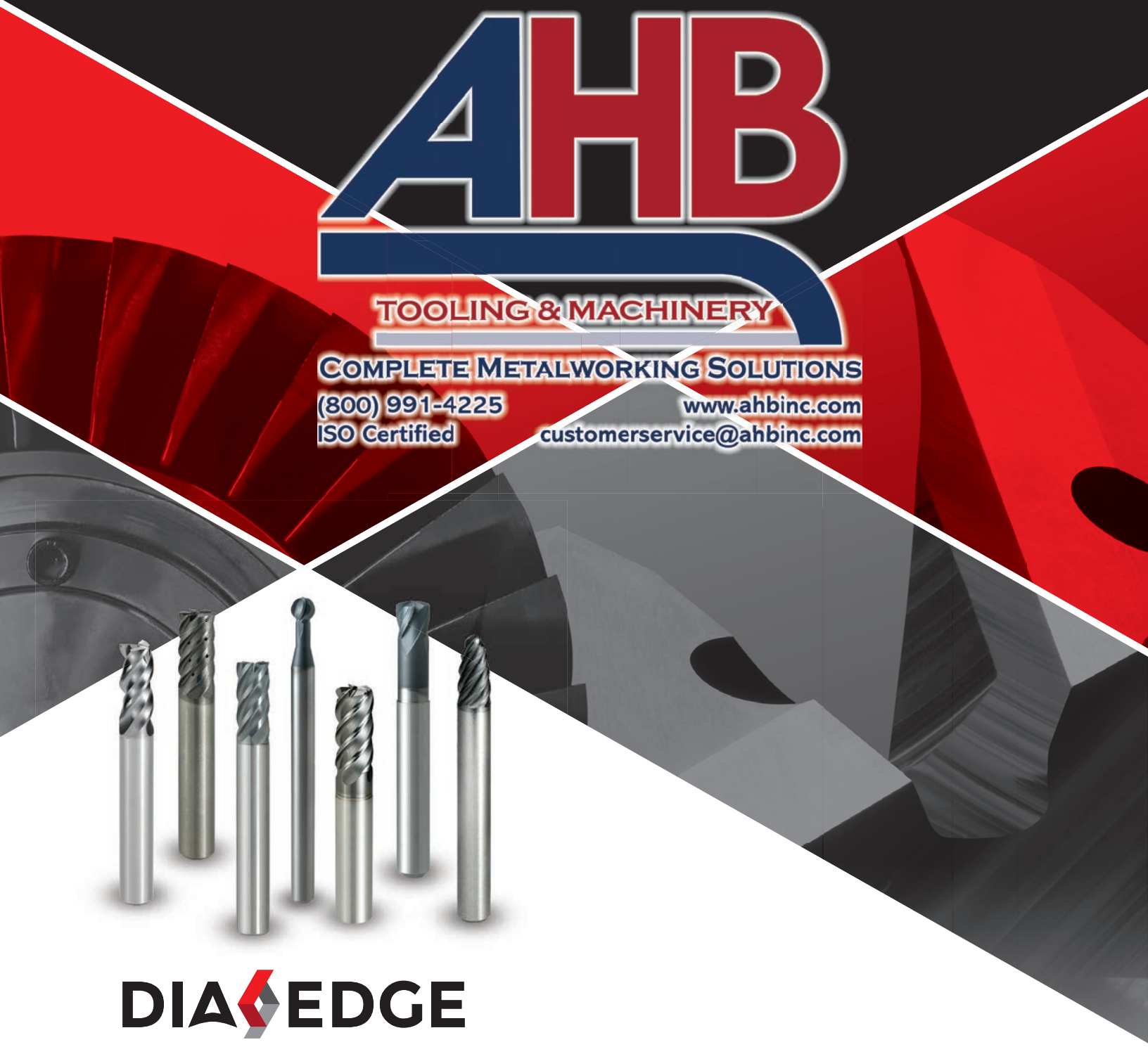


DIA EDGE

# VQ SERIES

VIBRATION CONTROL
END MILLS FOR
MACHINING
DIFFICULT-TO-CUT
MATERIALS

# ABOUT OUR BRAND

## Your manufacturing success is our success.

It's simple. We want to provide high-quality cutting tool products that help deliver unparalleled performance and control for you to manufacture precisely perfect products every day.

Our long heritage of building partnerships through cutting tool solutions to metal working manufacturers, like yours, has given Mitsubishi Materials USA a solid reputation as an industry leader. We understand the importance of getting it right the first time by delivering high-quality cutting tool product brands to help overcome machining challenges to improve machining processes.

Your success is our success and is the driving force behind our innovative products. Our product brands, DIAEDGE and MOLDINO, are trusted globally in the metal manufacturing and die & mold industries for delivering expertly-designed manufactured tools of the trade for highly specialized industries like yours.

With the acquisition of MOLDINO Tool Engineering, Ltd, our traditional Mitsubishi Materials USA cutting tool product line is now sold under the DIAEDGE product brand name.

**Brands you can trust:**

MITSUBISHI MATERIALS U.S.A.

TRUSTED PRODUCT BRANDS

DIAEDGE MOLDINO

DIA EDGE

# VQ SERIES

If you are looking for a versatile, high-quality end mill with outstanding performance in difficult-to-cut material, then DIAEDGE's VQ series is the ideal solution. VQ series end mills offer a wide variety of sizes to meet your application needs. The VQ end mills irregular helix flutes are designed to reduce vibrations and have been treated with a newly developed (Al, Cr)N group coating, which delivers substantially better wear resistance, resulting in better-machined surfaces, reduced cutting resistance, and improved chip discharge for reliable metal removal applications for optimal machining consistency.

# TABLE OF CONTENTS

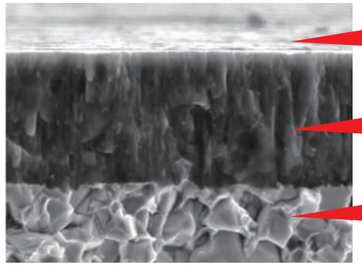
# VIBRATION CONTROL END MILLS FOR MACHINING DIFFICULT-TO-CUT MATERIALS

DIA EDGE

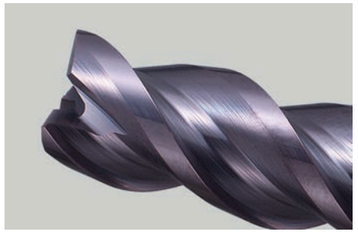
# SMART MIRACLE

## 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 smoothening 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.

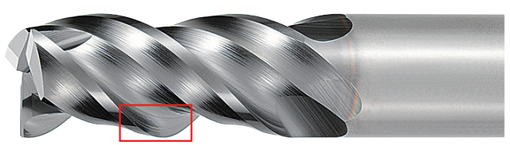



SMART MIRACLE Coating

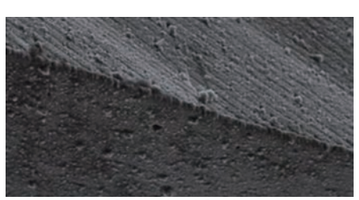

Conventional Coating

## 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

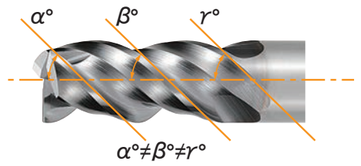
# Features

**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.**

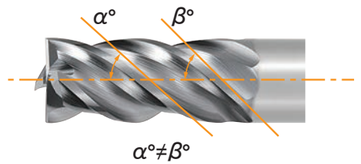
## Geometry

**Irregular Helical Flutes**

**No vibration!**



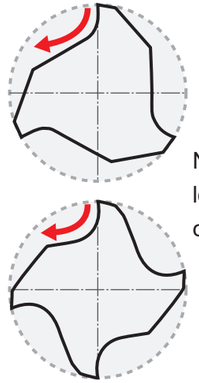

3 flute




4 flute

**Special Flute Geometry**

**Improved chip disposal**



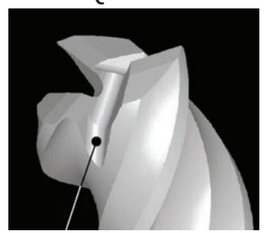
New flute geometry with low resistance for smooth chip evacuation.

**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

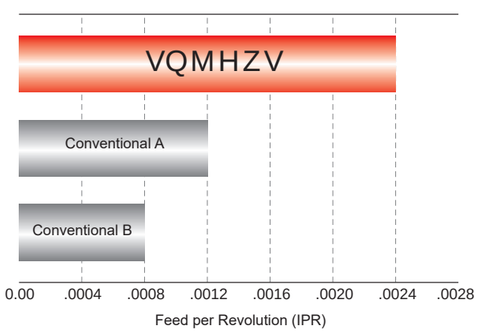
## Effect of New Gash Geometry

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 | : 3200min$^{-1}$ |
| 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<br>External Coolant (Emulsion) |
| Machine | : Vertical M/C (BT50) |

AISI 304 DCx0.5 Vertical Feed Limit



## Classification

### VQMHZV

**Inch: DC=.0625"-.5000" Metric: DC=1mm-20mm**
End mill, Medium cut length,
3 flute for drilling and slot milling

### VQMHZVOH

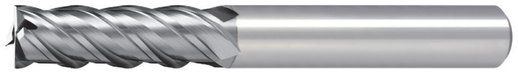
**Inch: DC=.2500"-.5000" Metric: DC=6mm-16mm**
End mill, Medium cut length,
3 flute for drilling and slot milling,
with multiple internal through coolant holes

### VQMHV

**Inch: DC=.1250"-.5000" Metric: DC=1mm-25mm**
End mill, Medium cut length,
4 flute, Irregular helix flutes
Slim shank types DC=9mm–18mm for vertical wall and deep applications

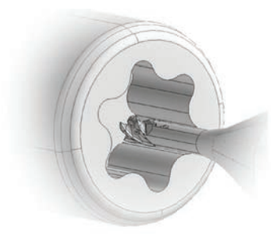
### VQJHV

**Inch: DC=.1250"-.5000" Metric: DC=1mm-20mm**
End mill, Semi-long cut length,
4 flute, Irregular helix flutes



### VQXL

**Metric: DC=0.2mm-1mm**
End mill, Short cut length,
4 flute, Long neck



### VQSVR

**Metric: DC=3mm-20mm**
Roughing, Short cut length,
4 flute, Irregular helix flutes

### VQMHVRB

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

### VQMHVRBF

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

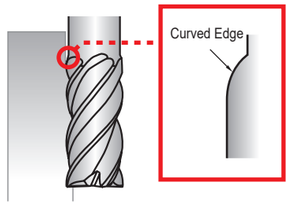
### VQ4SVB

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

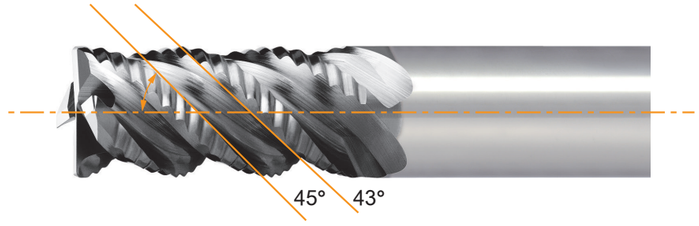
### VQMHV Undercut Size

**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.




### VQSVR



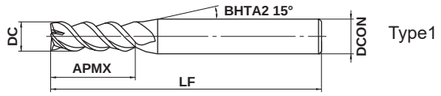

Provides a long tool life without vibration, because of the efficiency of irregular helix asymmetrical nick geometry.

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

## VQMHZV - 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 |
|---|---|---|---|---|---|---|---|
| ◎ | ○ | | | ◎ | ◎ | ○ | |




| 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 |
|---|---|---|---|---|---|---|---|
| **VQMHZVD1/16** | .0625 | .1250 | 2.00 | .2500 | 3 | ● | 1 |
| **VQMHZVD5/64** | .0781 | .1560 | 2.00 | .2500 | 3 | ● | 1 |
| **VQMHZVD3/32** | .0938 | .1880 | 2.00 | .2500 | 3 | ● | 1 |
| **VQMHZVD7/64** | .1094 | .2500 | 2.00 | .2500 | 3 | ● | 1 |
| **VQMHZVD1/8** | .1250 | .3130 | 2.00 | .2500 | 3 | ● | 1 |
| **VQMHZVD5/32** | .1562 | .3750 | 2.00 | .2500 | 3 | ● | 1 |
| **VQMHZVD3/16** | .1875 | .4375 | 2.00 | .2500 | 3 | ● | 1 |
| **VQMHZVD1/4** | .2500 | .6250 | 2.50 | .2500 | 3 | ● | 2 |
| **VQMHZVD5/16** | .3125 | .7500 | 2.75 | .3125 | 3 | ● | 2 |
| **VQMHZVD11/32** | .3438 | .7500 | 3.00 | .3750 | 3 | ● | 1 |
| **VQMHZVD3/8** | .3750 | .8750 | 3.00 | .3750 | 3 | ● | 2 |
| **VQMHZVD1/2** | .5000 | 1.1250 | 3.50 | .5000 | 3 | ● | 2 |

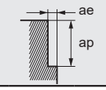
(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work. When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

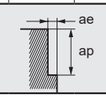
* Number of Flutes

● : USA Stock

## ■Shoulder Milling

(inch)

| Work Material | Carbon Steel (—30HRC) | | | | | | Alloy Steel, Pre-hardened Steel | | | | | | Austenitic Stainless Steel, Titanium Alloy | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | 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 |
| Depth of Cut |  | | | | | | | | | | | | | | | | | |

| Work Material | Precipitation Hardening Stainless Steel, Cobaly Chromium Alloy | | | | | | Copper, Copper Alloy | | | | | | Heat Resistant Alloy | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | 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 |
| 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.

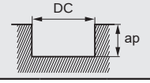
# Vibration Control End Mills for Machining Difficult-to-cut Materials

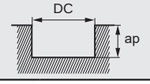
## VQMHZV - Inch sizes

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

### ■Slot Milling

(inch)

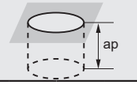
| Work Material | Carbon Steel (—30HRC) | | | | | Alloy Steel, Pre-hardened Steel | | | | | Austenitic Stainless Steel, Titanium Alloy | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | High Speed Cutting | | General Purpose Cutting | | ap | High Speed Cutting | | General 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 |
| Depth of Cut |  DC : Dia. | | | | | | | | | | | | | | |

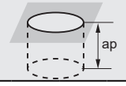
| Work Material | Precipitation Hardening Stainless Steel, Cobaly Chromium Alloy | | | | | Copper, Copper Alloy | | | | | Heat Resistant Alloy | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | High Speed Cutting | | General Purpose Cutting | | ap | High Speed Cutting | | 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 |
| 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.

### ■Drilling

(inch)

| Work Material | Carbon Steel (—30HRC) | | | | | | | Alloy Steel, Pre-hardened Steel | | | | | | | Austenitic Stainless Steel, Titanium Alloy | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | 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, Cobaly Chromium Alloy | | | | | | | Copper, Copper Alloy | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | 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 |  | | | | | | | | | | | | | |

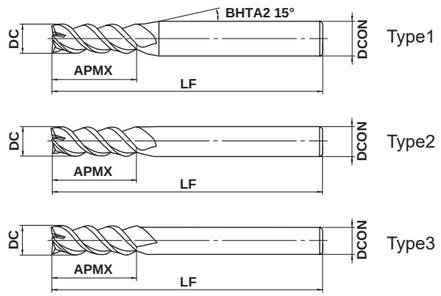
(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work. When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.
(Note 2) Effective 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

## VQMHZV

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 |
|---|---|---|---|---|---|---|---|
| ◎ | ○ | | | ◎ | ◎ | ○ | |




| 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 |
|---|---|---|---|---|---|---|---|
| **VQMHZVD0100** | 1 | 2 | 45 | 4 | 3 | ● | 1 |
| **VQMHZVD0110** | 1.1 | 2.2 | 45 | 4 | 3 | ★ | 1 |
| **VQMHZVD0120** | 1.2 | 2.4 | 45 | 4 | 3 | ★ | 1 |
| **VQMHZVD0130** | 1.3 | 2.6 | 45 | 4 | 3 | ★ | 1 |
| **VQMHZVD0140** | 1.4 | 2.8 | 45 | 4 | 3 | ★ | 1 |
| **VQMHZVD0150** | 1.5 | 3 | 45 | 4 | 3 | ● | 1 |
| **VQMHZVD0160** | 1.6 | 3.2 | 45 | 4 | 3 | ★ | 1 |
| **VQMHZVD0170** | 1.7 | 3.4 | 45 | 4 | 3 | ★ | 1 |
| **VQMHZVD0180** | 1.8 | 3.6 | 45 | 4 | 3 | ★ | 1 |
| **VQMHZVD0190** | 1.9 | 3.8 | 45 | 4 | 3 | ★ | 1 |
| **VQMHZVD0200** | 2 | 4 | 50 | 6 | 3 | ● | 1 |
| **VQMHZVD0210** | 2.1 | 4.2 | 50 | 6 | 3 | ★ | 1 |
| **VQMHZVD0220** | 2.2 | 4.4 | 50 | 6 | 3 | ★ | 1 |
| **VQMHZVD0230** | 2.3 | 4.6 | 50 | 6 | 3 | ★ | 1 |
| **VQMHZVD0240** | 2.4 | 4.8 | 50 | 6 | 3 | ★ | 1 |
| **VQMHZVD0250** | 2.5 | 5 | 50 | 6 | 3 | ● | 1 |
| **VQMHZVD0260** | 2.6 | 5.2 | 50 | 6 | 3 | ★ | 1 |
| **VQMHZVD0270** | 2.7 | 5.4 | 50 | 6 | 3 | ★ | 1 |
| **VQMHZVD0280** | 2.8 | 5.6 | 50 | 6 | 3 | ★ | 1 |
| **VQMHZVD0290** | 2.9 | 5.8 | 50 | 6 | 3 | ★ | 1 |
| **VQMHZVD0300** | 3 | 6 | 50 | 6 | 3 | ● | 1 |
| **VQMHZVD0310** | 3.1 | 7 | 50 | 6 | 3 | ★ | 1 |
| **VQMHZVD0320** | 3.2 | 7 | 50 | 6 | 3 | ★ | 1 |
| **VQMHZVD0330** | 3.3 | 7 | 50 | 6 | 3 | ★ | 1 |
| **VQMHZVD0340** | 3.4 | 7 | 50 | 6 | 3 | ★ | 1 |
| **VQMHZVD0350** | 3.5 | 8 | 50 | 6 | 3 | ● | 1 |
| **VQMHZVD0360** | 3.6 | 8 | 50 | 6 | 3 | ★ | 1 |
| **VQMHZVD0370** | 3.7 | 8 | 50 | 6 | 3 | ★ | 1 |

(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

**● : USA Stock ★ : Stocked 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, Cobaly 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, Cobaly 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 |
| 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 | ae |
| 1 | 120 | 38000 | 560 | 1.5 | 0.2 | 30 | 9500 | 75 | 1.5 | 0.05 |
| 1.5 | 140 | 30000 | 890 | 2.25 | 0.3 | 30 | 6400 | 82 | 2.25 | 0.07 |
| 2 | 140 | 22000 | 1100 | 3 | 0.6 | 30 | 4800 | 86 | 3 | 0.2 |
| 3 | 140 | 15000 | 1200 | 4.5 | 0.9 | 30 | 3200 | 89 | 4.5 | 0.3 |
| 4 | 140 | 11000 | 1200 | 6 | 1.2 | 30 | 2400 | 90 | 6 | 0.4 |
| 5 | 140 | 8900 | 1200 | 7.5 | 1.5 | 30 | 1900 | 90 | 7.5 | 0.5 |
| 6 | 140 | 7400 | 1200 | 9 | 1.8 | 30 | 1600 | 95 | 9 | 0.6 |
| 8 | 140 | 5600 | 1200 | 12 | 2.4 | 30 | 1200 | 95 | 12 | 0.8 |
| 10 | 140 | 4500 | 1100 | 15 | 3 | 30 | 950 | 110 | 15 | 1 |
| 12 | 140 | 3700 | 880 | 18 | 3.6 | 30 | 800 | 100 | 18 | 1.2 |
| 16 | 140 | 2800 | 750 | 24 | 4.8 | 30 | 600 | 76 | 24 | 1.6 |
| 20 | 140 | 2200 | 590 | 30 | 6 | 30 | 480 | 61 | 30 | 2 |
| Depth of Cut |  | | | | | | | | | |

(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

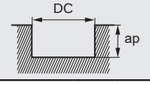
When machine rigidity, work material rigidity and chip discharge are enough, please select the high efficiency cutting conditions.
When either machine rigidity, work material rigidity or chip discharge are not enough, please select the general-purpose cutting conditions.

### 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, Cobaly 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) | ap |
| 1 | 100 | 32000 | 380 | 0.5 | 80 | 25000 | 150 | 0.5 | 60 | 19000 | 100 | 0.5 | 45 | 14000 | 80 | 0.3 | 120 | 38000 | 460 | 0.5 | 30 | 9500 | 60 | 0.2 |
| 1.5 | 130 | 28000 | 590 | 0.75 | 100 | 21000 | 250 | 0.75 | 85 | 18000 | 220 | 0.75 | 60 | 12000 | 140 | 0.4 | 150 | 32000 | 670 | 0.75 | 30 | 6400 | 80 | 0.3 |
| 2 | 150 | 24000 | 940 | 2 | 120 | 19000 | 460 | 2 | 100 | 16000 | 480 | 2 | 60 | 9500 | 230 | 1 | 180 | 29000 | 1100 | 2 | 30 | 4800 | 100 | 0.6 |
| 3 | 150 | 16000 | 1100 | 3 | 120 | 13000 | 550 | 3 | 100 | 11000 | 500 | 3 | 60 | 6400 | 270 | 1.5 | 180 | 19000 | 1300 | 3 | 30 | 3200 | 120 | 0.9 |
| 4 | 150 | 12000 | 1400 | 4 | 120 | 9500 | 680 | 4 | 100 | 8000 | 530 | 4 | 60 | 4800 | 350 | 2 | 180 | 14000 | 1700 | 4 | 30 | 2400 | 130 | 1.2 |
| 5 | 150 | 9500 | 1400 | 5 | 120 | 7600 | 680 | 5 | 100 | 6400 | 540 | 5 | 60 | 3800 | 350 | 2.5 | 180 | 11000 | 1700 | 5 | 30 | 1900 | 130 | 1.5 |
| 6 | 150 | 8000 | 1400 | 6 | 120 | 6400 | 770 | 6 | 100 | 5300 | 560 | 6 | 60 | 3200 | 380 | 3 | 180 | 9500 | 1700 | 6 | 30 | 1600 | 130 | 1.8 |
| 8 | 150 | 6000 | 1300 | 8 | 120 | 4800 | 720 | 8 | 100 | 4000 | 600 | 8 | 60 | 2400 | 360 | 4 | 180 | 7200 | 1500 | 8 | 30 | 1200 | 140 | 2.4 |
| 10 | 150 | 4800 | 1200 | 10 | 120 | 3800 | 630 | 10 | 100 | 3200 | 670 | 10 | 60 | 1900 | 310 | 5 | 180 | 5700 | 1400 | 10 | 30 | 950 | 160 | 3 |
| 12 | 150 | 4000 | 960 | 12 | 120 | 3200 | 580 | 12 | 100 | 2700 | 650 | 12 | 60 | 1600 | 290 | 6 | 180 | 4800 | 1200 | 12 | 30 | 800 | 150 | 3.6 |
| 16 | 150 | 3000 | 810 | 12 | 120 | 2400 | 500 | 12 | 100 | 2000 | 480 | 12 | 60 | 1200 | 250 | 8 | 180 | 3600 | 970 | 12 | 30 | 600 | 120 | 4.8 |
| 20 | 150 | 2400 | 650 | 12 | 120 | 1900 | 400 | 12 | 100 | 1600 | 380 | 12 | 60 | 950 | 200 | 10 | 180 | 2900 | 780 | 12 | 30 | 480 | 90 | 6 |

Depth of Cut



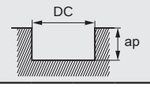

DC : Dia.

### General Purpose 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, Cobaly 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) | ap |
| 1 | 100 | 32000 | 250 | 0.5 | 80 | 25000 | 99 | 0.5 | 60 | 19000 | 80 | 0.5 | 45 | 14000 | 60 | 0.3 | 120 | 38000 | 300 | 0.5 | 25 | 8000 | 30 | 0.2 |
| 1.5 | 100 | 21000 | 290 | 0.75 | 80 | 17000 | 130 | 0.75 | 60 | 13000 | 100 | 0.75 | 50 | 11000 | 87 | 0.4 | 120 | 25000 | 350 | 0.75 | 25 | 5300 | 40 | 0.3 |
| 2 | 100 | 16000 | 410 | 2 | 80 | 13000 | 210 | 2 | 60 | 9500 | 190 | 2 | 50 | 8000 | 130 | 1 | 120 | 19000 | 490 | 2 | 25 | 4000 | 55 | 0.6 |
| 3 | 100 | 11000 | 500 | 3 | 80 | 8500 | 240 | 3 | 60 | 6400 | 190 | 3 | 50 | 5300 | 150 | 1.5 | 120 | 13000 | 590 | 3 | 25 | 2700 | 64 | 0.9 |
| 4 | 100 | 8000 | 630 | 4 | 80 | 6400 | 300 | 4 | 60 | 4800 | 210 | 4 | 50 | 4000 | 190 | 2 | 120 | 9500 | 750 | 4 | 25 | 2000 | 70 | 1.2 |
| 5 | 100 | 6400 | 630 | 5 | 80 | 5100 | 300 | 5 | 60 | 3800 | 210 | 5 | 50 | 3200 | 190 | 2.5 | 120 | 7600 | 750 | 5 | 25 | 1600 | 71 | 1.5 |
| 6 | 100 | 5300 | 630 | 6 | 80 | 4200 | 330 | 6 | 60 | 3200 | 220 | 6 | 50 | 2700 | 210 | 3 | 120 | 6400 | 760 | 6 | 25 | 1300 | 72 | 1.8 |
| 8 | 100 | 4000 | 550 | 8 | 80 | 3200 | 320 | 8 | 60 | 2400 | 240 | 8 | 50 | 2000 | 200 | 4 | 120 | 4800 | 670 | 8 | 25 | 990 | 78 | 2.4 |
| 10 | 100 | 3200 | 510 | 10 | 80 | 2500 | 270 | 10 | 60 | 1900 | 260 | 10 | 50 | 1600 | 170 | 5 | 120 | 3800 | 600 | 10 | 25 | 800 | 89 | 3 |
| 12 | 100 | 2700 | 430 | 12 | 80 | 2100 | 250 | 12 | 60 | 1600 | 250 | 12 | 50 | 1300 | 150 | 6 | 120 | 3200 | 510 | 12 | 25 | 660 | 84 | 3.6 |
| 16 | 100 | 2000 | 360 | 12 | 80 | 1600 | 220 | 12 | 60 | 1200 | 190 | 12 | 50 | 990 | 140 | 8 | 120 | 2400 | 430 | 12 | 25 | 500 | 63 | 4.8 |
| 20 | 100 | 1600 | 290 | 12 | 80 | 1300 | 180 | 12 | 60 | 950 | 150 | 12 | 50 | 800 | 110 | 10 | 120 | 1900 | 340 | 12 | 25 | 400 | 50 | 6 |

Depth of Cut




DC : Dia.

