

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

SMART MIRACLE

Item
Expansion

**Revolutionary
performance for
difficult-to-cut
materials.**



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

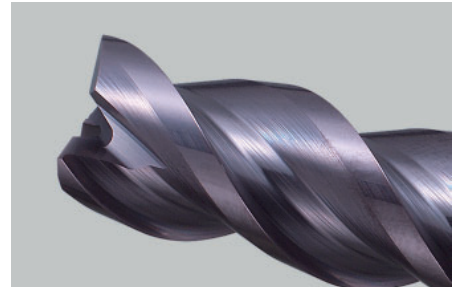
SMART MIRACLE

SMART MIRACLE Coating

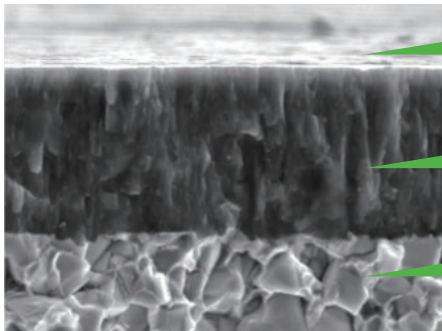
SMART MIRACLE end mills have been treated with a newly developed (Al, Cr)N group coating which delivers substantially better wear resistance. The surface of the coating has been given a smoothing treatment resulting in better machined surfaces, reduced cutting resistance and improved chip discharge.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



SMART MIRACLE Coating



Conventional Coating



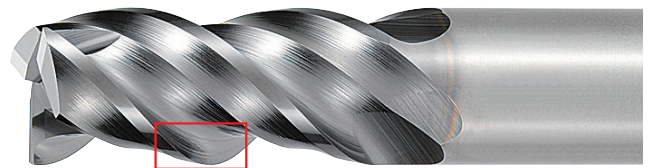
**Smoothed Surface
"ZERO-μ Surface"**

**Newly Developed
(Al, Cr)N Group Coating**

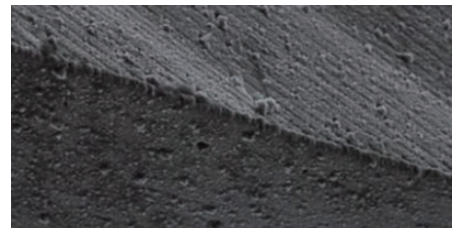
**Super-fine-particle,
Super-hard Base Material**

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

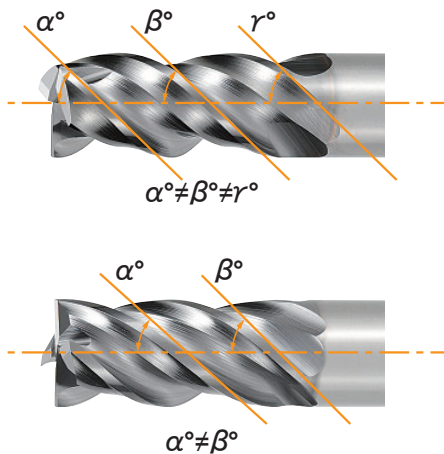
Features

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

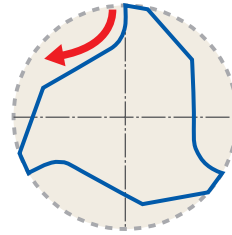
No vibration!



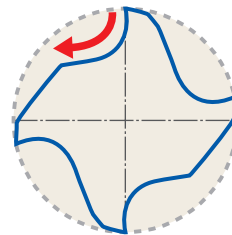
Special Flute Geometry

Improved chip disposal

3 flute



4 flute



New flute geometry with low resistance for smooth chip evacuation.

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 optimized pocket size helps improve chip discharge performance.

VQMHZV



2 stage gash with rounded geometry

Conventional



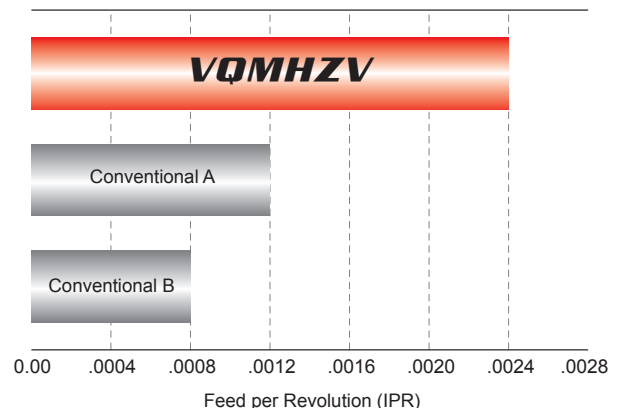
Standard 2 stage gash shape

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 : 195 SFM
 Table Feed : 1.260-7.559 IPM
 Depth of Cut : ap=.118 inch
 Overhang Length : .787 inch
 Cutting Mode : Down(Climb) Cut
 External Coolant (Emulsion)
 Machine : Vertical M/C (BT50)

AISI 304 DCx0.5 Vertical Feed Limit



Classification

VQMHZV

Inch: DC = .0625" - .5000" Metric: DC = 1 mm - 20 mm

End mill, Medium cut length,
3 flute for drilling and slot milling



VQMHZVOH

Inch: DC = .2500" - .5000" Metric: DC = 6 mm - 16 mm

End mill, Medium cut length,
3 flute for drilling and slot milling,
with multiple internal through coolant holes



VQMHV

Inch: DC = .625" - .5000" Metric: DC = 1 mm - 25 mm

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

Slim shank types DC = 9mm – 18mm for vertical wall and deep applications



VQJHV

Inch: DC = .625" - .5000" Metric: DC = 1 mm - 20 mm

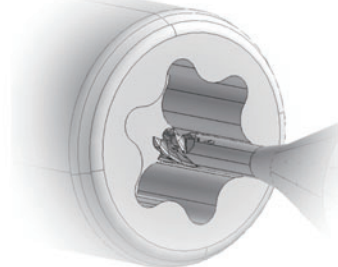
End mill, Semi-long cut length,
4 flute, Irregular helix flutes



VQXL

Metric: DC = 0.2 mm - 1 mm

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



VQ5VR

Metric: DC = 3 mm - 20 mm

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



VQMHVRB

Inch: DC = .1250" - .5000" Metric: DC = 2 mm - 20 mm
 Corner radius, Medium cut length,
 4 flute, Irregular helix flutes



VQMHVRBF

Inch: DC = .2500" - .5000" Metric: DC = 6 mm - 16 mm
 Corner radius, Medium cut length,
 4 flute, Irregular helix flutes (For finish cutting)



VQ45VB

Inch: RE = .0625" - .2500" Metric: RE = 1 mm - 6 mm
 Ball nose, Short cut length,
 4 flute, Irregular curve

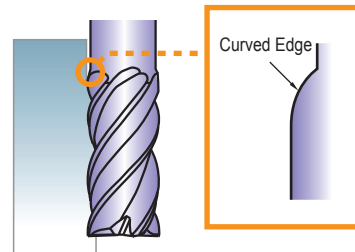


VQMHV Undercut Size

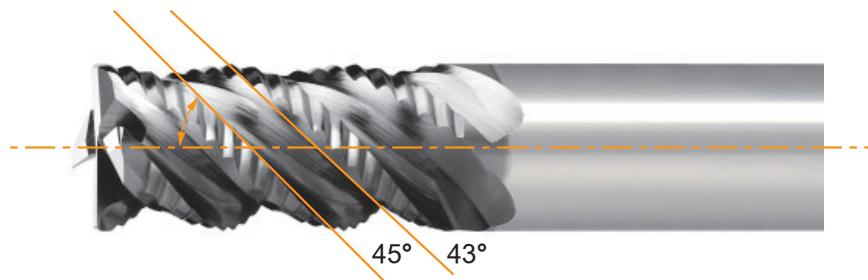
Curved Edge

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.



VQ5VR



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

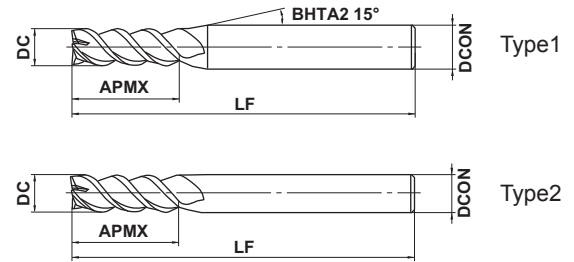
Vibration Control End Mills for Machining Difficult-to-cut Materials

VQM^HZV - Inch sizes

End mill, Medium cut length, 3 flute for drilling and slot milling



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



h6	DC < .5000"	DC = .5000"			
	0 - .0008"	0 - .0012"			
	.250° ≤ DCON ≤ .375°	DCON = .500°			
	0 - .00035"	0 - .00043"			

- 3 flute end mill for drilling and slot milling.
- Featuring irregular helical geometry for reducing vibration.

(inch)

Order Number	DC	APMX	LF	DCON	No. F *	Stock	Type
VQM ^H ZVD1/16	.0625	.1250	2.00	.2500	3	●	1
VQM ^H ZVD5/64	.0781	.1560	2.00	.2500	3	●	1
VQM ^H ZVD3/32	.0938	.1880	2.00	.2500	3	●	1
VQM ^H ZVD7/64	.1094	.2500	2.00	.2500	3	●	1
VQM ^H ZVD1/8	.1250	.3130	2.00	.2500	3	●	1
VQM ^H ZVD5/32	.1562	.3750	2.00	.2500	3	●	1
VQM ^H ZVD3/16	.1875	.4375	2.00	.2500	3	●	1
VQM ^H ZVD1/4	.2500	.6250	2.50	.2500	3	●	2
VQM ^H ZVD5/16	.3125	.7500	2.75	.3125	3	●	2
VQM ^H ZVD11/32	.3438	.7500	3.00	.3750	3	●	1
VQM ^H ZVD3/8	.3750	.8750	3.00	.3750	3	●	2
VQM ^H ZVD1/2	.5000	1.1250	3.50	.5000	3	●	2

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

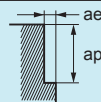
* Number of Flutes

● : Inventory maintained.

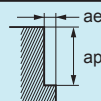
Shoulder Milling

(inch)

Work Material	Carbon Steel (–30HRC)						Alloy Steel, Pre-hardened Steel						Austenitic Stainless Steel, Titanium Alloy					
	High Speed Cutting		General Purpose Cutting		ap	ae	High Speed Cutting		General Purpose Cutting		ap	ae	High Speed Cutting		General Purpose Cutting		ap	ae
	n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)			n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)			n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)		
1/16	26000	55.3	24000	33.9	.094	.013	20000	26.0	20000	17.3	.094	.013	18000	23.4	16000	13.8	.094	.013
5/64	24000	70.9	19000	37.0	.120	.023	19000	33.7	16000	18.9	.120	.023	16000	24.6	13000	13.0	.120	.023
3/32	20000	70.9	16000	37.4	.140	.028	16000	34.0	13000	18.1	.140	.028	13000	24.6	11000	13.8	.140	.028
7/64	17000	72.3	14000	39.4	.160	.033	14000	34.7	11000	18.1	.160	.033	11000	24.7	9200	13.8	.160	.033
1/8	15000	76.2	12000	39.4	.190	.038	12000	36.9	10000	20.1	.190	.038	10000	26.0	8000	13.8	.190	.038
5/32	12000	78.0	9600	39.4	.230	.047	9600	37.4	8000	20.5	.230	.047	8000	26.5	6400	13.8	.230	.047
3/16	10000	74.4	8000	39.4	.280	.056	8000	37.8	6700	20.9	.280	.056	6700	26.5	5300	13.8	.280	.056
1/4	7500	74.4	6000	39.4	.380	.075	6000	39.0	5000	21.3	.380	.075	5000	35.4	4000	18.9	.380	.075
5/16	6000	74.4	4800	39.4	.470	.094	4800	39.7	4000	21.7	.470	.094	4000	35.4	3200	18.9	.470	.094
11/32	5500	71.5	4400	37.8	.520	.100	4400	37.9	3600	20.5	.520	.100	3600	36.1	2900	19.3	.520	.100
3/8	5000	67.9	4000	35.8	.560	.110	4000	36.9	3300	20.1	.560	.110	3300	37.0	2700	20.1	.560	.110
1/2	3800	56.1	3000	29.1	.750	.150	3000	32.6	2500	18.1	.750	.150	2500	32.5	2000	17.3	.750	.150



Work Material	Precipitation Hardening Stainless Steel, Cobalt Chromium Alloy						Copper, Copper Alloy						Heat Resistant Alloy					
	High Speed Cutting		General Purpose Cutting		ap	ae	High Speed Cutting		General Purpose Cutting		ap	ae	High Speed Cutting		General Purpose Cutting		ap	ae
	n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)			n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)			n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)		
1/16	13000	16.9	13000	11.0	.094	.0063	30000	63.8	28000	39.4	.094	.013	8000	3.3	6000	13.8	.094	.0031
5/64	12000	21.3	11000	13.0	.120	.0160	29000	85.6	22000	43.3	.120	.023	6400	3.4	4800	13.0	.120	.0078
3/32	10000	21.3	9400	13.4	.140	.0190	24000	85.0	19000	43.3	.140	.028	5300	3.4	4000	13.8	.140	.0094
7/64	8600	21.3	8000	13.0	.160	.0220	21000	89.3	16000	43.3	.160	.033	4600	3.5	3400	13.8	.160	.0110
1/8	7500	23.0	7000	14.2	.190	.0250	18000	91.4	14000	47.2	.190	.038	4000	3.5	3000	13.8	.190	.0130
5/32	6000	23.4	5600	14.6	.230	.0310	14000	90.9	11000	47.2	.230	.047	3200	3.5	2400	13.8	.230	.0160
3/16	5000	23.6	4700	14.6	.280	.0380	12000	89.3	9400	47.2	.280	.056	2700	3.6	2000	13.8	.280	.0190
1/4	3800	24.7	3500	15.0	.380	.0500	9000	89.3	7000	47.2	.380	.075	2000	3.7	1500	18.9	.380	.0250
5/16	3000	24.8	2800	15.4	.470	.0630	7200	89.3	5600	47.2	.470	.094	1600	3.7	1200	18.9	.470	.0310
11/32	2700	23.3	2600	15.0	.520	.0690	6600	85.7	5100	43.3	.520	.100	1500	3.9	1100	19.3	.520	.0340
3/8	2500	23.0	2300	14.2	.560	.0750	6000	81.5	4700	43.3	.560	.110	1300	3.9	1000	20.1	.560	.0380
1/2	1900	20.6	1800	13.0	.750	.1000	4500	66.4	3500	34.3	.750	.150	1000	3.7	750	17.3	.750	.0500



- (Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work. When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.
- (Note 2) Effective cutting of stainless steel, and titanium alloy can be achieved with the use of water-soluble cutting fluid.
- (Note 3) Higher feeds and speeds can be used for smaller depth of cut.
- (Note 4) Vibration can still occur if the machine rigidity and clamping method are insufficient. In these cases the feed and speed should be reduced proportionately.

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

VQMHZV-Inch sizes

End mill, Medium cut length, 3 flute for drilling and slot milling

Slot Milling

(inch)

Work Material	Carbon Steel (–30HRC)					Alloy Steel, Pre-hardened Steel					Austenitic Stainless Steel, Titanium Alloy				
	High Speed Cutting		General Purpose Cutting		ap	High Speed Cutting		General Purpose Cutting		ap	High Speed Cutting		General Purpose Cutting		ap
	n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)		n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)		n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)	
1/16	26000	27.6	20000	14.2	.031	20000	11.8	16000	6.3	.031	18000	10.6	12000	4.7	.031
5/64	24000	36.9	16000	16.1	.078	19000	18.0	13000	8.3	.078	16000	18.9	9600	7.5	.078
3/32	20000	37.8	13000	16.1	.094	16000	18.9	11000	8.7	.094	13000	19.2	8000	7.9	.094
7/64	17000	40.2	11000	17.3	.110	14000	19.8	9200	8.7	.110	11000	19.5	6900	7.9	.110
1/8	15000	44.3	10000	19.7	.130	12000	22.7	8000	9.8	.130	10000	20.1	6000	7.9	.130
5/32	12000	56.7	8000	24.8	.160	9600	26.1	6400	11.4	.160	8000	20.8	4800	8.3	.160
3/16	10000	56.7	6700	25.2	.190	8000	26.9	5300	11.8	.190	6700	21.4	4000	8.3	.190
1/4	7500	55.8	5000	24.4	.250	6000	29.8	4000	13.0	.250	5000	21.9	3000	8.7	.250
5/16	6000	49.6	4000	21.7	.310	4800	28.3	3200	12.6	.310	4000	23.6	2400	9.4	.310
11/32	5500	48.7	3600	20.9	.340	4400	27.0	2900	11.8	.340	3600	24.2	2200	9.8	.340
3/8	5000	46.1	3300	20.1	.380	4000	25.5	2700	11.4	.380	3300	25.3	2000	10.2	.380
1/2	3800	35.9	2500	15.7	.500	3000	22.3	2000	9.8	.500	2500	23.6	1500	9.4	.500

DC : Dia.

