 4 Flute, Irregular Helix Flutes

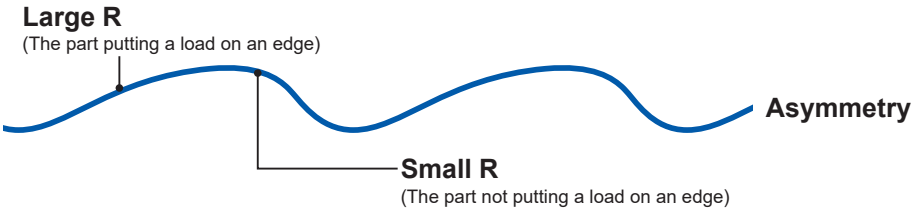
VQSVR

Feature of Asymmetrical Nick

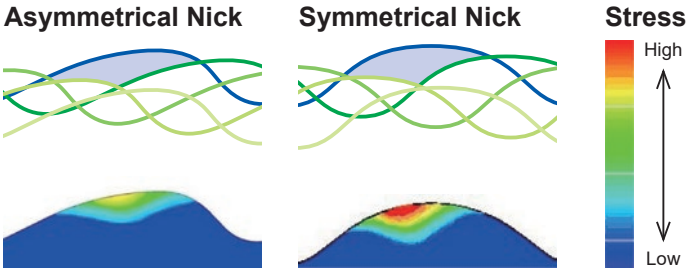
Improve the efficiency of fracture resistance dispersing a load on the top of nick by adopting the asymmetrical nick.

Nick Geometry of VQSVR

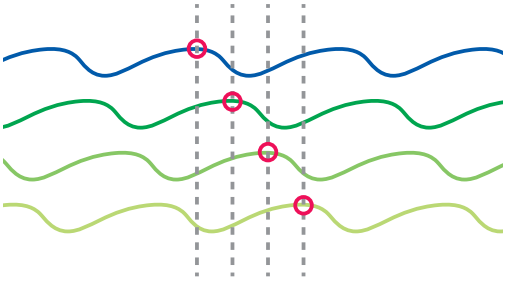
Achieve a long tool life without fracture



Cutting Amount of Each Nick

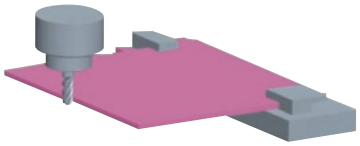
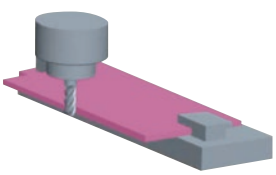


Deviation of Nick at a Machining



The Advantage of Roughing End Mill

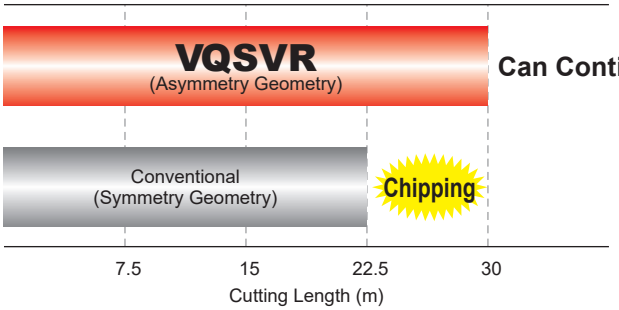
Roughing end mill achieves excellent performance under the unstable machining, such as bad clamp condition of work material and long overhang.

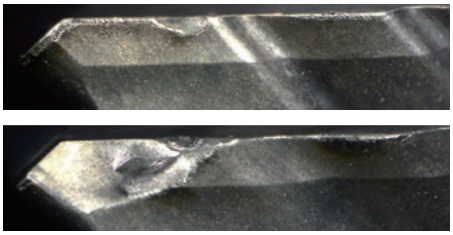
	Work Material Rigidity	Tool Overhang	Spindle Rigidity
Roughing	Thin Plate Having a Distance between Clamp and Machining Part 3 Claw Chuck, Weak Fixture Less Clamp Spots 	Machining with Long Overhang 	BT20 Small Spindle Rigidity Old Machine 
Square			

Compared to the roughing end mill, the square end mill excels in tool life and machining efficiency.
Therefore, when executing stable machining with high rigidity of work material, clamp, and main spindle, we recommend the square end mill, even in rough machining.