(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

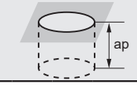
When machine rigidity, work material rigidity and chip discharge are enough, please select the high efficiency cutting conditions.
When either machine rigidity, work material rigidity or chip discharge are not enough, please select the general-purpose cutting conditions.

### 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, Cobaly 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 | Step |
| 1 | 65 | 20000 | 160 | 0.5 | 0.1 | 50 | 16000 | 100 | 0.5 | 0.1 | 50 | 16000 | 50 | 0.5 | 0.05 | 30 | 9500 | 30 | 0.5 | 0.05 | 75 | 24000 | 190 | 0.5 | 0.1 |
| 1.5 | 85 | 18000 | 270 | 0.75 | 0.3 | 60 | 13000 | 120 | 0.75 | 0.3 | 60 | 13000 | 80 | 0.75 | 0.1 | 35 | 7400 | 40 | 0.75 | 0.1 | 100 | 21000 | 320 | 0.75 | 0.3 |
| 2 | 100 | 16000 | 480 | 2 | 0.5 | 70 | 11000 | 200 | 2 | 0.4 | 60 | 9500 | 90 | 1 | 0.15 | 40 | 6400 | 60 | 1 | 0.1 | 120 | 19000 | 570 | 2 | 0.5 |
| 3 | 100 | 11000 | 660 | 3 | 1 | 70 | 7400 | 270 | 3 | 0.6 | 60 | 6400 | 100 | 1.5 | 0.2 | 40 | 4200 | 60 | 1.5 | 0.2 | 120 | 13000 | 780 | 3 | 1.0 |
| 4 | 100 | 8000 | 800 | 4 | 2 | 70 | 5600 | 340 | 4 | 0.8 | 60 | 4800 | 100 | 2 | 0.4 | 40 | 3200 | 60 | 2 | 0.4 | 120 | 9500 | 950 | 4 | 2 |
| 5 | 100 | 6400 | 960 | 5 | 2.5 | 70 | 4500 | 410 | 5 | 1 | 60 | 3800 | 100 | 2.5 | 0.5 | 40 | 2500 | 60 | 2.5 | 0.5 | 120 | 7600 | 1100 | 5 | 2.5 |
| 6 | 100 | 5300 | 950 | 6 | 3 | 70 | 3700 | 440 | 6 | 1.2 | 60 | 3200 | 100 | 3 | 0.6 | 40 | 2100 | 60 | 3 | 0.6 | 120 | 6400 | 1200 | 6 | 3 |
| 8 | 100 | 4000 | 720 | 8 | 4 | 70 | 2800 | 340 | 8 | 1.6 | 60 | 2400 | 70 | 4 | 0.6 | 40 | 1600 | 50 | 4 | 0.6 | 120 | 4800 | 860 | 8 | 4 |
| 10 | 100 | 3200 | 580 | 10 | 5 | 70 | 2200 | 260 | 10 | 2.5 | 60 | 1900 | 60 | 5 | 0.6 | 40 | 1300 | 40 | 5 | 0.6 | 120 | 3800 | 680 | 10 | 5 |
| 12 | 100 | 2700 | 490 | 12 | 5 | 70 | 1900 | 230 | 12 | 3 | 60 | 1600 | 50 | 6 | 0.6 | 40 | 1100 | 30 | 6 | 0.6 | 120 | 3200 | 580 | 12 | 5 |
| 16 | 100 | 2000 | 360 | 16 | 5 | 70 | 1400 | 170 | 16 | 4 | 60 | 1200 | 40 | 8 | 0.6 | 40 | 800 | 20 | 8 | 0.6 | 120 | 2400 | 430 | 16 | 5 |
| 20 | 100 | 1600 | 290 | 20 | 5 | 70 | 1100 | 130 | 20 | 5 | 60 | 950 | 30 | 10 | 0.6 | 40 | 640 | 20 | 10 | 0.6 | 120 | 1900 | 340 | 20 | 5 |

Depth of Cut

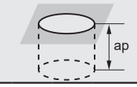



### General Purpose Cutting Conditions

(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, Cobaly 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 | Step |
| 1 | 65 | 20000 | 160 | 0.5 | 0.05 | 50 | 16000 | 100 | 0.5 | 0.05 | 50 | 16000 | 50 | 0.5 | 0.05 | 30 | 9500 | 30 | 0.5 | 0.05 | 75 | 24000 | 190 | 0.5 | 0.05 |
| 1.5 | 85 | 18000 | 270 | 0.75 | 0.15 | 60 | 13000 | 120 | 0.75 | 0.1 | 60 | 13000 | 80 | 0.75 | 0.05 | 35 | 7400 | 40 | 0.75 | 0.05 | 100 | 21000 | 320 | 0.75 | 0.15 |
| 2 | 100 | 16000 | 480 | 2 | 0.25 | 70 | 11000 | 200 | 2 | 0.2 | 60 | 9500 | 90 | 1 | 0.05 | 40 | 6400 | 60 | 1 | 0.05 | 120 | 19000 | 570 | 2 | 0.25 |
| 3 | 100 | 11000 | 660 | 3 | 0.3 | 70 | 7400 | 270 | 3 | 0.3 | 60 | 6400 | 100 | 1.5 | 0.1 | 40 | 4200 | 60 | 1.5 | 0.1 | 120 | 13000 | 780 | 3 | 0.3 |
| 4 | 100 | 8000 | 800 | 4 | 0.4 | 70 | 5600 | 340 | 4 | 0.4 | 60 | 4800 | 100 | 2 | 0.2 | 40 | 3200 | 60 | 2 | 0.2 | 120 | 9500 | 950 | 4 | 0.4 |
| 5 | 100 | 6400 | 960 | 5 | 0.5 | 70 | 4500 | 410 | 5 | 0.5 | 60 | 3800 | 100 | 2.5 | 0.25 | 40 | 2500 | 60 | 2.5 | 0.25 | 120 | 7600 | 1100 | 5 | 0.5 |
| 6 | 100 | 5300 | 950 | 6 | 0.6 | 70 | 3700 | 440 | 6 | 0.6 | 60 | 3200 | 100 | 3 | 0.3 | 40 | 2100 | 60 | 3 | 0.3 | 120 | 6400 | 1200 | 6 | 0.6 |
| 8 | 100 | 4000 | 720 | 8 | 0.7 | 70 | 2800 | 340 | 8 | 0.7 | 60 | 2400 | 70 | 4 | 0.3 | 40 | 1600 | 50 | 4 | 0.3 | 120 | 4800 | 860 | 8 | 0.7 |
| 10 | 100 | 3200 | 580 | 10 | 0.75 | 70 | 2200 | 260 | 10 | 0.75 | 60 | 1900 | 60 | 5 | 0.3 | 40 | 1300 | 40 | 5 | 0.3 | 120 | 3800 | 680 | 10 | 0.75 |
| 12 | 100 | 2700 | 490 | 12 | 0.75 | 70 | 1900 | 230 | 12 | 0.75 | 60 | 1600 | 50 | 6 | 0.3 | 40 | 1100 | 30 | 6 | 0.3 | 120 | 3200 | 580 | 12 | 0.75 |
| 16 | 100 | 2000 | 360 | 16 | 0.75 | 70 | 1400 | 170 | 16 | 0.75 | 60 | 1200 | 40 | 8 | 0.3 | 40 | 800 | 20 | 8 | 0.3 | 120 | 2400 | 430 | 16 | 0.75 |
| 20 | 100 | 1600 | 290 | 20 | 0.75 | 70 | 1100 | 130 | 20 | 0.75 | 60 | 950 | 30 | 10 | 0.3 | 40 | 640 | 20 | 10 | 0.3 | 120 | 1900 | 340 | 20 | 0.75 |

Depth of Cut

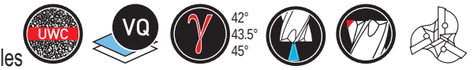



(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work. When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.
(Note 2) Effective 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.

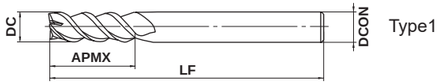
# Vibration Control End Mills for Machining Difficult-to-cut Materials

## 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 |
|---|---|---|---|---|---|---|---|
| ◎ | ○ | | | ◎ | ◎ | ○ | |




Type1

| 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 |
|---|---|---|---|---|---|---|---|
| **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 |

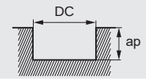
(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work. When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

* Number of Flutes

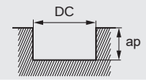
● : USA Stock

## ■Slot Milling

(inch)

| Work Material | Carbon Steel (−30HRC) | | | | | Alloy Steel, Pre-hardened Steel | | | | | Austenitic Stainless Steel, Titanium Alloy | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | 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, Cobaly Chromium Alloy | | | | | Copper, Copper Alloy | | | | | Heat Resistant Alloy | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | 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. | | | | | | | | | | | | | | |



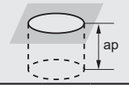
(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work. When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.
(Note 2) Effective 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.

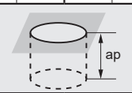
# VQMHZVOH - Inch sizes

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 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | 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 |  | | | | | | | | | | | | | | | | | | | | |

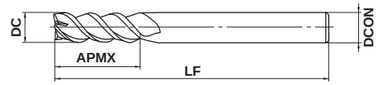
| Work Material | Precipitation Hardening Stainless Steel, Cobaly Chromium Alloy | | | | | | | Copper, Copper Alloy | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | High Speed Cutting | | | General Purpose Cutting | | | ap | High Speed Cutting | | | General Purpose Cutting | | | 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.

# VQMHZVOH

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 |
|---|---|---|---|---|---|---|---|
| ◎ | ○ | | | ◎ | ◎ | ○ | |




Type1

| | DC≤12 | DC=16 | | | |
|---|---|---|---|---|---|
| | 0 - 0.02 | 0 - 0.03 | | | |
| h6 | 4≤DCON≤6 | 8≤DCON≤10 | 12≤DCON≤16 | | |
| | 0 - 0.008 | 0 - 0.009 | 0 - 0.011 | | |

- 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 |
|---|---|---|---|---|---|---|---|
| **VQMHZVOHD0600** | 6 | 13 | 60 | 6 | 3 | ● | 1 |
| **VQMHZVOHD0800** | 8 | 19 | 70 | 8 | 3 | ● | 1 |
| **VQMHZVOHD1000** | 10 | 22 | 80 | 10 | 3 | ● | 1 |
| **VQMHZVOHD1200** | 12 | 26 | 90 | 12 | 3 | ● | 1 |
| **VQMHZVOHD1600** | 16 | 30 | 110 | 16 | 3 | ★ | 1 |

(Note 1) SMART MIRACLE coating 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

● : USA Stock ★ : Stocked in Japan

# VQMHZVOH

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

## ■ Slot Milling

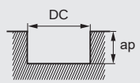
When machine rigidity, work material rigidity and chip discharge are enough, please select the high efficiency cutting conditions.
When either machine rigidity, work material rigidity or chip discharge are not enough, please select the general-purpose cutting conditions.

### 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, Cobaly 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) | ap |
| 6 | 150 | 8000 | 1400 | 6 | 120 | 6400 | 770 | 6 | 100 | 5300 | 560 | 6 | 60 | 3200 | 380 | 3 | 180 | 9500 | 1700 | 6 | 30 | 1600 | 130 | 1.8 |
| 8 | 150 | 6000 | 1300 | 8 | 120 | 4800 | 720 | 8 | 100 | 4000 | 600 | 8 | 60 | 2400 | 360 | 4 | 180 | 7200 | 1500 | 8 | 30 | 1200 | 140 | 2.4 |
| 10 | 150 | 4800 | 1200 | 10 | 120 | 3800 | 630 | 10 | 100 | 3200 | 670 | 10 | 60 | 1900 | 310 | 5 | 180 | 5700 | 1400 | 10 | 30 | 950 | 160 | 3 |
| 12 | 150 | 4000 | 960 | 12 | 120 | 3200 | 580 | 12 | 100 | 2700 | 650 | 12 | 60 | 1600 | 290 | 6 | 180 | 4800 | 1200 | 12 | 30 | 800 | 150 | 3.6 |
| 16 | 150 | 3000 | 810 | 12 | 120 | 2400 | 500 | 12 | 100 | 2000 | 480 | 12 | 60 | 1200 | 250 | 8 | 180 | 3600 | 970 | 12 | 30 | 600 | 120 | 4.8 |

Depth of Cut



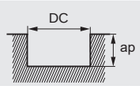

DC : Dia.

### General Purpose 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, Cobaly 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) | ap |
| 6 | 100 | 5300 | 630 | 6 | 80 | 4200 | 330 | 6 | 60 | 3200 | 220 | 6 | 50 | 2700 | 210 | 3 | 120 | 6400 | 760 | 6 | 25 | 1300 | 72 | 1.8 |
| 8 | 100 | 4000 | 550 | 8 | 80 | 3200 | 320 | 8 | 60 | 2400 | 240 | 8 | 50 | 2000 | 200 | 4 | 120 | 4800 | 670 | 8 | 25 | 990 | 78 | 2.4 |
| 10 | 100 | 3200 | 510 | 10 | 80 | 2500 | 270 | 10 | 60 | 1900 | 260 | 10 | 50 | 1600 | 170 | 5 | 120 | 3800 | 600 | 10 | 25 | 800 | 89 | 3 |
| 12 | 100 | 2700 | 430 | 12 | 80 | 2100 | 250 | 12 | 60 | 1600 | 250 | 12 | 50 | 1300 | 150 | 6 | 120 | 3200 | 510 | 12 | 25 | 660 | 84 | 3.6 |
| 16 | 100 | 2000 | 360 | 12 | 80 | 1600 | 220 | 12 | 60 | 1200 | 190 | 12 | 50 | 990 | 140 | 8 | 120 | 2400 | 430 | 12 | 25 | 500 | 63 | 4.8 |

Depth of Cut




DC : Dia.

(Note 1) SMART MIRACLE coating 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

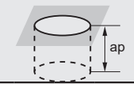
When machine rigidity, work material rigidity and chip discharge are enough, please select the high efficiency cutting conditions.
When either machine rigidity, work material rigidity or chip discharge are not enough, please select the general-purpose cutting conditions.

### 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, Cobaly 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 | 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

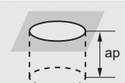



### General Purpose Cutting Conditions

(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, Cobaly 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 | 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



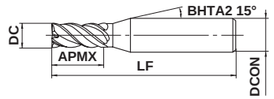

(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.
When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.
(Note 2) Effective 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

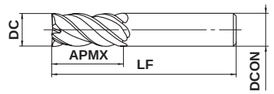
## VQMHV - Inch sizes

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 |
|---|---|---|---|---|---|---|---|
| ◎ | ○ | | | ◎ | ◎ | ○ | |




Type1




Type2

| DC<.5000" | DC=.5000" | | | |
|---|---|---|---|---|
| 0 - .0008" | 0 - .0012" | | | |
| .250"≤DCONs.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 |

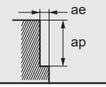
(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work. When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

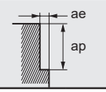
* Number of Flutes

● : USA Stock

## ■Shoulder Milling

(inch)

| Work Material | Carbon Steel (−30HRC) | | | | | | Alloy Steel, Pre-hardened Steel | | | | | | Austenitic Stainless Steel, Titanium Alloy | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | 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, Cobaly Chromium Alloy | | | | | | Copper, Copper Alloy | | | | | | Heat Resistant Alloy | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | 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.

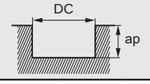
# VQMHV - Inch sizes

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 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | 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, Cobaly Chromium Alloy | | | | | Copper, Copper Alloy | | | | | Heat Resistant Alloy | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | 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.

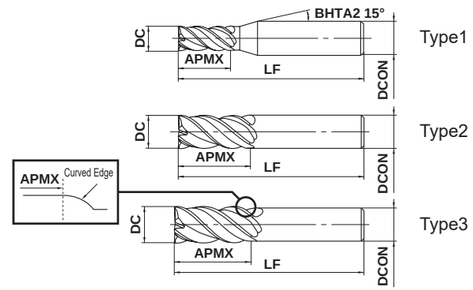


# VQMHV

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

UNC VQ 37° 40°

| 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>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 |
|---|---|---|---|---|---|---|---|
| **VQMHVD0100** | 1 | 2 | 45 | 4 | 4 | ● | 1 |
| **VQMHVD0150** | 1.5 | 3 | 45 | 4 | 4 | ● | 1 |
| **VQMHVD0200** | 2 | 4 | 45 | 4 | 4 | ● | 1 |
| **VQMHVD0250** | 2.5 | 5 | 45 | 4 | 4 | ● | 1 |
| **VQMHVD0300** | 3 | 8 | 45 | 6 | 4 | ● | 1 |
| **VQMHVD0350** | 3.5 | 8 | 45 | 6 | 4 | ● | 1 |
| **VQMHVD0400** | 4 | 11 | 45 | 6 | 4 | ● | 1 |
| **VQMHVD0500** | 5 | 13 | 50 | 6 | 4 | ● | 1 |
| **VQMHVD0600** | 6 | 13 | 50 | 6 | 4 | ● | 2 |
| **VQMHVD0700** | 7 | 19 | 60 | 8 | 4 | ● | 1 |
| **VQMHVD0800** | 8 | 19 | 60 | 8 | 4 | ● | 2 |
| **VQMHVD0900** | 9 | 22 | 70 | 10 | 4 | ● | 1 |
| **VQMHVD0900S08** | 9 | 22 | 75 | 8 | 4 | ● | 3 |
| **VQMHVD1000** | 10 | 22 | 70 | 10 | 4 | ● | 2 |
| **VQMHVD1000S08** | 10 | 22 | 100 | 8 | 4 | ● | 3 |
| **VQMHVD1100** | 11 | 26 | 75 | 12 | 4 | ● | 1 |
| **VQMHVD1100S10** | 11 | 26 | 100 | 10 | 4 | ● | 3 |
| **VQMHVD1200** | 12 | 26 | 75 | 12 | 4 | ● | 2 |
| **VQMHVD1200S10** | 12 | 26 | 110 | 10 | 4 | ● | 3 |
| **VQMHVD1300** | 13 | 26 | 75 | 12 | 4 | ★ | 3 |
| **VQMHVD1300S12** | 13 | 26 | 110 | 12 | 4 | ★ | 3 |
| **VQMHVD1400** | 14 | 30 | 90 | 16 | 4 | ★ | 1 |
| **VQMHVD1400S12** | 14 | 32 | 130 | 12 | 4 | ★ | 3 |
| **VQMHVD1600** | 16 | 35 | 90 | 16 | 4 | ★ | 2 |
| **VQMHVD1800** | 18 | 40 | 100 | 16 | 4 | ★ | 3 |
| **VQMHVD1800S16** | 18 | 42 | 150 | 16 | 4 | ★ | 3 |
| **VQMHVD2000** | 20 | 45 | 110 | 20 | 4 | ★ | 2 |
| **VQMHVD2500** | 25 | 55 | 125 | 25 | 4 | ★ | 2 |

(Note 1) SMART MIRACLE coating 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

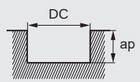
● : USA Stock ★ : Stocked in Japan

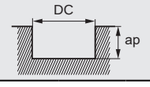
# VQMHV - Inch sizes

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 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | 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, Cobaly Chromium Alloy | | | | | Copper, Copper Alloy | | | | | Heat Resistant Alloy | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | 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. | | | | | | | | | | | | | | |

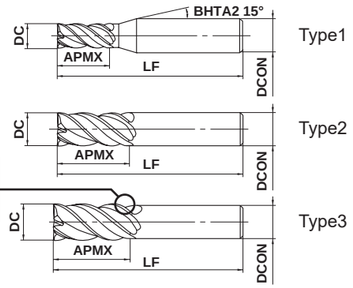
(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work. When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.
(Note 2) Effective 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 |
|---|---|---|---|---|---|---|---|
| ◎ | ○ | | | ◎ | ◎ | ○ | |




| 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 |
|---|---|---|---|---|---|---|---|
| **VQMHVD0100** | 1 | 2 | 45 | 4 | 4 | ● | 1 |
| **VQMHVD0150** | 1.5 | 3 | 45 | 4 | 4 | ● | 1 |
| **VQMHVD0200** | 2 | 4 | 45 | 4 | 4 | ● | 1 |
| **VQMHVD0250** | 2.5 | 5 | 45 | 4 | 4 | ● | 1 |
| **VQMHVD0300** | 3 | 8 | 45 | 6 | 4 | ● | 1 |
| **VQMHVD0350** | 3.5 | 8 | 45 | 6 | 4 | ● | 1 |
| **VQMHVD0400** | 4 | 11 | 45 | 6 | 4 | ● | 1 |
| **VQMHVD0500** | 5 | 13 | 50 | 6 | 4 | ● | 1 |
| **VQMHVD0600** | 6 | 13 | 50 | 6 | 4 | ● | 2 |
| **VQMHVD0700** | 7 | 19 | 60 | 8 | 4 | ● | 1 |
| **VQMHVD0800** | 8 | 19 | 60 | 8 | 4 | ● | 2 |
| **VQMHVD0900** | 9 | 22 | 70 | 10 | 4 | ● | 1 |
| **VQMHVD0900S08** | 9 | 22 | 75 | 8 | 4 | ● | 3 |
| **VQMHVD1000** | 10 | 22 | 70 | 10 | 4 | ● | 2 |
| **VQMHVD1000S08** | 10 | 22 | 100 | 8 | 4 | ● | 3 |
| **VQMHVD1100** | 11 | 26 | 75 | 12 | 4 | ● | 1 |
| **VQMHVD1100S10** | 11 | 26 | 100 | 10 | 4 | ● | 3 |
| **VQMHVD1200** | 12 | 26 | 75 | 12 | 4 | ● | 2 |
| **VQMHVD1200S10** | 12 | 26 | 110 | 10 | 4 | ● | 3 |
| **VQMHVD1300** | 13 | 26 | 75 | 12 | 4 | ★ | 3 |
| **VQMHVD1300S12** | 13 | 26 | 110 | 12 | 4 | ★ | 3 |
| **VQMHVD1400** | 14 | 30 | 90 | 16 | 4 | ★ | 1 |
| **VQMHVD1400S12** | 14 | 32 | 130 | 12 | 4 | ★ | 3 |
| **VQMHVD1600** | 16 | 35 | 90 | 16 | 4 | ★ | 2 |
| **VQMHVD1800** | 18 | 40 | 100 | 16 | 4 | ★ | 3 |
| **VQMHVD1800S16** | 18 | 42 | 150 | 16 | 4 | ★ | 3 |
| **VQMHVD2000** | 20 | 45 | 110 | 20 | 4 | ★ | 2 |
| **VQMHVD2500** | 25 | 55 | 125 | 25 | 4 | ★ | 2 |

(Note 1) SMART MIRACLE coating 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

**● : USA Stock ★ : Stocked 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, Cobaly 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, Cobaly 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 | ae |
| 1 | 130 | 40000 | 1800 | 1.5 | 0.3 | 40 | 13000 | 210 | 1.5 | 0.1 |
| 2 | 180 | 29000 | 2900 | 3 | 0.6 | 40 | 6400 | 230 | 3 | 0.2 |
| 3 | 180 | 19000 | 3000 | 4.5 | 0.9 | 40 | 4200 | 240 | 4.5 | 0.3 |
| 4 | 180 | 14000 | 3000 | 6 | 1.2 | 40 | 3200 | 240 | 6 | 0.4 |
| 5 | 180 | 11000 | 3000 | 7.5 | 1.5 | 40 | 2500 | 240 | 7.5 | 0.5 |
| 6 | 180 | 9500 | 3000 | 9 | 1.8 | 40 | 2100 | 250 | 9 | 0.6 |
| 8 | 180 | 7200 | 3000 | 12 | 2.4 | 40 | 1600 | 260 | 12 | 0.8 |
| 10 | 180 | 5700 | 2700 | 15 | 3 | 40 | 1300 | 290 | 15 | 1 |
| 12 | 180 | 4800 | 2300 | 18 | 3.6 | 40 | 1100 | 280 | 18 | 1.2 |
| 16 | 180 | 3600 | 1900 | 24 | 4.8 | 40 | 800 | 200 | 24 | 1.6 |
| 20 | 180 | 2900 | 1600 | 30 | 6 | 40 | 640 | 160 | 30 | 2 |
| 25 | 180 | 2300 | 1300 | 37.5 | 7.5 | 40 | 510 | 130 | 37.5 | 2.5 |
| Depth of Cut |  | | | | | | | | | |

### General Purpose 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 | 130 | 40000 | 1300 | 1.5 | 0.3 | 30 | 9600 | 92 | 1.5 | 0.1 |
| 2 | 140 | 22000 | 1500 | 3 | 0.6 | 30 | 4800 | 110 | 3 | 0.2 |
| 3 | 140 | 15000 | 1600 | 4.5 | 0.9 | 30 | 3200 | 120 | 4.5 | 0.3 |
| 4 | 140 | 11000 | 1600 | 6 | 1.2 | 30 | 2400 | 120 | 6 | 0.4 |
| 5 | 140 | 8900 | 1600 | 7.5 | 1.5 | 30 | 1900 | 120 | 7.5 | 0.5 |
| 6 | 140 | 7400 | 1600 | 9 | 1.8 | 30 | 1600 | 130 | 9 | 0.6 |
| 8 | 140 | 5600 | 1600 | 12 | 2.4 | 30 | 1200 | 130 | 12 | 0.8 |
| 10 | 140 | 4500 | 1400 | 15 | 3 | 30 | 950 | 140 | 15 | 1 |
| 12 | 140 | 3700 | 1200 | 18 | 3.6 | 30 | 800 | 140 | 18 | 1.2 |
| 16 | 140 | 2800 | 1000 | 24 | 4.8 | 30 | 600 | 100 | 24 | 1.6 |
| 20 | 140 | 2200 | 780 | 30 | 6 | 30 | 480 | 81 | 30 | 2 |
| 25 | 140 | 1800 | 670 | 37.5 | 7.5 | 30 | 380 | 64 | 37.5 | 2.5 |
| Depth of Cut |  | | | | | | | | | |

(Note 1) SMART MIRACLE coating 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.