Work Material	Precipitation Hardening Stainless Steel, Cobalt Chromium Alloy					Copper, Copper Alloy					Heat Resistant Alloy				
	High Speed Cutting		General Purpose Cutting		ap	High Speed Cutting		General Purpose Cutting		ap	High Speed Cutting		General Purpose Cutting		ap
	n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)		n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)		n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)	
1/16	11000	6.5	10000	3.9	.019	30000	31.9	24000	16.9	.031	6000	3.5	5000	2.0	.013
5/64	9600	9.1	8000	5.1	.039	29000	44.5	19000	19.3	.078	4800	4.0	4000	2.2	.023
3/32	8000	9.5	6700	5.1	.047	24000	45.4	16000	20.1	.094	4000	4.3	3300	2.3	.028
7/64	6900	9.8	5700	5.5	.055	21000	49.6	14000	21.7	.110	3400	4.4	2900	2.5	.033
1/8	6000	11.3	5000	6.3	.063	18000	53.1	12000	23.2	.130	3000	4.6	2500	2.5	.038
5/32	4800	13.0	4000	7.1	.078	14000	66.1	9600	29.9	.160	2400	5.0	2000	2.8	.047
3/16	4000	13.7	3300	7.5	.094	12000	68.0	8000	29.9	.190	2000	5.1	1700	2.9	.056
1/4	3000	14.9	2500	8.3	.130	9000	67.0	6000	29.5	.250	1500	5.3	1300	3.0	.075
5/16	2400	14.2	2000	7.9	.160	7200	59.5	4800	26.4	.310	1200	5.7	1000	3.1	.094
11/32	2200	13.5	1800	7.5	.170	6600	58.5	4400	25.6	.340	1100	5.9	910	3.2	.100
3/8	2000	12.8	1700	7.1	.190	6000	55.3	4000	24.4	.380	1000	6.1	840	3.4	.110
1/2	1500	11.2	1300	6.3	.250	4500	42.5	3000	18.9	.500	750	5.7	630	3.1	.150

DC : Dia.

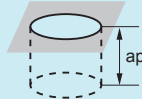
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- (Note 2) Effective cutting of stainless steel, titanium alloy, and heat-resistant alloy can be achieved with the use of water-soluble cutting fluid.
- (Note 3) Higher feeds and speeds can be used for smaller depth of cut.
- (Note 4) Vibration can still occur if the machine rigidity and clamping method are insufficient. In these cases the feed and speed should be reduced proportionately.

Drilling

(inch)

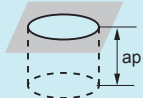
Work Material	Carbon Steel (–30HRC)							Alloy Steel, Pre-hardened Steel							Austenitic Stainless Steel, Titanium Alloy						
	High Speed Cutting			General Purpose Cutting			ap	High Speed Cutting			General Purpose Cutting			ap	High Speed Cutting			General Purpose Cutting			ap
	n (min ⁻¹)	vf (IPM)	Step	n (min ⁻¹)	vf (IPM)	Step		n (min ⁻¹)	vf (IPM)	Step	n (min ⁻¹)	vf (IPM)	Step		n (min ⁻¹)	vf (IPM)	Step	n (min ⁻¹)	vf (IPM)	Step	
1/16	18000	12.8	.013	18000	12.6	.006	.031	12000	5.2	.013	12000	5.2	.006	.031	12000	3.3	.004	12000	3.3	.002	.031
5/64	16000	18.9	.020	16000	18.9	.006	.078	11000	7.8	.016	11000	7.8	.006	.078	9600	3.5	.004	9600	3.5	.002	.039
3/32	13000	20.5	.023	13000	20.5	.010	.094	9400	8.8	.019	9400	8.8	.010	.094	8000	3.5	.006	8000	3.5	.002	.047
7/64	11000	21.7	.033	11000	21.7	.010	.110	8000	9.4	.022	8000	9.4	.010	.110	6900	3.5	.008	6900	3.5	.002	.055
1/8	10000	27.6	.044	10000	27.6	.012	.130	7000	11.0	.025	7000	11.0	.012	.130	6000	4.0	.008	6000	4.0	.004	.063
5/32	8000	31.5	.078	8000	31.5	.012	.160	5600	13.2	.031	5600	13.2	.012	.160	4800	3.8	.016	4800	3.8	.004	.078
3/16	6700	34.3	.094	6700	34.3	.016	.190	4700	15.0	.038	4700	15.0	.016	.190	4000	3.8	.020	4000	3.8	.008	.094
1/4	5000	35.4	.130	5000	35.4	.024	.250	3500	16.5	.050	3500	16.5	.024	.250	3000	3.5	.024	3000	3.5	.012	.130
5/16	4000	28.3	.160	4000	28.3	.028	.310	2800	13.2	.063	2800	13.2	.028	.310	2400	2.8	.024	2400	2.8	.012	.160
11/32	3600	25.5	.170	3600	25.5	.028	.340	2600	12.3	.069	2600	12.3	.028	.340	2200	2.6	.024	2200	2.6	.012	.170
3/8	3300	23.4	.190	3300	23.4	.030	.380	2300	11.0	.094	2300	11.0	.030	.380	2000	2.3	.024	2000	2.3	.012	.190
1/2	2500	17.7	.200	2500	17.7	.030	.500	1800	8.5	.130	1800	8.5	.030	.500	1500	2.0	.024	1500	2.0	.012	.250

Depth of Cut



Work Material	Precipitation Hardening Stainless Steel, Cobalt Chromium Alloy							Copper, Copper Alloy						
	High Speed Cutting			General Purpose Cutting			ap	High Speed Cutting			General Purpose Cutting			ap
	n (min ⁻¹)	vf (IPM)	Step	n (min ⁻¹)	vf (IPM)	Step		n (min ⁻¹)	vf (IPM)	Step	n (min ⁻¹)	vf (IPM)	Step	
1/16	7000	2.0	.004	7000	2.0	.002	.031	22000	15.6	.013	22000	15.6	.006	.031
5/64	6400	2.4	.004	6400	2.4	.002	.039	19000	22.4	.020	19000	22.4	.006	.039
3/32	5300	2.4	.006	5300	2.4	.002	.047	16000	25.2	.023	16000	25.2	.010	.047
7/64	4600	2.4	.008	4600	2.4	.002	.055	14000	27.6	.033	14000	27.6	.010	.055
1/8	4000	2.8	.008	4000	2.8	.004	.063	12000	33.1	.044	12000	33.1	.012	.063
5/32	3200	2.4	.016	3200	2.4	.004	.078	9600	37.8	.078	9600	37.8	.012	.078
3/16	2700	2.4	.020	2700	2.4	.008	.094	8000	39.4	.094	8000	39.4	.016	.094
1/4	2000	2.4	.024	2000	2.4	.012	.130	6000	43.3	.130	6000	43.3	.024	.130
5/16	1600	2.0	.024	1600	2.0	.012	.160	4800	33.9	.160	4800	33.9	.028	.160
11/32	1500	1.8	.024	1500	1.8	.012	.170	4400	31.1	.170	4400	31.1	.028	.170
3/8	1300	1.5	.024	1300	1.5	.012	.190	4000	28.3	.190	4000	28.3	.030	.190
1/2	1000	1.2	.024	1000	1.2	.012	.250	3000	21.3	.200	3000	21.3	.030	.250

Depth of Cut



(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.

When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

(Note 2) Effective cutting of stainless steel, and titanium alloy can be achieved with the use of water-soluble cutting fluid.

(Note 3) Higher feeds and speeds can be used for smaller depth of cut.

(Note 4) Vibration can still occur if the machine rigidity and clamping method are insufficient. In these cases the feed and speed should be reduced proportionately.

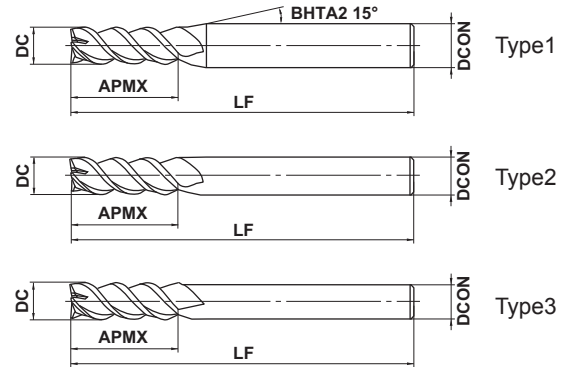
Vibration Control End Mills for Machining Difficult-to-cut Materials

VQMHSZV

End mill, Medium cut length, 3 flute for drilling and slot milling



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



h6	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

- 3 flute end mill for drilling and slot milling.
- Featuring irregular helical geometry for reducing vibration.

(mm)

Order Number	DC	APMX	LF	DCON	* No. F	Stock	Type
VQMHSZVD0100	1	2	45	4	3	●	1
VQMHSZVD0110	1.1	2.2	45	4	3	★	1
VQMHSZVD0120	1.2	2.4	45	4	3	★	1
VQMHSZVD0130	1.3	2.6	45	4	3	★	1
VQMHSZVD0140	1.4	2.8	45	4	3	★	1
VQMHSZVD0150	1.5	3	45	4	3	●	1
VQMHSZVD0160	1.6	3.2	45	4	3	★	1
VQMHSZVD0170	1.7	3.4	45	4	3	★	1
VQMHSZVD0180	1.8	3.6	45	4	3	★	1
VQMHSZVD0190	1.9	3.8	45	4	3	★	1
VQMHSZVD0200	2	4	50	6	3	●	1
VQMHSZVD0210	2.1	4.2	50	6	3	★	1
VQMHSZVD0220	2.2	4.4	50	6	3	★	1
VQMHSZVD0230	2.3	4.6	50	6	3	★	1
VQMHSZVD0240	2.4	4.8	50	6	3	★	1
VQMHSZVD0250	2.5	5	50	6	3	●	1
VQMHSZVD0260	2.6	5.2	50	6	3	★	1
VQMHSZVD0270	2.7	5.4	50	6	3	★	1
VQMHSZVD0280	2.8	5.6	50	6	3	★	1
VQMHSZVD0290	2.9	5.8	50	6	3	★	1
VQMHSZVD0300	3	6	50	6	3	●	1
VQMHSZVD0310	3.1	7	50	6	3	★	1
VQMHSZVD0320	3.2	7	50	6	3	★	1
VQMHSZVD0330	3.3	7	50	6	3	★	1
VQMHSZVD0340	3.4	7	50	6	3	★	1
VQMHSZVD0350	3.5	8	50	6	3	●	1
VQMHSZVD0360	3.6	8	50	6	3	★	1
VQMHSZVD0370	3.7	8	50	6	3	★	1

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

* Number of Flutes

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

(mm)

Order Number	DC	APMX	LF	DCON	* No. F	Stock	Type
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
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 has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.
When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

★ Number of Flutes

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

VQMHZV

End mill, Medium cut length, 3 flute for drilling and slot milling

Shoulder Milling

When machine rigidity, work material rigidity and chip discharge are enough, please select the high efficiency cutting conditions.

When either machine rigidity, work material rigidity or chip discharge are not enough, please select the general-purpose cutting conditions.

High Efficiency Cutting Conditions

(mm)

Work Material	Carbon Steel, Alloy Steel, Mild Steel					Pre-hardened Steel, Carbon Steel, Alloy Steel, Alloy Tool Steel					Austenitic, Ferritic and Martensitic Stainless Steels, Titanium Alloys					Precipitation Hardening Stainless Steels, Cobalt Chromium Alloy					
	DC	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	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 Cutting Conditions

(mm)

Work Material	Carbon Steel, Alloy Steel, Mild Steel					Pre-hardened Steel, Carbon Steel, Alloy Steel, Alloy Tool Steel					Austenitic, Ferritic and Martensitic Stainless Steels, Titanium Alloys					Precipitation Hardened Stainless Steels, Cobalt Chromium Alloy					
	DC	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	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 has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.

When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

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

(Note 3) Chattering can still occur if the machine rigidity and clamping method are insufficient.

In these cases the feed and speed should be reduced proportionately.

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


Shoulder Milling

When machine rigidity, work material rigidity and chip discharge are enough, please select the high efficiency cutting conditions.
When either machine rigidity, work material rigidity or chip discharge are not enough, please select the general-purpose cutting conditions.

High Efficiency Cutting Conditions

(mm)


Work Material	Copper, Copper Alloy					Heat Resistant Alloys					
	DC	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	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	



General Purpose Cutting Conditions

(mm)

Work Material	Copper, Copper Alloy					Heat Resistant Alloys					
	DC	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	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	



(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.

When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

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

(Note 3) Chattering can still occur if the machine rigidity and clamping method are insufficient.

In these cases the feed and speed should be reduced proportionately.

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

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

VQMHZV

End mill, Medium cut length, 3 flute for drilling and slot milling

Slot Milling

When machine rigidity, work material rigidity and chip discharge are enough, please select the high efficiency cutting conditions.

When either machine rigidity, work material rigidity or chip discharge are not enough, please select the general-purpose cutting conditions.

High Efficiency Cutting Conditions

(mm)

Work Material	Carbon Steel, Alloy Steel, Mild Steel				Pre-hardened Steel, Carbon Steel, Alloy Steel, Alloy Tool Steel				Austenitic, Ferritic and Martensitic Stainless Steels, Titanium Alloys				Precipitation Hardening Stainless Steels, Cobalt Chromium Alloy				Copper, Copper Alloy				Heat Resistant Alloys			
	DC	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)
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

DC : Dia.

General Purpose Cutting Conditions

(mm)

Work Material	Carbon Steel, Alloy Steel, Mild Steel				Pre-hardened Steel, Carbon Steel, Alloy Steel, Alloy Tool Steel				Austenitic, Ferritic and Martensitic Stainless Steels, Titanium Alloys				Precipitation Hardening Stainless Steels, Cobalt Chromium Alloy				Copper, Copper Alloy				Heat Resistant Alloys			
	DC	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)
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

DC : Dia.

(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.

When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

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

(Note 3) Chattering can still occur if the machine rigidity and clamping method are insufficient.

In these cases the feed and speed should be reduced proportionately.

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

Drilling

When machine rigidity, work material rigidity and chip discharge are enough, please select the high efficiency cutting conditions.
When either machine rigidity, work material rigidity or chip discharge are not enough, please select the general-purpose cutting conditions.

High Efficiency Cutting Conditions

(mm)

Work Material	Carbon Steel, Alloy Steel, Mild Steel					Pre-hardened Steel, Carbon Steel, Alloy Steel, Alloy Tool Steel					Austenitic, Ferritic and Martensitic Stainless Steels, Titanium Alloys					Precipitation Hardening Stainless Steels, Cobalt Chromium Alloy					Copper, Copper Alloy				
	DC	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	Step	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	Step	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	Step	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	Step	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap
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

General Purpose Cutting Conditions

(mm)

Work Material	Carbon Steel, Alloy Steel, Mild Steel					Pre-hardened Steel, Carbon Steel, Alloy Steel, Alloy Tool Steel					Austenitic, Ferritic and Martensitic Stainless Steels, Titanium Alloys					Precipitation Hardening Stainless Steels, Cobalt Chromium Alloy					Copper, Copper Alloy				
	DC	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	Step	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	Step	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	Step	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	Step	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap
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

- (Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.
When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.
- (Note 2) Effective cutting of stainless steel, titanium alloys and heat-resistant alloys etc. can be achieved with the use of emulsion.
- (Note 3) Chattering can still occur if the machine rigidity and clamping method are insufficient.
In these cases the feed and speed should be reduced proportionately.

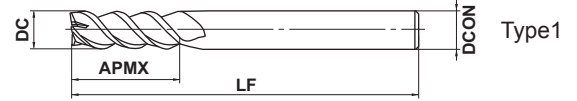
Vibration Control End Mills for Machining Difficult-to-cut Materials

VQMHZVOH-Inch sizes

End mill, Medium cut length, 3 flute for drilling and slot milling with coolant holes



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



DC	DC < .5000"	DC = .5000"			
	0 - .0008"	0 - .0012"			
h6	.250" ≤ DCON ≤ .375"	DCON = .500"			
	0 - .00035"	0 - .00043"			

- 3 flute end mill for drilling and slot milling.
- Featuring irregular helical geometry for reducing vibration.

(inch)

Order Number	DC	APMX	LF	DCON	* No. F	Stock	Type
VQMHZVOHD1/4	.2500	.6250	2.50	.2500	3	●	1
VQMHZVOHD5/16	.3125	.7500	2.75	.3125	3	●	1
VQMHZVOHD3/8	.3752	.8750	3.00	.3750	3	●	1
VQMHZVOHD1/2	.5000	1.1250	3.50	.5000	3	●	1

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

* Number of Flutes

● : Inventory maintained.