Cutting Performance

VQSVR's asymmetrical geometry gives longer tool life than a symmetrical type.



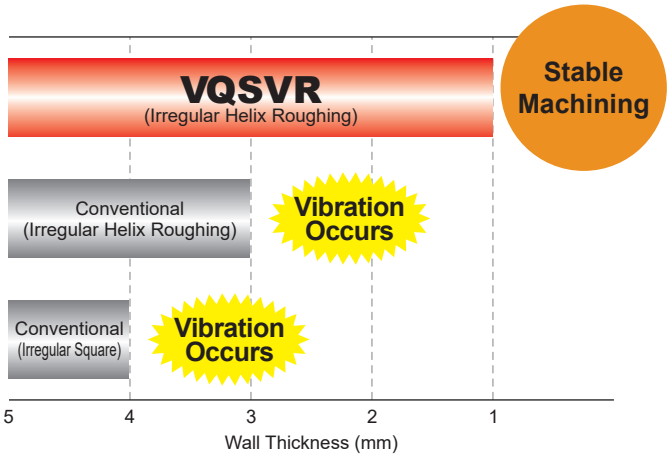


Cutting Length 22.5m

<Cutting Conditions>
Work Material : AISI 304
Tool Size : DC=10mm
Revolution : 2500min^{-1} (80m/min)
Feed Rate : 610mm/min (0.06mm/t.)
Depth of Cut : ap=3mm
Width of Cut ae=5mm
Cutting Mode : Shoulder Milling
External Coolant (Emulsion)
Machine : Vertical M/C (BT50)

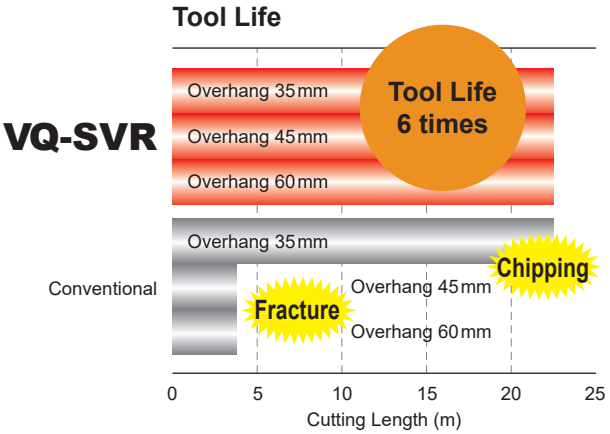
Machined Surface of Wall Thickness 1mm

VQSVR is machinable without vibration even with a thin wall.



<Cutting Conditions>
Work Material : AISI 304
Tool Size : DC=10mm
Revolution : 3200min^{-1} (100m/min)
Feed Rate : 570mm/min (0.045mm/t.)
Depth of Cut : ap=20mm
Width of Cut ae=1mm
Overhang Length : 35mm
Cutting Mode : Shoulder Milling
External Coolant (Emulsion)
Machine : Vertical M/C (BT50)

VQSVR can provide an excellent fracture resistance even in the machining with long overhang. (overhang DC x4 or more)



<Cutting Conditions>
Work Material : AISI 304
Tool Size : DC=10mm
Revolution : 2550min^{-1} (80m/min)
Feed Rate : 410mm/min (0.04mm/t.)
Depth of Cut : ap=10mm
Width of Cut ae=5mm
Cutting Mode : Shoulder Milling
External Coolant (Emulsion)
Machine : Vertical M/C (BT50)