# VQMHV

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

## ■Slot Milling

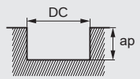
When machine rigidity, work material rigidity and chip discharge are enough, please select the high efficiency cutting conditions.
When either machine rigidity, work material rigidity or chip discharge are not enough, please select the general-purpose cutting conditions.

### High Efficiency Cutting Conditions

(mm)

| Work Material | Carbon Steel, Alloy Steel, Mild Steel | | | | Pre-hardened Steel, Carbon Steel, Alloy Tool Steel | | | | Austenitic, Ferritic and Martensitic Stainless Steels, Titanium Alloys | | | | Precipitation Hardening Stainless Steel, Cobaly 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) | 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



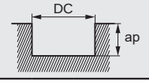

DC : Dia.

### General Purpose Cutting Conditions

(mm)

| Work Material | Carbon Steel, Alloy Steel, Mild Steel | | | | Pre-hardened Steel, Carbon Steel, Alloy Tool Steel | | | | Austenitic, Ferritic and Martensitic Stainless Steels, Titanium Alloys | | | | Precipitation Hardening Stainless Steel, Cobaly 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) | ap |
| 1 | 100 | 32000 | 500 | 1 | 80 | 25000 | 250 | 1 | 80 | 25000 | 300 | 1 | 50 | 16000 | 150 | 0.5 | 120 | 38000 | 590 | 1 | 25 | 8000 | 67 | 0.3 |
| 2 | 100 | 16000 | 550 | 2 | 80 | 13000 | 270 | 2 | 60 | 9500 | 250 | 2 | 50 | 8000 | 170 | 1 | 120 | 19000 | 650 | 2 | 25 | 4000 | 74 | 0.6 |
| 3 | 100 | 11000 | 670 | 3 | 80 | 8500 | 310 | 3 | 60 | 6400 | 250 | 3 | 50 | 5300 | 200 | 1.5 | 120 | 13000 | 790 | 3 | 25 | 2700 | 86 | 0.9 |
| 4 | 100 | 8000 | 840 | 4 | 80 | 6400 | 410 | 4 | 60 | 4800 | 280 | 4 | 50 | 4000 | 250 | 2 | 120 | 9500 | 1000 | 4 | 25 | 2000 | 93 | 1.2 |
| 5 | 100 | 6400 | 840 | 5 | 80 | 5100 | 410 | 5 | 60 | 3800 | 280 | 5 | 50 | 3200 | 250 | 2.5 | 120 | 7600 | 1000 | 5 | 25 | 1600 | 95 | 1.5 |
| 6 | 100 | 5300 | 840 | 6 | 80 | 4200 | 440 | 6 | 60 | 3200 | 300 | 6 | 50 | 2700 | 290 | 3 | 120 | 6400 | 1000 | 6 | 25 | 1300 | 96 | 1.8 |
| 8 | 100 | 4000 | 740 | 8 | 80 | 3200 | 420 | 8 | 60 | 2400 | 320 | 8 | 50 | 2000 | 260 | 4 | 120 | 4800 | 890 | 8 | 25 | 990 | 100 | 2.4 |
| 10 | 100 | 3200 | 680 | 10 | 80 | 2500 | 360 | 10 | 60 | 1900 | 350 | 10 | 50 | 1600 | 230 | 5 | 120 | 3800 | 800 | 10 | 25 | 800 | 120 | 3 |
| 12 | 100 | 2700 | 570 | 12 | 80 | 2100 | 330 | 12 | 60 | 1600 | 340 | 12 | 50 | 1300 | 210 | 6 | 120 | 3200 | 680 | 12 | 25 | 660 | 110 | 3.6 |
| 16 | 100 | 2000 | 480 | 12 | 80 | 1600 | 300 | 12 | 60 | 1200 | 250 | 12 | 50 | 990 | 180 | 8 | 120 | 2400 | 570 | 12 | 25 | 500 | 84 | 4.8 |
| 20 | 100 | 1600 | 380 | 12 | 80 | 1300 | 240 | 12 | 60 | 950 | 200 | 12 | 50 | 800 | 150 | 10 | 120 | 1900 | 450 | 12 | 25 | 400 | 68 | 6 |
| 25 | 100 | 1300 | 340 | 12 | 80 | 1000 | 180 | 12 | 60 | 760 | 160 | 12 | 50 | 640 | 120 | 12 | 120 | 1500 | 400 | 12 | 25 | 320 | 50 | 7.5 |

Depth of Cut




DC : Dia.

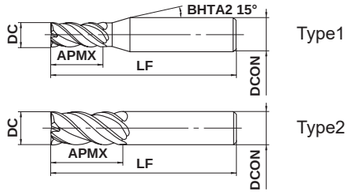
(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.
When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.
(Note 2) Effective 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

UWC | VQ | γ 38° 40° DC≤1/4 | γ 37.5° 40° DC>1/4

| 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" | | | |

h6

● SMART MIRACLE vibration control end mills for reduced 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 |
|---|---|---|---|---|---|---|---|
| **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

● : USA Stock

# 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, Cobaly 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 | ae |
| 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 |  | | | | | | | |

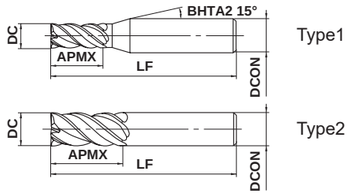
(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.
When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.
(Note 2) Effective 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

UWC | VQ | γ 38° 40° DC≤6 | γ 37.5° 40° DC 6

| 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>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 |
|---|---|---|---|---|---|---|---|
| **VQJHVD0100** | 1 | 4 | 45 | 4 | 4 | ● | 1 |
| **VQJHVD0150** | 1.5 | 6 | 45 | 4 | 4 | ● | 1 |
| **VQJHVD0200** | 2 | 8 | 60 | 6 | 4 | ● | 1 |
| **VQJHVD0250** | 2.5 | 10 | 60 | 6 | 4 | ● | 1 |
| **VQJHVD0300** | 3 | 12 | 60 | 6 | 4 | ● | 1 |
| **VQJHVD0350** | 3.5 | 14 | 60 | 6 | 4 | ● | 1 |
| **VQJHVD0400** | 4 | 16 | 60 | 6 | 4 | ● | 1 |
| **VQJHVD0450** | 4.5 | 18 | 60 | 6 | 4 | ● | 1 |
| **VQJHVD0500** | 5 | 20 | 60 | 6 | 4 | ● | 1 |
| **VQJHVD0600** | 6 | 24 | 60 | 6 | 4 | ● | 2 |
| **VQJHVD0700** | 7 | 25 | 80 | 8 | 4 | ● | 1 |
| **VQJHVD0800** | 8 | 28 | 80 | 8 | 4 | ● | 2 |
| **VQJHVD0900** | 9 | 32 | 90 | 10 | 4 | ● | 1 |
| **VQJHVD1000** | 10 | 35 | 90 | 10 | 4 | ● | 2 |
| **VQJHVD1200** | 12 | 40 | 100 | 12 | 4 | ● | 2 |
| **VQJHVD1600** | 16 | 55 | 125 | 16 | 4 | ★ | 2 |
| **VQJHVD2000** | 20 | 70 | 140 | 20 | 4 | ★ | 2 |

(Note 1) SMART MIRACLE coating 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

**● : USA Stock ★ : Stocked in Japan**

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

# VQJHV

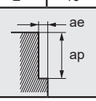
End mill, Semi-long cut length, 4 flute, Irregular helix flutes

## ■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, Cobaly 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 | 530 | 2.5 | 0.1 | 100 | 32000 | 410 | 2.5 | 0.1 | 80 | 25000 | 300 | 2.5 | 0.05 | 75 | 24000 | 290 | 2.5 | 0.05 |
| 2 | 130 | 21000 | 700 | 5 | 0.2 | 100 | 16000 | 510 | 5 | 0.2 | 80 | 13000 | 390 | 5 | 0.1 | 75 | 12000 | 360 | 5 | 0.1 |
| 3 | 130 | 14000 | 960 | 7.5 | 0.3 | 100 | 11000 | 680 | 7.5 | 0.3 | 80 | 8500 | 490 | 7.5 | 0.15 | 75 | 8000 | 460 | 7.5 | 0.15 |
| 4 | 130 | 10000 | 1000 | 10 | 0.4 | 100 | 8000 | 690 | 10 | 0.4 | 80 | 6400 | 540 | 10 | 0.2 | 75 | 6000 | 510 | 10 | 0.2 |
| 5 | 130 | 8300 | 1100 | 12.5 | 0.5 | 100 | 6400 | 730 | 12.5 | 0.5 | 80 | 5100 | 570 | 12.5 | 0.25 | 75 | 4800 | 540 | 12.5 | 0.25 |
| 6 | 130 | 6900 | 1200 | 15 | 0.6 | 100 | 5300 | 810 | 15 | 0.6 | 80 | 4200 | 630 | 15 | 0.3 | 75 | 4000 | 600 | 15 | 0.3 |
| 8 | 130 | 5200 | 1200 | 20 | 0.8 | 100 | 4000 | 840 | 20 | 0.8 | 80 | 3200 | 640 | 20 | 0.4 | 75 | 3000 | 600 | 20 | 0.4 |
| 10 | 130 | 4100 | 1100 | 25 | 1 | 100 | 3200 | 810 | 25 | 1 | 80 | 2500 | 590 | 25 | 0.5 | 75 | 2400 | 570 | 25 | 0.5 |
| 12 | 130 | 3400 | 1100 | 30 | 1.2 | 100 | 2700 | 780 | 30 | 1.2 | 80 | 2100 | 550 | 30 | 0.6 | 75 | 2000 | 520 | 30 | 0.6 |
| 16 | 130 | 2600 | 920 | 40 | 1.6 | 100 | 2000 | 640 | 40 | 1.6 | 80 | 1600 | 450 | 40 | 0.8 | 75 | 1500 | 420 | 40 | 0.8 |
| 20 | 130 | 2100 | 820 | 50 | 2 | 100 | 1600 | 570 | 50 | 2 | 80 | 1300 | 420 | 50 | 1 | 75 | 1200 | 390 | 50 | 1 |
| Depth of Cut |  | | | | | | | | | | | | | | | | | | | |



| Work Material | Copper, Copper Alloy | | | | | Heat Resistant Alloys | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| DC | 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 | 530 | 2.5 | 0.1 | 40 | 13000 | 73 | 2.5 | 0.02 |
| 2 | 160 | 25000 | 830 | 5 | 0.2 | 40 | 6400 | 90 | 5 | 0.04 |
| 3 | 160 | 17000 | 1200 | 7.5 | 0.3 | 40 | 4200 | 130 | 7.5 | 0.06 |
| 4 | 160 | 13000 | 1300 | 10 | 0.4 | 40 | 3200 | 190 | 10 | 0.08 |
| 5 | 160 | 10000 | 1300 | 12.5 | 0.5 | 40 | 2500 | 180 | 12.5 | 0.1 |
| 6 | 160 | 8500 | 1500 | 15 | 0.6 | 40 | 2100 | 180 | 15 | 0.12 |
| 8 | 160 | 6400 | 1500 | 20 | 0.8 | 40 | 1600 | 170 | 20 | 0.16 |
| 10 | 160 | 5100 | 1300 | 25 | 1 | 40 | 1300 | 170 | 25 | 0.2 |
| 12 | 160 | 4200 | 1300 | 30 | 1.2 | 40 | 1100 | 140 | 30 | 0.24 |
| 16 | 160 | 3200 | 1100 | 40 | 1.6 | 40 | 800 | 110 | 40 | 0.32 |
| 20 | 160 | 2500 | 970 | 50 | 2 | 40 | 640 | 80 | 50 | 0.4 |
| Depth of Cut |  | | | | | | | | | |



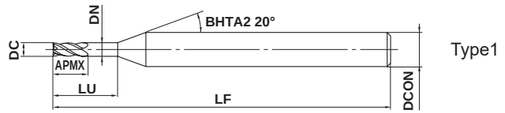
(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.
When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.
(Note 2) Effective 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

UWC | VQ | γ 35° | DC≤0.3 | DC≥0.4

| 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

| | | | | | |
|---|---|---|---|---|---|
| DC≤1 | | | | | |
| 0 - 0.010 | | | | | |
| 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.

(mm)

| 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** | |
| **VQXLD0040N010** | T8 |
| **VQXLD0040N018** | |
| **VQXLD0050N015** | T15 |
| **VQXLD0050N025** | |
| **VQXLD0050N030** | |
| **VQXLD0080N024** | TS25 |
| **VQXLD0080N040** | |
| **VQXLD0100N050** | T40 |

● : **USA Stock**

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

# VQXL

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

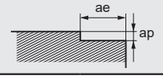
## ■Shoulder Milling

(mm)

| Work Material | | Carbon Steel, Alloy Steel, Mild Steel, Alloy Tool Steel, Austenitic Stainless Steels, Titanium Alloys Cobaly 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 |
| Depth of Cut | |   | | | | | | | | | |

## ■Face Milling

(mm)

| Work Material | | Carbon Steel, Alloy Steel, Mild Steel, Alloy Tool Steel, Austenitic Stainless Steels, Titanium Alloys Cobaly 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 |
| 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.

## ■Slot Milling

(mm)

| Work Material | | Carbon Steel, Alloy Steel, Mild Steel, Alloy Tool Steel, Austenitic Stainless Steels, Titanium Alloys Cobaly 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 | |   | | | | | | | |

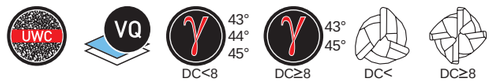
DC : Dia.

(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.

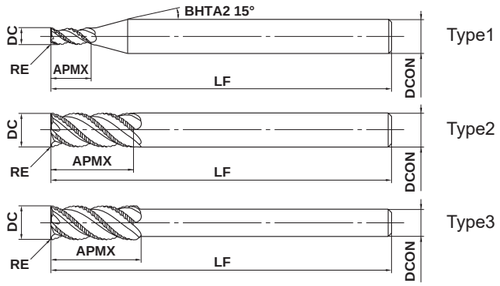
# Vibration Control End Mills for Machining Difficult-to-cut Materials

# 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 |
|---|---|---|---|---|---|---|---|
| ◎ | ○ | | | ◎ | ◎ | ○ | |




h6

| DCON=6 | 8≤DCON≤10 | 12≤DCON≤16 | DCON=20 | |
|---|---|---|---|---|
| 0<br>- 0.008 | 0<br>- 0.009 | 0<br>- 0.011 | 0<br>- 0.013 | |

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

(mm)

| 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

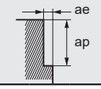
● : USA Stock ★ : Stocked in Japan

## ■ 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

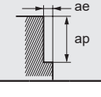
(mm)

| 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, Cobaly 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 | ae |
| 3 | 150 | 16000 | 960 | 4.5 | 1.5 | 120 | 13000 | 640 | 4.5 | 1.5 | 100 | 11000 | 450 | 4.5 | 1.5 | 75 | 8000 | 330 | 4.5 | 0.9 | 180 | 19000 | 1100 | 4.5 | 1.5 |
| 4 | 150 | 12000 | 960 | 6 | 2 | 120 | 9500 | 640 | 6 | 2 | 100 | 8000 | 430 | 6 | 2 | 75 | 6000 | 330 | 6 | 1.2 | 180 | 14000 | 1100 | 6 | 2 |
| 5 | 150 | 9500 | 960 | 7.5 | 2.5 | 120 | 7600 | 640 | 7.5 | 2.5 | 100 | 6400 | 440 | 7.5 | 2.5 | 75 | 4800 | 330 | 7.5 | 1.5 | 180 | 11000 | 1100 | 7.5 | 2.5 |
| 6 | 150 | 8000 | 960 | 9 | 3 | 120 | 6400 | 680 | 9 | 3 | 100 | 5300 | 480 | 9 | 3 | 75 | 4000 | 360 | 9 | 1.8 | 180 | 9500 | 1100 | 9 | 3 |
| 7 | 150 | 6800 | 950 | 10.5 | 3.5 | 120 | 5500 | 700 | 10.5 | 3.5 | 100 | 4500 | 500 | 10.5 | 3.5 | 75 | 3400 | 380 | 10.5 | 2.1 | 180 | 8200 | 1100 | 10.5 | 3.5 |
| 8 | 150 | 6000 | 1100 | 12 | 4 | 120 | 4800 | 800 | 12 | 4 | 100 | 4000 | 570 | 12 | 4 | 75 | 3000 | 430 | 12 | 2.4 | 180 | 7200 | 1300 | 12 | 4 |
| 9 | 150 | 5300 | 1100 | 13.5 | 4.5 | 120 | 4200 | 760 | 13.5 | 4.5 | 100 | 3500 | 570 | 13.5 | 4.5 | 75 | 2700 | 430 | 13.5 | 2.7 | 180 | 6400 | 1300 | 13.5 | 4.5 |
| 10 | 150 | 4800 | 1100 | 15 | 5 | 120 | 3800 | 760 | 15 | 5 | 100 | 3200 | 570 | 15 | 5 | 75 | 2400 | 430 | 15 | 3 | 180 | 5700 | 1200 | 15 | 5 |
| 12 | 150 | 4000 | 960 | 18 | 6 | 120 | 3200 | 700 | 18 | 6 | 100 | 2700 | 540 | 18 | 6 | 75 | 2000 | 400 | 18 | 3.6 | 180 | 4800 | 1200 | 18 | 6 |
| 14 | 150 | 3400 | 880 | 21 | 7 | 120 | 2700 | 650 | 21 | 7 | 100 | 2300 | 510 | 21 | 7 | 75 | 1700 | 380 | 21 | 4.2 | 180 | 4100 | 1100 | 21 | 7 |
| 16 | 150 | 3000 | 840 | 24 | 8 | 120 | 2400 | 620 | 24 | 8 | 100 | 2000 | 500 | 24 | 8 | 75 | 1500 | 380 | 24 | 4.8 | 180 | 3600 | 1000 | 24 | 8 |
| 18 | 150 | 2700 | 810 | 27 | 9 | 120 | 2100 | 590 | 27 | 9 | 100 | 1800 | 500 | 27 | 9 | 75 | 1300 | 360 | 27 | 5.4 | 180 | 3200 | 960 | 27 | 9 |
| 20 | 150 | 2400 | 760 | 30 | 10 | 120 | 1900 | 560 | 30 | 10 | 100 | 1600 | 500 | 30 | 10 | 75 | 1200 | 360 | 30 | 6 | 180 | 2900 | 920 | 30 | 10 |
| Depth of Cut |  | | | | | | | | | | | | | | | | | | | | | | | | |



### General Purpose 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, Cobaly 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 | ae |
| 3 | 120 | 13000 | 610 | 4.5 | 1.5 | 100 | 11000 | 430 | 4.5 | 1.5 | 80 | 8500 | 280 | 4.5 | 1.5 | 70 | 7400 | 240 | 4.5 | 0.9 | 140 | 15000 | 700 | 4.5 | 1.5 |
| 4 | 120 | 9500 | 610 | 6 | 2 | 100 | 8000 | 430 | 6 | 2 | 80 | 6400 | 280 | 6 | 2 | 70 | 5600 | 240 | 6 | 1.2 | 140 | 11000 | 700 | 6 | 2 |
| 5 | 120 | 7600 | 610 | 7.5 | 2.5 | 100 | 6400 | 430 | 7.5 | 2.5 | 80 | 5100 | 280 | 7.5 | 2.5 | 70 | 4500 | 250 | 7.5 | 1.5 | 140 | 8900 | 720 | 7.5 | 2.5 |
| 6 | 120 | 6400 | 610 | 9 | 3 | 100 | 5300 | 450 | 9 | 3 | 80 | 4200 | 300 | 9 | 3 | 70 | 3700 | 270 | 9 | 1.8 | 140 | 7400 | 720 | 9 | 3 |
| 7 | 120 | 5500 | 620 | 10.5 | 3.5 | 100 | 4500 | 480 | 10.5 | 3.5 | 80 | 3600 | 320 | 10.5 | 3.5 | 70 | 3200 | 290 | 10.5 | 2.1 | 140 | 6400 | 720 | 10.5 | 3.5 |
| 8 | 120 | 4800 | 720 | 12 | 4 | 100 | 4000 | 570 | 12 | 4 | 80 | 3200 | 380 | 12 | 4 | 70 | 2800 | 340 | 12 | 2.4 | 140 | 5600 | 840 | 12 | 4 |
| 9 | 120 | 4200 | 670 | 13.5 | 4.5 | 100 | 3500 | 510 | 13.5 | 4.5 | 80 | 2800 | 360 | 13.5 | 4.5 | 70 | 2500 | 320 | 13.5 | 2.7 | 140 | 5000 | 800 | 13.5 | 4.5 |
| 10 | 120 | 3800 | 670 | 15 | 5 | 100 | 3200 | 510 | 15 | 5 | 80 | 2500 | 360 | 15 | 5 | 70 | 2200 | 310 | 15 | 3 | 140 | 4500 | 790 | 15 | 5 |
| 12 | 120 | 3200 | 610 | 18 | 6 | 100 | 2700 | 470 | 18 | 6 | 80 | 2100 | 340 | 18 | 6 | 70 | 1900 | 300 | 18 | 3.6 | 140 | 3700 | 710 | 18 | 6 |
| 14 | 120 | 2700 | 560 | 21 | 7 | 100 | 2300 | 440 | 21 | 7 | 80 | 1800 | 320 | 21 | 7 | 70 | 1600 | 280 | 21 | 4.2 | 140 | 3200 | 670 | 21 | 7 |
| 16 | 120 | 2400 | 540 | 24 | 8 | 100 | 2000 | 410 | 24 | 8 | 80 | 1600 | 320 | 24 | 8 | 70 | 1400 | 280 | 24 | 4.8 | 140 | 2800 | 630 | 24 | 8 |
| 18 | 120 | 2100 | 500 | 27 | 9 | 100 | 1800 | 400 | 27 | 9 | 80 | 1400 | 310 | 27 | 9 | 70 | 1200 | 270 | 27 | 5.4 | 140 | 2500 | 600 | 27 | 9 |
| 20 | 120 | 1900 | 480 | 30 | 10 | 100 | 1600 | 380 | 30 | 10 | 80 | 1300 | 310 | 30 | 10 | 70 | 1100 | 270 | 30 | 6 | 140 | 2200 | 560 | 30 | 10 |
| Depth of Cut |  | | | | | | | | | | | | | | | | | | | | | | | | |



(Note 1) SMART MIRACLE coating 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

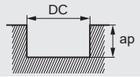
Roughing, Short cut length, 4 flute, Irregular helix flutes