Slot Milling

(inch)

Work Material	Carbon Steel (–30HRC)					Alloy Steel, Pre-hardened Steel					Austenitic Stainless Steel, Titanium Alloy				
	High Speed Cutting		General Purpose Cutting		ap	High Speed Cutting		General Purpose Cutting		ap	High Speed Cutting		General Purpose Cutting		ap
	n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)		n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)		n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)	
1/4	7500	55.8	5000	24.4	.250	6000	29.8	5000	16.5	.250	5000	21.9	3000	8.7	.250
5/16	6000	49.6	4000	21.7	.310	4800	28.3	4000	15.7	.310	4000	23.6	2400	9.4	.310
3/8	5000	46.1	3300	20.1	.380	4000	25.5	3300	13.8	.380	3300	25.3	2000	10.2	.380
1/2	3800	35.9	2500	15.7	.500	3000	22.3	2500	12.2	.500	2500	23.6	1500	9.4	.500
Depth of Cut															

DC : Dia.

Work Material	Precipitation Hardening Stainless Steel, Cobalt Chromium Alloy					Copper, Copper Alloy					Heat Resistant Alloy				
	High Speed Cutting		General Purpose Cutting		ap	High Speed Cutting		General Purpose Cutting		ap	High Speed Cutting		General Purpose Cutting		ap
	n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)		n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)		n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)	
1/4	3000	14.9	2500	8.3	.250	9000	67.0	6000	29.5	.250	1500	5.3	1300	3.0	.075
5/16	2400	14.2	2000	7.9	.310	7200	59.5	4800	26.4	.310	1200	5.7	1000	3.1	.094
3/8	2000	12.8	1700	7.1	.380	6000	55.3	4000	24.4	.380	1000	6.1	840	3.4	.110
1/2	1500	11.2	1300	6.3	.500	4500	42.5	3000	18.9	.500	750	5.7	630	3.1	.150
Depth of Cut															

DC : Dia.

- (Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work. When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.
- (Note 2) Effective cutting of stainless steel, titanium alloy, and heat-resistant alloy can be achieved with the use of water-soluble cutting fluid.
- (Note 3) Higher feeds and speeds can be used for smaller depth of cut.
- (Note 4) Vibration can still occur if the machine rigidity and clamping method are insufficient. In these cases the feed and speed should be reduced proportionately.

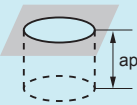
Vibration Control End Mills for Machining Difficult-to-cut Materials

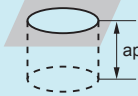
VQMHZVOH-Inch sizes

End mill, Medium cut length, 3 flute for drilling and slot milling with coolant holes

Drilling

(inch)

Work Material	Carbon Steel (–30HRC)								Alloy Steel, Pre-hardened Steel								Austenitic Stainless Steel, Titanium Alloy							
	High Speed Cutting			General Purpose Cutting			ap	High Speed Cutting			General Purpose Cutting			ap	High Speed Cutting			General Purpose Cutting			ap			
	n (min ⁻¹)	vf (IPM)	Step	n (min ⁻¹)	vf (IPM)	Step		n (min ⁻¹)	vf (IPM)	Step	n (min ⁻¹)	vf (IPM)	Step		n (min ⁻¹)	vf (IPM)	Step	n (min ⁻¹)	vf (IPM)	Step				
1/4	5000	35.4	.13	5000	35.4	.024	.38	3500	16.5	.050	3500	16.5	.024	.38	3000	3.5	.024	3000	3.5	.012	.38			
5/16	4000	28.3	.16	4000	28.3	.028	.47	2800	13.2	.063	2800	13.2	.028	.47	2400	2.8	.024	2400	2.8	.012	.47			
3/8	3300	23.4	.19	3300	23.4	.030	.56	2300	11.0	.094	2300	11.0	.030	.56	2000	2.3	.024	2000	2.3	.012	.56			
1/2	2500	17.7	.20	2500	17.7	.030	.75	1800	8.5	.130	1800	8.5	.030	.75	1500	2.0	.024	1500	2.0	.012	.75			
Depth of Cut																								

Work Material	Precipitation Hardening Stainless Steel, Cobalt Chromium Alloy								Copper, Copper Alloy							
	High Speed Cutting			General Purpose Cutting			ap	High Speed Cutting			General Purpose Cutting			ap		
	n (min ⁻¹)	vf (IPM)	Step	n (min ⁻¹)	vf (IPM)	Step		n (min ⁻¹)	vf (IPM)	Step	n (min ⁻¹)	vf (IPM)	Step			
1/4	2000	2.3	.024	2000	2.3	.012	.38	6000	42.5	.13	6000	42.5	.0024	.38		
5/16	1600	2.0	.024	1600	2.0	.012	.47	4800	34.0	.16	4800	34.0	.0028	.47		
3/8	1300	1.5	.024	1300	1.5	.012	.56	4000	28.3	.19	4000	28.3	.0030	.56		
1/2	1000	1.2	.024	1000	1.2	.012	.75	3000	21.3	.20	3000	21.3	.0030	.75		
Depth of Cut																

(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.

When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

(Note 2) Effective cutting of stainless steel, titanium alloy, and heat-resistant alloy can be achieved with the use of water-soluble cutting fluid.

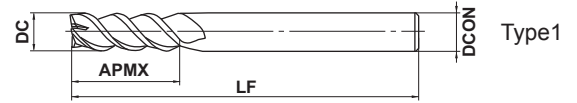
(Note 3) Vibration can still occur if the machine rigidity and clamping method are insufficient. In these cases the feed and speed should be reduced proportionately.

VQMZHVOH

End mill, Medium cut length, 3 flute for drilling and slot milling with coolant holes



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



	DC≤12	DC=16			
	$\frac{0}{-0.02}$	$\frac{0}{-0.03}$			
	4≤DCON≤6	8≤DCON≤10	12≤DCON≤16		
	$\frac{0}{-0.008}$	$\frac{0}{-0.009}$	$\frac{0}{-0.011}$		

- 3 flute end mill for drilling and slot milling.
- Featuring irregular helical geometry for reducing vibration.

Order Number	DC	APMX	LF	DCON	No. F*	Stock	Type
VQMZHVOHD0600	6	13	60	6	3	●	1
VQMZHVOHD0800	8	19	70	8	3	●	1
VQMZHVOHD1000	10	22	80	10	3	●	1
VQMZHVOHD1200	12	26	90	12	3	●	1
VQMZHVOHD1600	16	30	110	16	3	★	1

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

* Number of Flutes

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

VQM[®]HZVOH

End mill, Medium cut length, 3 flute for drilling and slot milling, with internal through coolant holes

Slot Milling

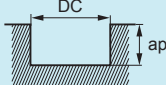
When machine rigidity, work material rigidity and chip discharge are enough, please select the high efficiency cutting conditions.

When either machine rigidity, work material rigidity or chip discharge are not enough, please select the general-purpose cutting conditions.

High Efficiency Cutting Conditions

(mm)

Work Material	Carbon Steel, Alloy Steel, Mild Steel				Pre-hardened Steel, Carbon Steel, Alloy Steel, Alloy Tool Steel				Austenitic, Ferritic and Martensitic Stainless Steels, Titanium Alloys				Precipitation Hardening Stainless Steels, Cobalt Chromium Alloy				Copper, Copper Alloy				Heat Resistant Alloys			
	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	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

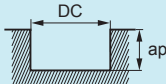


DC : Dia.

General Purpose Cutting Conditions

(mm)

Work Material	Carbon Steel, Alloy Steel, Mild Steel				Pre-hardened Steel, Carbon Steel, Alloy Steel, Alloy Tool Steel				Austenitic, Ferritic and Martensitic Stainless Steels, Titanium Alloys				Precipitation Hardening Stainless Steels, Cobalt Chromium Alloy				Copper, Copper Alloy				Heat Resistant Alloys			
	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	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



DC : Dia.

(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.

When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

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

(Note 3) Chattering can still occur if the machine rigidity and clamping method are insufficient.

In these cases the feed and speed should be reduced proportionately.

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

Drilling

When machine rigidity, work material rigidity and chip discharge are enough, please select the high efficiency cutting conditions.
When either machine rigidity, work material rigidity or chip discharge are not enough, please select the general-purpose cutting conditions.

High Efficiency Cutting Conditions

(mm)

Work Material	Carbon Steel, Alloy Steel, Mild Steel					Pre-hardened Steel, Carbon Steel, Alloy Steel, Alloy Tool Steel					Austenitic, Ferritic and Martensitic Stainless Steels, Titanium Alloys					Precipitation Hardening Stainless Steels, Cobalt Chromium Alloy					Copper, Copper Alloy						
	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	Step	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	Step	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	Step	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	Step	vc (m/min)	n (min ⁻¹)	vf (mm/min)	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	120	6400	1200	9	3		
8	100	4000	720	12	4	70	2800	340	12	1.6	60	2400	70	8	0.6	40	1600	50	8	0.6	120	4800	860	12	4		
10	100	3200	580	15	5	70	2200	260	15	2.5	60	1900	60	10	0.6	40	1300	40	10	0.6	120	3800	680	15	5		
12	100	2700	490	18	5	70	1900	230	18	3	60	1600	50	12	0.6	40	1100	30	12	0.6	120	3200	580	18	5		
16	100	2000	360	24	5	70	1400	170	24	4	60	1200	40	16	0.6	40	800	20	16	0.6	120	2400	430	24	5		
Depth of Cut																											

General Purpose Cutting Conditions

(mm)

Work Material	Carbon Steel, Alloy Steel, Mild Steel					Pre-hardened Steel, Carbon Steel, Alloy Steel, Alloy Tool Steel					Austenitic, Ferritic and Martensitic Stainless Steels, Titanium Alloys					Precipitation Hardening Stainless Steels, Cobalt Chromium Alloy					Copper, Copper Alloy						
	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	Step	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	Step	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	Step	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	Step	vc (m/min)	n (min ⁻¹)	vf (mm/min)	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	120	6400	1200	9	0.6		
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	120	4800	860	12	0.7		
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	120	3800	680	15	0.75		
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	120	3200	580	18	0.75		
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	120	2400	430	24	0.75		
Depth of Cut																											

(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.

When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

(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.

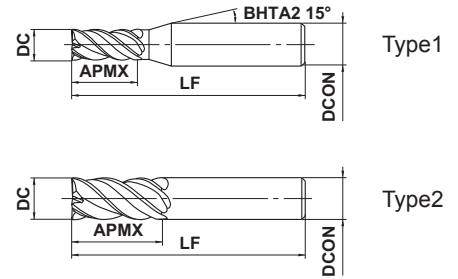
Vibration Control End Mills for Machining Difficult-to-cut Materials

VQMHV-Inch sizes

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



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



	DC < .5000"	DC = .5000"			
	0 - .0008"	0 - .0012"			
	.250" ≤ DCON ≤ .375"	DCON = .500"			
	0 - .00035"	0 - .00043"			

● SMART MIRACLE vibration control end mills for reducing chattering and for delivering stable performance on difficult-to-cut materials and long overhang applications.

(inch)

Order Number	DC	APMX	LF	DCON	* No. F	Stock	Type
VQMHVD1/8	.1250	.3130	2.00	.2500	4	●	1
VQMHVD3/16	.1875	.4375	2.00	.2500	4	●	1
VQMHVD1/4	.2500	.6250	2.50	.2500	4	●	2
VQMHVD5/16	.3125	.7500	2.75	.3125	4	●	2
VQMHVD3/8	.3750	.8750	3.00	.3750	4	●	2
VQMHVD1/2	.5000	1.1250	3.50	.5000	4	●	2

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

* Number of Flutes

● : Inventory maintained.

Shoulder Milling

(inch)

Work Material	Carbon Steel (–30HRC)						Alloy Steel, Pre-hardened Steel						Austenitic Stainless Steel, Titanium Alloy					
	High Speed Cutting		General Purpose Cutting		ap	ae	High Speed Cutting		General Purpose Cutting		ap	ae	High Speed Cutting		General Purpose Cutting		ap	ae
	n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)			n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)			n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)		
1/8	15000	102.0	12000	55.1	.19	.038	12000	49.1	10000	27.2	.19	.038	10000	34.6	8000	18.1	.19	.038
3/16	10000	99.2	8000	51.2	.28	.056	8000	50.4	6700	28.0	.28	.056	6700	35.3	5300	18.5	.28	.056
1/4	7500	99.2	6000	51.2	.38	.075	6000	52.0	5000	28.7	.38	.075	5000	47.2	4000	24.8	.38	.075
5/16	6000	99.2	4800	51.2	.47	.094	4800	52.9	4000	29.1	.47	.094	4000	47.2	3200	24.8	.47	.094
3/8	5000	90.6	4000	47.2	.56	.110	4000	49.1	3300	26.8	.56	.110	3300	49.4	2700	26.8	.56	.110
1/2	3800	74.8	3000	39.0	.75	.150	3000	43.5	2500	24.0	.75	.150	2500	43.3	2000	22.8	.75	.150
Depth of Cut																		

Work Material	Precipitation Hardening Stainless Steel, Cobalt Chromium Alloy						Copper, Copper Alloy						Heat Resistant Alloy					
	High Speed Cutting		General Purpose Cutting		ap	ae	High Speed Cutting		General Purpose Cutting		ap	ae	High Speed Cutting		General Purpose Cutting		ap	ae
	n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)			n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)			n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)		
1/8	7500	30.7	7000	18.9	.19	.025	18000	122.0	14000	63.0	.19	.038	4000	9.5	3000	4.7	.19	.013
3/16	5000	31.5	4700	19.7	.28	.038	12000	119.0	9400	63.0	.28	.056	2700	9.8	2000	4.7	.28	.019
1/4	3800	32.9	3500	20.1	.38	.050	9000	119.0	7000	63.0	.38	.075	2000	10.1	1500	5.1	.38	.025
5/16	3000	33.1	2800	20.5	.47	.063	7200	119.0	5600	63.0	.47	.094	1600	10.1	1200	5.1	.47	.031
3/8	2500	30.7	2300	18.5	.56	.075	6000	109.0	4700	55.1	.56	.110	1300	10.6	1000	5.5	.56	.038
1/2	1900	27.5	1800	17.3	.75	.100	4500	88.6	3500	47.2	.75	.150	1000	10.1	750	5.1	.75	.050
Depth of Cut																		

(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.

When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

(Note 2) Effective cutting of stainless steel, titanium alloy and heat-resistant alloy can be achieved with the use of water-soluble cutting fluid.

(Note 3) Higher feeds and speeds can be used for smaller depth of cut.

(Note 4) Vibration can still occur if the machine rigidity and clamping method are insufficient. In these cases the feed and speed should be reduced proportionately.

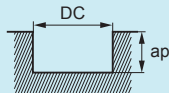
Vibration Control End Mills for Machining Difficult-to-cut Materials

VQMHV-Inch sizes

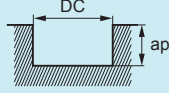
End mill, Medium cut length, 4 flute, Irregular helix flutes

Slot Milling

(inch)

Work Material	Carbon Steel (–30HRC)					Alloy Steel, Pre-hardened Steel					Austenitic Stainless Steel, Titanium Alloy				
	High Speed Cutting		General Purpose Cutting		ap	High Speed Cutting		General Purpose Cutting		ap	High Speed Cutting		General Purpose Cutting		ap
	n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)		n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)		n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)	
1/8	15000	59.1	10000	26.0	.130	12000	30.2	8000	13.4	.130	10000	26.8	6000	10.6	.130
3/16	10000	75.6	6700	33.5	.190	8000	35.9	5300	15.7	.190	6700	28.5	4000	11.4	.190
1/4	7500	74.4	5000	32.7	.250	6000	39.7	4000	17.3	.250	5000	29.1	3000	11.4	.250
5/16	6000	66.1	4000	29.1	.310	4800	37.8	3200	16.5	.310	4000	31.5	2400	12.6	.310
3/8	5000	61.4	3300	26.8	.380	4000	34.0	2700	15.0	.380	3300	33.8	2000	13.4	.380
1/2	3800	47.9	2500	20.9	.500	3000	29.8	2000	13.0	.500	2500	31.5	1500	12.6	.500
Depth of Cut															

DC : Dia.

Work Material	Precipitation Hardening Stainless Steel, Cobalt Chromium Alloy					Copper, Copper Alloy					Heat Resistant Alloy				
	High Speed Cutting		General Purpose Cutting		ap	High Speed Cutting		General Purpose Cutting		ap	High Speed Cutting		General Purpose Cutting		ap
	n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)		n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)		n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)	
1/8	6000	15.1	5000	8.3	.063	18000	70.9	12000	31.1	.13	3000	6.14	2500	3.4	.038
3/16	4000	18.3	3300	9.8	.094	12000	90.7	8000	39.4	.19	2000	6.80	1700	3.8	.056
1/4	3000	19.8	2500	11.0	.130	9000	89.3	6000	39.4	.25	1500	7.09	1300	3.9	.075
5/16	2400	18.9	2000	10.2	.160	7200	79.4	4800	35.0	.31	1200	7.56	1000	4.3	.094
3/8	2000	17.0	1700	9.4	.190	6000	73.7	4000	32.3	.38	1000	8.19	840	4.7	.110
1/2	1500	14.9	1300	8.7	.250	4500	56.7	3000	24.8	.50	750	7.56	630	4.3	.150
Depth of Cut															

DC : Dia.

(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.

When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

(Note 2) Effective cutting of stainless steel, titanium alloy and heat-resistant alloy can be achieved with the use of water-soluble cutting fluid.