End Mill, 4 Flute, Irregular Helix Flutes

VQMHV, VQJHV

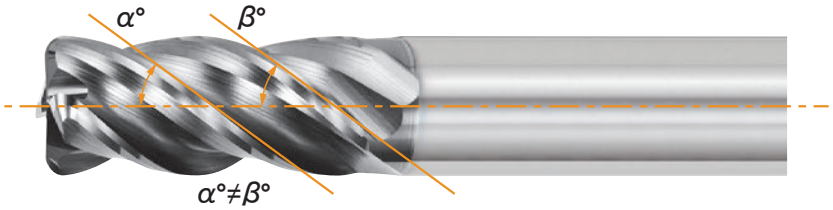
A carbide substrate with excellent wear and fracture resistance allows a wide range of different machining applications.

VQMHVRB

Available in a wide range of corner radius, including large sizes suitable for aerospace components.

VQMHVRBF

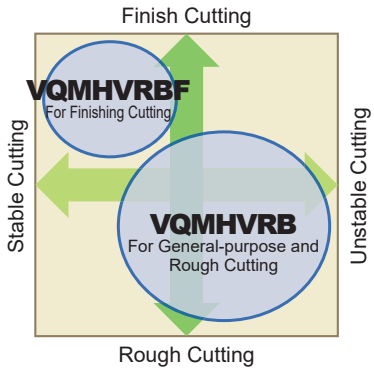
Ideal for finish machining of heat resistant alloys and precipitation hardening stainless steel due to the special carbide substrate with excellent wear resistance.



Optimised irregular helix angle improves cutting performance.
The combination of an excellent carbide substrate and SMART MIRACLE coating allows a wide range of machining applications.

How to Select VQMHVRB and VQMHVRBF

Comparing Different Forms of Machining



Comparing Different Work Material

Finish Cutting

◎=1st Recommendation
○=2nd Recommendation

	Inconel	AISI S17400	Titanium Alloy	AISI 304
VQMHVRB	○	○	◎	◎
VQMHVRBF	◎	◎	○	○

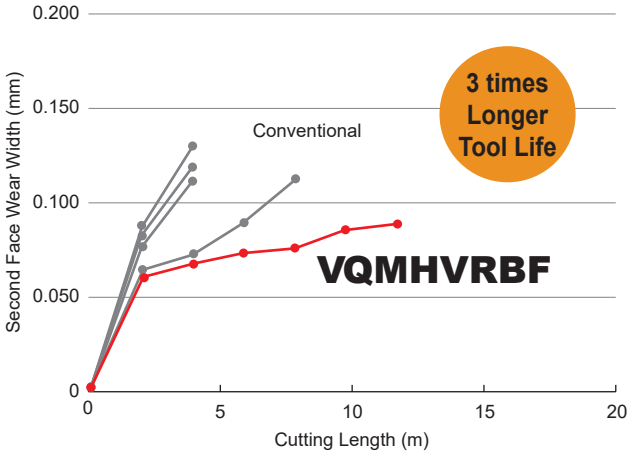
Cutting Performance

Wear Resistance Against Super Alloys

VQMHVRBF achieves 3 times longer tool life than conventional when finish machining Inconel 718.