## ■ 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.

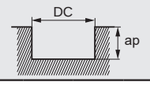
### High Efficiency Cutting Conditions

(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, Cobaly 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) | ap |
| 3 | 120 | 13000 | 720 | 3 | 100 | 11000 | 440 | 3 | 80 | 8500 | 340 | 3 | 60 | 6400 | 250 | 1.5 | 150 | 16000 | 890 | 3 |
| 4 | 120 | 9500 | 720 | 4 | 100 | 8000 | 450 | 4 | 80 | 6400 | 340 | 4 | 60 | 4800 | 250 | 2 | 150 | 12000 | 900 | 4 |
| 5 | 120 | 7600 | 720 | 5 | 100 | 6400 | 460 | 5 | 80 | 5100 | 300 | 5 | 60 | 3800 | 230 | 2.5 | 150 | 9500 | 900 | 5 |
| 6 | 120 | 6400 | 720 | 6 | 100 | 5300 | 460 | 6 | 80 | 4200 | 310 | 6 | 60 | 3200 | 240 | 3 | 150 | 8000 | 900 | 6 |
| 7 | 120 | 5500 | 730 | 7 | 100 | 4500 | 470 | 7 | 80 | 3600 | 330 | 7 | 60 | 2700 | 250 | 3.5 | 150 | 6800 | 950 | 7 |
| 8 | 120 | 4800 | 840 | 8 | 100 | 4000 | 560 | 8 | 80 | 3200 | 400 | 8 | 60 | 2400 | 300 | 4 | 150 | 6000 | 1100 | 8 |
| 9 | 120 | 4200 | 810 | 9 | 100 | 3500 | 540 | 9 | 80 | 2800 | 350 | 9 | 60 | 2100 | 260 | 4.5 | 150 | 5300 | 1000 | 9 |
| 10 | 120 | 3800 | 800 | 10 | 100 | 3200 | 520 | 10 | 80 | 2500 | 340 | 10 | 60 | 1900 | 260 | 5 | 150 | 4800 | 1000 | 10 |
| 12 | 120 | 3200 | 750 | 12 | 100 | 2700 | 480 | 12 | 80 | 2100 | 340 | 12 | 60 | 1600 | 260 | 6 | 150 | 4000 | 940 | 12 |
| 14 | 120 | 2700 | 670 | 14 | 100 | 2300 | 420 | 14 | 80 | 1800 | 300 | 14 | 60 | 1400 | 240 | 7 | 150 | 3400 | 840 | 14 |
| 16 | 120 | 2400 | 620 | 16 | 100 | 2000 | 380 | 16 | 80 | 1600 | 290 | 16 | 60 | 1200 | 220 | 8 | 150 | 3000 | 780 | 16 |
| 18 | 120 | 2100 | 570 | 18 | 100 | 1800 | 380 | 18 | 80 | 1400 | 260 | 18 | 60 | 1100 | 210 | 9 | 150 | 2700 | 730 | 18 |
| 20 | 120 | 1900 | 540 | 20 | 100 | 1600 | 350 | 20 | 80 | 1300 | 260 | 20 | 60 | 950 | 190 | 10 | 150 | 2400 | 680 | 20 |
| Depth of Cut |   DC : Dia. | | | | | | | | | | | | | | | | | | | |

### General Purpose 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, Cobaly 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) | ap |
| 3 | 100 | 11000 | 490 | 3 | 80 | 8500 | 300 | 3 | 60 | 6400 | 200 | 3 | 50 | 5300 | 170 | 1.5 | 120 | 13000 | 580 | 3 |
| 4 | 100 | 8000 | 490 | 4 | 80 | 6400 | 310 | 4 | 60 | 4800 | 200 | 4 | 50 | 4000 | 170 | 2 | 120 | 9500 | 580 | 4 |
| 5 | 100 | 6400 | 490 | 5 | 80 | 5100 | 310 | 5 | 60 | 3800 | 200 | 5 | 50 | 3200 | 170 | 2.5 | 120 | 7600 | 580 | 5 |
| 6 | 100 | 5300 | 490 | 6 | 80 | 4200 | 310 | 6 | 60 | 3200 | 200 | 6 | 50 | 2700 | 170 | 3 | 120 | 6400 | 580 | 6 |
| 7 | 100 | 4500 | 500 | 7 | 80 | 3600 | 320 | 7 | 60 | 2700 | 200 | 7 | 50 | 2300 | 170 | 3.5 | 120 | 5500 | 620 | 7 |
| 8 | 100 | 4000 | 600 | 8 | 80 | 3200 | 380 | 8 | 60 | 2400 | 240 | 8 | 50 | 2000 | 200 | 4 | 120 | 4800 | 720 | 8 |
| 9 | 100 | 3500 | 540 | 9 | 80 | 2800 | 330 | 9 | 60 | 2100 | 210 | 9 | 50 | 1800 | 180 | 4.5 | 120 | 4200 | 650 | 9 |
| 10 | 100 | 3200 | 540 | 10 | 80 | 2500 | 330 | 10 | 60 | 1900 | 210 | 10 | 50 | 1600 | 180 | 5 | 120 | 3800 | 640 | 10 |
| 12 | 100 | 2700 | 510 | 12 | 80 | 2100 | 320 | 12 | 60 | 1600 | 210 | 12 | 50 | 1300 | 170 | 6 | 120 | 3200 | 600 | 12 |
| 14 | 100 | 2300 | 460 | 14 | 80 | 1800 | 300 | 14 | 60 | 1400 | 190 | 14 | 50 | 1100 | 150 | 7 | 120 | 2700 | 540 | 14 |
| 16 | 100 | 2000 | 410 | 16 | 80 | 1600 | 290 | 16 | 60 | 1200 | 170 | 16 | 50 | 990 | 140 | 8 | 120 | 2400 | 500 | 16 |
| 18 | 100 | 1800 | 390 | 18 | 80 | 1400 | 260 | 18 | 60 | 1100 | 170 | 18 | 50 | 880 | 130 | 9 | 120 | 2100 | 460 | 18 |
| 20 | 100 | 1600 | 360 | 20 | 80 | 1300 | 260 | 20 | 60 | 950 | 150 | 20 | 50 | 800 | 130 | 10 | 120 | 1900 | 430 | 20 |
| Depth of Cut |   DC : Dia. | | | | | | | | | | | | | | | | | | | |

(Note 1) SMART MIRACLE coating 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.

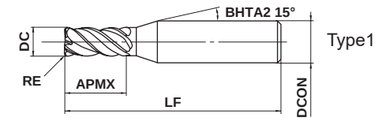


# VQMHVRB - Inch sizes

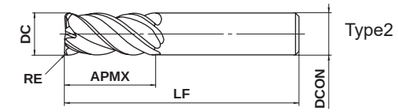
Corner radius, Medium cut length, 4 flute, Irregular helix flutes

UWC | VQ | γ 37° 40°

| 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

| | | | | | |
|---|---|---|---|---|---|
| | .008"≤RE≤.120" | | | | |
| | ±.0006" | | | | |
| | 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.

(inch)

| 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

● : **USA Stock**

# 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)

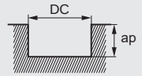
| Work Material | Carbon Steel (−30HRC) | | | | | | Alloy Steel, Pre-hardened Steel | | | | | | Austenitic Stainless Steel, Titanium Alloy | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | High Speed Cutting | | General Purpose Cutting | | ap | ae | High 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 |  | | | | | | | | | | | | | | | | | |

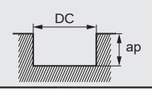
| Work Material | Precipitation Hardening Stainless Steel, Cobaly Chromium Alloy | | | | | | Copper, Copper Alloy | | | | | | Heat Resistant Alloy | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | High Speed Cutting | | General Purpose Cutting | | ap | ae | 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 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | 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, Cobarly Chromium Alloy | | | | | Copper, Copper Alloy | | | | | Heat Resistant Alloy | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | 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 |
| Depth of Cut |  DC : Dia. | | | | | | | | | | | | | | |

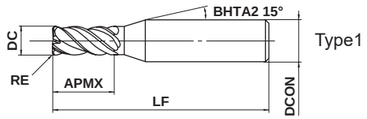
(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work. When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.
(Note 2) Effective 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.

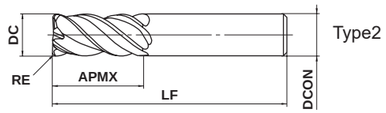
# Vibration Control End Mills for Machining Difficult-to-cut Materials

# VQMHVRB

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 |
|---|---|---|---|---|---|---|---|
| ◎ | ○ | | | ◎ | ◎ | ○ | |




| | | | | |
|---|---|---|---|---|
| 0.2≤RE≤6.35 | | | | |
| ±0.015 | | | | |
| DC≤12 | DC>12 | | | |
| 0<br>- 0.02 | 0<br>- 0.03 | | | |
| 4≤DCON≤6 | 8≤DCON≤10 | 12≤DCON≤16 | DCON=20 | |
| 0<br>- 0.008 | 0<br>- 0.009 | 0<br>- 0.011 | 0<br>- 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.

(mm)

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

(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

● : USA Stock ★ : Stocked in Japan

(mm)

| Order Number | DC | RE | APMX | LF | DCON | * No. F | Stock | Type |
|---|---|---|---|---|---|---|---|---|
| **VQMHVRBD1200R250** | 12 | 2.5 | 26 | 75 | 12 | 4 | ● | 2 |
| **VQMHVRBD1200R300** | 12 | 3 | 26 | 75 | 12 | 4 | ● | 2 |
| **VQMHVRBD1600R100** | 16 | 1 | 35 | 90 | 16 | 4 | ★ | 2 |
| **VQMHVRBD1600R150** | 16 | 1.5 | 35 | 90 | 16 | 4 | ★ | 2 |
| **VQMHVRBD1600R200** | 16 | 2 | 35 | 90 | 16 | 4 | ★ | 2 |
| **VQMHVRBD1600R250** | 16 | 2.5 | 35 | 90 | 16 | 4 | ★ | 2 |
| **VQMHVRBD1600R300** | 16 | 3 | 35 | 90 | 16 | 4 | ★ | 2 |
| **VQMHVRBD1600R400** | 16 | 4 | 35 | 90 | 16 | 4 | ★ | 2 |
| **VQMHVRBD1600R500** | 16 | 5 | 35 | 90 | 16 | 4 | ★ | 2 |
| **VQMHVRBD2000R100** | 20 | 1 | 45 | 110 | 20 | 4 | ★ | 2 |
| **VQMHVRBD2000R150** | 20 | 1.5 | 45 | 110 | 20 | 4 | ★ | 2 |
| **VQMHVRBD2000R200** | 20 | 2 | 45 | 110 | 20 | 4 | ★ | 2 |
| **VQMHVRBD2000R250** | 20 | 2.5 | 45 | 110 | 20 | 4 | ★ | 2 |
| **VQMHVRBD2000R300** | 20 | 3 | 45 | 110 | 20 | 4 | ★ | 2 |
| **VQMHVRBD2000R400** | 20 | 4 | 45 | 110 | 20 | 4 | ★ | 2 |
| **VQMHVRBD2000R500** | 20 | 5 | 45 | 110 | 20 | 4 | ★ | 2 |
| **VQMHVRBD2000R635** | 20 | 6.35 | 45 | 110 | 20 | 4 | ★ | 2 |

(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, Cobaly 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, Cobaly 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 | ae |
| 2 | 180 | 29000 | 2900 | 3 | 0.6 | 40 | 6400 | 230 | 3 | 0.2 |
| 3 | 180 | 19000 | 3000 | 4.5 | 0.9 | 40 | 4200 | 240 | 4.5 | 0.3 |
| 4 | 180 | 14000 | 3000 | 6 | 1.2 | 40 | 3200 | 240 | 6 | 0.4 |
| 5 | 180 | 11000 | 3000 | 7.5 | 1.5 | 40 | 2500 | 240 | 7.5 | 0.5 |
| 6 | 180 | 9500 | 3000 | 9 | 1.8 | 40 | 2100 | 250 | 9 | 0.6 |
| 8 | 180 | 7200 | 3000 | 12 | 2.4 | 40 | 1600 | 260 | 12 | 0.8 |
| 10 | 180 | 5700 | 2700 | 15 | 3 | 40 | 1300 | 290 | 15 | 1 |
| 12 | 180 | 4800 | 2300 | 18 | 3.6 | 40 | 1100 | 280 | 18 | 1.2 |
| 16 | 180 | 3600 | 1900 | 24 | 4.8 | 40 | 800 | 200 | 24 | 1.6 |
| 20 | 180 | 2900 | 1600 | 30 | 6 | 40 | 640 | 160 | 30 | 2 |
| 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 | ae |
| 2 | 140 | 22000 | 1500 | 3 | 0.6 | 30 | 4800 | 110 | 3 | 0.2 |
| 3 | 140 | 15000 | 1600 | 4.5 | 0.9 | 30 | 3200 | 120 | 4.5 | 0.3 |
| 4 | 140 | 11000 | 1600 | 6 | 1.2 | 30 | 2400 | 120 | 6 | 0.4 |
| 5 | 140 | 8900 | 1600 | 7.5 | 1.5 | 30 | 1900 | 120 | 7.5 | 0.5 |
| 6 | 140 | 7400 | 1600 | 9 | 1.8 | 30 | 1600 | 130 | 9 | 0.6 |
| 8 | 140 | 5600 | 1600 | 12 | 2.4 | 30 | 1200 | 130 | 12 | 0.8 |
| 10 | 140 | 4500 | 1400 | 15 | 3 | 30 | 950 | 140 | 15 | 1 |
| 12 | 140 | 3700 | 1200 | 18 | 3.6 | 30 | 800 | 140 | 18 | 1.2 |
| 16 | 140 | 2800 | 1000 | 24 | 4.8 | 30 | 600 | 100 | 24 | 1.6 |
| 20 | 140 | 2200 | 780 | 30 | 6 | 30 | 480 | 81 | 30 | 2 |
| 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

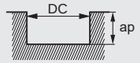
Corner radius, Medium cut length, 4 flute, Irregular helix flutes

## ■ 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.

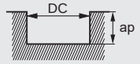
### High Efficiency Cutting Conditions

(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, Cobaly 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) | 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)

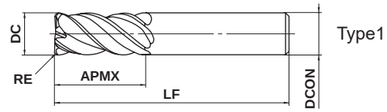
| Work Material | Carbon Steel, Alloy Steel, Mild Steel | | | | Pre-hardened Steel, Carbon Steel, Alloy Steel, Alloy Tool Steel | | | | Austenitic, Ferritic and Martensitic Stainless Steels, Titanium Alloys | | | | Precipitation Hardening Stainless Steels, Cobaly Chromium Alloy | | | | Copper, Copper Alloy | | | | Heat Resistant Alloys | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | vc (m/min) | n ($min^{-1}$) | vf (mm/min) | ap | vc (m/min) | n ($min^{-1}$) | vf (mm/min) | | 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 |
|---|---|---|---|---|---|---|---|
| ○ | ○ | | | ○ | ◎ | ○ | |



Type1

| | | | | | |
|---|---|---|---|---|---|
| | .015"≤RE≤.120" | | | | |
| | ±.0006" | | | | |
| | 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 delivering stable performance on finish cutting for difficult-to-cut materials such as inconel.

(inch)

| 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

● : **USA Stock**

# VQMHVRBF- Inch sizes

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

## ■Shoulder Milling

(inch)

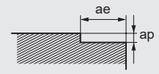
| Work Material | Carbon Steel (—30Hrc) | | | | Alloy Steel, Pre-hardened Steel | | | | Precipitation Hardening Stainless Steel, Cobaly Chromium Alloy | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | n ($min^{-1}$) | vf (IPM) | ap | ae | n ($min^{-1}$) | vf (IPM) | ap | ae | n ($min^{-1}$) | 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 |  | | | | | | | | | | | |

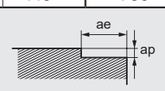
| Work Material | Copper, Copper Alloy | | | | Heat Resistant Alloy | | | |
|---|---|---|---|---|---|---|---|---|
| DC | n ($min^{-1}$) | vf (IPM) | ap | ae | n ($min^{-1}$) | vf (IPM) | ap | ae |
| 1/4 | 9000 | 113 | .38 | .013 | 2000 | 9.5 | .38 | .008 |
| 5/16 | 7200 | 119 | .47 | .016 | 1600 | 10.1 | .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, Cobaly 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 |  | | | | | | | |

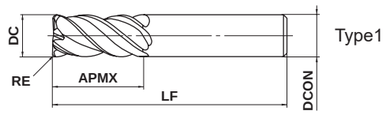
(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work. When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.
(Note 2) Effective 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

## VQMHVRBF

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 |
|---|---|---|---|---|---|---|---|
| ○ | ○ | | | ○ | ◎ | ○ | |




Type1

| | | | | | |
|---|---|---|---|---|---|
| 0.3≤RE≤2 | | | | | |
| ±0.015 | | | | | |
| DC≤12 | DC>12 | | | | |
| 0<br>- 0.02 | 0<br>- 0.03 | | | | |
| DCON=6 | 8≤DCON≤10 | 12≤DCON≤16 | | | |
| 0<br>- 0.008 | 0<br>- 0.009 | 0<br>- 0.011 | | | |

● 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 |
|---|---|---|---|---|---|---|---|---|
| **VQMHVRBFD0600R030** | 6 | 0.3 | 13 | 50 | 6 | 4 | ● | 1 |
| **VQMHVRBFD0600R050** | 6 | 0.5 | 13 | 50 | 6 | 4 | ● | 1 |
| **VQMHVRBFD0600R100** | 6 | 1 | 13 | 50 | 6 | 4 | ● | 1 |
| **VQMHVRBFD0800R050** | 8 | 0.5 | 19 | 60 | 8 | 4 | ● | 1 |
| **VQMHVRBFD0800R100** | 8 | 1 | 19 | 60 | 8 | 4 | ● | 1 |
| **VQMHVRBFD1000R030** | 10 | 0.3 | 22 | 70 | 10 | 4 | ● | 1 |
| **VQMHVRBFD1000R050** | 10 | 0.5 | 22 | 70 | 10 | 4 | ● | 1 |
| **VQMHVRBFD1000R100** | 10 | 1 | 22 | 70 | 10 | 4 | ● | 1 |
| **VQMHVRBFD1000R200** | 10 | 2 | 22 | 70 | 10 | 4 | ● | 1 |
| **VQMHVRBFD1200R100** | 12 | 1 | 26 | 75 | 12 | 4 | ● | 1 |
| **VQMHVRBFD1200R200** | 12 | 2 | 26 | 75 | 12 | 4 | ● | 1 |
| **VQMHVRBFD1200R300** | 12 | 3 | 26 | 75 | 12 | 4 | ● | 1 |
| **VQMHVRBFD1600R100** | 16 | 1 | 35 | 90 | 16 | 4 | ★ | 1 |
| **VQMHVRBFD1600R200** | 16 | 2 | 35 | 90 | 16 | 4 | ★ | 1 |

(Note 1) SMART MIRACLE coating 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

● : USA Stock ★ : Stocked in Japan

### ■ Shoulder Milling

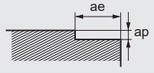
(mm)

| Work Material | Carbon Steel, Alloy Steel, Mild Steel | | | | | Pre-hardened Steel, Carbon Steel, Alloy Tool Steel | | | | | Precipitation Hardening Stainless Steels, Cobaly Chromium Alloy | | | | | 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 | 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 Tool Steel | | | | | Precipitation Hardening Stainless Steels, Cobaly Chromium Alloy | | | | | 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 | 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 |  | | | | | | | | | | | | | | | | | | | | | | | | |



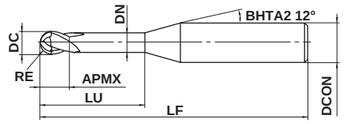
(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.
When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.
(Note 2) Effective 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

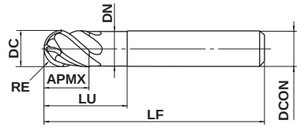
## VQ4SVB - Inch sizes

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

| | | | | | |
|---|---|---|---|---|---|
| .0625"≤RE≤.2500" | | | | | |
| ±.0004" | | | | | |
| DC<.5000" | DC=.5000" | | | | |
| 0<br>- .0008" | 0<br>- .0012" | | | | |
| .250"≤DCON≤.375" | DCON=.500" | | | | |
| 0<br>- .00035" | 0<br>- .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 |

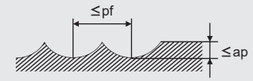
(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work.
When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

* Number of Flutes

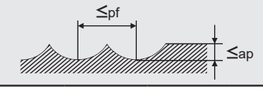
● : USA Stock

## ■Shoulder Milling (Slot Milling)

(inch)

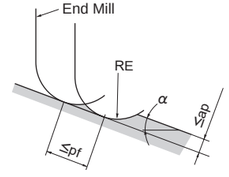
| Work Material | Carbon Steel, Alloy Steel, Mild Steel, Pre-hardened Steel | | | | | | Austenitic Steinless Steel, Titanium Alloy, Precipitation Hardening Stainless Steels, Cobaly Chomium Alloy, Ferritic And Martensitic Stainless Steels | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RE | α≤15° | | α>15° | | ap | pf | α≤15° | | α>15° | | 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 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RE | α≤15° | | α>15° | | ap | pf | α≤15° | | α>15° | | 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.

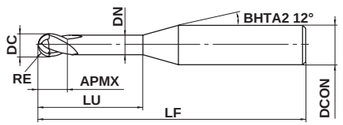


# Vibration Control End Mills for Machining Difficult-to-cut Materials

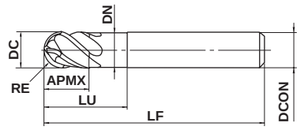
## VQ4SVB

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

| | | | | |
|---|---|---|---|---|
| 1≤RE≤6 | | | | |
| ±0.01 | | | | |
| DC≤12 | | | | |
| 0 - 0.02 | | | | |
| DCON=6 | 8≤DCON≤10 | DCON=12 | | |
| 0 - 0.008 | 0 - 0.009 | 0 - 0.011 | | |

● 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 |

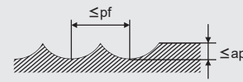
(Note 1) SMART MIRACLE coating has reduced electric conductivity; therefore an external contact type (electric transmitted) tool setter may not work. When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

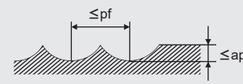
* Number of Flutes

● : USA Stock ★ : Stocked in Japan

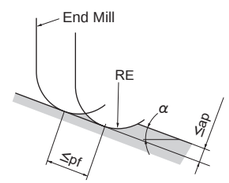
## ■ Shoulder Milling (Slot Milling)

(mm)

| Work Material | Carbon Steel, Alloy Steel, Mild Steel, Pre-hardened Steel | | | | | | | | Austenitic Stainless Steel, Titanium Alloy, Precipitation Hardening Stainless Steels, Cobaly Chromium Alloy, Ferritic And Martensitic Stainless Steels | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RE | α≤15° | | | α>15° | | | ap | pf | α≤15° | | | α>15° | | | 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 |   | | | | | | | | | | | | | | | |

| Work Material | Copper, Copper Alloy | | | | | | | | Heat Resistant Alloys | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RE | α≤15° | | | α>15° | | | ap | pf | α≤15° | | | α>15° | | | 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.



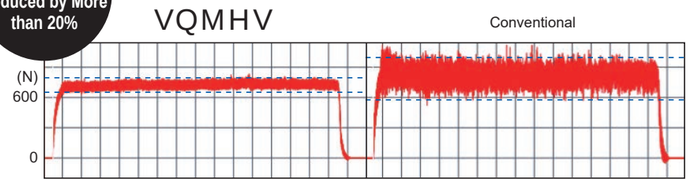
# Benefits of the ZERO-μ Surface

**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



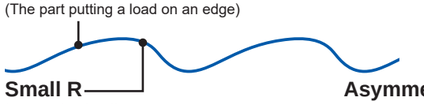

# VQSVR
# Feature of Asymmetrical Nick

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

## Nick Geometry of VQSVR

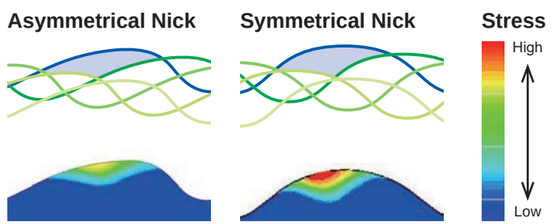
Achieve a long tool life without fracture

**Large R**
(The part putting a load on an edge)

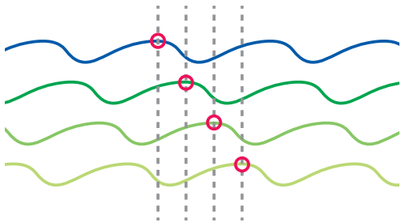



(The part not putting a load on an edge)

## Cutting Amount of Each Nick




## 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<br>Having a Distance between Clamp and Machining Part<br>3 Claw Chuck, Weak Fixture<br>Less Clamp Spots<br>○ Low<br>▼ High | Machining with Long Overhang<br>○ Long<br>▼ Short | BT20<br>Small Spindle Rigidity<br>Old Machine<br>○ Low<br>▼ High |
| **Square** | | | |

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

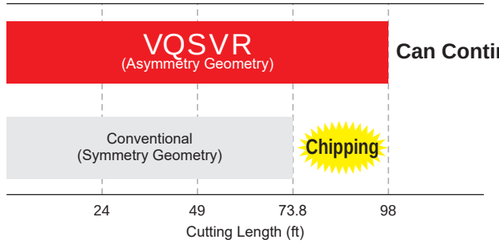


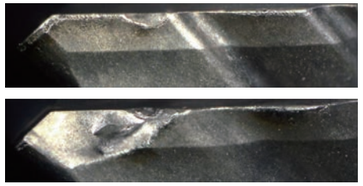
# Roughing End Mill, 4 Flute, Irregular Helix Flutes

# VQSVR

## Cutting Performance

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



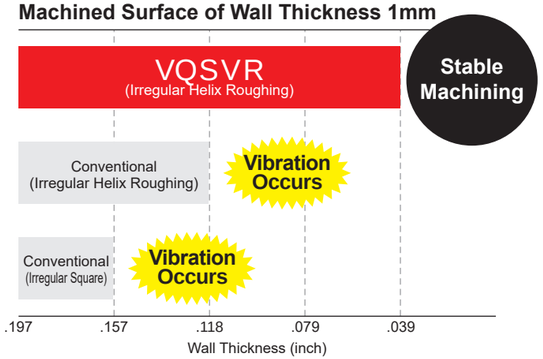




Cutting Length 73.8 feet

<Cutting Conditions>
Work Material : AISI 304
Tool Size : DC=10mm
Revolution : 2500$min^{-1}$ (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.