(Note 3) Higher feeds and speeds can be used for smaller depth of cut.

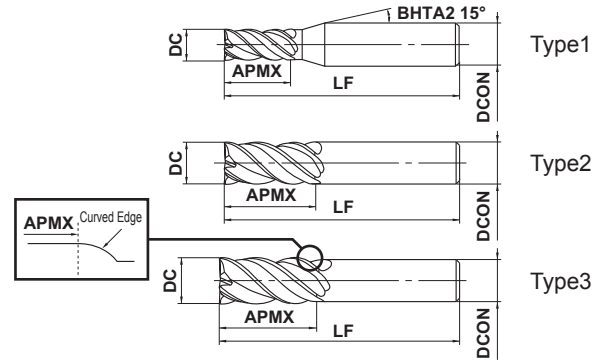
(Note 4) Vibration can still occur if the machine rigidity and clamping method are insufficient. In these cases the feed and speed should be reduced proportionately.

VQMHV

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



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



h ₆	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 mills for reduced chattering and for delivering stable performance on difficult-to-cut materials and long overhang applications.

(mm)

Order Number	DC	APMX	LF	DCON	No. F	Stock	Type
NEW VQMHVD0100	1	2	45	4	4	●	1
NEW 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 has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work. When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

★ Number of Flutes

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

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

VQMHV

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


Shoulder Milling

When machine rigidity, work material rigidity and chip discharge are enough, please select the high efficiency cutting conditions.

When either machine rigidity, work material rigidity or chip discharge are not enough, please select the general-purpose cutting conditions.


High Efficiency Cutting Conditions

(mm)

Work Material	Carbon Steel, Alloy Steel, Mild Steel					Pre-hardened Steel, Carbon Steel, Alloy Steel, Alloy Tool Steel					Austenitic, Ferritic and Martensitic Stainless Steels, Titanium Alloys					Precipitation Hardening Stainless Steel, Cobalt Chromium Alloy					
	DC	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	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 Cutting Conditions

(mm)

Work Material	Carbon Steel, Alloy Steel, Mild Steel					Pre-hardened Steel, Carbon Steel, Alloy Steel, Alloy Tool Steel					Austenitic, Ferritic and Martensitic Stainless Steels, Titanium Alloys					Precipitation Hardening Stainless Steel, Cobalt Chromium Alloy					
	DC	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	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 has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.

When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

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

(Note 3) Chattering can still occur if the machine rigidity and clamping method are insufficient.

In these cases the revolution and feed rate should be reduced proportionately, or set a lower depth of cut.


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

Shoulder Milling

When machine rigidity, work material rigidity and chip discharge are enough, please select the high efficiency cutting conditions.
When either machine rigidity, work material rigidity or chip discharge are not enough, please select the general-purpose cutting conditions.


High Efficiency Cutting Conditions (mm)

Work Material	Copper, Copper Alloy					Heat Resistant Alloys				
	DC	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap
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



General Purpose Cutting Conditions (mm)

Work Material	Copper, Copper Alloy					Heat Resistant Alloys				
	DC	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap
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



(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.

When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

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

(Note 3) Chattering can still occur if the machine rigidity and clamping method are insufficient.

In these cases the revolution and feed rate should be reduced proportionately, or set a lower depth of cut.

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

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

VQMHV

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

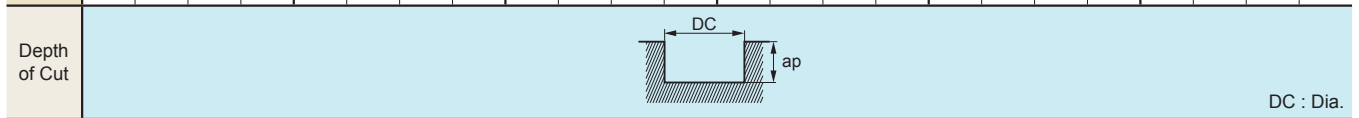
Slot Milling

When machine rigidity, work material rigidity and chip discharge are enough, please select the high efficiency cutting conditions.
When either machine rigidity, work material rigidity or chip discharge are not enough, please select the general-purpose cutting conditions.

High Efficiency Cutting Conditions

(mm)

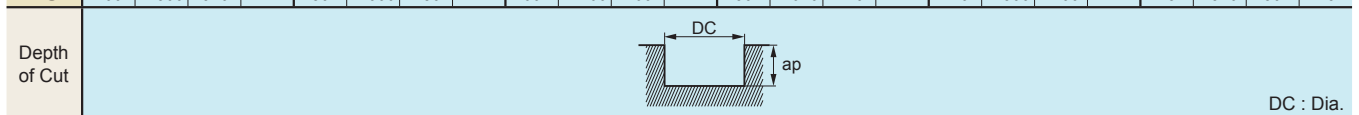
Work Material	Carbon Steel, Alloy Steel, Mild Steel				Pre-hardened Steel, Carbon Steel, Alloy Steel, Alloy Tool Steel				Austenitic, Ferritic and Martensitic Stainless Steels, Titanium Alloys				Precipitation Hardening Stainless Steel, Cobalt Chromium Alloy				Copper, Copper Alloy				Heat Resistant Alloys			
	DC	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)
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



General Purpose Cutting Conditions

(mm)

Work Material	Carbon Steel, Alloy Steel, Mild Steel				Pre-hardened Steel, Carbon Steel, Alloy Steel, Alloy Tool Steel				Austenitic, Ferritic and Martensitic Stainless Steels, Titanium Alloys				Precipitation Hardening Stainless Steel, Cobalt Chromium Alloy				Copper, Copper Alloy				Heat Resistant Alloys			
	DC	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)
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



(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.

When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

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

(Note 3) Chattering can still occur if the machine rigidity and clamping method are insufficient.

In these cases the revolution and feed rate should be reduced proportionately, or set a lower depth of cut.

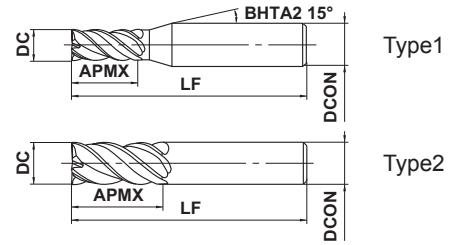
(Note 4) When the depth of cut is smaller than shown the feed rate can be increased.

VQJHV - Inch sizes

End mill, Semi-long cut length, 4 flute, Irregular helix flutes



Carbon Steel, Alloy Steel (<30HRC)	Pre-hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Hardened Steel (>55HRC)	Austenitic Stainless Steel	Titanium Alloy, Heat Resistant Alloy	Copper Alloy	Aluminum Alloy
⊙	○			⊙	⊙	○	



h6	DC < .5000"	DC = .5000"			
	0 - .0008"	0 - .0012"			
h6	.250" ≤ DCON ≤ .375"	DCON = .500"			
	0 - .00035"	0 - .00043"			

● SMART MIRACLE vibration control end mills for reduced chattering and for delivering stable performance on difficult-to-cut materials and long overhang applications.

Order Number	DC	APMX	LF	DCON	* No. F	Stock	Type
VQJHVD1/8	.1250	.5000	2.50	.2500	4	●	1
VQJHVD3/16	.1875	.7500	2.50	.2500	4	●	1
VQJHVD1/4	.2500	1.0000	2.50	.2500	4	●	2
VQJHVD5/16	.3125	1.0900	3.25	.3125	4	●	2
VQJHVD3/8	.3750	1.3100	3.50	.3750	4	●	2
VQJHVD1/2	.5000	1.6500	4.00	.5000	4	●	2

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

* Number of Flutes


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


VQJHV - Inch sizes

End mill, Semi-long cut length, 4 flute, Irregular helix flutes

Shoulder Milling

(inch)

Work Material	Carbon Steel, Alloy Steel, Mild Steel				Pre-hardened Steel, Carbon Steel, Alloy Steel, Alloy Tool Steel				Austenitic, Ferritic and Martensitic Stainless Steels, Titanium Alloys				Precipitation Hardening Stainless Steels, Cobalt Chromium Alloy			
	DC	n (min ⁻¹)	vf (IPM)	ap	ae	n (min ⁻¹)	vf (IPM)	ap	ae	n (min ⁻¹)	vf (IPM)	ap	ae	n (min ⁻¹)	vf (IPM)	ap
1/8	13000	39.0	.313	.013	10000	26.8	.313	.013	8000	2.1	.313	.006	7500	18.9	.313	.006
3/16	8700	39.4	.469	.019	6700	27.6	.469	.019	5300	21.7	.469	.009	5000	20.5	.469	.009
1/4	6500	47.2	.625	.025	5000	32.3	.625	.025	4000	25.2	.625	.013	3800	24.0	.625	.013
5/16	5200	47.2	.781	.031	4000	33.5	.781	.031	3200	25.2	.781	.016	3000	23.6	.781	.016
3/8	4300	43.3	.938	.038	3300	31.9	.938	.038	2700	23.2	.938	.019	2500	22.4	.938	.019
1/2	3300	43.3	1.250	.050	2500	29.1	1.250	.050	2000	2.9	1.250	.025	1900	20.1	1.250	.025
Depth of Cut																

Work Material	Copper, Copper Alloy				Heat Resistant Alloys				
	DC	n (min ⁻¹)	vf (IPM)	ap	ae	n (min ⁻¹)	vf (IPM)	ap	ae
1/8	16000	48.0	.013	.013	4000	5.1	.313	.003	
3/16	11000	51.9	.019	.019	2700	7.1	.469	.004	
1/4	8000	57.9	.025	.025	2000	6.7	.625	.005	
5/16	6400	59.4	.031	.031	1600	6.7	.781	.006	
3/8	5300	51.7	.038	.038	1300	6.7	.938	.008	
1/2	4000	50.4	.050	.050	1000	5.1	1.250	.010	
Depth of Cut									

(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.

When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

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

(Note 3) Chattering can still occur if the machine rigidity and clamping method are insufficient.

In these cases the feed and speed should be reduced proportionately.

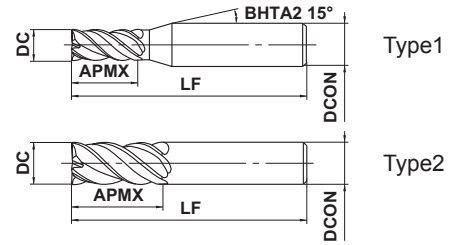
(Note 4) When the depth of cut is smaller than shown the revolution and feed rate can be increased.

VQJHV

End mill, Semi-long cut length, 4 flute, Irregular helix flutes



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



h6	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 mills for reduced chattering and for delivering stable performance on difficult-to-cut materials and long overhang applications.

(mm)

Order Number	DC	APMX	LF	DCON	* No. F	Stock	Type
NEW VQJHVD0100	1	4	45	4	4	●	1
NEW 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 has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work. When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

* Number of Flutes

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

VQJHV

End mill, Semi-long cut length, 4 flute, Irregular helix flutes

Shoulder Milling

(mm)

Work Material	Carbon Steel, Alloy Steel, Mild Steel					Pre-hardened Steel, Carbon Steel, Alloy Steel, Alloy Tool Steel					Austenitic, Ferritic and Martensitic Stainless Steels, Titanium Alloys					Precipitation Hardening Stainless Steel, Cobalt Chromium Alloy				
	DC	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap
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

The diagram illustrates the geometry of a shoulder mill cut. It shows a cylindrical workpiece with a flat top surface. A vertical dimension line indicates the depth of cut, labeled 'ap'. A horizontal dimension line indicates the axial depth of cut, labeled 'ae'. The cutting tool is shown as a shaded area on the left side of the workpiece.

Work Material	Copper, Copper Alloy					Heat Resistant Alloys				
	DC	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap
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

The diagram illustrates the geometry of a shoulder mill cut. It shows a cylindrical workpiece with a flat top surface. A vertical dimension line indicates the depth of cut, labeled 'ap'. A horizontal dimension line indicates the axial depth of cut, labeled 'ae'. The cutting tool is shown as a shaded area on the left side of the workpiece.

(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.

When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

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

(Note 3) Chattering can still occur if the machine rigidity and clamping method are insufficient.

In these cases the revolution and feed rate should be reduced proportionately, or set a lower depth of cut.

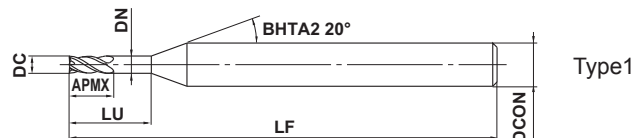
(Note 4) When the depth of cut is smaller than shown the revolution and feed rate can be increased.

VQXL

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



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



DC	DC ≤ 1				
	0 - 0.010				
h5	DCON = 4				
	0 - 0.005				

- SMART MIRACLE coating enhances efficiency due to an improved chip disposal.
- Providing a high efficiency and a long tool life by increasing the number of flutes.

Order Number	DC	APMX	LU	DN	LF	DCON	* No. F	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 has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work. When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

* Number of Flutes

TORX Chart

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

● : Inventory maintained.

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

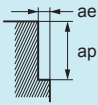
VQXL

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

Shoulder Milling

(mm)

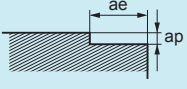
Work Material		Carbon Steel, Alloy Steel, Mild Steel, Alloy Tool Steel, Austenitic Stainless Steels, Titanium Alloys, Cobalt Chromium Alloy, Copper, Copper Alloy					Heat Resistant Alloys, Pre-hardened Steel, Hardened Steel				
DC	LU	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	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	1.2	50	40000	800	0.06	0.02	20	16000	320	0.06	0.02
0.4	2	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



Face Milling

(mm)

Work Material		Carbon Steel, Alloy Steel, Mild Steel, Alloy Tool Steel, Austenitic Stainless Steels, Titanium Alloys, Cobalt Chromium Alloy, Copper, Copper Alloy					Heat Resistant Alloys, Pre-hardened Steel, Hardened Steel				
DC	LU	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	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	1.2	50	40000	800	0.03	≤0.4	20	16000	320	0.03	≤0.2
0.4	2	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



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

Slot Milling

(mm)

Work Material		Carbon Steel, Alloy Steel, Mild Steel, Alloy Tool Steel, Austenitic Stainless Steels, Titanium Alloys, Cobalt Chromium Alloy, Copper, Copper Alloy				Heat Resistant Alloys, Pre-hardened Steel, Hardened Steel			
DC	LU	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	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	1.2	40	30000	600	0.06	15	12000	240	0.06
0.4	2	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 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.

When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

(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 feed rate can be increased.

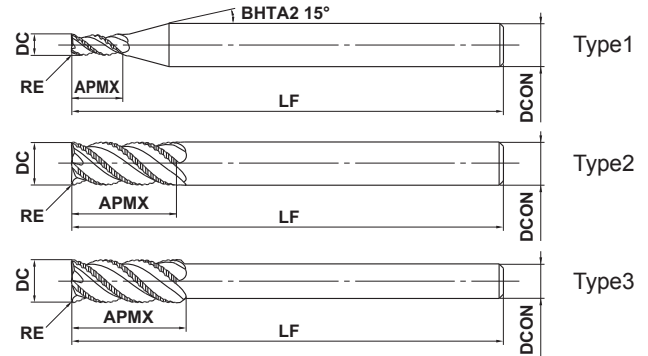
Vibration Control End Mills for Machining Difficult-to-cut Materials

VQSVR

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



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



h ₆	DCON=6	8 ≤ DCON ≤ 10	12 ≤ DCON ≤ 16	DCON=20
	$\begin{matrix} 0 \\ -0.008 \end{matrix}$	$\begin{matrix} 0 \\ -0.009 \end{matrix}$	$\begin{matrix} 0 \\ -0.011 \end{matrix}$	$\begin{matrix} 0 \\ -0.013 \end{matrix}$

- Featuring irregular helical geometry for reducing vibration.
- Offering greater fracture resistance than conventional roughing by adopting an asymmetrical nick.

Order Number	DC	RE	APMX	LF	DCON	* No. F	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
VQSVRD1000S08	10	0.5	22	90	8	4	●	3
VQSVRD1000	10	0.5	22	90	10	4	●	2
VQSVRD1200S10	12	0.5	27	100	10	4	●	3
VQSVRD1200	12	0.5	27	100	12	4	●	2
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 has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work. When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

* Number of Flutes

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

Shoulder Milling

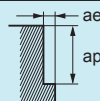
When machine rigidity, work material rigidity and chip discharge are enough, please select the high efficiency cutting conditions.

When either machine rigidity, work material rigidity or chip discharge are not enough, please select the general-purpose cutting conditions.

High Efficiency Cutting Conditions

(mm)

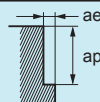
Work Material	Carbon Steel, Alloy Steel, Mild Steel					Pre-hardened Steel, Carbon Steel, Alloy Steel, Alloy Tool Steel					Austenitic, Ferritic and Martensitic Stainless Steels, Titanium Alloys					Precipitation Hardening Stainless Steels, Cobalt Chromium Alloy					Copper, Copper Alloy				
	DC	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap
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



General Purpose Cutting Conditions

(mm)

Work Material	Carbon Steel, Alloy Steel, Mild Steel					Pre-hardened Steel, Carbon Steel, Alloy Steel, Alloy Tool Steel					Austenitic, Ferritic and Martensitic Stainless Steels, Titanium Alloys					Precipitation Hardening Stainless Steels, Cobalt Chromium Alloy					Copper, Copper Alloy				
	DC	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap
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



(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.