<Cutting Conditions>

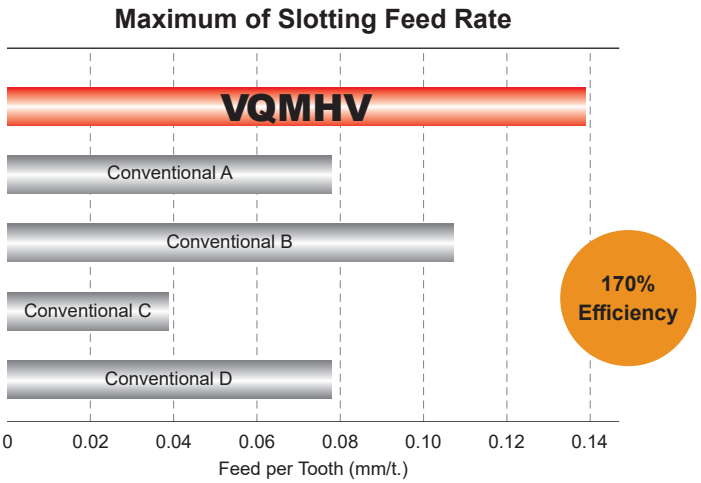
Work Material	: Inconel718
End Mill	: VQMHVRBFD1000R050 (DC=10mm / RE=0.5mm)
Revolution	: 950min^{-1}
Cutting Speed	: 30m/min
Feed Rate	: 110mm/min(0.03mm/t.)
Depth of Cut	: ap=5mm
Width of Cut	ae=0.3mm
Overhang Length	: 35mm
Cutting Mode	: Down (Climb) Cut External Coolant (Emulsion)
Machine	: Vertical M/C (BT50)



Cutting Performance

Efficiency Comparison in AISI 304

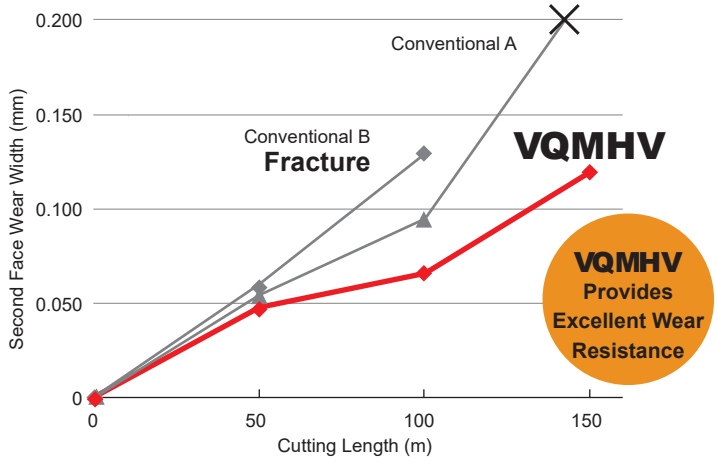
Compared to conventional machining time can be shortened by using high efficiency machining methods.



<Cutting Conditions>
Work Material : AISI 304
End Mill : VQMHVD1000(DC=10mm)
Revolution : 4800min^{-1}
Cutting Speed : 150m/min
Feed Rate : 384−2688mm/min
Feed per Tooth : 0.02−0.14mm/t.
Depth of Cut : ap=10mm
Overhang Length : 33mm
Cutting Length : 250mm
Cutting Mode : External Coolant (Emulsion)
Machine : Vertical M/C (BT40)

Comparison of Tool Life when Machining Titanium Alloy

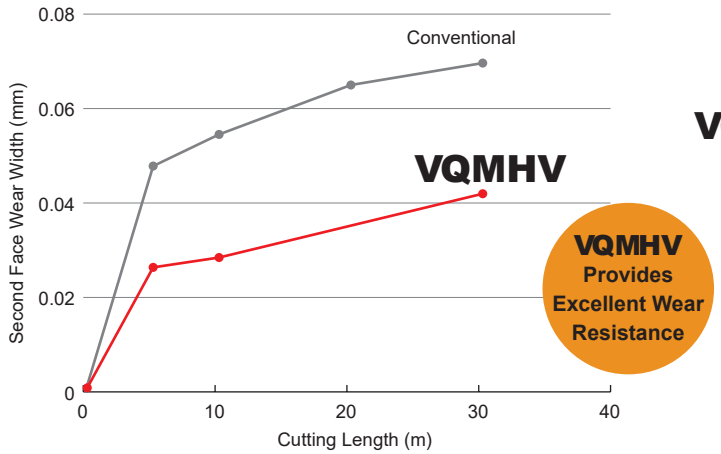
The wear resistance of SMART MIRACLE End Mills exceeds that of conventional end mills when machining Ti-6Al-4V.