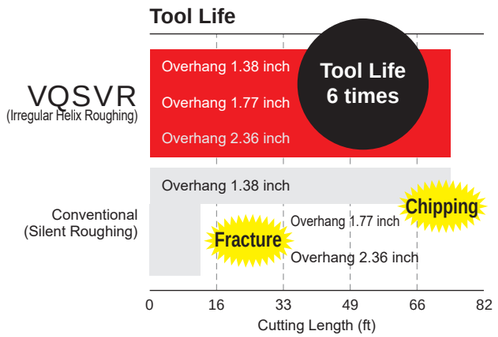
**Machined Surface of Wall Thickness 1mm**




<Cutting Conditions>
Work material : AISI 304
Tool Size : DC=10mm
Revolution : 3200$min^{-1}$ (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 DC×4 or more)

**Tool Life**




| | 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 : 2550$min^{-1}$ (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)

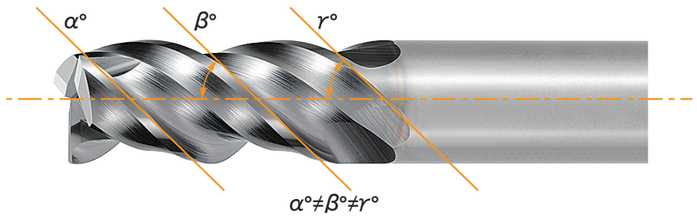
# End Mill, 3 Flute for Drilling and Slot Milling

## 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.

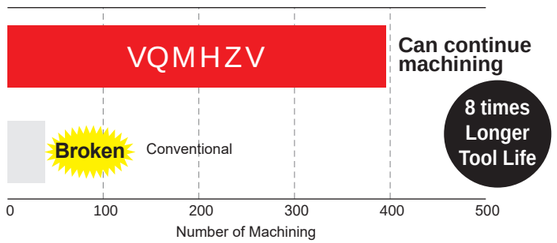



Unique geometry - 3 flute end mill with irregular helix flutes suppresses chatter for increased machining stability.
Optimized tool geometry and SMART MIRACLE coating give excellent chip evacuation for higher efficiency.
The performance of VQMHZVOH when drilling is significantly improved on difficult-to-cut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

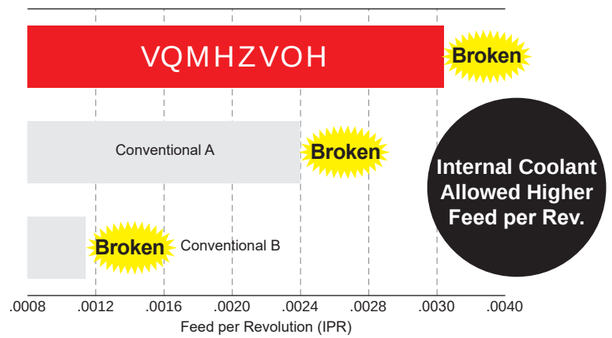



<Cutting Conditions>

| | |
|---|---|
| Work Material | : AISI 304 |
| End Mill | : VQMHZVD0800 (DC=8mm) |
| Revolution | : 2400min$^{-1}$ |
| 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 conventionals.




<Cutting Conditions>

| | |
|---|---|
| Work Material | : AISI 304 |
| End Mill | : VQMHZVOHD0600 (DC=6mm) |
| Revolution | : 3200min$^{-1}$ |
| 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

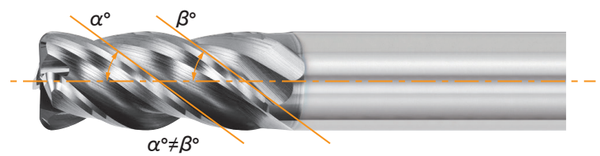
A carbide substrate with excellent wear and fracture resistance allows a wide range of different machining applications.

## VQMHVRB

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

## VQMHVRBF

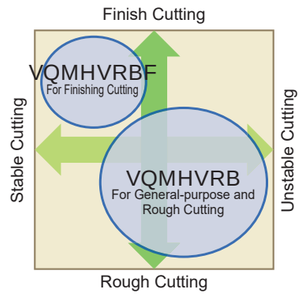
Ideal for finish machining of heat resistant alloys and precipitation hardening stainless steels due to the special carbide substrate with excellent wear resistance.




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 VQMHVRB and VQMHVRBF

**Comparing Different Forms of Machining**




**Comparing Different Work Material**

<Finish Cutting>

◎=1st Recommendation
○=2nd Recommendation

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

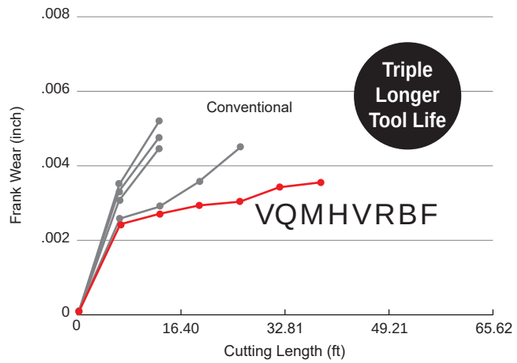
# Cutting Performance

**Wear Resistance against Super Alloys**

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

<Cutting Conditions>

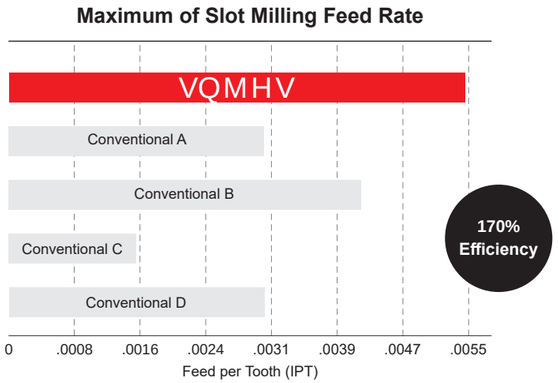
| | |
|---|---|
| Work Material | : Inconel718 |
| End Mill | : VQMHVRBFD1000R050 (DC=10mm / RE=0.5mm) |
| Revolution | : 950min$^{-1}$ |
| Cutting Speed | : 100 SFM |
| Table Feed | : 4.331 IPM(.001 IPT) |
| Depth of Cut | : ap .197 inch, ae .012 inch |
| Overhang Length | : 1.378 inch |
| Cutting Mode | : Down(Climb) Cut External Coolant (Emulsion) |
| Machine | : Vertical M/C (BT50) |



# Cutting Performance

### Efficiency Comparison in AISI 304

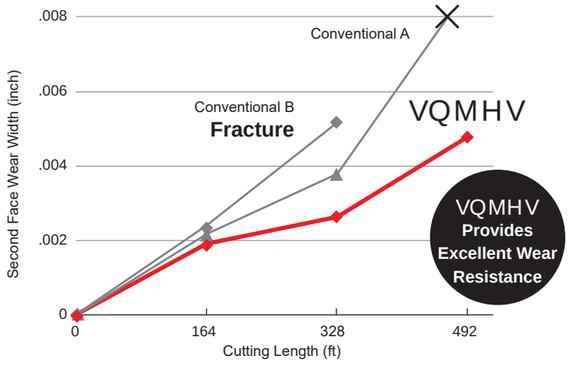
Compared to conventional machining time can be shortened by using high efficiency machining methods.




<Cutting Conditions>
Work Material : AISI 304
End Mill : VQMHVD1000 (DC=10mm)
Revolution : 4800min-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

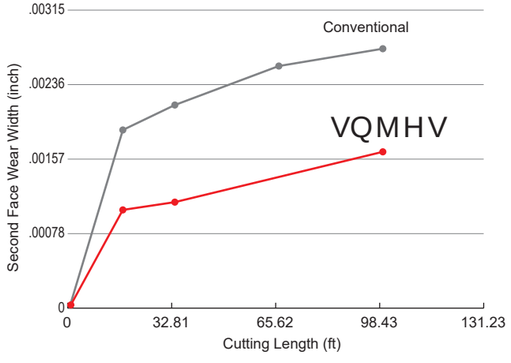
The wear resistance of SMART MIRACLE End Mills exceeds that of conventional end mills when machining Ti-6Al-4V.



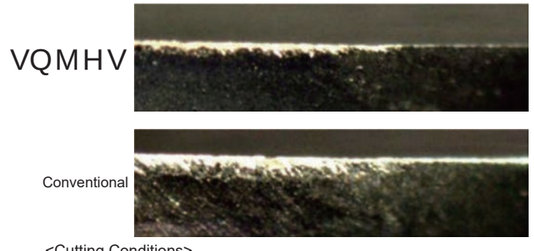

<Cutting Conditions>
Work Material : Ti-6Al-4V
End Mill : VQMHVD0600 (DC=6mm)
Revolution : 8000min-1
Cutting Speed : 490 SFM
Table Feed : 63 IPM(.002 IPT)
Depth of Cut : ap .236 inch, ae .012 inch
Overhang Length : .787 inch
Cutting Mode : Down(Climb) Cut
External Coolant (Emulsion)
Machine : Vertical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

### Comparison of Wear in Cobalt Chromium Alloy

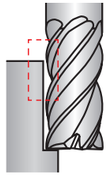
Long tool life even when machining cobalt chromium alloy used in the medical industry.




**Wear at the depth of cut point after 98.43 feet machining**

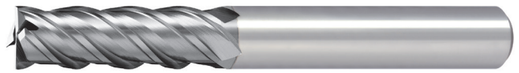



<Cutting Conditions>
Work Material : Cobalt Chromium Alloy
End Mill : VQMHVD0600 (DC=6mm)
Revolution : 3700min-1
Cutting Speed : 227 SFM
Table Feed : 29 IPM(.002 IPT)
Depth of Cut : ap .079 inch, ae .012 inch
Overhang Length : .787 inch
Cutting Mode : Down(Climb) Cut
External Coolant (Emulsion)
Machine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



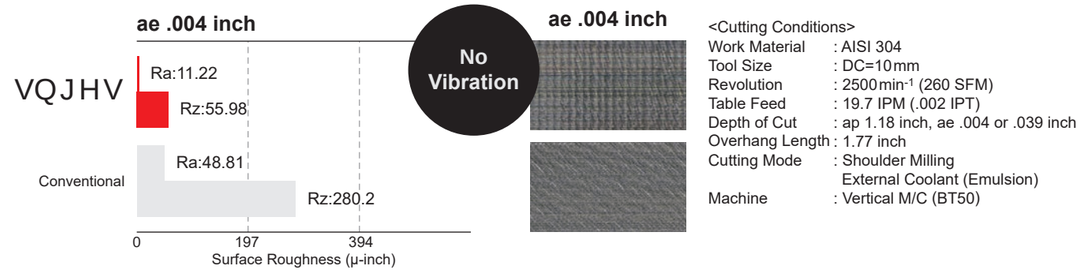
# End Mill, 4 Flute, Irregular Helix Flutes

VQJHV



# Cutting Performance

Irregular helix provides an excellent finishing performance without vibration.




<Cutting Conditions>
Work Material : AISI 304
Tool Size : DC=10mm
Revolution : 2500min-1 (260 SFM)
Table Feed : 19.7 IPM (.002 IPT)
Depth of Cut : ap 1.18 inch, ae .004 or .039 inch
Overhang Length : 1.77 inch
Cutting Mode : Shoulder Milling
External Coolant (Emulsion)
Machine : Vertical M/C (BT50)

Surface roughness is improved by decreasing a Feed per Tooth.




<Cutting Conditions>
Work Material : AISI 304
Tool Size : DC=10mm
Revolution : 2500min-1 (260 SFM)
Table Feed : 3.93–39.37 IPM (.0004–.0039 IPT)
Depth of Cut : ap 1.18 inch, ae .012 inch
Overhang Length : 1.77 inch
Cutting Mode : Shoulder Milling
External Coolant (Emulsion)
Machine : Vertical M/C (BT50)

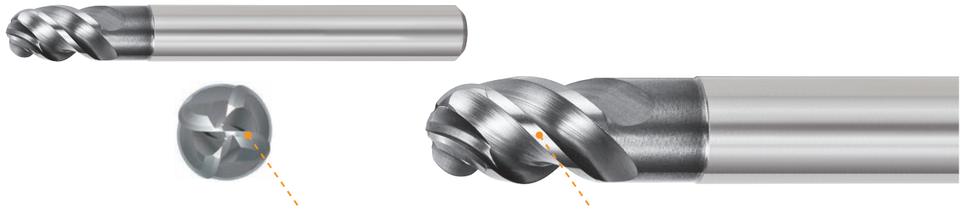
Available condition for finishing is ae .020inch or less when considering only the roughness of machining surface.




<Cutting Conditions>
Work Material : AISI 304
Tool Size : DC=10mm
Revolution : 2500min-1 (260 SFM)
Table Feed : 19.7 IPM (.002 IPT)
Depth of Cut : ap 1.18 inch, ae .004– .020 inch
Overhang Length : 1.77 inch
Cutting Mode : Shoulder Milling
External Coolant (Emulsion)
Machine : Vertical M/C (BT50)

# Ball Nose, 4 Flute, Irregular Curve

## VQ4SVB

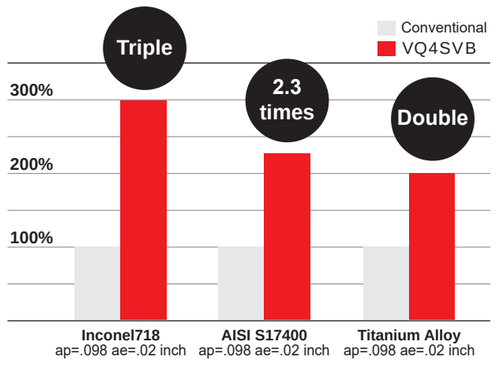


Irregular curve and irregular pitch.

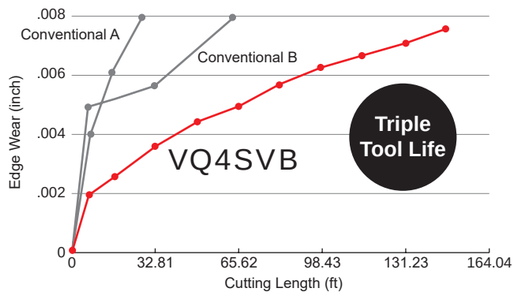
4 flutes, Helix angle 45°
Dedicated carbide substrate gives excellent wear resistance.

## Cutting Performance

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



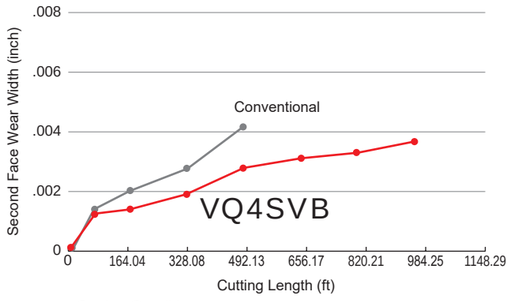

**Comparison of Edge Wear when Shoulder Milling Inconel 718**




<Cutting Conditions>

| | |
|---|---|
| Work Material | : Inconel718 |
| End Mill | : VQ4SVBR0500 (RE=5mm) |
| Revolution | : 1100min$^{-1}$ |
| Cutting Speed | : 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<br>External Coolant (Emulsion) |
| Machine | : Vertical M/C (BT40) |

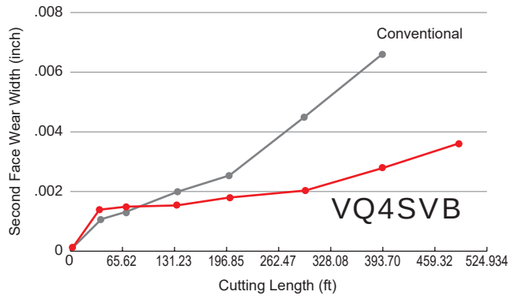
**Comparison of Edge Wear when Shoulder Milling AISI S17400**




<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<br>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<br>External Coolant (Emulsion) |
| Machine | : Vertical M/C (BT40) |

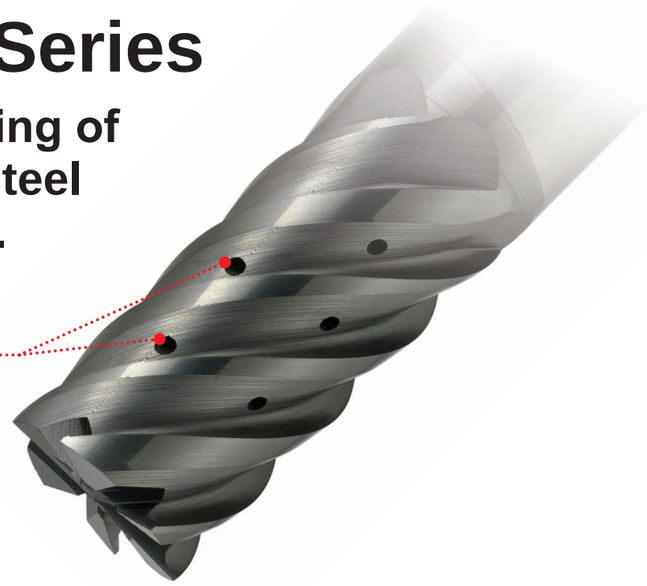
## Memo

VIBRATION CONTROL END MILLS WITH MULTIPLE THRU-COOLANT HOLES FOR DIFFICULT-TO-CUT MATERIALS

DIA EDGE

# CoolStar Series

## Highly effective machining of titanium and stainless steel aerospace components.

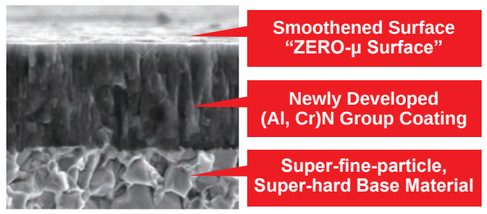


### Multiple Thru-Coolant Holes

The multiple thru-coolant hole system and spiral arrangement of the coolant holes greatly improves welding resistance and allows for a wide-range of machining applications while the vibration control design provides excellent stability making it especially suited for machining of difficult-to-cut materials.

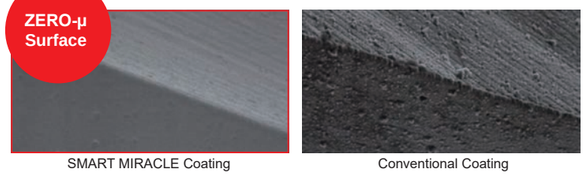
## SMART MIRACLE Coating

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 smoothening 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.




## ZERO-μ Surface

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

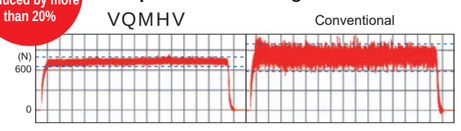


SMART MIRACLE Coating


Conventional Coating

Cutting Resistance Reduced by more than 20%

**Comparison of Cutting Resistance**




<Cutting Conditions>

| | | | |
|---|---|---|---|
| Workpiece Material | : AISI 304 | Depth of Cut | : ap=.236 inch |
| Tool | : VQMHVD0600 (DC=6mm) | Overhang Length | : .787 inch |
| Revolution | : n=2650min$^{-1}$ | Cutting Mode | : Down(Climb) Cut Internal Coolant (Emulsion) |
| Cutting Speed | : vc=165 SFM | | |
| Table Feed | : vf=12.6 IPM (.001 IPT) | Machine | : Vertical MC(BT50) |

# VQ6MHVCH

**4 Sizes (DC=10mm, 12mm, 16mm, 20mm)**

End mill, Medium cut length,
6 flute, Irregular helix flutes,
with multiple thru-coolant holes

# VQ6MHVRBCH

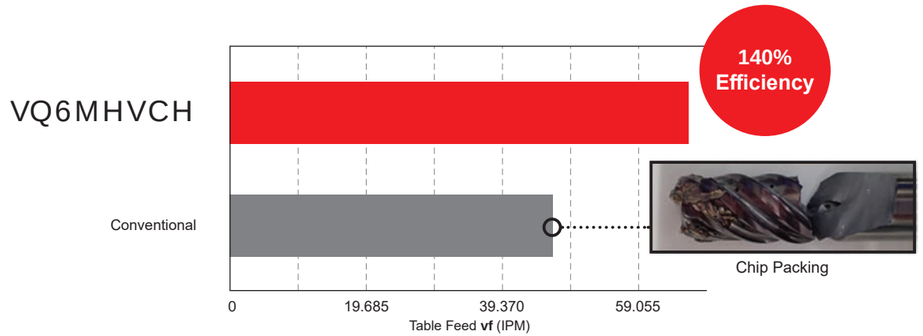
**10 Sizes (DC=10mm, 12mm, 16mm, 20mm)**

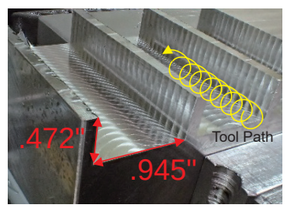
Corner radius, Medium cut length,
6 flute, Irregular helix flutes,
with multiple thru-coolant holes

## Cutting Performance

### AISI 304 Efficiency Comparison in Trochoid Milling

VQ6MHVCH achieves machine 140% more efficiently compared to conventional.




<Cutting Conditions>

| | |
|---|---|
| Workpiece Material | : AISI 304 |
| Tool | : VQ6MHVCHD1600 (DC=16mm) |
| Revolution | : n=2000min$^{-1}$ (330 SFM) |
| Depth of Cut | : ap=.472 inch, ae (Trochoid Pitch)=.094 inch |
| Cutting Mode | : Trochoid Milling, Down(Climb) Cut Internal Coolant (Emulsion) |
| Machine | : Vertical MC (BT50) |

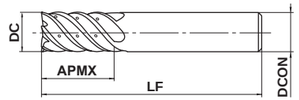
# Vibration Control End Mills with Multiple Thru-Coolant Holes for Difficult-to-Cut Materials

## VQ6MHVCH

End mill, Medium cut length, 6 flute, Irregular helix flutes, With multiple thru-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 |
|---|---|---|---|---|---|---|---|
| ○ | ○ | | | ◎ | ◎ | ○ | |

CoolStar




Type1

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

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

(mm)

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

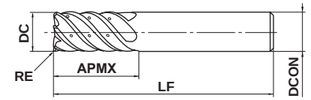
* Number of Flutes

## VQ6MHVRBCH

Corner radius, Medium cut length, 6 flute, Irregular helix flutes, With multiple thru-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 |
|---|---|---|---|---|---|---|---|
| ○ | ○ | | | ◎ | ◎ | ○ | |

CoolStar




Type1

| 0.5≤RE≤4 | | | | |
|---|---|---|---|---|
| ±0.015 | | | | |
| DC≤12 | DC>12 | | | |
| 0<br>- 0.020 | 0<br>- 0.030 | | | |
| **DCON=10** | **DCON=12** | **DCON=16** | **DCON=20** | |
| 0<br>- 0.009 | 0<br>- 0.011 | 0<br>- 0.011 | 0<br>- 0.013 | |

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

(mm)

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

* Number of Flutes

**● : USA Stock**

# Vibration Control End Mills with Multiple Thru-Coolant Holes for Difficult-to-Cut Materials

End mill, Medium cut length, 6 flute, Irregular helix flutes, With multiple thru-coolant holes — VQ6MHVCH

Corner radius, Medium cut length, 6 flute, Irregular helix flutes, With multiple thru-coolant holes — VQ6MHVRBCH

## Recommended Cutting Conditions

### ■ Shoulder Milling

(inch)

| Workpiece Material | | Alloy Steels, Tool Steels, Pre-hardened Steels<br>AISI H13, AISI W1-10, AISI P21 | | Austenitic Stainless Steels(≤200HB) Titanium Alloys<br>AISI 304, AISI 316, Ti-6AL-4V | | Copper, Copper Alloys | | Heat Resistant Alloys<br>Inconel 718 | |
|---|---|---|---|---|---|---|---|---|---|
| DC (mm) | DC (inch) | Revolution **n** ($min^{-1}$) | Feed Rate **vf** (IPM) | Revolution **n** ($min^{-1}$) | Feed Rate **vf** (IPM) | Revolution **n** ($min^{-1}$) | Feed Rate **vf** (IPM) | Revolution **n** ($min^{-1}$) | Feed Rate **vf** (IPM) |
| 10 | .394 | — | — | 4800 | 78.7 | — | — | 1300 | 10.2 |
| 12 | .472 | — | — | 4000 | 78.7 | — | — | 1100 | 9.1 |
| 16 | .630 | 4000 | 86.6 | 3000 | 63.0 | 2400 | 55.1 | 800 | 7.1 |
| 20 | .787 | 3200 | 74.8 | 2400 | 55.1 | 1900 | 43.3 | 640 | 5.9 |
| Depth of Cut | | ≤0.12DC<br>0.5DC—1.5DC | | | | | | ≤0.05DC<br>0.5DC—1.5DC | |

DC = Dia.

### ■ Trochoid Milling

(inch)

| Workpiece Material | | Alloy Steels, Tool Steels, Pre-hardened Steels<br>AISI H13, AISI W1-10, AISI P21 | | Austenitic Stainless Steels(≤200HB) Titanium Alloys<br>AISI 304, AISI 316, Ti-6AL-4V | |
|---|---|---|---|---|---|
| DC (mm) | DC (inch) | Revolution **n** ($min^{-1}$) | Feed Rate **vf** (IPM) | Revolution **n** ($min^{-1}$) | Feed Rate **vf** (IPM) |
| 10 | .394 | — | — | 4800 | 55.1 |
| 12 | .472 | — | — | 4000 | 47.2 |
| 16 | .630 | 4000 | 63.0 | 3000 | 43.3 |
| 20 | .787 | 3200 | 55.1 | 2400 | 35.4 |
| Depth of Cut | | 1.5DC≤<br>≤0.12DC<br>0.5DC—1.5DC | | | |

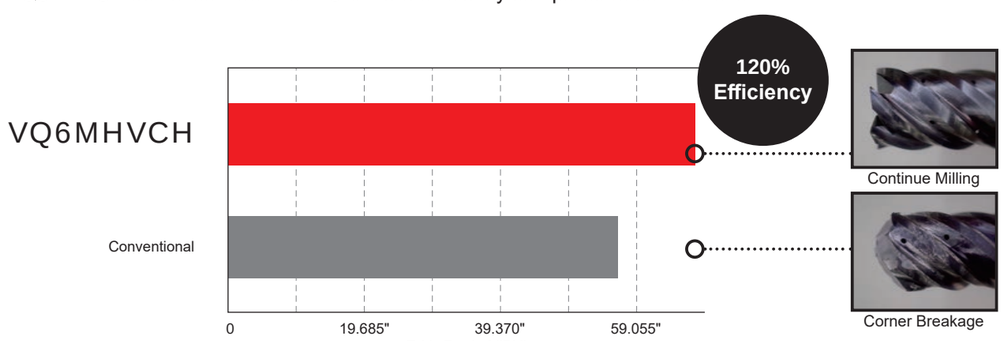
DC = Dia.