When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

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

(Note 3) Chattering can still occur if the machine rigidity and clamping method are insufficient.

In these cases the feed and speed should be reduced proportionately.

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

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

VQSVR

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

Slot Milling

When machine rigidity, work material rigidity and chip discharge are enough, please select the high efficiency cutting conditions.

When either machine rigidity, work material rigidity or chip discharge are not enough, please select the general-purpose cutting conditions.

High Efficiency Cutting Conditions

(mm)

Work Material	Carbon Steel, Alloy Steel, Mild Steel				Pre-hardened Steel, Carbon Steel, Alloy Steel, Alloy Tool Steel				Austenitic, Ferritic and Martensitic Stainless Steels, Titanium Alloys				Precipitation Hardening Stainless Steels, Cobalt Chromium Alloy				Copper, Copper Alloy			
	DC	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)
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

DC : Dia.

General Purpose Cutting Conditions

(mm)

Work Material	Carbon Steel, Alloy Steel, Mild Steel				Pre-hardened Steel, Carbon Steel, Alloy Steel, Alloy Tool Steel				Austenitic, Ferritic and Martensitic Stainless Steels, Titanium Alloys				Precipitation Hardening Stainless Steels, Cobalt Chromium Alloy				Copper, Copper Alloy			
	DC	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)
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

DC : Dia.

(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.

When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

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

(Note 3) Chattering can still occur if the machine rigidity and clamping method are insufficient.

In these cases the feed and speed should be reduced proportionately.

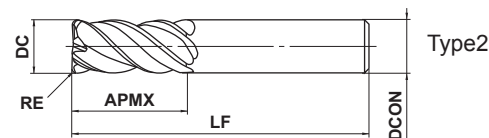
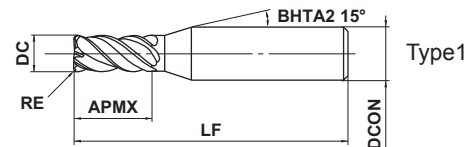
(Note 4) When the depth of cut is smaller than shown the feed rate can be increased.

VQMHVRB - Inch sizes

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



Carbon Steel, Alloy Steel (<30HRC)	Pre-hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Hardened Steel (>55HRC)	Austenitic Stainless Steel	Titanium Alloy Heat Resistant Alloy	Copper Alloy	Aluminum Alloy
⊙	○			⊙	⊙	○	



R	.008" ≤ RE ≤ .120"				
	±.0006"				
DC	DC < .5000"	DC = .5000"			
	0 - .0008"	0 - .0012"			
h6	.250" ≤ DCON ≤ .375"		DCON = .500"		
	0 - .00035"		0 - .00043"		

● SMART MIRACLE corner radius, irregular helix end mills for reducing vibration and for delivering stable performance on difficult-to-cut materials and long overhang applications.

Order Number	DC	RE	APMX	LF	DCON	No. F	Stock	Type
VQMHVRBD1/8R008	.1250	.0080	.3130	2.00	.2500	4	●	1
VQMHVRBD1/8R010	.1250	.0100	.3130	2.00	.2500	4	●	1
VQMHVRBD3/16R010	.1875	.0100	.4375	2.00	.2500	4	●	1
VQMHVRBD3/16R015	.1875	.0150	.4375	2.00	.2500	4	●	1
VQMHVRBD3/16R020	.1875	.0200	.4375	2.00	.2500	4	●	1
VQMHVRBD3/16R030	.1875	.0300	.4375	2.00	.2500	4	●	1
VQMHVRBD1/4R008	.2500	.0080	.6250	2.50	.2500	4	●	2
VQMHVRBD1/4R010	.2500	.0100	.6250	2.50	.2500	4	●	2
VQMHVRBD1/4R015	.2500	.0150	.6250	2.50	.2500	4	●	2
VQMHVRBD1/4R020	.2500	.0200	.6250	2.50	.2500	4	●	2
VQMHVRBD1/4R030	.2500	.0300	.6250	2.50	.2500	4	●	2
VQMHVRBD5/16R010	.3125	.0100	.7500	2.75	.3125	4	●	2
VQMHVRBD5/16R015	.3125	.0150	.7500	2.75	.3125	4	●	2
VQMHVRBD5/16R020	.3125	.0200	.7500	2.75	.3125	4	●	2
VQMHVRBD5/16R030	.3125	.0300	.7500	2.75	.3125	4	●	2
VQMHVRBD5/16R060	.3125	.0600	.7500	2.75	.3125	4	●	2
VQMHVRBD3/8R010	.3750	.0100	.8750	3.00	.3750	4	●	2
VQMHVRBD3/8R015	.3750	.0150	.8750	3.00	.3750	4	●	2
VQMHVRBD3/8R020	.3750	.0200	.8750	3.00	.3750	4	●	2
VQMHVRBD3/8R030	.3750	.0300	.8750	3.00	.3750	4	●	2
VQMHVRBD3/8R040	.3750	.0400	.8750	3.00	.3750	4	●	2
VQMHVRBD3/8R060	.3750	.0600	.8750	3.00	.3750	4	●	2
VQMHVRBD3/8R090	.3750	.0900	.8750	3.00	.3750	4	●	2
VQMHVRBD1/2R010	.5000	.0100	1.1250	3.50	.5000	4	●	2
VQMHVRBD1/2R015	.5000	.0150	1.1250	3.50	.5000	4	●	2
VQMHVRBD1/2R020	.5000	.0200	1.1250	3.50	.5000	4	●	2
VQMHVRBD1/2R030	.5000	.0300	1.1250	3.50	.5000	4	●	2
VQMHVRBD1/2R060	.5000	.0600	1.1250	3.50	.5000	4	●	2
VQMHVRBD1/2R090	.5000	.0900	1.1250	3.50	.5000	4	●	2
VQMHVRBD1/2R120	.5000	.1200	1.1250	3.50	.5000	4	●	2

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

* Number of Flutes

● : Inventory maintained.


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


VQMHVRB - Inch sizes

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

Shoulder Milling

(inch)

Work Material	Carbon Steel (–30HRC)						Alloy Steel, Pre-hardened Steel						Austenitic Stainless Steel, Titanium Alloy					
	High Speed Cutting		General Purpose Cutting		ap	ae	High Speed Cutting		General Purpose Cutting		ap	ae	High Speed Cutting		General Purpose Cutting		ap	ae
	n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)			n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)			n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)		
1/8	15000	102.0	12000	55.1	.19	.038	12000	49.1	10000	27.2	.19	.038	10000	34.6	8000	18.1	.19	.038
3/16	10000	99.2	8000	51.2	.28	.056	8000	50.4	6700	28.0	.28	.056	6700	35.3	5300	18.5	.28	.056
1/4	7500	99.2	6000	51.2	.38	.075	6000	52.0	5000	28.7	.38	.075	5000	47.2	4000	24.8	.38	.075
5/16	6000	99.2	4800	51.2	.47	.094	4800	52.9	4000	29.1	.47	.094	4000	47.2	3200	24.8	.47	.094
3/8	5000	90.6	4000	47.2	.56	.110	4000	49.1	3300	26.8	.56	.110	3300	49.4	2700	26.8	.56	.110
1/2	3800	74.8	3000	39.0	.75	.150	3000	43.5	2500	24.0	.75	.150	2500	43.3	2000	22.8	.75	.150
Depth of Cut																		

Work Material	Precipitation Hardening Stainless Steel, Cobalt Chromium Alloy						Copper, Copper Alloy						Heat Resistant Alloy					
	High Speed Cutting		General Purpose Cutting		ap	ae	High Speed Cutting		General Purpose Cutting		ap	ae	High Speed Cutting		General Purpose Cutting		ap	ae
	n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)			n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)			n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)		
1/8	7500	30.7	7000	18.9	.19	.025	18000	122.0	14000	63.0	.19	.038	4000	9.5	3000	4.7	.19	.013
3/16	5000	31.5	4700	19.7	.28	.038	12000	119.0	9400	63.0	.28	.056	2700	9.8	2000	4.7	.28	.019
1/4	3800	32.9	3500	20.1	.38	.050	9000	119.0	7000	63.0	.38	.075	2000	10.1	1500	5.1	.38	.025
5/16	3000	33.1	2800	20.5	.47	.063	7200	119.0	5600	63.0	.47	.094	1600	10.1	1200	5.1	.47	.031
3/8	2500	30.7	2300	18.5	.56	.075	6000	109.0	4700	55.1	.56	.110	1300	10.6	1000	5.5	.56	.038
1/2	1900	27.5	1800	17.3	.75	.100	4500	88.6	3500	47.2	.75	.150	1000	10.1	750	5.1	.75	.050
Depth of Cut																		

(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.

When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

(Note 2) Effective cutting of stainless steel, titanium alloy and heat-resistant alloy can be achieved with the use of water-soluble cutting fluid.

(Note 3) Higher feeds and speeds can be used for smaller depth of cut.

(Note 4) Vibration can still occur if the machine rigidity and clamping method are insufficient. In these cases the feed and speed should be reduced proportionately.

Slot Milling

(inch)

Work Material	Carbon Steel (–30HRC)					Alloy Steel, Pre-hardened Steel					Austenitic Stainless Steel, Titanium Alloy				
	High Speed Cutting		General Purpose Cutting		ap	High Speed Cutting		General Purpose Cutting		ap	High Speed Cutting		General Purpose Cutting		ap
	n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)		n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)		n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)	
1/8	15000	59.1	10000	26.0	.130	12000	30.2	8000	13.4	.130	10000	26.8	6000	10.6	.130
3/16	10000	75.6	6700	33.5	.190	8000	35.9	5300	15.7	.190	6700	28.5	4000	11.4	.190
1/4	7500	74.4	5000	32.7	.250	6000	39.7	4000	17.3	.250	5000	29.1	3000	11.4	.250
5/16	6000	66.1	4000	29.1	.310	4800	37.8	3200	16.5	.310	4000	31.5	2400	12.6	.310
3/8	5000	61.4	3300	26.8	.380	4000	34.0	2700	15.0	.380	3300	33.8	2000	13.4	.380
1/2	3800	47.9	2500	20.9	.500	3000	29.8	2000	13.0	.500	2500	31.5	1500	12.6	.500

DC : Dia.

Work Material	Precipitation Hardening Stainless Steel, Cobalt Chromium Alloy					Copper, Copper Alloy					Heat Resistant Alloy				
	High Speed Cutting		General Purpose Cutting		ap	High Speed Cutting		General Purpose Cutting		ap	High Speed Cutting		General Purpose Cutting		ap
	n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)		n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)		n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)	
1/8	6000	15.1	5000	8.3	.063	18000	70.9	12000	31.1	.130	3000	6.14	2500	3.4	.038
3/16	4000	18.3	3300	9.8	.094	12000	90.7	8000	39.4	.190	2000	6.80	1700	3.8	.056
1/4	3000	19.8	2500	11.0	.130	9000	89.3	6000	39.4	.250	1500	7.09	1300	3.9	.075
5/16	2400	18.9	2000	10.2	.160	7200	79.4	4800	35.0	.310	1200	7.56	1000	4.3	.094
3/8	2000	17.0	1700	9.4	.190	6000	73.7	4000	32.3	.380	1000	8.19	840	4.7	.110
1/2	1500	14.9	1300	8.7	.250	4500	56.7	3000	24.8	.500	750	7.56	630	4.3	.150

DC : Dia.

(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.

When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

(Note 2) Effective cutting of stainless steel, titanium alloy and heat-resistant alloy can be achieved with the use of water-soluble cutting fluid.

(Note 3) Higher feeds and speeds can be used for smaller depth of cut.

(Note 4) Vibration can still occur if the machine rigidity and clamping method are insufficient. In these cases the feed and speed should be reduced proportionately.

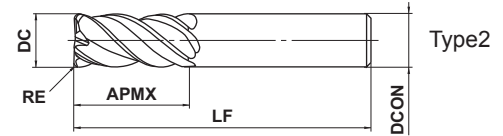
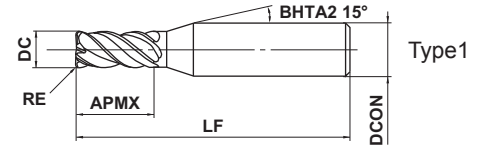
Vibration Control End Mills for Machining Difficult-to-cut Materials

VQMHV RB

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



Carbon Steel, Alloy Steel (<30HRC)	Pre-hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Hardened Steel (>55HRC)	Austenitic Stainless Steel	Titanium Alloy Heat Resistant Alloy	Copper Alloy	Aluminum Alloy
⊙	○			⊙	⊙	○	



R	0.2 ≤ RE ≤ 6.35				
	±0.015				
DC	DC ≤ 12	DC > 12			
	0 - 0.02	0 - 0.03			
h6	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 corner radius, irregular helix end mills for reducing vibration and for delivering stable performance on difficult-to-cut materials and long overhang applications.

Order Number	DC	RE	APMX	LF	DCON	No. F*	Stock	Type
VQMHV RBD0200R020	2	0.2	4	45	4	4	●	1
VQMHV RBD0200R030	2	0.3	4	45	4	4	●	1
VQMHV RBD0300R020	3	0.2	8	45	6	4	●	1
VQMHV RBD0300R030	3	0.3	8	45	6	4	●	1
VQMHV RBD0300R050	3	0.5	8	45	6	4	●	1
VQMHV RBD0400R020	4	0.2	11	45	6	4	●	1
VQMHV RBD0400R030	4	0.3	11	45	6	4	●	1
VQMHV RBD0400R050	4	0.5	11	45	6	4	●	1
VQMHV RBD0500R020	5	0.2	13	50	6	4	●	1
VQMHV RBD0500R030	5	0.3	13	50	6	4	●	1
VQMHV RBD0500R050	5	0.5	13	50	6	4	●	1
VQMHV RBD0500R100	5	1	13	50	6	4	●	1
VQMHV RBD0600R030	6	0.3	13	50	6	4	●	2
VQMHV RBD0600R050	6	0.5	13	50	6	4	●	2
VQMHV RBD0600R100	6	1	13	50	6	4	●	2
VQMHV RBD0800R030	8	0.3	19	60	8	4	●	2
VQMHV RBD0800R050	8	0.5	19	60	8	4	●	2
VQMHV RBD0800R100	8	1	19	60	8	4	●	2
VQMHV RBD0800R150	8	1.5	19	60	8	4	●	2
VQMHV RBD1000R030	10	0.3	22	70	10	4	●	2
VQMHV RBD1000R050	10	0.5	22	70	10	4	●	2
VQMHV RBD1000R100	10	1	22	70	10	4	●	2
VQMHV RBD1000R150	10	1.5	22	70	10	4	●	2
VQMHV RBD1000R200	10	2	22	70	10	4	●	2
VQMHV RBD1200R050	12	0.5	26	75	12	4	●	2
VQMHV RBD1200R100	12	1	26	75	12	4	●	2
VQMHV RBD1200R150	12	1.5	26	75	12	4	●	2
VQMHV RBD1200R200	12	2	26	75	12	4	●	2

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

* Number of Flutes

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

(mm)

Order Number	DC	RE	APMX	LF	DCON	* No. F	Stock	Type
VQMHRBD1200R250	12	2.5	26	75	12	4	●	2
VQMHRBD1200R300	12	3	26	75	12	4	●	2
VQMHRBD1600R100	16	1	35	90	16	4	★	2
VQMHRBD1600R150	16	1.5	35	90	16	4	★	2
VQMHRBD1600R200	16	2	35	90	16	4	★	2
VQMHRBD1600R250	16	2.5	35	90	16	4	★	2
VQMHRBD1600R300	16	3	35	90	16	4	★	2
VQMHRBD1600R400	16	4	35	90	16	4	★	2
VQMHRBD1600R500	16	5	35	90	16	4	★	2
VQMHRBD2000R100	20	1	45	110	20	4	★	2
VQMHRBD2000R150	20	1.5	45	110	20	4	★	2
VQMHRBD2000R200	20	2	45	110	20	4	★	2
VQMHRBD2000R250	20	2.5	45	110	20	4	★	2
VQMHRBD2000R300	20	3	45	110	20	4	★	2
VQMHRBD2000R400	20	4	45	110	20	4	★	2
VQMHRBD2000R500	20	5	45	110	20	4	★	2
VQMHRBD2000R635	20	6.35	45	110	20	4	★	2

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

★ Number of Flutes

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

VQMHVRB

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

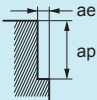
Shoulder Milling

When machine rigidity, work material rigidity and chip discharge are enough, please select the high efficiency cutting conditions.

When either machine rigidity, work material rigidity or chip discharge are not enough, please select the general-purpose cutting conditions.