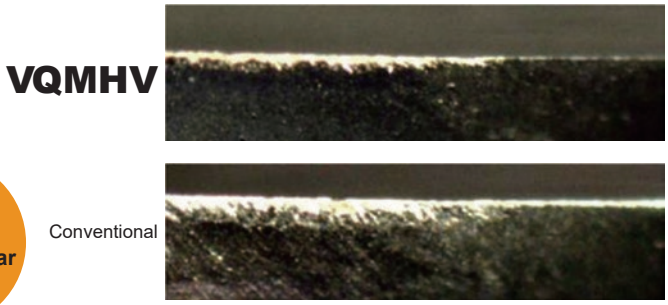
<Cutting Conditions>
Work Material : Ti-6Al-4V
End Mill : VQMHVD0600(DC=6mm)
Revolution : 8000min^{-1}
Cutting Speed : 150m/min
Feed Rate : 1600mm/min(0.03mm/t.)
Depth of Cut : ap=6mm
Width of Cut ae=0.3mm
Overhang Length : 20mm
Cutting Mode : Down (Climb) Cut
External Coolant (Emulsion)
Machine : Vertical M/C (BT40)

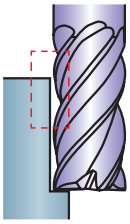
Comparison of Wear in Co-Cr-Mo Alloy

Long tool life even when machining Co-Cr-Mo alloys used in the medical industry.



Wear at the depth of cut point after 30m machining

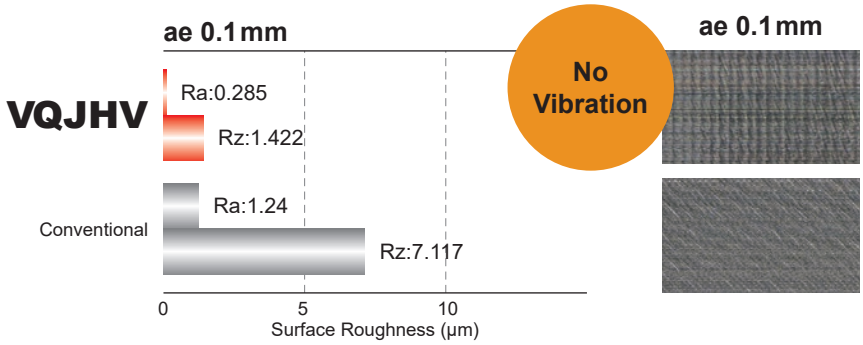




<Cutting Conditions>
Work Material : Co-Cr-Mo Alloy
End Mill : VQMHVD0600(DC=6mm)
Revolution : 3700min^{-1}
Cutting Speed : 70m/min
Feed Rate : 740mm/min(0.05mm/t.)
Depth of Cut : ap=2mm
Width of Cut ae=0.3mm
Overhang Length : 20mm
Cutting Mode : Down (Climb) Cut
External Coolant (Emulsion)
Machine : Vertical M/C (BT40)

Cutting Performance

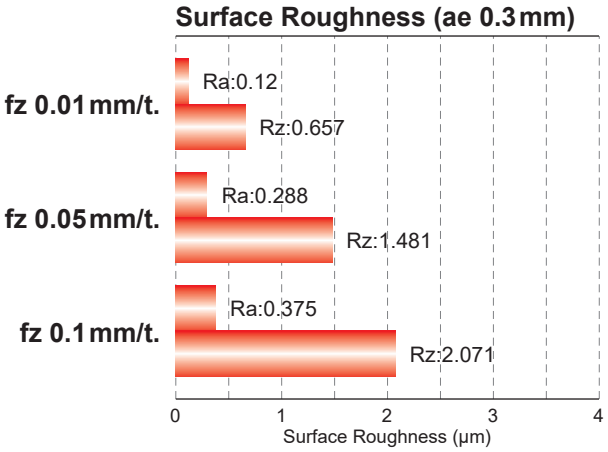
Irregular helix provides an excellent finishing performance without vibration.