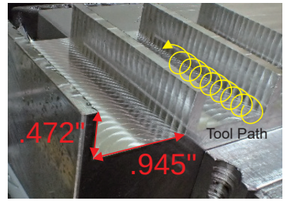
Note 1) If the depth of cut is smaller, the revolution and the feed rate can be increased.
Note 2) The irregular helix flute end mill has a larger effect on controlling vibration when compared to standard end mills. However, if the rigidity of the machine or the work material installation is very low, then vibration can occur. In this case, please reduce the revolution and the feed rate proportionately, or set a lower depth of cut.

# Cutting Performance

## Ti-6Al-4V Efficiency Comparison in Trochoid Milling

VQ6MHVCH achieves machine 120% more efficiently compared to conventional.




<Cutting Conditions>
Workpiece Material : Ti-6Al-4V
Tool : VQ6MHVCHD1600 (DC=16mm)
Revolution : n=2000$min^{-1}$ (330 SFM)
Depth of Cut : ap=.472 inch, ae (Trochoid Pitch)=.094 inch
Cutting Mode : Trochoid Milling, Down(Climb) Cut
Internal Coolant (Emulsion)
Machine : Vertical MC (BT50)

DIA EDGE

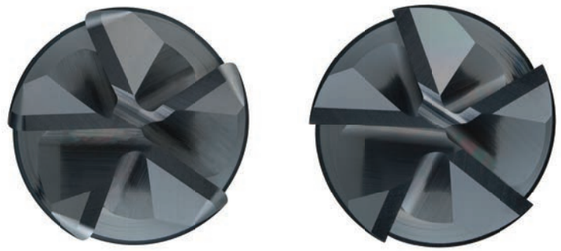
## SMART MIRACLE End Mill Series

# VQ5MHV/MHVRB

**The combination of 5 flutes and irregular helix for reducing vibration enables highly efficient machining of difficult-to-cut materials.**

### 5 Flutes

Optimal flute shape improves chip evacuation and is ideal for slot milling with deep depths of cut.



### Variable helix: 39°/40°/41°

Excellent chatter resistance with variable helix angle for stability and smooth cutting.

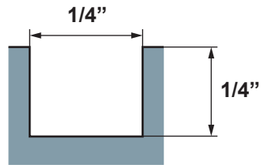
### Corner Radius

Strong chipping resistance and increased tool life in heavy cutting as a result of a new and improved geometric design.

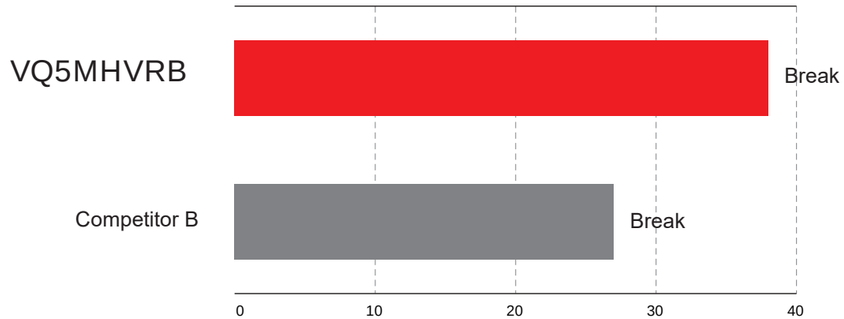
### SMART MIRACLE Coating

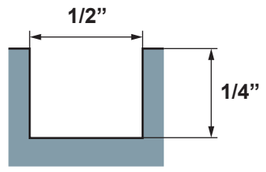
Improved flank wear through use of SMART MIRACLE coating and Micro-grain Cemented Carbide.


## Application Example

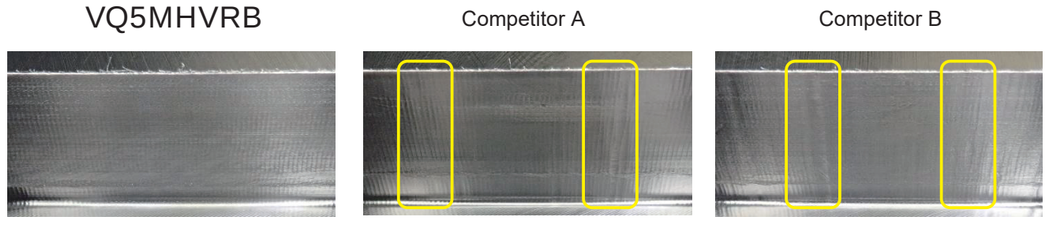



<Cutting Conditions>
Workpiece Material : 17-4PH (AISI S17400)
Tool : VQ5MHVRBD1/4R020
ø1/4 RE = .020
Revolution : n = 3509 min$^{-1}$
Cutting Speed : vc = 230 SFM
Cutting Modev: External Coolant (Emulsion)
Machine : Vertical M/C (HSK100A)




<Cutting Conditions>
Workpiece Material : 17-4PH (AISI S17400)
Tool : VQ5MHVRBD1/2R030
ø1/2 RE = .030
Revolution : n = 1754 min$^{-1}$
Cutting Speed : vc = 230 SFM
Table Feed : vf = 24.17 IPM
Feed per Tooth : .0038 inch
Cutting Mode : External Coolant (Emulsion)
Machine : Vertical M/C (HSK100A)




Smooth Surface Finish

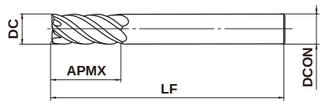
Uneven Surface

## Vibration Control End Mills for High Efficiency Machining of Difficult-to-Cut Materials

# VQ5MHV – Inch sizes NEW

End mill, Medium cut length, 5 flute, Irregular helix flutes

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




| | | | | | |
|---|---|---|---|---|---|
| | .2500"≤DC≤.5000" | | | | |
| | 0<br>- .0012" | | | | |
| h6 | .2500"≤DCON≤.3750" | DCON=.5000" | | | |
| | 0<br>- .0002" | 0<br>- .0003" | | | |

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

(inch)

| Order Number | DC | APMX | LF | DCON | No.F * | Stock |
|---|---|---|---|---|---|---|
| **VQ5MHVD1/4** | .2500 | .625 | 2.500 | .2500 | 5 | ● |
| **VQ5MHVD5/16** | .3125 | .750 | 2.750 | .3125 | 5 | ● |
| **VQ5MHVD3/8** | .3750 | .875 | 3.250 | .3750 | 5 | ● |
| **VQ5MHVD1/2** | .5000 | 1.125 | 4.000 | .5000 | 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.

* Number of Flutes

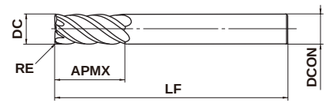
**DC** = Dia.
**APMX** = Length of Cut
**LF** = Overall Length
**DCON** = Shank Dia.

● : USA Stock

# VQ5MHVRB – Inch sizes NEW

Corner radius, Medium cut length, 5 flute, Irregular helix flutes

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




| | | | | | |
|---|---|---|---|---|---|
| | .0010"≤RE≤.030" | | | | |
| | ±.0006" | | | | |
| | .2500"≤DC≤.5000" | | | | |
| | 0<br>- .0012" | | | | |
| h6 | .2500"≤DCON≤.3750" | DCON=.5000" | | | |
| | 0<br>- .0002" | 0<br>- .0003" | | | |

● 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.

(inch)

| Order Number | DC | RE | APMX | LF | DCON | No.F * | Stock |
|---|---|---|---|---|---|---|---|
| **VQ5MHVRBD1/4R010** | .2500 | .010 | .625 | 2.500 | .2500 | 5 | ● |
| **VQ5MHVRBD5/16R010** | .3125 | .015 | .750 | 2.750 | .3125 | 5 | ● |
| **VQ5MHVRBD3/8R030** | .3750 | .030 | .875 | 3.250 | .3750 | 5 | ● |
| **VQ5MHVRBD1/2R030** | .5000 | .030 | 1.125 | 4.000 | .5000 | 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.

* Number of Flutes

**DC** = Dia.
**RE** = Radius
**APMX** = Length of Cut
**LF** = Overall Length
**DCON** = Shank Dia.

# Vibration Control End Mills for High Efficiency Machining of Difficult-to-Cut Materials

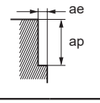
# VQ5MHV/MHVRB

## Recommended Cutting Conditions

### ■ Shoulder Milling

(inch)

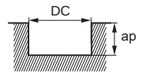
| Workpiece Material | | Carbon Steels(–30HRC) | | | | | | Alloy Steels, Pre-hardened Steels | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DC** | | High Speed Cutting | | General Purpose Cutting | | Depth of Cut **ap** | Depth of Cut **ae** | High Speed Cutting | | General Purpose Cutting | | Depth of Cut **ap** | Depth of Cut **ae** |
| mm | inch | Revolution **n** ($min^{-1}$) | Feed Rate **vf** (IPM) | Revolution **n** ($min^{-1}$) | Feed Rate **vf** (IPM) | | | Revolution **n** ($min^{-1}$) | Feed Rate **vf** (IPM) | Revolution **n** ($min^{-1}$) | Feed Rate **vf** (IPM) | | |
| 6.350 | .2500 | 7500 | 90.6 | 6000 | 63.0 | .375 | .075 | 6000 | 47.2 | 5000 | 31.5 | .375 | .075 |
| 7.938 | .3125 | 6000 | 90.6 | 4800 | 63.0 | .469 | .094 | 4800 | 51.2 | 4000 | 35.4 | .469 | .094 |
| 9.525 | .3750 | 5000 | 90.6 | 4000 | 59.1 | .563 | .113 | 4000 | 51.2 | 3300 | 33.5 | .563 | .113 |
| 12.700 | .5000 | 3800 | 66.9 | 3000 | 43.3 | .750 | .150 | 3000 | 43.3 | 2500 | 29.5 | .750 | .150 |
| Depth of Cut | |  | | | | | | | | | | | |

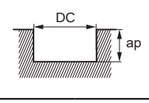
| Workpiece Material | | Austenitic Stainless Steels, Titanium Alloys | | | | | | Precipitation Hardening Steinless Steels, Cobalt Chrome Alloys | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DC** | | High Speed Cutting | | General Purpose Cutting | | Depth of Cut **ap** | Depth of Cut **ae** | High Speed Cutting | | General Purpose Cutting | | Depth of Cut **ap** | Depth of Cut **ae** |
| mm | inch | Revolution **n** ($min^{-1}$) | Feed Rate **vf** (IPM) | Revolution **n** ($min^{-1}$) | Feed Rate **vf** (IPM) | | | Revolution **n** ($min^{-1}$) | Feed Rate **vf** (IPM) | Revolution **n** ($min^{-1}$) | Feed Rate **vf** (IPM) | | |
| 6.350 | .2500 | 5000 | 39.4 | 4000 | 25.6 | .375 | .050 | 3800 | 37.4 | 3500 | 21.7 | .375 | .050 |
| 7.938 | .3125 | 4000 | 43.3 | 3200 | 29.5 | .469 | .063 | 3000 | 43.3 | 2800 | 25.6 | .469 | .063 |
| 9.525 | .3750 | 3300 | 51.2 | 2700 | 33.5 | .563 | .075 | 2500 | 39.4 | 2300 | 23.6 | .563 | .075 |
| 12.700 | .5000 | 2500 | 39.4 | 2000 | 27.6 | .750 | .100 | 1900 | 30.3 | 1800 | 19.7 | .750 | .100 |
| Depth of Cut | |  | | | | | | | | | | | |

Note 1) SMART MIRACLE coating has very low electrical conductivity; therefore, an external contact type of tool setter (electric transmitted) may not work.
When measuring the tool length, please use an internal contact type (non-electricity type) or a laser tool setter.
Note 2) When cutting titanium alloys, the use of water-soluble cutting fluid is effective.
Note 3) 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 workpiece material installation is poor, vibration or abnormal sound can occur.
In this case, please reduce the revolution and the feed rate proportionately, or set a lower depth of cut.
Note 4) If the depth of cut is smaller, the revolution and the feed rate can be increased.

### ■ Slot Milling

(inch)

| Workpiece Material | | Carbon Steels(–30HRC) | | | | | Alloy Steels, Pre-hardened Steels | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **DC** | | High Speed Cutting | | General Purpose Cutting | | Depth of Cut **ap** | High Speed Cutting | | General Purpose Cutting | | Depth of Cut **ap** |
| mm | inch | Revolution **n** ($min^{-1}$) | Feed Rate **vf** (IPM) | Revolution **n** ($min^{-1}$) | Feed Rate **vf** (IPM) | | Revolution **n** ($min^{-1}$) | Feed Rate **vf** (IPM) | Revolution **n** ($min^{-1}$) | Feed Rate **vf** (IPM) | |
| 6.350 | .2500 | 7500 | 55.1 | 5000 | 37.4 | .250 | 6000 | 31.5 | 4000 | 19.7 | .250 |
| 7.938 | .3125 | 6000 | 55.1 | 4000 | 35.4 | .312 | 4800 | 31.5 | 3200 | 19.7 | .312 |
| 9.525 | .3750 | 5000 | 51.2 | 3300 | 33.5 | .375 | 4000 | 28.3 | 2700 | 17.7 | .375 |
| 12.700 | .5000 | 3800 | 39.4 | 2500 | 25.6 | .500 | 3000 | 23.2 | 2000 | 13.8 | .500 |
| Depth of Cut | |  | | | | | | | | | |

| Workpiece Material | | Austenitic Stainless Steels, Titanium Alloys | | | | | Precipitation Hardening Steinless Steels | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **DC** | | High Speed Cutting | | General Purpose Cutting | | Depth of Cut **ap** | High Speed Cutting | | General Purpose Cutting | | Depth of Cut **ap** |
| mm | inch | Revolution **n** ($min^{-1}$) | Feed Rate **vf** (IPM) | Revolution **n** ($min^{-1}$) | Feed Rate **vf** (IPM) | | Revolution **n** ($min^{-1}$) | Feed Rate **vf** (IPM) | Revolution **n** ($min^{-1}$) | Feed Rate **vf** (IPM) | |
| 6.350 | .2500 | 5000 | 34.3 | 3000 | 13.8 | .250 | 3000 | 23.6 | 2500 | 11.8 | .250 |
| 7.938 | .3125 | 4000 | 39.4 | 2400 | 15.7 | .312 | 2400 | 23.6 | 2000 | 11.8 | .312 |
| 9.525 | .3750 | 3300 | 37.8 | 2000 | 17.7 | .375 | 2000 | 21.7 | 1700 | 9.8 | .375 |
| 12.700 | .5000 | 2500 | 31.5 | 1500 | 13.8 | .500 | 1500 | 17.7 | 1300 | 7.9 | .500 |
| Depth of Cut | |  | | | | | | | | | |

Note 1) SMART MIRACLE coating has very low electrical conductivity; therefore, an external contact type of tool setter (electric transmitted) may not work.
When measuring the tool length, please use an internal contact type (non-electricity type) or a laser tool setter.
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However, if the rigidity of the machine or the workpiece material installation is poor, vibration or abnormal sound can occur.
In this case, please reduce the revolution and the feed rate proportionately, or set a lower depth of cut.
Note 4) If the depth of cut is smaller, the revolution and the feed rate can be increased.

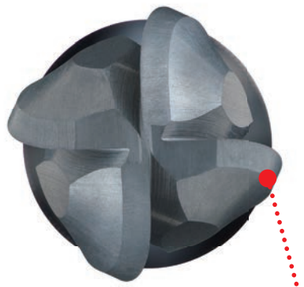
Lollipop End Mill for Multi-Functional Difficult-to-Cut Machining

DIA EDGE

SMART MIRACLE End Mill Series

# VQ4WB

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



## High Efficiency

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

## Low Cutting Resistance

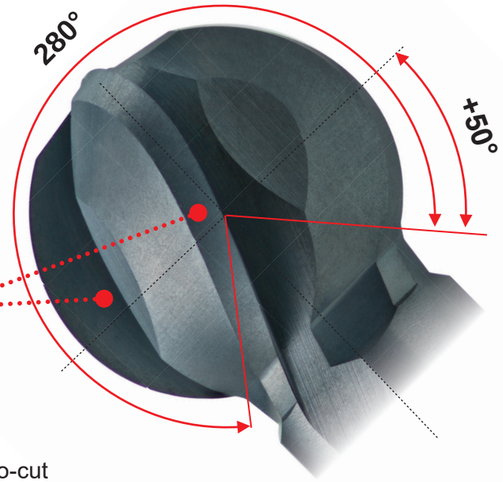
Constant edge and rake geometry helps to prevent burrs and chattering.

## Long Tool Life

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

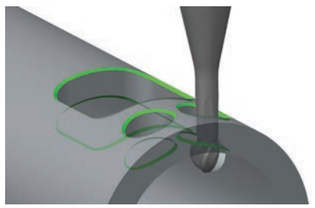
## Multiple-Applications

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

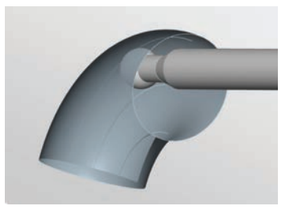



## Multiple Applications

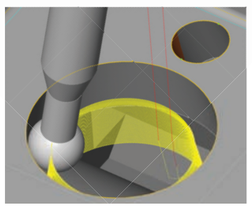
Deburring (Chamfering)



Internal Profile Milling



Undercut Machining



## Application Example

①Rounded Shape Slotting

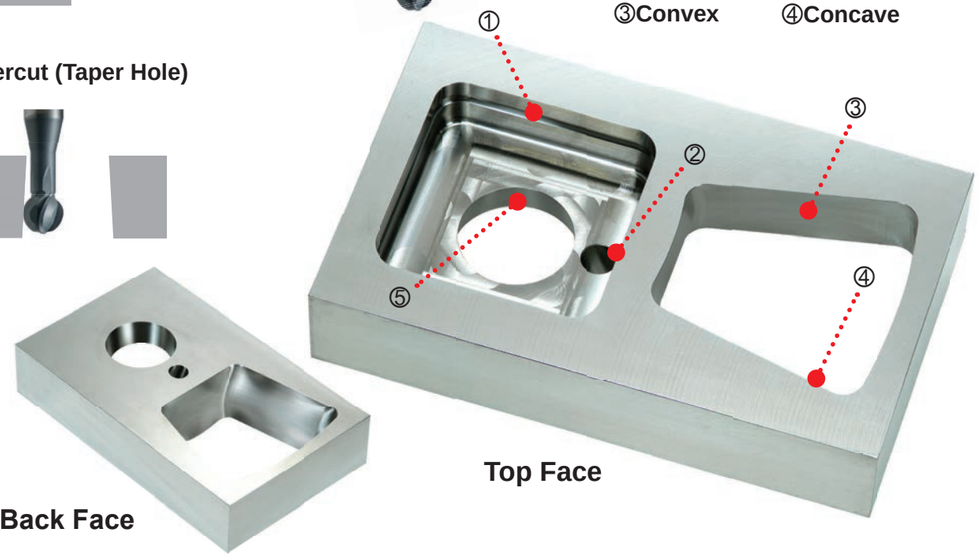
②Deburring (Top & Back Face)

Internal Profile

③Convex

④Concave

⑤Undercut (Taper Hole)

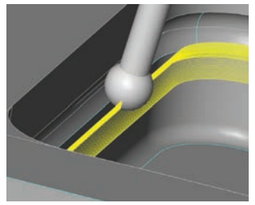



Back Face

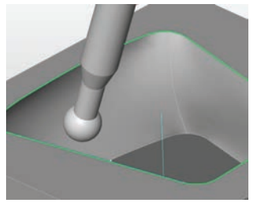
Top Face

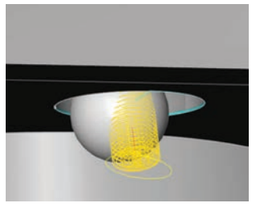
## Multiple Applications

Rounded Shape Slotting

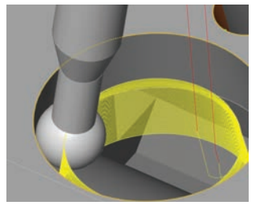


Deburring and Chamfering

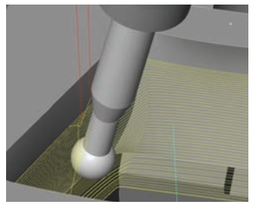


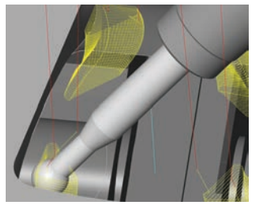


Under Cut (Taper Hole)



Internal Profile Milling





# Cutting Performance

## Comparison of Back Deburring in AISI S17400

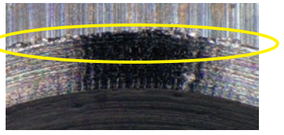
Significantly less burrs than Competing Lollipop End Mills

VQ4WB

Excellent Finish with No Burrs

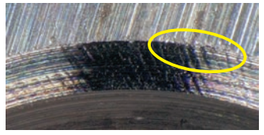
Competitor A

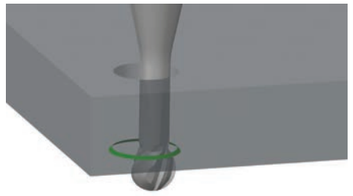
Heavy Burring Remains



Competitor B

Visible Burrs Persist

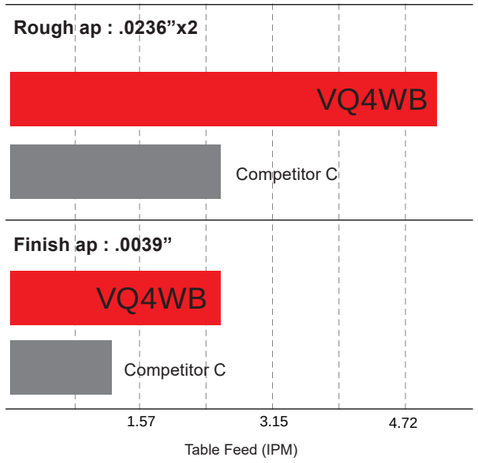


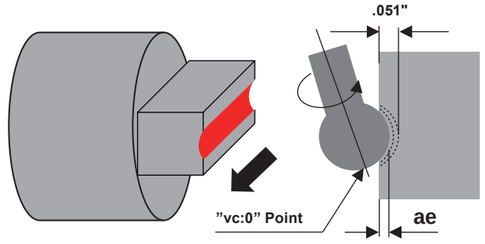


<Cutting Conditions>
Workpiece Material : AISI S17400
Tool : VQ4WBR0150N08E280
DC = .1181”
Revolution : n = 3200 $min^{-1}$
Cutting Speed : vc = 98.5 SFM
Feed Rate : vf = 2.16 IPM, fz = .0002 IPT
Chamfer Width : .0394”
Cutting Mode : Hole Size .1575”
External Coolant (Emulsion)
Machine : Vertical M/C (HSK-E25)

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

VQ4WB (4 flute) achieves double machining efficiency compared to conventional lollipop end mill (2 flute).
Even after the same number of machining (rough + finish) as competitor tool, wear is minimal and VQ4WB can continue machining.



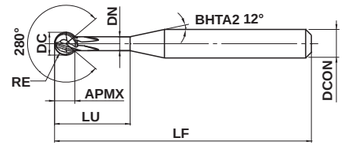

<Cutting Conditions>
Workpiece Material : Ti-6Al-4V ELI
Tool : VQ4WBR0300N12E280
DC = .2362”
Revolution : n = 800 $min^{-1}$
Cutting Speed : vc = 49.0 SFM
Cutting Mode : External Coolant (Oil)
Machine : Multi-task Lathe

# Lollipop End Mill for Multi-Functional Difficult-to-Cut Machining

## VQ4WB NEW

Lollipop, Short cut length, 4 flute

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




| | | | | | |
|---|---|---|---|---|---|
| 0.5≤RE≤3 | | | | | |
| ±0.01 | | | | | |
| 4≤DCON≤6 | | | | | |
| 0 / - 0.008 | | | | | |

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

(mm)

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

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

### <Order for Special Product>

For special products other than the above tool specifications, please contact our sales department.

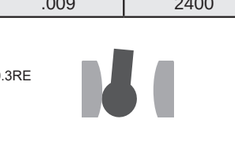
**DC** = Dia.
**RE** = Radius
**APMX** = Length of Cut
**LU** = Neck Length
**DN** = Neck Dia.
**LF** = Overall Length
**DCON** = Shank Dia.