High Efficiency Cutting Conditions

(mm)

Work Material	Carbon Steel, Alloy Steel, Mild Steel					Pre-hardened Steel, Carbon Steel, Alloy Steel, Alloy Tool Steel					Austenitic, Ferritic and Martensitic Stainless Steels, Titanium Alloys					Precipitation Hardening Stainless Steels, Cobalt Chromium Alloy					
	DC	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	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	
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 Cutting Conditions

(mm)

Work Material	Carbon Steel, Alloy Steel, Mild Steel					Pre-hardened Steel, Carbon Steel, Alloy Steel, Alloy Tool Steel					Austenitic, Ferritic and Martensitic Stainless Steels, Titanium Alloys					Precipitation Hardening Stainless Steels, Cobalt Chromium Alloy					
	DC	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	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	
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 has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.

When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

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

(Note 3) Chattering can still occur if the machine rigidity and clamping method are insufficient.

In these cases the feed and speed should be reduced proportionately.

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

Shoulder Milling

When machine rigidity, work material rigidity and chip discharge are enough, please select the high efficiency cutting conditions.
When either machine rigidity, work material rigidity or chip discharge are not enough, please select the general-purpose cutting conditions.

High Efficiency Cutting Conditions

(mm)

Work Material	Copper, Copper Alloy					Heat Resistant Alloys				
	DC	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap
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 Cutting Conditions

(mm)

Work Material	Copper, Copper Alloy					Heat Resistant Alloys				
	DC	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap
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 has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.

When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

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

(Note 3) Chattering can still occur if the machine rigidity and clamping method are insufficient.

In these cases the feed and speed should be reduced proportionately.

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

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

VQMHVRB

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

Slot Milling

When machine rigidity, work material rigidity and chip discharge are enough, please select the high efficiency cutting conditions.

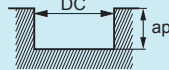
When either machine rigidity, work material rigidity or chip discharge are not enough, please select the general-purpose cutting conditions.

High Efficiency Cutting Conditions

(mm)

Work Material	Carbon Steel, Alloy Steel, Mild Steel				Pre-hardened Steel, Carbon Steel, Alloy Steel, Alloy Tool Steel				Austenitic, Ferritic and Martensitic Stainless Steels, Titanium Alloys				Precipitation Hardening Stainless Steels, Cobalt Chromium Alloy				Copper, Copper Alloy				Heat Resistant Alloys			
	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	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



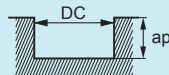
DC: Dia

General Purpose Cutting Conditions

(mm)

Work Material	Carbon Steel, Alloy Steel, Mild Steel				Pre-hardened Steel, Carbon Steel, Alloy Steel, Alloy Tool Steel				Austenitic, Ferritic and Martensitic Stainless Steels, Titanium Alloys				Precipitation Hardening Stainless Steels, Cobalt Chromium Alloy				Copper, Copper Alloy				Heat Resistant Alloys			
	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	vc (m/min)	n (min ⁻¹)	vf (mm/min)	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
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 has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.

When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

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

(Note 3) Chattering can still occur if the machine rigidity and clamping method are insufficient.

In these cases the feed and speed should be reduced proportionately.

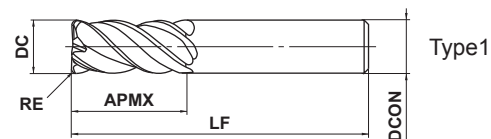
(Note 4) When the depth of cut is smaller than shown the feed rate can be increased.

VQMHVRBF - Inch sizes

Corner radius, Medium cut length, 4 flute, Irregular helix flutes (For finish cutting)



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



R	.015" ≤ RE ≤ .120"				
	±.0006"				
DC	DC < .5000"	DC = .5000"			
	$\begin{matrix} 0 \\ - .0008" \end{matrix}$	$\begin{matrix} 0 \\ - .0012" \end{matrix}$			
h6	.250" ≤ DCON ≤ .375"	DCON = .500"			
	$\begin{matrix} 0 \\ - .00035" \end{matrix}$	$\begin{matrix} 0 \\ - .00043" \end{matrix}$			

● SMART MIRACLE corner radius, irregular helix end mills for reducing vibration and delivering stable performance on finish cutting for difficult-to-cut materials such as inconel.

Order Number	DC	RE	APMX	LF	DCON	* No. F	Stock	Type
VQMHVRBFD1/4R015	.2500	.0150	.6250	2.50	.2500	4	●	1
VQMHVRBFD1/4R030	.2500	.0300	.6250	2.50	.2500	4	●	1
VQMHVRBFD5/16R015	.3125	.0150	.7500	2.75	.3125	4	●	1
VQMHVRBFD5/16R030	.3125	.0300	.7500	2.75	.3125	4	●	1
VQMHVRBFD5/16R060	.3125	.0600	.7500	2.75	.3125	4	●	1
VQMHVRBFD3/8R015	.3750	.0150	.8750	3.00	.3750	4	●	1
VQMHVRBFD3/8R030	.3750	.0300	.8750	3.00	.3750	4	●	1
VQMHVRBFD3/8R060	.3750	.0600	.8750	3.00	.3750	4	●	1
VQMHVRBFD3/8R090	.3750	.0900	.8750	3.00	.3750	4	●	1
VQMHVRBFD1/2R030	.5000	.0300	1.1250	3.50	.5000	4	●	1
VQMHVRBFD1/2R060	.5000	.0600	1.1250	3.50	.5000	4	●	1
VQMHVRBFD1/2R090	.5000	.0900	1.1250	3.50	.5000	4	●	1
VQMHVRBFD1/2R120	.5000	.1200	1.1250	3.50	.5000	4	●	1

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

* Number of Flutes

● : Inventory maintained.

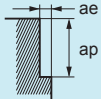
Vibration Control End Mills for Machining Difficult-to-cut Materials

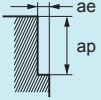
VQMHVRBF - Inch sizes

Corner radius, Medium cut length, 4 flute, Irregular helix flutes (For finish cutting)

Shoulder Milling

(inch)

Work Material	Carbon Steel (-30Hrc)				Alloy Steel, Pre-hardened Steel				Precipitation Hardening Stainless Steel, Cobalt Chromium Alloy				
	DC	n (min ⁻¹)	vf (IPM)	ap	ae	n (min ⁻¹)	vf (IPM)	ap	ae	n (min ⁻¹)	vf (IPM)	ap	ae
1/4		7500	94.5	.38	.013	6000	47.2	.38	.013	3800	29.9	.38	.013
5/16		6000	99.2	.47	.016	4800	52.9	.47	.016	3000	33.1	.47	.016
3/8		5000	94.5	.56	.019	4000	50.4	.56	.019	2500	31.5	.56	.019
1/2		3800	71.8	.75	.025	3000	42.5	.75	.025	1900	26.9	.75	.025
Depth of Cut													

Work Material	Copper, Copper Alloy				Heat Resistant Alloy				
	DC	n (min ⁻¹)	vf (IPM)	ap	ae	n (min ⁻¹)	vf (IPM)	ap	ae
1/4		9000	113	.38	.013	2000	9.5	.38	.008
5/16		7200	119	.47	.016	1600	10.1	.47	.009
3/8		6000	113	.56	.019	1300	11.5	.56	.011
1/2		4500	85.0	.75	.025	1000	10.1	.75	.015
Depth of Cut									

(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.

When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

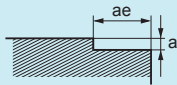
(Note 2) Effective cutting of stainless steel, titanium alloy, and heat-resistant alloy can be achieved with the use of water-soluble cutting fluid.

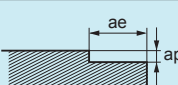
(Note 3) If the depth of cut is smaller than this table, feed rate can be increased.

(Note 4) The irregular helix 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 work material installation is very low, then vibration can occur. In this case, please reduce the revolution and feed rate proportionately, or set a lower depth of cut.

Face Milling

(inch)

Work Material	Carbon Steel (–30Hrc)				Alloy Steel, Pre-hardened Steel				Precipitation Hardening Stainless Steel, Cobalt Chromium Alloy				
	DC	n (min ⁻¹)	vf (IPM)	ap	ae	n (min ⁻¹)	vf (IPM)	ap	ae	n (min ⁻¹)	vf (IPM)	ap	ae
1/4		5500	52.0	.013	.20	4500	28.3	.013	.20	2800	17.6	.013	.20
5/16		4400	48.5	.016	.25	3600	28.3	.016	.25	2200	17.3	.016	.25
3/8		3700	46.6	.019	.30	3000	26.0	.019	.30	1800	15.6	.019	.30
1/2		2800	35.3	.025	.40	2300	21.7	.025	.40	1400	13.2	.025	.40
Depth of Cut													

Work Material	Copper, Copper Alloy				Heat Resistant Alloy				
	DC	n (min ⁻¹)	vf (IPM)	ap	ae	n (min ⁻¹)	vf (IPM)	ap	ae
1/4		6500	61.4	.013	.20	1500	6.6	.008	.20
5/16		5200	57.3	.016	.25	1200	7.6	.009	.25
3/8		4300	54.2	.019	.30	1000	8.8	.011	.30
1/2		3300	41.6	.025	.40	750	7.6	.015	.40
Depth of Cut									

- (Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work. When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.
- (Note 2) Effective cutting of stainless steel, titanium alloy, and heat-resistant alloy can be achieved with the use of water-soluble cutting fluid.
- (Note 3) Higher feeds and speeds can be used for smaller depth of cut.
- (Note 4) The irregular helix 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 work material installation is very low, then vibration can occur. In this case, please reduce the revolution and feed rate proportionately, or set a lower depth of cut.

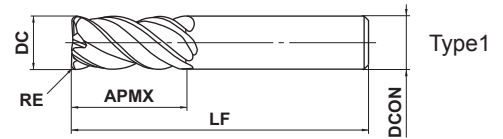
Vibration Control End Mills for Machining Difficult-to-cut Materials

VQMHRBF

Corner radius, Medium cut length, 4 flute, Irregular helix flutes (For finish cutting)



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



R	0.3 ≤ RE ≤ 2				
	±0.015				
DC	DC ≤ 12	DC > 12			
	$\begin{matrix} 0 \\ -0.02 \end{matrix}$	$\begin{matrix} 0 \\ -0.03 \end{matrix}$			
h6	DCON = 6	8 ≤ DCON ≤ 10	12 ≤ DCON ≤ 16		
	$\begin{matrix} 0 \\ -0.008 \end{matrix}$	$\begin{matrix} 0 \\ -0.009 \end{matrix}$	$\begin{matrix} 0 \\ -0.011 \end{matrix}$		

● SMART MIRACLE corner radius, irregular helix end mills for reducing vibration and delivering stable performance on finish cutting for difficult-to-cut materials such as inconel.

(mm)

Order Number	DC	RE	APMX	LF	DCON	* No. F	Stock	Type
VQMHRBFD0600R030	6	0.3	13	50	6	4	●	1
VQMHRBFD0600R050	6	0.5	13	50	6	4	●	1
VQMHRBFD0600R100	6	1	13	50	6	4	●	1
VQMHRBFD0800R050	8	0.5	19	60	8	4	●	1
VQMHRBFD0800R100	8	1	19	60	8	4	●	1
VQMHRBFD1000R030	10	0.3	22	70	10	4	●	1
VQMHRBFD1000R050	10	0.5	22	70	10	4	●	1
VQMHRBFD1000R100	10	1	22	70	10	4	●	1
VQMHRBFD1000R200	10	2	22	70	10	4	●	1
VQMHRBFD1200R100	12	1	26	75	12	4	●	1
VQMHRBFD1200R200	12	2	26	75	12	4	●	1
VQMHRBFD1200R300	12	3	26	75	12	4	●	1
VQMHRBFD1600R100	16	1	35	90	16	4	★	1
VQMHRBFD1600R200	16	2	35	90	16	4	★	1

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

* Number of Flutes

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

Shoulder Milling

(mm)

Work Material	Carbon Steel, Alloy Steel, Mild Steel					Pre-hardened Steel, Carbon Steel, Alloy Steel, Alloy Tool Steel					Precipitation Hardening Stainless Steels, Cobalt Chromium Alloy					Copper, Copper Alloy					Heat Resistant Alloys						
	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	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																											

Face Milling

(mm)

Work Material	Carbon Steel, Alloy Steel, Mild Steel					Pre-hardened Steel, Carbon Steel, Alloy Steel, Alloy Tool Steel					Precipitation Hardening Stainless Steels, Cobalt Chromium Alloy					Copper, Copper Alloy					Heat Resistant Alloys						
	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	ae	vc (m/min)	n (min ⁻¹)	vf (mm/min)	ap	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 has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.

When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

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

(Note 3) Chattering can still occur if the machine rigidity and clamping method are insufficient.

In these cases the feed and speed should be reduced proportionately.

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

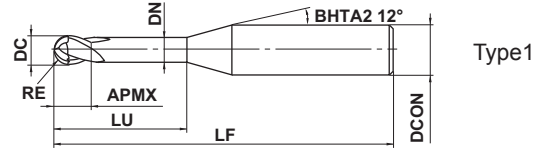
Vibration Control End Mills for Machining Difficult-to-cut Materials

VQ45VB - Inch sizes

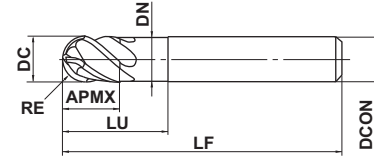
Ball nose, Short cut length, 4 flute, Irregular curve



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



Type1



Type2

R	.0625" ≤ RE ≤ .2500"						
	±.0004"						
N	DC < .5000"		DC = .5000"				
	0 - .0008"		0 - .0012"				
h6	.250" ≤ DCON ≤ .375"		DCON = .500"				
	0 - .00035"		0 - .00043"				

● SMART MIRACLE irregular helix ball nose end mills for reducing vibration and for delivering stable performance on difficult-to-cut materials such as Inconel.

(inch)

Order Number	RE	DC	APMX	LU	DN	LF	DCON	No. F*	Stock	Type
VQ4SVBD1/8	.0625	.1250	.188	.3126	.1213	2.00	.2500	4	●	1
VQ4SVBD3/16	.0938	.1875	.281	.4689	.1835	2.00	.2500	4	●	1
VQ4SVBD1/4	.1250	.2500	.375	.6252	.2441	2.00	.2500	4	●	2
VQ4SVBD5/16	.1562	.3125	.469	.7811	.3067	2.50	.3125	4	●	2
VQ4SVBD3/8	.1875	.3750	.563	.9374	.3693	2.75	.3750	4	●	2
VQ4SVBD1/2	.2500	.5000	.750	1.2500	.4882	3.00	.5000	4	●	2

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

* Number of Flutes

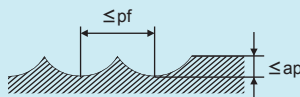
● : Inventory maintained.

Shoulder Milling (Slot Milling)

(inch)

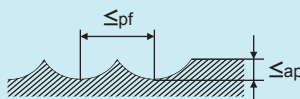
Work Material	Carbon Steel, Alloy Steel, Mild Steel, Pre-hardened Steel						Austenitic Stainless Steel, Titanium Alloy, Precipitation Hardening Stainless Steels, Cobalt Chromium Alloy, Ferritic And Martensitic Stainless Steels					
	$\alpha \leq 15^\circ$		$\alpha > 15^\circ$		ap	pf	$\alpha \leq 15^\circ$		$\alpha > 15^\circ$		ap	pf
	n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)			n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)		
.063	30000	283.5	20000	118.1	.0098	.0313	22500	189.0	15000	74.8	.0098	.0313
.094	20000	220.5	13400	102.4	.0165	.0469	15000	137.8	10000	59.1	.0165	.0469
.125	15000	177.2	10000	82.7	.0197	.0626	11200	126.0	7500	55.1	.0197	.0626
.156	12000	169.3	8000	74.8	.0315	.0781	9000	126.0	6000	55.1	.0315	.0781
.187	10000	161.4	6700	70.9	.0394	.0937	7500	118.1	5000	51.2	.0394	.0937
.250	7600	149.6	5000	70.9	.0472	.125	5600	118.1	3800	51.2	.0472	.125

Depth of Cut



Work Material	Copper, Copper Alloys						Heat Resistant Alloy					
	$\alpha \leq 15^\circ$		$\alpha > 15^\circ$		ap	pf	$\alpha \leq 15^\circ$		$\alpha > 15^\circ$		ap	pf
	n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)			n (min ⁻¹)	vf (IPM)	n (min ⁻¹)	vf (IPM)		
.063	36000	338.6	24000	141.7	.0098	.0313	6000	25.2	4000	13.4	.0051	.0313
.094	24000	263.8	16000	122.0	.0165	.0469	4000	20.9	2700	9.8	.0083	.0469
.125	18000	212.6	12000	98.4	.0197	.0626	3000	19.7	2000	8.3	.0098	.0626
.156	14000	196.9	9600	90.6	.0315	.0781	2400	16.9	1600	7.5	.0157	.0781
.187	12000	192.9	8000	82.7	.0394	.0937	2000	16.5	1300	7.1	.0197	.0937
.250	9100	181.1	6000	86.6	.0472	.125	1500	13.8	1000	5.9	.0236	.0125

Depth of Cut



(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.