<Cutting Conditions>
Work Material : AISI 304
Tool Size : DC=10mm
Revolution : 2500min^{-1} (80m/min)
Feed Rate : 500mm/min (0.05mm/t.)
Depth of Cut : ap=30mm
Width of Cut ae=0.1 or 1mm
Overhang Length : 45mm
Cutting Mode : Shoulder Milling
External Coolant (Emulsion)
Machine : Vertical M/C (BT50)

Test of Changing the Feed per Tooth

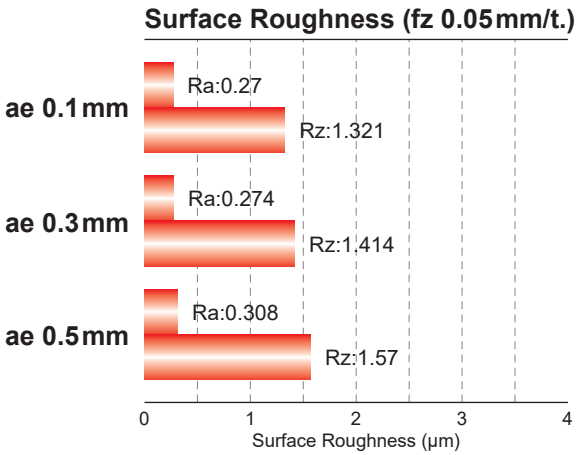
Surface roughness is improved by decreasing a feed rate.



<Cutting Conditions>
Work Material : AISI 304
Tool Size : DC=10mm
Revolution : 2500min^{-1} (80m/min)
Feed Rate : 100−1000mm/min (0.01−0.1mm/t.)
Depth of Cut : ap=30mm
Width of Cut ae=0.3mm
Overhang Length : 45mm
Cutting Mode : Shoulder Milling
External Coolant (Emulsion)
Machine : Vertical M/C (BT50)

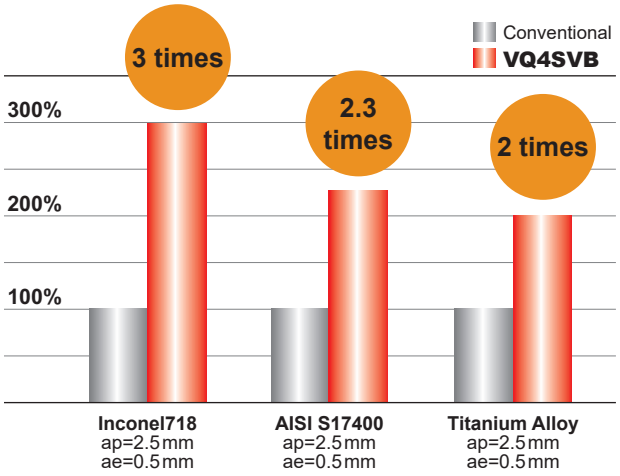
Test of Changing the Width of Cut

Available condition for finishing is ae 0.5mm or less when considering only the roughness of machining surface.