● : USA Stock

## Recommended Cutting Conditions

### ■ Chamfering (Debarring)

(inch)

| Workpiece Material | | | | Milld Steels, Carbon Steels, Copper Alloys, Pre-hardened Steels<br>AISI 1045, 4140, 1010, P20, P21, 4340, ASTM A36 etc. | | | Austentic, Ferritic and Martensitic Stainless Steels, Precipitation Hardening Stainless Steels, Cobalt Chrome Alloys, Titanium Alloys<br>AISI 304, 316, 630, 631, 431, 420, Ti-6Al-4V, 15-5PH, 17-4PH etc. | | |
|---|---|---|---|---|---|---|---|---|---|
| DC | | RE | | Revolution **n** ($min^{-1}$) | Feed Rate **vf** (IPM) | Depth of Cut **Max.CF** | Revolution **n** ($min^{-1}$) | Feed Rate **vf** (IPM) | Depth of Cut **Max.CF** |
| mm | inch | mm | inch | | | | | | |
| 1.0 | .039 | 0.5 | .020 | 19000 | 11.8 | .004 | 14000 | 8.7 | .004 |
| 1.3 | .051 | 0.65 | .026 | 15000 | 16.5 | .005 | 11000 | 12.2 | .005 |
| 1.8 | .071 | 0.9 | .035 | 11000 | 22.4 | .007 | 8000 | 16.5 | .007 |
| 2.0 | .079 | 1.0 | .039 | 9500 | 24.0 | .008 | 7200 | 18.1 | .008 |
| 2.8 | .110 | 1.4 | .055 | 6800 | 29.9 | .011 | 5100 | 22.4 | .011 |
| 3.0 | .118 | 1.5 | .059 | 6400 | 30.3 | .012 | 4800 | 22.8 | .012 |
| 3.8 | .150 | 1.9 | .075 | 5000 | 33.1 | .015 | 3800 | 25.2 | .015 |
| 4.0 | .157 | 2.0 | .079 | 4800 | 34.6 | .016 | 3600 | 26.0 | .016 |
| 4.8 | .189 | 2.4 | .094 | 4000 | 37.8 | .019 | 3000 | 28.3 | .019 |
| 5.0 | .197 | 2.5 | .098 | 3800 | 38.2 | .020 | 2900 | 29.1 | .020 |
| 6.0 | .236 | 3.0 | .118 | 3200 | 39.4 | .024 | 2400 | 30.3 | .024 |
| Depth of Cut | | | |  | | | | | |

RE : Radius

### ■ Internal Profile / Undercut

(inch)

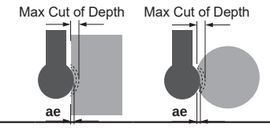
| Workpiece Material | | | | Milld Steels, Carbon Steels, Copper Alloys, Pre-hardened Steels<br>AISI 1045, 4140, 1010, P20, P21, 4340, ASTM A36 etc. | | | Austentic, Ferritic and Martensitic Stainless Steels, Precipitation Hardening Stainless Steels, Cobalt Chrome Alloys, Titanium Alloys<br>AISI 304, 316, 630, 631, 431, 420, Ti-6Al-4V, 15-5PH, 17-4PH etc. | | |
|---|---|---|---|---|---|---|---|---|---|
| DC | | RE | | Revolution **n** ($min^{-1}$) | Feed Rate **vf** (IPM) | Depth of Cut **ae** | Revolution **n** ($min^{-1}$) | Feed Rate **vf** (IPM) | Depth of Cut **ae** |
| mm | inch | mm | inch | | | | | | |
| 2.0 | .079 | 1.0 | .039 | 9500 | 18.1 | .001 | 7200 | 11.4 | .001 |
| 3.0 | .118 | 1.5 | .059 | 6400 | 22.0 | .004 | 4800 | 13.8 | .004 |
| 4.0 | .157 | 2.0 | .079 | 4800 | 25.6 | .006 | 3600 | 15.4 | .006 |
| 5.0 | .197 | 2.5 | .098 | 3800 | 28.7 | .007 | 2900 | 17.3 | .007 |
| 6.0 | .236 | 3.0 | .118 | 3200 | 30.3 | .009 | 2400 | 18.1 | .009 |
| Depth of Cut | | | |  | | | | | |

RE : Radius

Note 1) SMART MIRACLE coating has very low electrical conductivity; therefore, an external contact type of tool setter (electric transmitted) may not work. When measuring the tool length, please use an internal contact type (non-electricity type) or a laser tool setter.
Note 2) If the depth of cut is smaller than this table, feed rate can be increased.
Note 3) If the rigidity of the machine or the workpiece material installation is very low, or chattering is generated, please reduce the revolution and the feed rate proportionately.
Note 4) For sizes RE 0.5, 0.65, 0.9, 1.4, 1.9 and RE 2.4 which have long neck lengths, internal profile milling and round shape slotting are not recommended.

### ■ Radiused Shape Slotting

(inch)

| Workpiece Material | | | | Milld Steels, Carbon Steels, Copper Alloys, Pre-hardened Steels<br>AISI 1045, 4140, 1010, P20, P21, 4340, ASTM A36 etc. | | | | Austentic, Ferritic and Martensitic Stainless Steels, Precipitation Hardening Stainless Steels, Cobalt Chrome Alloys, Titanium Alloys<br>AISI 304, 316, 630, 631, 431, 420, Ti-6Al-4V, 15-5PH, 17-4PH etc. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | | RE | | Revolution **n** ($min^{-1}$) | Feed Rate **vf** (IPM) | Depth of Cut | | Revolution **n** ($min^{-1}$) | Feed Rate **vf** (IPM) | Depth of Cut | |
| mm | inch | mm | inch | | | **ae** | **Max. ae** | | | **ae** | **Max. ae** |
| 2.0 | .079 | 1.0 | .039 | 9500 | 11.8 | .001 | .002 | 7200 | 5.5 | .001 | .002 |
| 3.0 | .118 | 1.5 | .059 | 6400 | 15.0 | .004 | .008 | 4800 | 7.5 | .004 | .008 |
| 4.0 | .157 | 2.0 | .079 | 4800 | 17.3 | .006 | .011 | 3600 | 9.1 | .006 | .011 |
| 5.0 | .197 | 2.5 | .098 | 3800 | 19.3 | .007 | .021 | 2900 | 10.2 | .007 | .021 |
| 6.0 | .236 | 3.0 | .118 | 3200 | 20.1 | .009 | .035 | 2400 | 10.6 | .009 | .035 |
| Depth of Cut | | | |  | | | | | | | |

RE : Radius

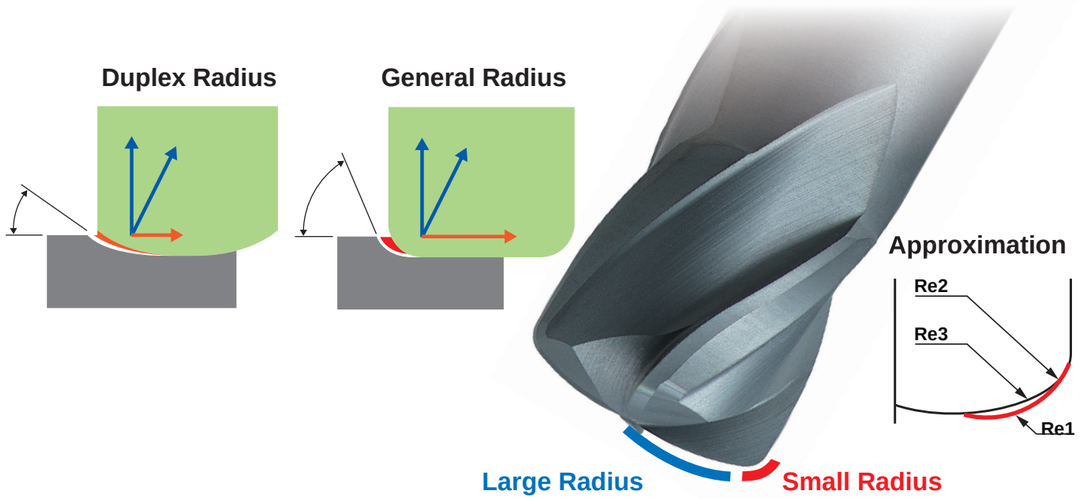
Note 1) SMART MIRACLE coating has very low electrical conductivity; therefore, an external contact type of tool setter (electric transmitted) may not work. When measuring the tool length, please use an internal contact type (non-electricity type) or a laser tool setter.
Note 2) If the depth of cut is smaller than this table, feed rate can be increased.
Note 3) If the rigidity of the machine or the workpiece material installation is very low, or chattering is generated, please reduce the revolution and the feed rate proportionately.
Note 4) For sizes RE 0.5, 0.65, 0.9, 1.4, 1.9 and RE 2.4 which have long neck lengths, internal profile milling and round shape slotting are not recommended.
Note 5) Though max ae means stably machinable cutting condition, maximum depth of calculated by effective cutting edge angle is 0.3 times RE. (In that case please reduce the revolution and feed rate than this table.)

DIA EDGE

# Duplex Radius End Mills VQFDRB

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

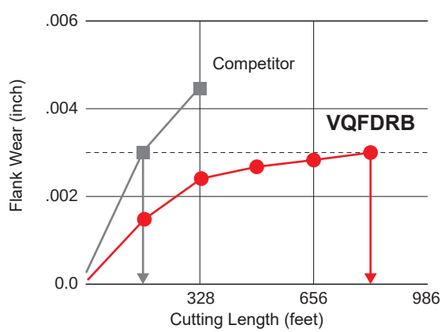
- Improved notch wear via the small side cutting edge angle.
- Reduced flank wear through use of SMART MIRACLE coating and ultra micro-grain cemented carbide.
- Provides stable machining with low radial cutting force.




## Cutting Performance : Competitive Comparison

**VQFDRB achieved 5 times longer tool life than competitors duplex radius when machining cobalt chrome alloy.**

<Cutting Conditions>
Workpiece Material : Co-Cr-Mo Alloy (ASTM F1537)
Tool : VQFDRBD0300N080 ø0.1181″
Revolution : n=8600min$^{-1}$(vc=260 SFM)
Feed Rate : vf=51.2 IPM (.0016 IPT)
Depth of Cut : ap=.0079 inch ae=.0512 inch
Coolant : Emulsion




## Cutting Example

### Competitive Comparison

<Cutting Conditions>
Part Name : Dental Crown
Workpiece Material : Co-Cr-Mo Alloy (ASTM F1537)
Cutting Process : Rough
Tool : VQFDRBD0400N120 (ø.1575” Re: .0279")
Machine : 5 axis M/C (HSK63)
Coolant : Emulsion
CAM : Hyper Dent

**< Cutting conditions & Result >**

VQFDRB can machine at twice the feed rate without chipping.

| Tool | Revolution (min$^{-1}$) | Feed rate (IPM) | Depth of Cut (inch) |
|---|---|---|---|
| **VQFDRB** | 6000 (245 SFM) | 118 (.0049 IPT) | ap=.0157 ae=.0787 |
| General Radius | 6000 (245 SFM) | 59 (.0025 IPT) | ap=.0157 ae=.0787 |

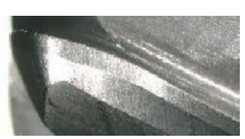
### Competitive Comparison

<Cutting Conditions>
Part Name : Dental Denture
Workpiece Material : Co-Cr-Mo Alloy (CAD/CAM Milling Disc)
Cutting Process : Rough
Tool : VQFDRBD0400N120 (ø.1575” Re: .0279")
Machine : 5 axis M/C (HSK63)
Coolant : Emulsion
Revolution : n=8600min$^{-1}$(vc=355 SFM)
Feed Rate : vf=51.2 IPM (.0016 IPT)
Depth of Cut : ap=.0098 inch (Z Level Operation)

**< Result >**

VQFDRB maintained stable machining and achieved good wear resistance throughout machining of disc.

**Vb=.0018″**

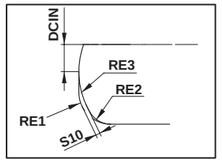


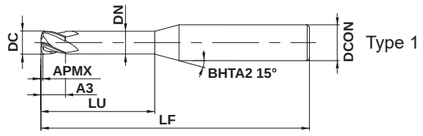
# Smart Miracle End Mills for Medical and Dental Parts

## VQFDRB

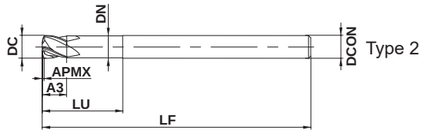
Duplex corner radius end mill for high speed cutting

| Carbon Steel, Alloy Steel, Cast Iron (<30HRC) | Tool Steel, Pre-Hardened Steel, Hardened Steel (≤45HRC) | Hardened Steel (≤55HRC) | Precipitation Hardening Stainless Steel | Austenitic Stainless Steel | Cobalt Chrome Alloy, Heat Resistant Alloy | Titanium Alloy | Aluminum Alloy |
|---|---|---|---|---|---|---|---|
| | | | | | ◎ | ○ | |




Type 1




Type 2

| | | | | | |
|---|---|---|---|---|---|
| 1≤DC≤4 | 0 - 0.020 | | | | |
| DCON=6 | 0 - 0.005 | | | | |

- Duplex corner radius type allows more efficient high feed.
- High feed cutting realized through use of multiple cuts.

(mm)

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

*1 RE1 : Approx. R
*2 RMPX : Max. Ramping Angle
*3 A3 : Cutting Edge Effective Length
*4 Number of Flutes

**DC** = Dia.
**APMX** = Length of Cut
**LU** = Neck Length
**DN** = Neck Dia.
**LF** = Overall Length
**DCON** = Shank Dia.

● : USA Stock

## Recommended Cutting Conditions

(inch)

| Workpiece Material | | Titanium Alloys Ti-6Al-4V ELI, ASTM F136, etc. | | | | | Cobalt Chromium Alloys ASTM F75:Casting, F1537:Wrought Bar, F799:Forgings, etc. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DC (mm) | DC (inch) | Revolution **n** (min-1) | Cutting Speed **vc** (SFM) | Feed Rate **vf** (IPM) | Depth of cut **ap** | Width of cut **ae** | Revolution **n** (min-1) | Cutting Speed **vc** (SFM) | Feed Rate **vf** (IPM) | Depth of cut **ap** | Width of cut **ae** |
| 3 | .118 | 8500 | 260 | 82.7 | .008 | .051 | 6400 | 195 | 118.1 | .008 | .051 |
| 4 | .157 | 6400 | 260 | 86.6 | .008 | .067 | 4800 | 195 | 106.3 | .008 | .067 |
| 6 | .236 | 4200 | 260 | 55.1 | .012 | .079 | 3200 | 195 | 82.7 | .012 | .102 |
| Depth of Cut | |   | | | | | | | | | |

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

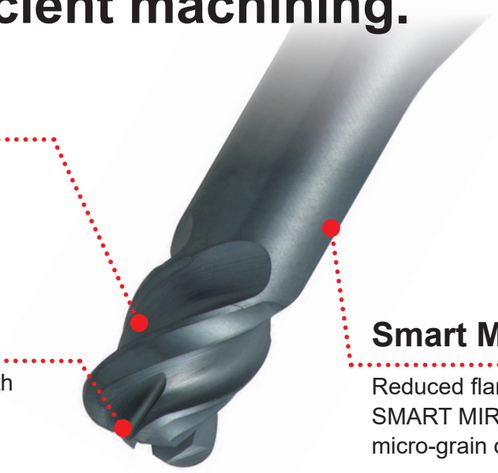
## Smart Miracle End Mills for Medical and Dental Parts

DIA EDGE

### Vibration Control Radius End Mills

# VQHVRB

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



### Variable Helix

Vibration control geometry for stable and smooth cutting.

### Special Gash

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

### Smart Miracle Coating

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

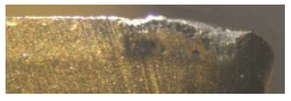
## Cutting Performance : Competitive Comparison

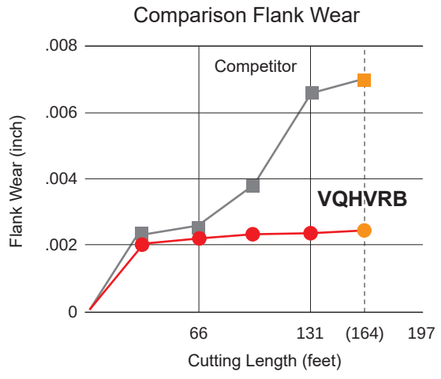
**VQHVRB wears less than competitor and enables stable cutting.**

<Cutting Conditions>
Workpiece Material : Titanium Alloy
Tool : VQHVRBD0300R05N180 (ø.118")
Revolution : n=8600min$^{-1}$ (vc=260 SFM)
Feed Rate : vf=51.2 IPM (.002 IPT)
Depth of Cut : ap=.008" ae=.051"
Coolant : Emulsion
Cutting Length : 164 feet

VQHVRB

Competitor



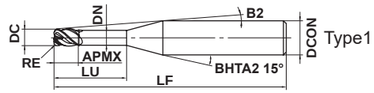


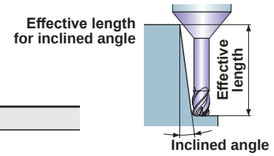

# VQHVRB

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

UWC | VQ | γ 43° 45°

| Carbon Steel, Alloy Steel, Cast Iron (<30HRC) | Tool Steel, Pre-Hardened Steel, Hardened Steel (≤45HRC) | Hardened Steel (≤55HRC) | Precipitation Hardening Stainless Steel | Austenitic Stainless Steel | Cobalt Chrome Alloy, Heat Resistant Alloy | Titanium Alloy | Aluminum Alloy |
|---|---|---|---|---|---|---|---|
| | | | | | ◎ | ○ | |




| | | | | |
|---|---|---|---|---|
| | 0.1≤RE≤1 | | | |
| | ±0.01 | | | |
| | 1≤DC≤4 | | | |
| | 0 -0.02 | | | |
| | DCON=6 | | | |
| h5 | 0 -0.005 | | | |

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

(mm)

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

*1 Number of Flutes

**DC** = Dia.
**RE** = Corner Radius
**APMX** = Length of Cut
**LU** = Neck Length
**DN** = Neck Dia.
**LF** = Overall Length
**DCON** = Shank Dia.

● : USA Stock

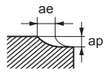
# VQHVRB

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

## Recommended Cutting Conditions

(inch)

### ■Large Depth of Cut Conditions

| Workpiece Material | | | | Titanium Alloys<br>Ti-6Al-4V ELI, ASTM F136, etc. | | | | | Cobalt Chromium Alloys<br>ASTM F75:Casting, F1537:Wrought Bar, F799:Forgings, etc. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC (mm) | DC (inch) | LU (mm) | LU (inch) | Revolution **n** ($min^{-1}$) | Cutting Speed **vc** (SFM) | Feed Rate **vf** (IPM) | Depth of cut **ap** | Width of cut **ae** | Revolution **n** ($min^{-1}$) | Cutting Speed **vc** (SFM) | Feed Rate **vf** (IPM) | Depth of cut **ap** | Width of cut **ae** |
| 1 | .039 | 8 | .315 | 2500 | 25 | 19.7 | .001 | .004 | 2500 | 25 | 19.7 | .001 | .004 |
| 1 | .039 | 12 | .472 | 2500 | 25 | 13.8 | .001 | .004 | 2500 | 25 | 13.8 | .001 | .004 |
| 2 | .079 | 12 | .472 | 4800 | 100 | 23.6 | .003 | .012 | 4800 | 100 | 23.6 | .003 | .012 |
| 2 | .079 | 16 | .630 | 4800 | 100 | 13.4 | .003 | .012 | 4800 | 100 | 13.8 | .003 | .012 |
| 3 | .118 | 10 | .394 | 8500 | 260 | 94.5 | .007 | .051 | 6400 | 195 | 86.6 | .007 | .051 |
| 3 | .118 | 18 | .709 | 8500 | 260 | 78.7 | .007 | .051 | 6400 | 195 | 63.0 | .007 | .051 |
| 4 | .157 | 12 | .472 | 6400 | 260 | 78.7 | .010 | .067 | 4800 | 195 | 70.9 | .009 | .067 |
| 4 | .157 | 20 | .787 | 6400 | 260 | 78.7 | .010 | .067 | 4800 | 195 | 70.9 | .009 | .067 |
| Depth of Cut | | | |  | | | | | | | | | |

Note 1) SMART MIRACLE coating has very low electrical conductivity; therefore, an external contact type of tool setter (electric transmitted) may not work.
When measuring the tool length, please use an internal contact type (non-electricity type) or a laser tool setter.
Note 2) When cutting titanium alloys, the use of water-soluble cutting fluid is effective.
Note 3) If the depth of cut is smaller, the revolution and the 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 workpiece material installation is poor, vibration or abnormal sound can occur.
In this case, please reduce the revolution and the feed rate proportionately, or set a lower depth of cut.



Smart Miracle End Mills for Medical and Dental Parts

## Long Neck Ball Nose End Mills

DIA EDGE

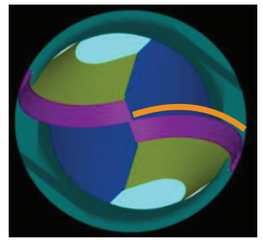
# VQ2XLB

## VQ2XLB provides long tool life and stable cutting when machining Cobalt Chrome Alloy and Titanium Alloy.

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

VQ2XLB (For Dental)

**Strong S**



General (For Mold)

Normal Curve

## Tooling Example

Workpiece Material : Co-Cr-Mo Alloys

## ● Customer Comment

“Machined surface roughness is better than conventional tools under normal conditions”

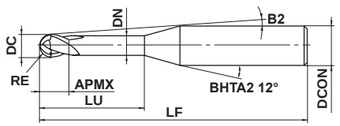
| Process | | Rough 1 | Rough 2 | Finish 1 | Finish 2 |
|---|---|---|---|---|---|
| Tool | | VQ2XLBR0150N140<br>Ø.118"(RE.059") | VQ2XLBR0150N140<br>Ø.118"(RE.059") | VQ2XLBR0100N100S06<br>Ø.079"(RE.039") | VQ2XLBR0050N080N06<br>Ø.039"(RE.020") |
| Cutting Speed **vc** (SFM) | | 195 | 260 | 245 | 205 |
| Revolution **n** ($min^{-1}$) | | 6400 | 8500 | 12000 | 20000 |
| Feed Rate **vf** (IPM) | | 31.5 | 37.8 | 31.5 | 26.0 |
| **fz** (IPT) | | .0025 | .0022 | .0013 | .0007 |
| Depth of Cut | **ap** (inch) | .0059 | .0047 | .0039 | .0020 |
| | **ae** (inch) | .0394 | .0118 | .0079 | .0031 |
| Cutting Time (min) | | 400 | 60 | 90 | 150 |
| Wear Condition | | Good | Good | Good | Good |

# Smart Miracle End Mills for Medical and Dental Parts

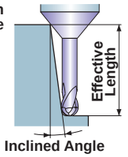
## VQ2XLB

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

| Carbon Steel, Alloy Steel, Cast Iron (<30HRC) | Tool Steel, Pre-Hardened Steel, Hardened Steel (≤45HRC) | Hardened Steel (≤55HRC) | Precipitation Hardening Stainless Steel | Austenitic Stainless Steel | Cobalt Chrome Alloy, Heat Resistant Alloy | Titanium Alloy | Aluminum Alloy |
|---|---|---|---|---|---|---|---|
| | | | | | ◎ | ◎ | |




Type1




| | | | |
|---|---|---|---|
| 0.05≤RE≤1.5 | | | |
| ±0.005 | | | |
| 4≤DCON≤6 | | | |
| 0<br>- 0.005 | | | |

● SMART MIRACLE coating providing better wear resistance when machining difficult-to-cut materials.

(mm)

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

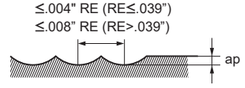
*1 Number of Flutes

**DC** = Dia.
**RE** = Radius of Ball Nose
**APMX** = Length of Cut
**LU** = Neck Length
**DN** = Neck Dia.
**LF** = Overall Length
**DCON** = Shank Dia.