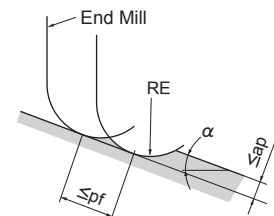
When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

(Note 2) When cutting austenitic stainless steels, the use of water-soluble cutting fluid is especially effective.

(Note 3) If the depth of cut is smaller than this table, feed rate can be increased.

(Note 4) The irregular helix 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 work material installation is very low, then vibration can occur. In this case, please reduce the revolution and feed rate proportionately, or set a lower depth of cut.

(Note 5) α is the inclination of the machined surface.



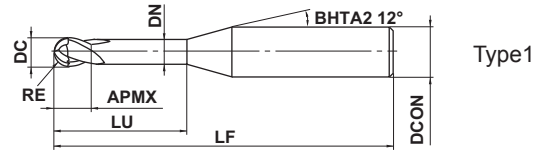
Vibration Control End Mills for Machining Difficult-to-cut Materials

VQ4SVB

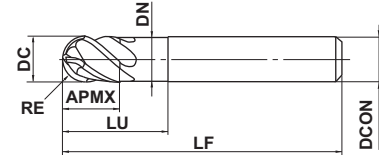
Ball nose, Short cut length, 4 flute, Irregular curve



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



Type1



Type2

R	1 ≤ RE ≤ 6				
	±0.01				
DC	DC ≤ 12				
	$\begin{matrix} 0 \\ -0.02 \end{matrix}$				
h6	DCON=6	8 ≤ DCON ≤ 10	DCON=12		
	$\begin{matrix} 0 \\ -0.008 \end{matrix}$	$\begin{matrix} 0 \\ -0.009 \end{matrix}$	$\begin{matrix} 0 \\ -0.011 \end{matrix}$		

● SMART MIRACLE irregular helix ball nose end mills for reducing vibration and for delivering stable performance on difficult-to-cut materials such as inconel.

(mm)

Order Number	RE	DC	APMX	LU	DN	LF	DCON	No. F*	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 has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work. When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

* Number of Flutes

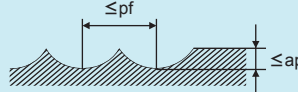
● : Inventory maintained. ★ : Inventory maintained in Japan.

Shoulder Milling (Slot Milling)

(mm)

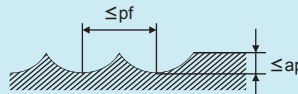
RE	Carbon Steel, Alloy Steel, Mild Steel, Pre-hardened Steel						Austenitic Stainless Steel, Titanium Alloy, Precipitation Hardening Stainless Steels, Cobalt Chromium Alloy, Ferritic And Martensitic Stainless Steels									
	$\alpha \leq 15^\circ$			$\alpha > 15^\circ$			ap	pf	$\alpha \leq 15^\circ$			$\alpha > 15^\circ$			ap	pf
	vc (m/min)	n (min ⁻¹)	vf (mm/min)	vc (m/min)	n (min ⁻¹)	vf (mm/min)			vc (m/min)	n (min ⁻¹)	vf (mm/min)	vc (m/min)	n (min ⁻¹)	vf (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



RE	Copper, Copper Alloy						Heat Resistant Alloys									
	$\alpha \leq 15^\circ$			$\alpha > 15^\circ$			ap	pf	$\alpha \leq 15^\circ$			$\alpha > 15^\circ$			ap	pf
	vc (m/min)	n (min ⁻¹)	vf (mm/min)	vc (m/min)	n (min ⁻¹)	vf (mm/min)			vc (m/min)	n (min ⁻¹)	vf (mm/min)	vc (m/min)	n (min ⁻¹)	vf (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 has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.

When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

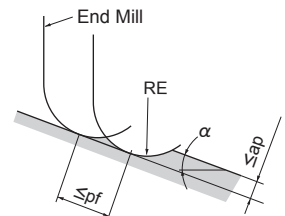
(Note 2) Effective cutting of stainless steel, titanium alloys and heat-resistant alloys etc. can be achieved with the use of emulsion.

(Note 3) Chattering can still occur if the machine rigidity and clamping method are insufficient.

In these cases the feed and speed should be reduced proportionately.

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

(Note 5) α is the inclination angle of the machined surface.



Technical Data

Benefits of the ZERO- μ Surface

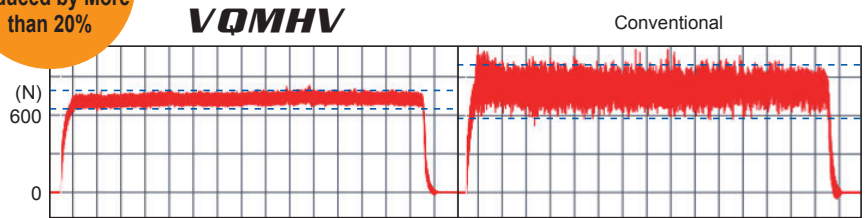
In addition to its low resistance, the stable cutting performance produces highly efficient machining.

<Cutting Conditions>

Work Material : AISI 304
 End Mill : VQMHVD0600 (DC=6 mm)
 Revolution : 2650 min⁻¹
 Cutting Speed : 165 SFM
 Table Feed : 12.6 IPM(.001 IPT)
 Depth of Cut : ap .236 inch (Slot Milling)
 Overhang Length : .787 inch
 Cutting Mode : Down(Climb) Cut
 External Coolant (Emulsion)
 Machine : Vertical M/C (BT50)

Cutting Resistance Reduced by More than 20%

Comparison of Cutting Resistance



VQSVR

Feature of Asymmetrical Nick

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

Nick Geometry of VQSVR

Achieve a long tool life without fracture

Large R

(The part putting a load on an edge)



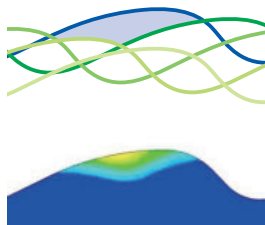
Small R

(The part not putting a load on an edge)

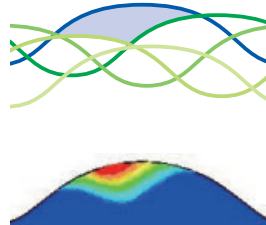
Asymmetry

Cutting Amount of Each Nick

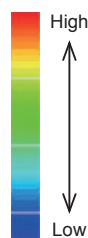
Asymmetrical Nick



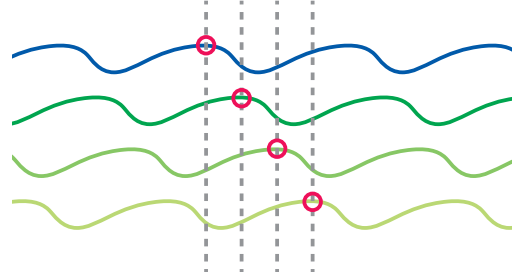
Symmetrical Nick



Stress



Deviation of Nick at a Machining



The Advantage of Roughing End Mill

Roughing end mill achieves excellent performance under 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 Low	Machining with Long Overhang Long	BT20 Small Spindle Rigidity Old Machine Low
Square	 High	 Short	 High

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.

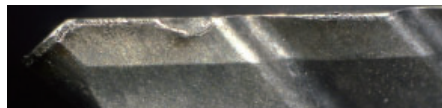
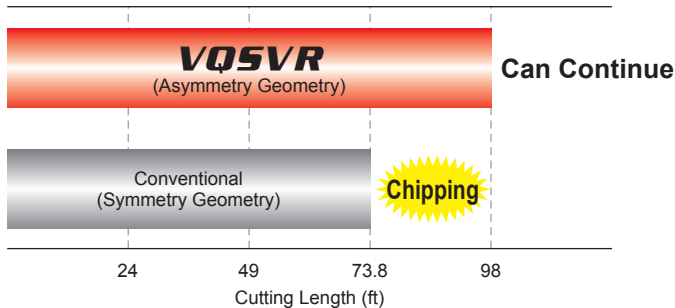
Roughing End Mill, 4 Flute, Irregular Helix Flutes

VQSVR



Cutting Performance

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



VQSVR



Conventional

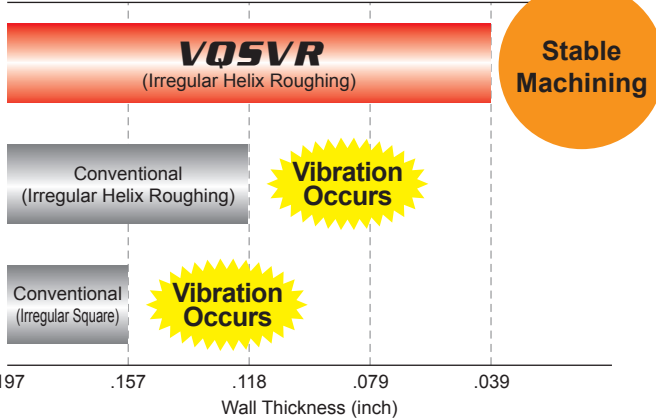
Cutting Length 73.8 feet

<Cutting Conditions>

Work Material : AISI 304
 Tool Size : DC=10mm
 Revolution : 2500min⁻¹ (260 SFM)
 Table Feed : 24.0 IPM (.0024 IPT)
 Depth of Cut : ap .118 inch, ae .197 inch
 Cutting Mode : Shoulder Milling
 External Coolant (Emulsion)
 Machine : Vertical M/C (BT50)

VQSVR is machinable without vibration even with a thin wall.

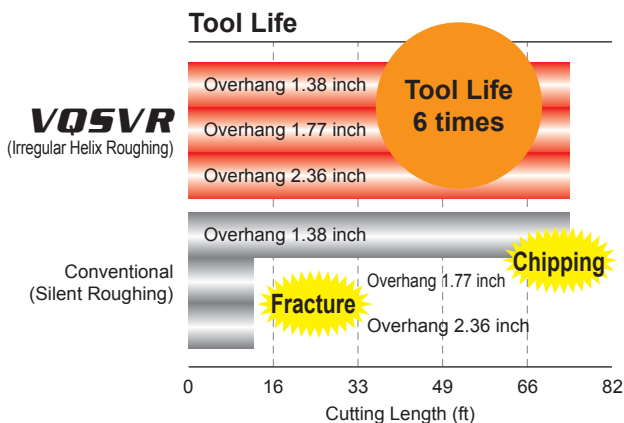
Machined Surface of Wall Thickness 1mm



<Cutting Conditions>

Work material : AISI 304
 Tool Size : DC=10mm
 Revolution : 3200min⁻¹ (330 SFM)
 Table Feed : 22.4 IPM (.0018 IPT)
 Depth of Cut : ap .787 inch, ae .039 inch
 Overhang Length : 1.38 inch
 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 DCx4 or more)



	Overhang 1.38 inch	Overhang 1.77 inch	Overhang 2.36 inch
VQSVR	○	○	○
Conventional	△	×	×

<Cutting Conditions>

Work Material : AISI 304
 Tool Size : DC=10mm
 Revolution : 2550min⁻¹ (260 SFM)
 Table Feed : 16.1 IPM (.0016 IPT)
 Depth of Cut : ap .394 inch, ae .197 inch
 Overhang Length : 1.38 inch
 Cutting Mode : Shoulder Milling
 External Coolant (Emulsion)
 Machine : Vertical M/C (BT50)

End Mill, 3 Flute for Drilling and Slot Milling

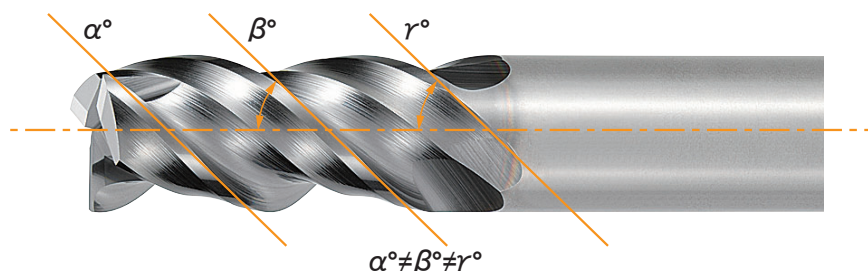
VQMHZV

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



VQMHZVOH

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

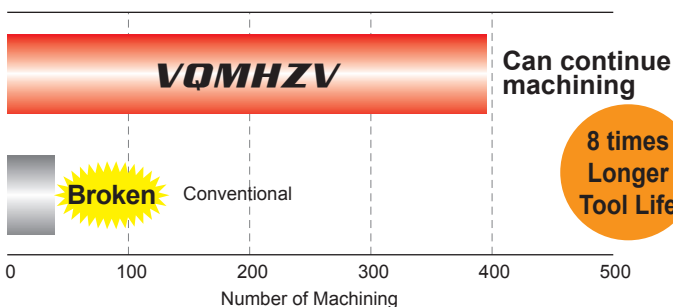


Unique geometry - 3 flute end mill with irregular helix flutes suppresses chatter for increased machining stability. Optimized tool geometry and SMART MIRACLE coating give excellent chip evacuation for higher efficiency. The performance of VQMHZVOH when drilling is significantly improved on difficult-to-cut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

Cutting Performance

AISI 304 Keyway Machining

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

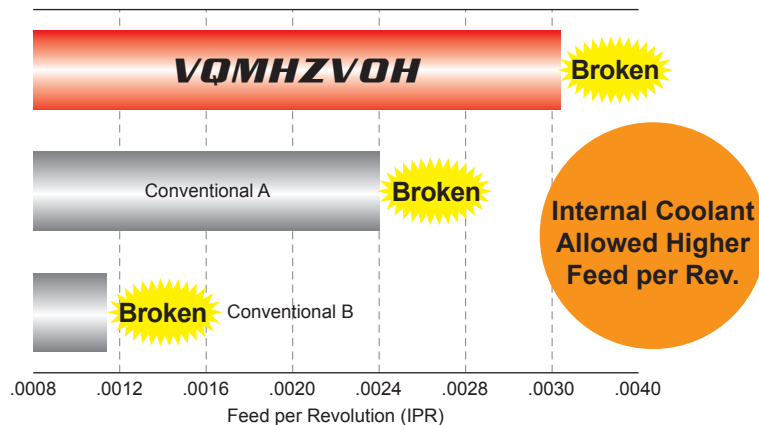


<Cutting Conditions>

Work Material : AISI 304
End Mill : VQMHZVD0800 (DC=8mm)
Revolution : 2400 min⁻¹
Cutting Speed : 195 SFM
Table Feed : Drilling 2.756, Slot Milling 14.173 IPM
(Drilling .001 IPR, Slot Milling .002 IPT)
Depth of Cut : ap .118 inch
Flute Length : .630 inch
Overhang Length : 1.181 inch
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 : 3200 min⁻¹
Cutting Speed : 195 SFM
Table Feed : 3.780~10.079 IPM(.001~.003 IPR)
Depth of Cut : .118 inch
Overhang Length : .787 inch
Cutting Mode : Internal Coolant (Emulsion)
Machine : Vertical M/C (BT50)

End Mill, 4 Flute, Irregular Helix Flutes

VQMHV

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



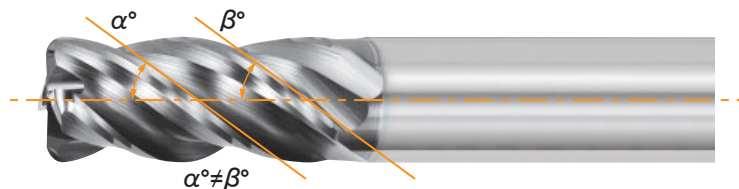
VQMHV RB

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



VQMHV RBF

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

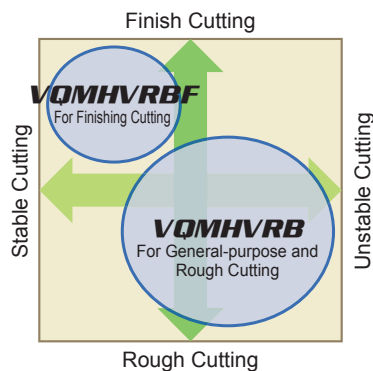


Optimized irregular helix angle improves cutting performance.

The combination of an excellent carbide substrate and SMART MIRACLE coating allows a wide range of machining applications.

How to Select VQMHV RB and VQMHV RBF

Comparing Different Forms of Machining



Comparing Different Work Material

<Finish Cutting>

◎=1st Recommendation
○=2nd Recommendation

	Inconel	AISI S17400	Titanium Alloy	AISI 304
VQMHV RB	○	○	◎	◎
VQMHV RBF	◎	◎	○	○

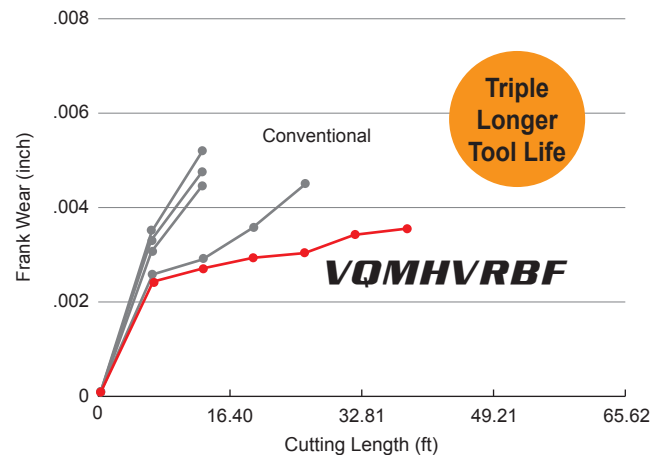
Cutting Performance

Wear Resistance against Super Alloys

VQMHV RBF achieves triple longer tool life than conventionals when finish machining Inconel 718.