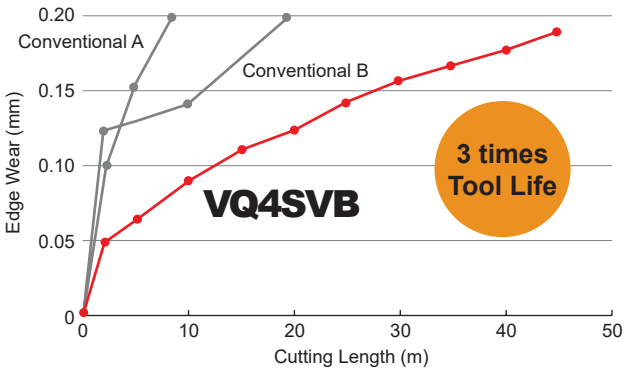


<Cutting Conditions>
Work Material : AISI 304
Tool Size : DC=10mm
Revolution : 2500min^{-1} (80m/min)
Feed Rate : 500mm/min (0.05mm/t.)
Depth of Cut : ap=30mm
Width of Cut ae=0.1−0.5mm
Overhang Length : 45mm
Cutting Mode : Shoulder Milling
External Coolant (Emulsion)
Machine : Vertical M/C (BT50)

VQ4SVB achieves double tool life when machining difficult-to-cut materials.



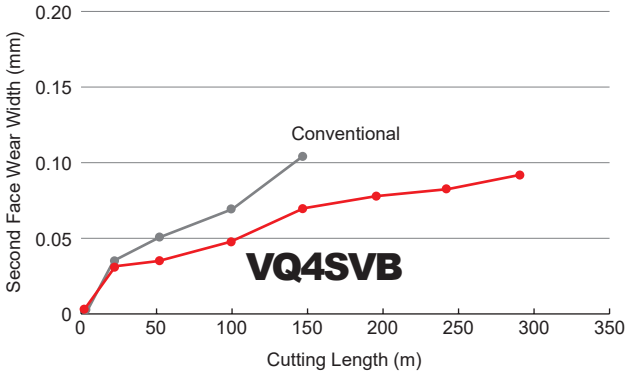
Comparison of Edge Wear when Shoulder Milling Inconel 718



<Cutting Conditions>

Work Material	: Inconel718
End Mill	: VQ4SVBR0500(RE=5mm)
Revolution	: 1100min^{-1}
Cutting Speed	: 30m/min
Feed Rate	: 220mm/min(0.05mm/t.)
Depth of Cut	: ap=2.5mm
Width of Cut	ae=0.5mm
Overhang Length	: 25mm
Cutting Mode	: Down (Climb) Cut External Coolant (Emulsion)
Machine	: Vertical M/C (BT40)

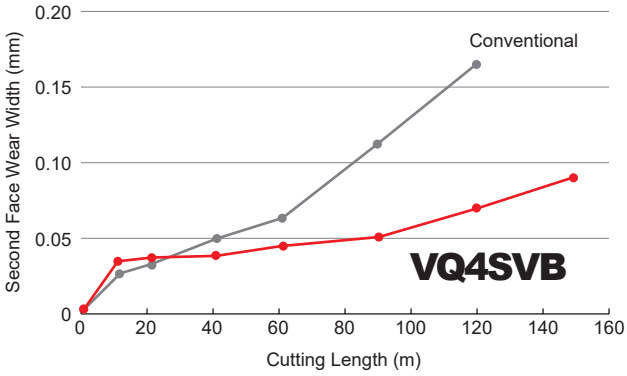
Comparison of Edge Wear when Shoulder Milling AISI S17400



<Cutting Conditions>

Work Material	: AISI S17400
End Mill	: VQ4SVBR0500(RE=5mm)
Revolution	: 2600min^{-1}
Cutting Speed	: 70m/min
Feed Rate	: 520mm/min(0.05mm/t.)
Depth of Cut	: ap=2.5mm
Width of Cut	ae=0.5mm
Overhang Length	: 20mm
Cutting Mode	: Down (Climb) Cut External Coolant (Emulsion)
Machine	: Vertical M/C (BT40)

Comparison of Edge Wear when Shoulder Milling Ti-6Al-4V



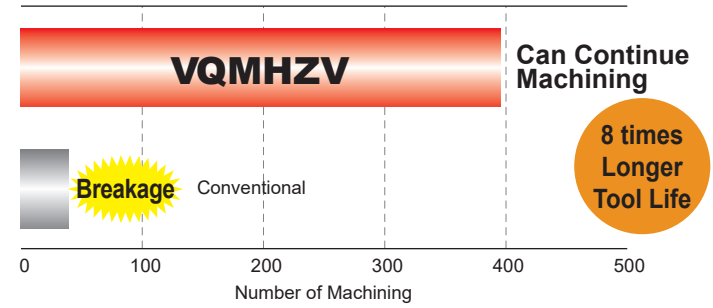
<Cutting Conditions>

Work Material	: Ti-6Al-4V
End Mill	: VQ4SVBR0500(RE=5mm)
Revolution	: 4800min^{-1}
Cutting Speed	: 150m/min
Feed Rate	: 960mm/min(0.05mm/t.)
Depth of Cut	: ap=2.5mm
Width of Cut	ae=0.5mm
Overhang Length	: 25mm
Cutting Mode	: Down (Climb) Cut External Coolant (Emulsion)
Machine	: Vertical M/C (BT40)

Cutting Performance

AISI 304 Keyway Machining

SMART MIRACLE coating with irregular helix angle achieves more than 8 times longer tool life compared to conventional.

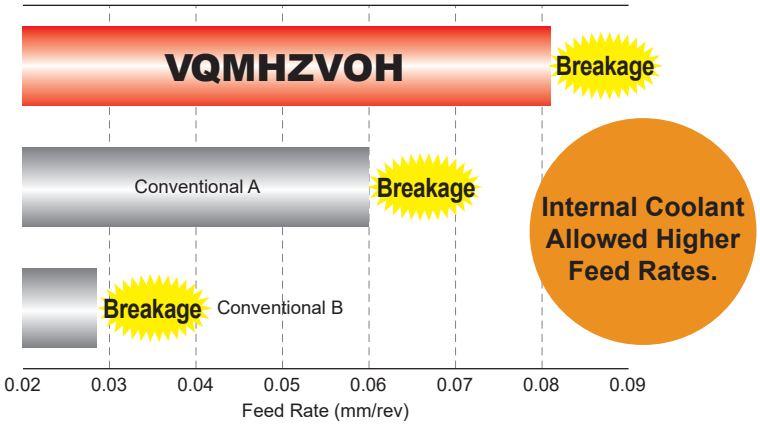


<Cutting Conditions>

Work Material	: AISI 304
End Mill	: VQMHZVD0800(DC=8mm)
Revolution	: 2400min^{-1}
Cutting Speed	: 60m/min
Feed Rate	: Drilling 70mm/min, Slotting 360mm/min (Drilling 0.03mm/rev, Slotting 0.05mm/t.)
Depth of Cut	: ap=3mm
Flute Length	: 16mm
Overhang Length	: 30mm
Cutting Mode	: External Coolant (Emulsion)
Machine	: Vertical M/C (BT50)

AISI 304 Vertical Feed Milling

With through coolant holes, vertical feed rates can be up to 5 times higher than conventional.



<Cutting Conditions>

Work Material	: AISI 304
End Mill	: VQMHZVOHD0600(DC=6mm)
Revolution	: 3200min^{-1}
Cutting Speed	: 60m/min
Feed Rate	: 96−256mm/min(0.03−0.08mm/rev)
Depth of Cut	: ap=3mm
Overhang Length	: 20mm
Cutting Mode	: Internal Coolant (Emulsion)
Machine	: Vertical M/C (BT50)

For Your Safety
●Don't handle inserts and chips without gloves. ●Please machine within the recommended application range and exchange expired tools with new ones in advance of breakage. ●Please use safety covers and wear safety glasses. ●When using compounded cutting oils, please take fire precautions. ●When attaching inserts or spare parts, please use only the correct wrench or driver. ●When using rotating tools, please make a trial run to check run-out, vibration and abnormal sounds etc.

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(Tools specifications subject to change without notice.)

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