<Cutting Conditions>

- Work Material : Inconel718
- End Mill : VQMHV RBF D1000R050 (DC=10mm / RE=0.5mm)
- Revolution : 950 min⁻¹
- Cutting Speed : 100 SFM
- Table Feed : 4.331 IPM (.001 IPT)
- Depth of Cut : ap .197 inch, ae .012 inch
- Overhang Length : 1.378 inch
- Cutting Mode : Down(Climb) Cut
- External Coolant (Emulsion)
- Machine : Vertical M/C (BT50)

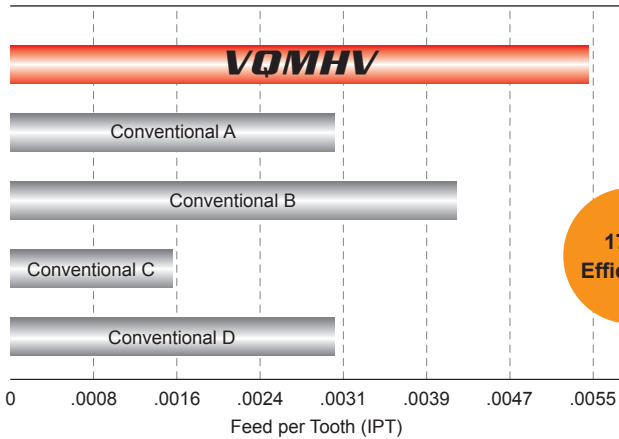


Cutting Performance

Efficiency Comparison in AISI 304

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

Maximum of Slot Milling Feed Rate



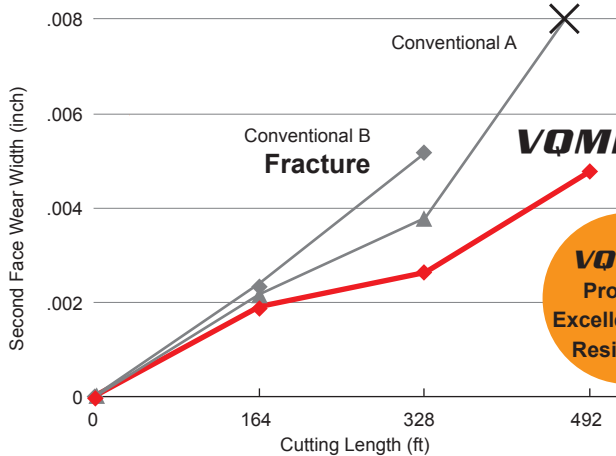
170% Efficiency

<Cutting Conditions>

Work Material : AISI 304
 End Mill : VQMHVD1000 (DC=10mm)
 Revolution : 4800 min⁻¹
 Cutting Speed : 490 SFM
 Table Feed : 15.12-105.83 IPM
 Feed per Tooth : .001-.006 IPT
 Depth of Cut : .394 inch
 Overhang Length : 1.299 inch
 Cutting Length : 9.843 inch/pass
 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.



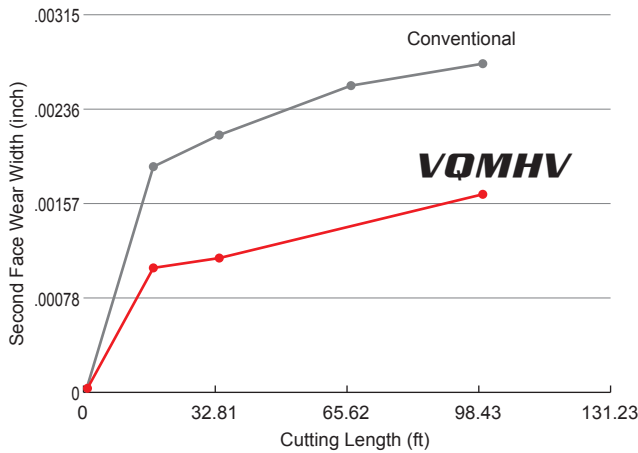
VQMHV Provides Excellent Wear Resistance

<Cutting Conditions>

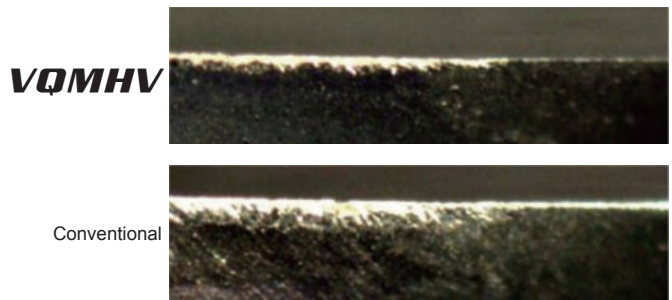
Work Material : Ti-6Al-4V
 End Mill : VQMHVD0600 (DC=6mm)
 Revolution : 8000 min⁻¹
 Cutting Speed : 490 SFM
 Table Feed : 63 IPM(.002 IPT)
 Depth of Cut : ap .236 inch, ae .012 inch
 Overhang Length : .787 inch
 Cutting Mode : Down(Climb) Cut
 External Coolant (Emulsion)
 Machine : Vertical M/C (BT40)

Comparison of Wear in Cobalt Chromium Alloy

Long tool life even when machining cobalt chromium alloy used in the medical industry.

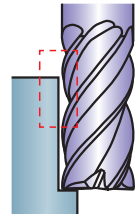


Wear at the depth of cut point after 98.43 feet machining



<Cutting Conditions>

Work Material : Cobalt Chromium Alloy
 End Mill : VQMHVD0600 (DC=6mm)
 Revolution : 3700 min⁻¹
 Cutting Speed : 227 SFM
 Table Feed : 29 IPM(.002 IPT)
 Depth of Cut : ap .079 inch, ae .012 inch
 Overhang Length : .787 inch
 Cutting Mode : Down(Climb) Cut
 External Coolant (Emulsion)
 Machine : Vertical M/C (BT40)



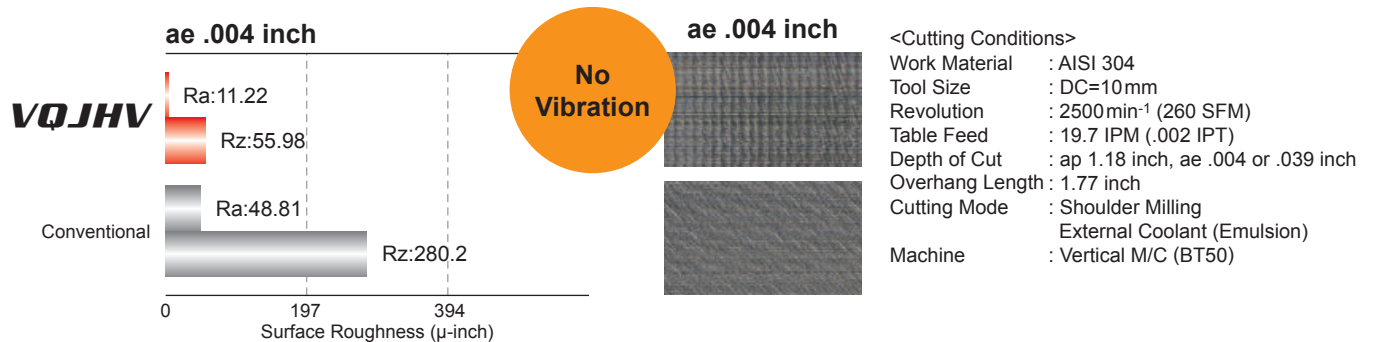
End Mill, 4 Flute, Irregular Helix Flutes

VQJHV

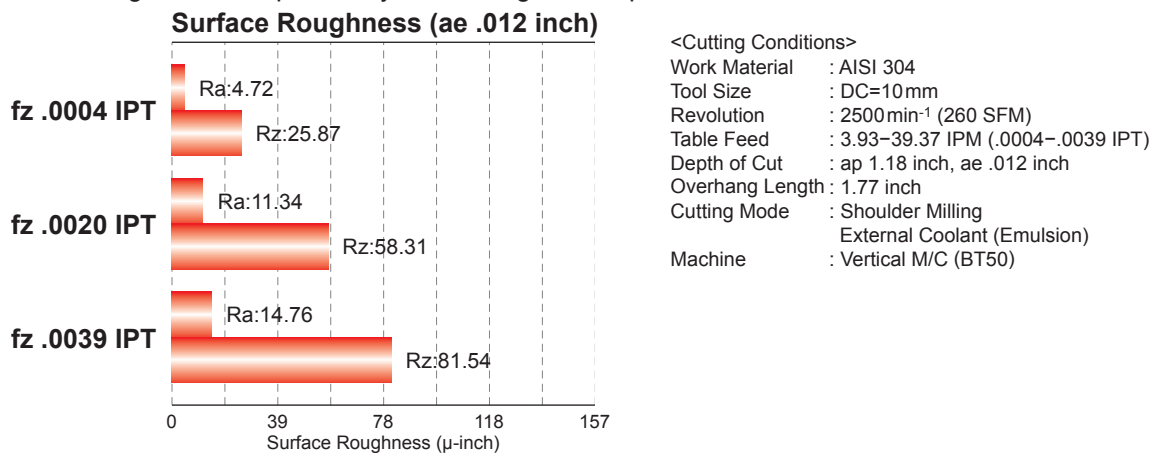


Cutting Performance

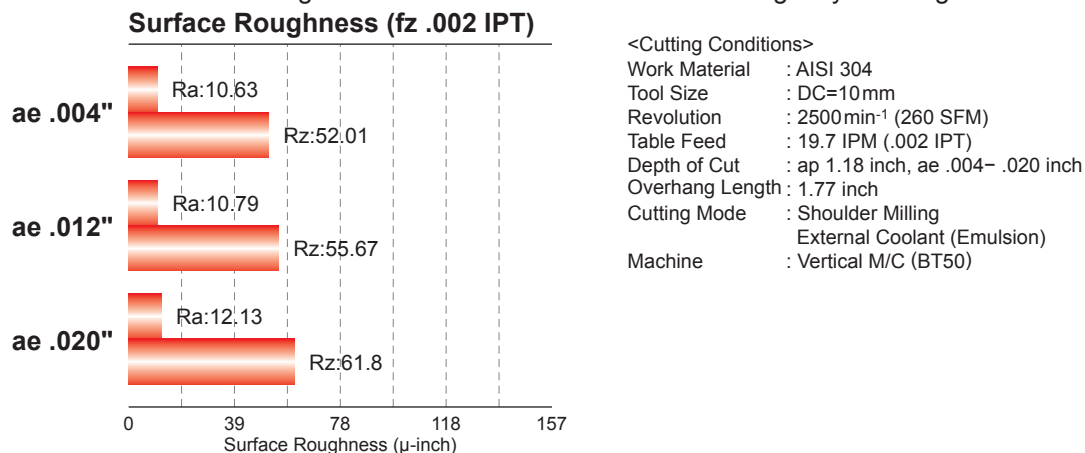
Irregular helix provides an excellent finishing performance without vibration.



Surface roughness is improved by decreasing a Feed per Tooth.

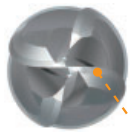


Available condition for finishing is ae .020 inch or less when considering only the roughness of machining surface.

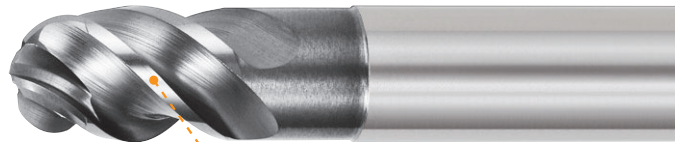


Ball Nose, 4 Flute, Irregular Curve

VQ45VB



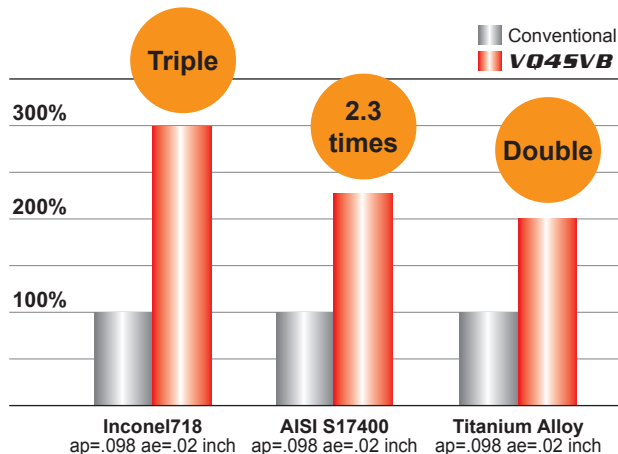
Irregular curve and irregular pitch.



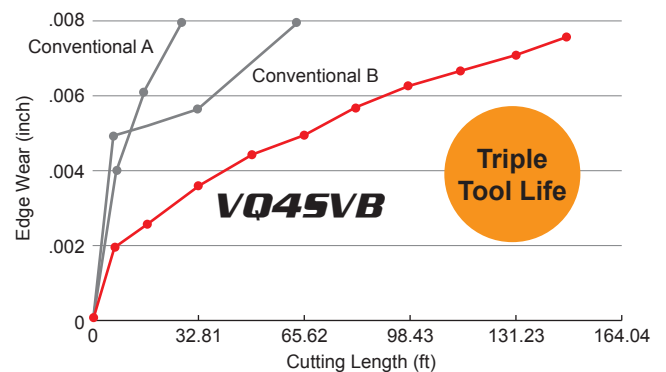
4 flutes, Helix angle 45°
Dedicated carbide substrate gives excellent wear resistance.

Cutting Performance

VQ45VB achieves double tool life when machining difficult-to-cut materials.



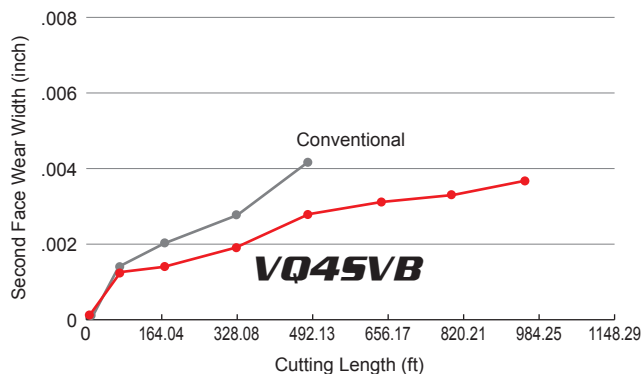
Comparison of Edge Wear when Shoulder Milling Inconel 718



<Cutting Conditions>

Work Material : Inconel718
End Mill : VQ4SVBR0500 (RE=5mm)
Revolution : 1100min⁻¹
Cutting Speed : 100 SFM
Table Feed : 8.66 IPM (.002 IPT)
Depth of Cut : ap .098 inch, ae .020 inch
Overhang Length : .984 inch
Cutting Mode : Down(Climb) Cut
External Coolant (Emulsion)
Machine : Vertical M/C (BT40)

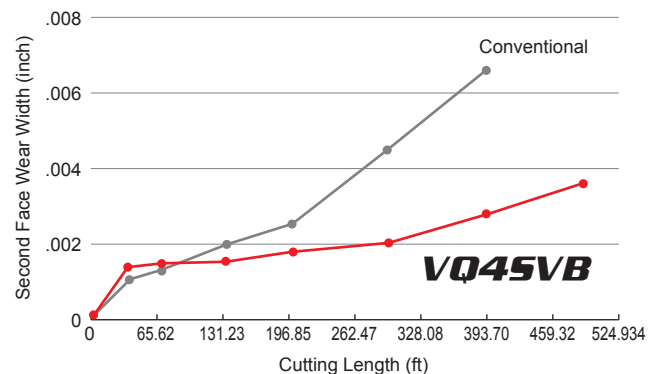
Comparison of Edge Wear when Shoulder Milling AISI S17400



<Cutting Conditions>

Work Material : AISI S17400
End Mill : VQ4SVBR0500 (RE=5mm)
Revolution : 2600min⁻¹
Cutting Speed : 230 SFM
Table Feed : 20.47 IPM (.002 IPT)
Depth of Cut : ap .098 inch, ae .020 inch
Overhang Length : .787 inch
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 : 490 SFM
Table Feed : 37.8 IPM (.002 IPT)
Depth of Cut : ap .098 inch, ae .020 inch
Overhang Length : .984 inch
Cutting Mode : Down(Climb) Cut
External Coolant (Emulsion)
Machine : Vertical M/C (BT40)

Memo

A series of horizontal dotted lines for writing, spanning the width of the page.



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

SMART MIRACLE

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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