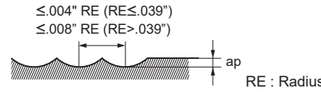
● : USA Stock

## Recommended Cutting Conditions

(inch)

| Workpiece Material | Titanium Alloys<br>Ti-6Al-4V ELI, ASTM F136, etc. | | | | | | | | Cobalt Chromium Alloys<br>ASTM F75:Casting, F1537:Wrought Bar, F799:Forgings, etc. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **RE** (mm) | **RE** (inch) | **LU** (mm) | **LU** (inch) | Revolution **n** ($min^{-1}$) | Cutting Speed **vc** (SFM) | Feed Rate **vf** (IPM) | Depth of cut **ap** | Width of cut **ae** | Revolution **n** ($min^{-1}$) | Cutting Speed **vc** (SFM) | Feed Rate **vf** (IPM) | Depth of cut **ap** | Width of cut **ae** |
| 0.5 | .020 | 8 | .315 | 32000 | 330 | 98.4 | .002 | .004 | 27000 | 260 | 78.7 | .002 | .004 |
| 0.5 | .020 | 10 | .394 | 24000 | 245 | 59.1 | .002 | .004 | 19000 | 195 | 59.1 | .002 | .004 |
| 0.5 | .020 | 12 | .472 | 24000 | 245 | 59.1 | .001 | .004 | 19000 | 195 | 59.1 | .001 | .004 |
| 0.75 | .030 | 10 | .394 | 21000 | 330 | 82.7 | .005 | .012 | 17000 | 260 | 66.9 | .003 | .004 |
| 0.75 | .030 | 12 | .472 | 16000 | 245 | 59.1 | .005 | .012 | 13000 | 195 | 47.2 | .003 | .004 |
| 1 | .039 | 10 | .394 | 16000 | 330 | 70.9 | .008 | .020 | 13000 | 260 | 59.1 | .008 | .020 |
| 1 | .039 | 12 | .472 | 16000 | 330 | 70.9 | .008 | .020 | 13000 | 260 | 59.1 | .008 | .020 |
| 1.5 | .059 | 12 | .472 | 10000 | 330 | 63.0 | .012 | .031 | 8500 | 260 | 51.2 | .012 | .031 |
| 1.5 | .059 | 14 | .551 | 10000 | 330 | 63.0 | .012 | .031 | 8500 | 260 | 51.2 | .012 | .031 |
| 1.5 | .059 | 16 | .630 | 10000 | 330 | 63.0 | .012 | .031 | 8500 | 260 | 51.2 | .012 | .031 |
| Depth of Cut | ≤.004" RE (RE≤.039")<br>≤.008" RE (RE>.039")<br>  <br>RE : Radius | | | | | | | | | | | | |



| Workpiece Material | Pure Titanium<br>ASTM F67, etc. | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **RE** (mm) | **RE** (inch) | **LU** (mm) | **LU** (inch) | Revolution **n** ($min^{-1}$) | Cutting Speed **vc** (SFM) | Feed Rate **vf** (IPM) | Depth of cut **ap** | Width of cut **ae** |
| 0.5 | .020 | 8 | .315 | 27000 | 260 | 63.0 | .003 | .004 |
| 0.5 | .020 | 10 | .394 | 19000 | 195 | 47.2 | .003 | .004 |
| 0.5 | .020 | 12 | .472 | 19000 | 195 | 47.2 | .002 | .004 |
| 0.75 | .030 | 10 | .394 | 25000 | 395 | 78.7 | .005 | .008 |
| 0.75 | .030 | 12 | .472 | 21000 | 330 | 63.0 | .005 | .008 |
| 1 | .039 | 10 | .394 | 32000 | 655 | 98.4 | .013 | .031 |
| 1 | .039 | 12 | .472 | 29000 | 590 | 66.9 | .013 | .031 |
| 1.5 | .059 | 12 | .472 | 21000 | 655 | 63.0 | .019 | .047 |
| 1.5 | .059 | 14 | .551 | 21000 | 655 | 63.0 | .019 | .047 |
| 1.5 | .059 | 16 | .630 | 21000 | 655 | 63.0 | .019 | .047 |
| Depth of Cut | ≤.004" RE (RE≤.039")<br>≤.008" RE (RE>.039")<br>  <br>RE : Radius | | | | | | | |



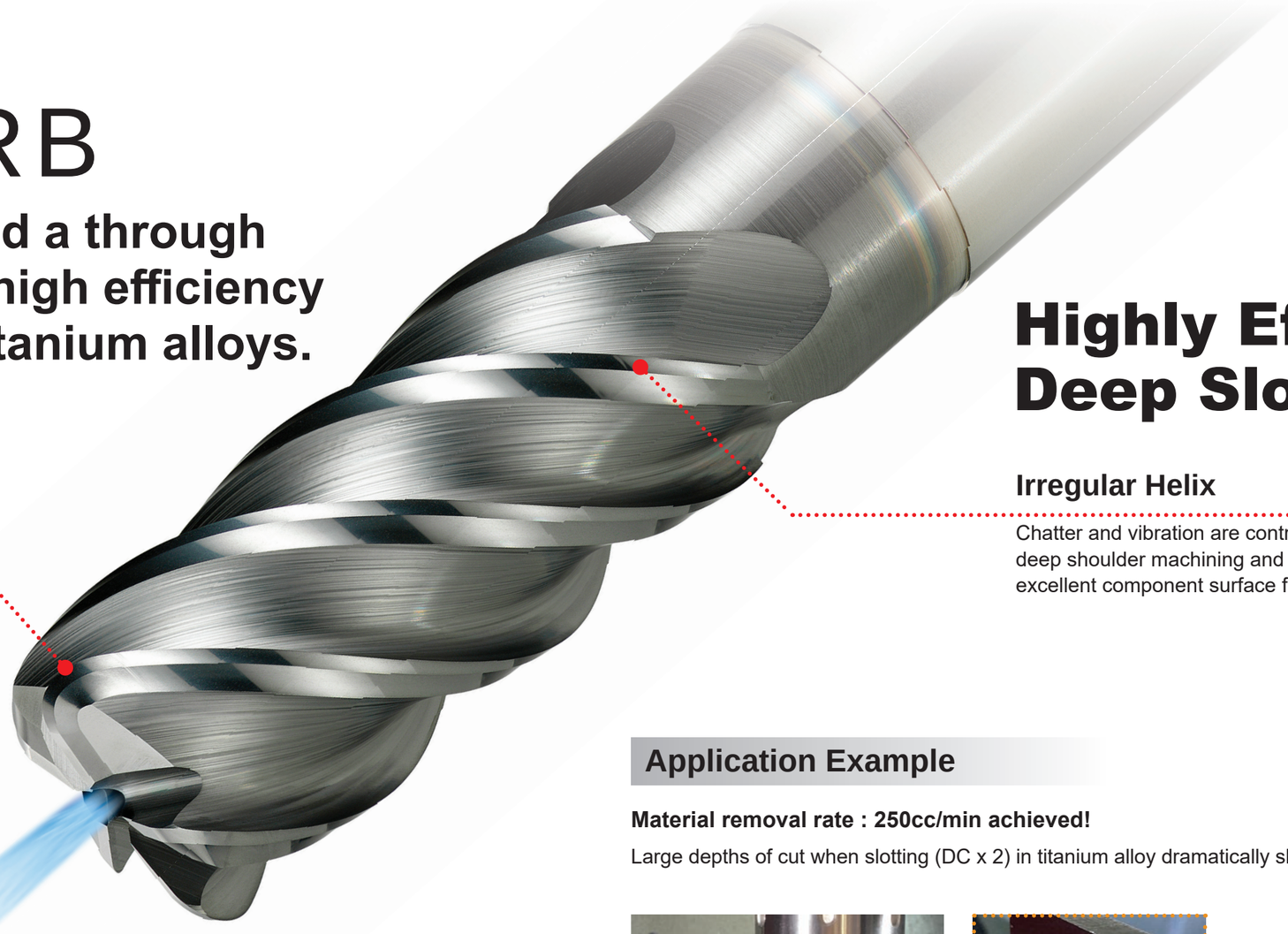
Note 1) SMART MIRACLE coating has very low electrical conductivity; therefore, an external contact type of tool setter (electric transmitted) may not work.
When measuring the tool length, please use an internal contact type (non-electricity type) or a laser tool setter.
Note 2) When cutting titanium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

Corner Radius End Mill for High Efficiency Titanium Alloy Machining

DIA EDGE

# VQT5MVRB

## Combining 5 flutes and a through coolant hole enables high efficiency rough machining of titanium alloys.

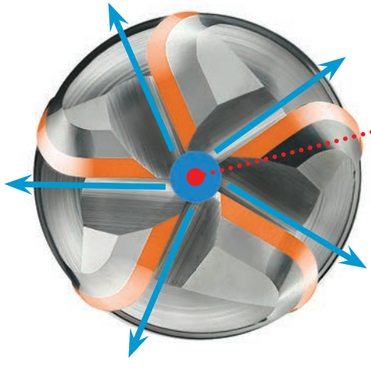


### Corner Radius (Emphasis on Sharpness)

A unique rake angle improves cutting resistance and chip discharge.
The seamless blend between the corner radius and peripheral cutting edge suppresses abnormal wear and provides a stable tool life.

### 5 Flutes

Having the same chip evacuation properties of a 4 flute type enables deep slot milling.
The additional flute and deep cutting capability reduces the number of passes.



### Coolant Hole

The center coolant provides a stable supply of cutting fluid and dramatically improves chip evacuation.
This also cools the cutting edge and prevents chip biting.

## Highly Efficient Deep Slot Milling

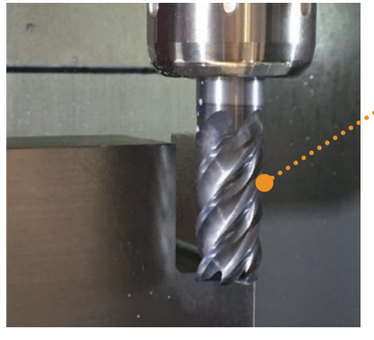
### Irregular Helix

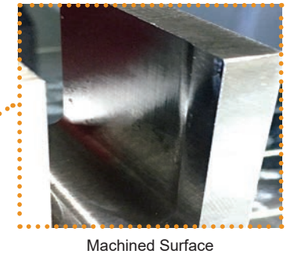
Chatter and vibration are controlled even during deep shoulder machining and also provides excellent component surface finishes.

## Application Example

**Material removal rate : 250cc/min achieved!**

Large depths of cut when slotting (DC x 2) in titanium alloy dramatically shortens rough machining times.





Machined Surface

<Cutting Conditions>

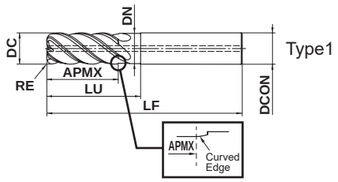
| | |
|---|---|
| Workpiece Material | : Ti-6Al-4V |
| Tool | : VQT5MVRB250R400N075C |
| Revolution | : n=636min$^{-1}$ |
| Feed Rate | : vf=8.110 IPM |
| Depth of Cut | : ap=1.969 inch (DC×2) |
| Width of Cut | : ae=.984 inch (Slot) |
| Overhang Length | : 2.953 inch (DC×3) |
| Cutting Mode | : Slot Milling<br>Internal Coolant +<br>External Coolant (Emulsion) |
| Machine | : Vertical MC (BT50) |

# Corner Radius End Mill for High Efficiency Titanium Alloy Machining

## VQT5MVRB NEW

Corner radius, Medium cut length, 5 flute, Irregular helix flutes, With coolant hole


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




| | | | | |
|---|---|---|---|---|
| RE | | | | |
| ±0.02 | | | | |
| DC≤16 | 20≤DC≤25 | | | |
| 0 -0.03 | 0 -0.04 | | | |
| DCON=16 | 20≤DCON≤25 | | | |
| h6 0 -0.011 | 0 -0.013 | | | |

- Flute geometry suitable for deep slotting and effective chip evacuation.
- Sharp cutting edges provide long tool life when machining titanium alloys.

(mm)

| Order Number | DC | RE | APMX | LU | DN | LF | DCON | * No.F | Stock | Type |
|---|---|---|---|---|---|---|---|---|---|---|
| VQT5MVRB160R100N48C | 16 | 1 | 34 | 48 | 15.5 | 120 | 16 | 5 | ● | 1 |
| VQT5MVRB160R300N48C | 16 | 3 | 34 | 48 | 15.5 | 120 | 16 | 5 | ● | 1 |
| VQT5MVRB160R400N48C | 16 | 4 | 34 | 48 | 15.5 | 120 | 16 | 5 | ● | 1 |
| VQT5MVRB200R100N60C | 20 | 1 | 44 | 60 | 19.5 | 135 | 20 | 5 | ● | 1 |
| VQT5MVRB200R300N60C | 20 | 3 | 44 | 60 | 19.5 | 135 | 20 | 5 | ● | 1 |
| VQT5MVRB200R400N60C | 20 | 4 | 44 | 60 | 19.5 | 135 | 20 | 5 | ● | 1 |
| VQT5MVRB200R600N60C | 20 | 6 | 44 | 60 | 19.5 | 135 | 20 | 5 | ● | 1 |
| VQT5MVRB250R100N75C | 25 | 1 | 54 | 75 | 24.5 | 155 | 25 | 5 | ● | 1 |
| VQT5MVRB250R300N75C | 25 | 3 | 54 | 75 | 24.5 | 155 | 25 | 5 | ● | 1 |
| VQT5MVRB250R400N75C | 25 | 4 | 54 | 75 | 24.5 | 155 | 25 | 5 | ● | 1 |
| VQT5MVRB250R600N75C | 25 | 6 | 54 | 75 | 24.5 | 155 | 25 | 5 | ● | 1 |

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

* Number of Flutes

**DC** = Dia.
**RE** = Corner Radius
**APMX** = Length of Cut
**LU** = Neck Length
**DN** = Neck Dia.
**LF** = Overall Length
**DCON** = Shank Dia.

● : USA Stock

# Recommended Cutting Conditions

## ■Shoulder Milling

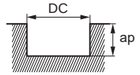
Overhang Length DC×1 (DC=Dia.) (inch)

| Workpiece Material | Titanium Alloys<br>Ti-6Al-4V etc. | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| DC | | RE | | Cutting Speed **vc** (SFM) | Revolution **n** (min-1) | Feed Rate **vf** (IPM) | Depth of Cut **ap** | Width of Cut **ae** |
| (mm) | (inch) | (mm) | (inch) | | | | | |
| 16 | .630 | 1 | .039 | 260 | 1600 | 31.5 | 1.260 | .097 |
| | | 3 | .118 | 260 | 1600 | 31.5 | 1.260 | .094 |
| | | 4 | .157 | 260 | 1600 | 31.5 | 1.260 | .094 |
| 20 | .787 | 1 | .039 | 260 | 1300 | 25.6 | 1.575 | .118 |
| | | 3 | .118 | 260 | 1300 | 25.6 | 1.575 | .118 |
| | | 4 | .157 | 260 | 1300 | 25.6 | 1.575 | .118 |
| | | 6 | .236 | 260 | 1300 | 25.6 | 1.575 | .118 |
| 25 | .984 | 1 | .039 | 260 | 1000 | 19.7 | 1.969 | .150 |
| | | 3 | .118 | 260 | 1000 | 19.7 | 1.969 | .150 |
| | | 4 | .157 | 260 | 1000 | 19.7 | 1.969 | .150 |
| | | 6 | .236 | 260 | 1000 | 19.7 | 1.969 | .150 |
| Depth of Cut | | | |  | | | | |



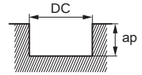
## ■Slot Milling

Depth of Cut DC×1 (inch)

| Workpiece Material | Titanium Alloys<br>Ti-6Al-4V etc. | | | | | | |
|---|---|---|---|---|---|---|---|
| DC | | RE | | Cutting Speed **vc** (SFM) | Revolution **n** (min-1) | Feed Rate **vf** (IPM) | Depth of Cut **ap** |
| (mm) | (inch) | (mm) | (inch) | | | | |
| 16 | .630 | 1 | .039 | 195 | 1200 | 16.5 | .630 |
| | | 3 | .118 | 195 | 1200 | 16.5 | .630 |
| | | 4 | .157 | 195 | 1200 | 11.8 | .630 |
| 20 | .787 | 1 | .039 | 195 | 950 | 13.0 | .787 |
| | | 3 | .118 | 195 | 950 | 13.0 | .787 |
| | | 4 | .157 | 195 | 950 | 13.0 | .787 |
| | | 6 | .236 | 195 | 950 | 9.4 | .787 |
| 25 | .984 | 1 | .039 | 165 | 640 | 8.7 | .984 |
| | | 3 | .118 | 165 | 640 | 8.7 | .984 |
| | | 4 | .157 | 165 | 640 | 8.7 | .984 |
| | | 6 | .236 | 165 | 640 | 6.3 | .984 |
| Depth of Cut | | | |  | | | |



Depth of Cut DC×2 (inch)

| Workpiece Material | Titanium Alloys<br>Ti-6Al-4V etc. | | | | | | |
|---|---|---|---|---|---|---|---|
| DC | | RE | | Cutting Speed **vc** (SFM) | Revolution **n** (min-1) | Feed Rate **vf** (IPM) | Depth of Cut **ap** |
| (mm) | (inch) | (mm) | (inch) | | | | |
| 16 | .630 | 1 | .039 | 195 | 1200 | 9.4 | 1.260 |
| | | 3 | .118 | 195 | 1200 | 9.4 | 1.260 |
| | | 4 | .157 | 195 | 1200 | 7.1 | 1.260 |
| 20 | .787 | 1 | .039 | 195 | 950 | 7.5 | 1.575 |
| | | 3 | .118 | 195 | 950 | 7.5 | 1.575 |
| | | 4 | .157 | 195 | 950 | 7.5 | 1.575 |
| | | 6 | .236 | 195 | 950 | 5.6 | 1.575 |
| 25 | .984 | 1 | .039 | 165 | 640 | 5.1 | 1.969 |
| | | 3 | .118 | 165 | 640 | 5.1 | 1.969 |
| | | 4 | .157 | 165 | 640 | 5.1 | 1.969 |
| | | 6 | .236 | 165 | 640 | 3.8 | 1.969 |
| Depth of Cut | | | |  | | | |



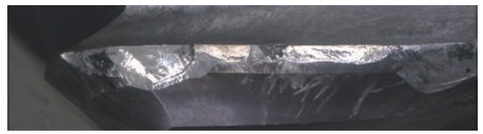
(Note 1) SMART MIRACLE coating has very low electrical conductivity; therefore, an external contact type of tool setter (electric transmitted) may not work.
When measuring the tool length, please use an internal contact type (non-electricity type) or a laser tool setter.
(Note 2) When cutting titanium alloys, the use of water-soluble cutting fluid is effective.
(Note 3) 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 poor, vibration or abnormal sound can occur.
In this case, please reduce the revolution and the feed rate proportionately, or set a lower depth of cut.
(Note 4) If the depth of cut is smaller, the revolution and the feed rate can be increased.
(Note 5) When machining deep slots where the depth of cut exceeds the diameter DC, use a high strength holder or one equipped with a retaining mechanism.
Additionally ensure the clamping and workpiece material rigidity are sufficient.
Refer to page 87 for
(Note 6) When machining a deep slot exceeding 1D, use a holder with a high gripping strength or an anti slippage mechanism.
Also, make sure that the clamping force and rigidity are sufficient before use.

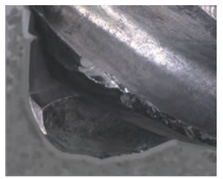
# Cutting Performance

## Slot Milling with Deep Depths of Cut in Titanium Alloy

The seamless corner radii achieves stable tool life.

Conventional

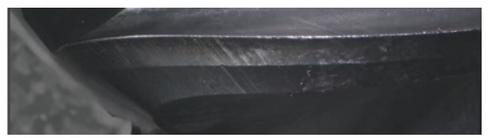




Fractures ( After 6 slots )

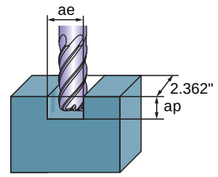
<Cutting Conditions>
Workpiece Material : Ti-6Al-4V
Tool : VQT5MVRB160R300N048C
Revolution : n=1200min$^{-1}$
Feed Rate : vf=26.0 IPM
Depth of Cut : ap=.630 inch
Width of Cut : ae=.630 inch (slot)
Cutting Length : 2.362 inch (1 slot)
Overhang Length : 1.890 inch (DC×3)
Cutting Mode : Slot Milling
Internal Coolant +
External Coolant (Emulsion)
Machine : Vertical MC (BT50)

VQT5MVRB



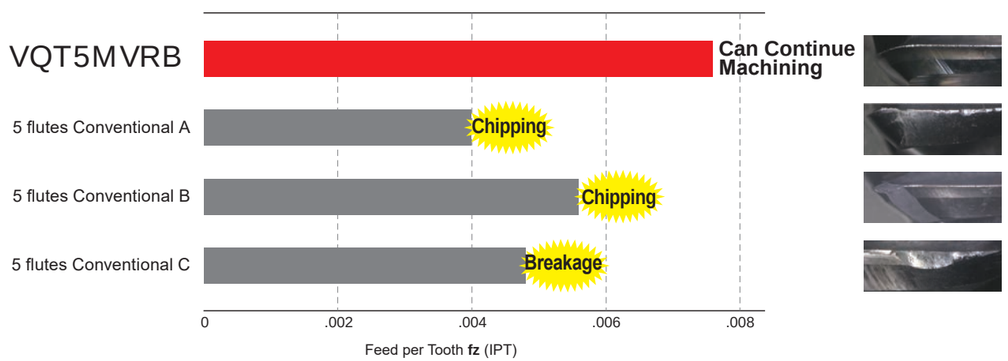
After 17 slots

**Triple Tool Life**




## Comparison of Maximum Cutting Feed for Titanium Alloy Slot Milling

When compared with conventional products, high efficiency milling can be achieved.






<Cutting Conditions>
Workpiece Material : Ti-6Al-4V
Tool : VQT5MVRB160R300N048C
Revolution : n=1200min$^{-1}$
Depth of Cut : ap=.630 inch
Width of Cut : ae=.630 inch (Slot)
Cutting Length : 2.362 inch (1 slot)
Overhang Length : 1.890 inch (DC×3)
Cutting Mode : Slot Milling
Internal Coolant +
External Coolant (Emulsion)
Machine : Vertical MC (BT50)



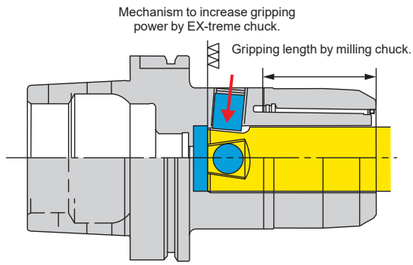
# Key Point for High Efficiency Machining of Titanium Alloys

For high efficiency machining, it is recommended to use a precision, high strength holder to prevent pull out of the tool.
Some high strength holders require modification of the cutting tool shank.

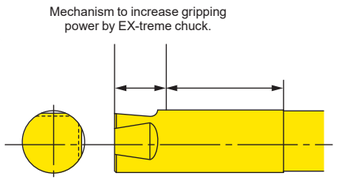
NIKKEN

## Never Pull Down Great Reliability in the Aircraft Industry

**X-Treme Shank**
**X-Treme Chuck**




EX-treme Chuck




EX-treme Chuck Exclusive Shank

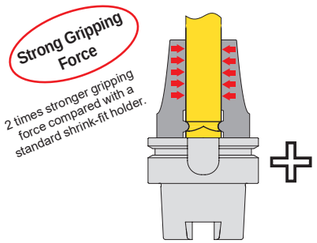
https://www.nikken-kosakusho.co.jp/en/

MST corporation

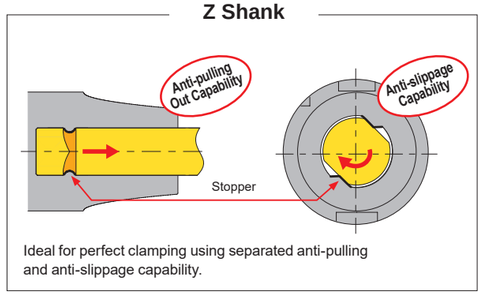
## Superior Rigidity and Thick Body Design

**Shrink-fit Holder with Anti Slippage Capability**

SLIMLINE Z




Shrink Fitting




Ideal for perfect clamping using separated anti-pulling and anti-slippage capability.

http://www.mst-corp.co.jp/en/slimline/z/

BARREL END MILL FOR FINISH CUTTING OF TITANIUM ALLOYS

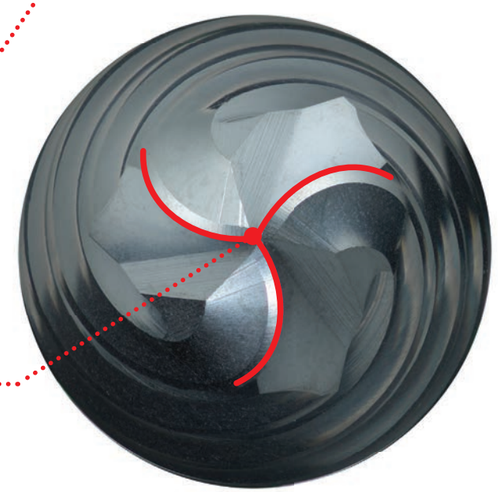
DIA EDGE

# VQT6UR

**Nose radius designed for both fillet milling and tangential form radius blade surface machining.**

### Radial Accuracy
RE1 and RE2 ±.0004 inch

### Optimum Cutting Edge Design

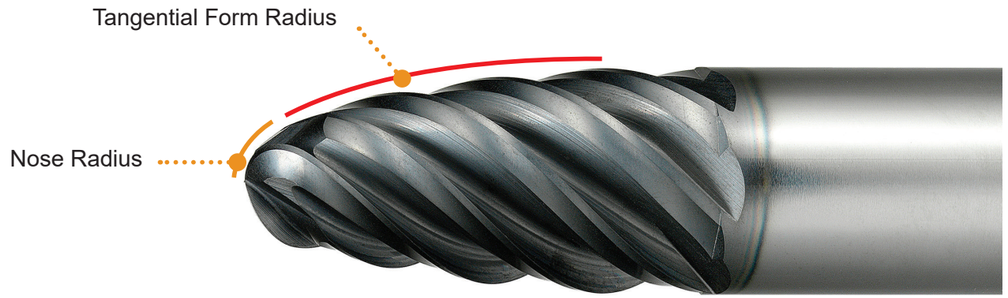


### 6-flute Peripheral Cutting Edge
Multi cutting edge designed for high efficiency mab ining.
Irregular pitch design prevents chattering.

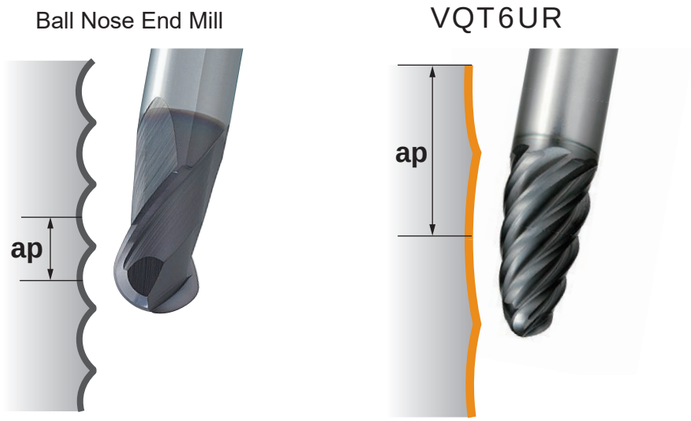
### 3-flute End Cutting Edge
A wide flute for superior chip evacuation.

### Ideal Shape

Compared with a ball nose end mill, the tangential form radius is larger and cusp height is minimized and more controllable. This design makes highly efficient machining with a pick feed.

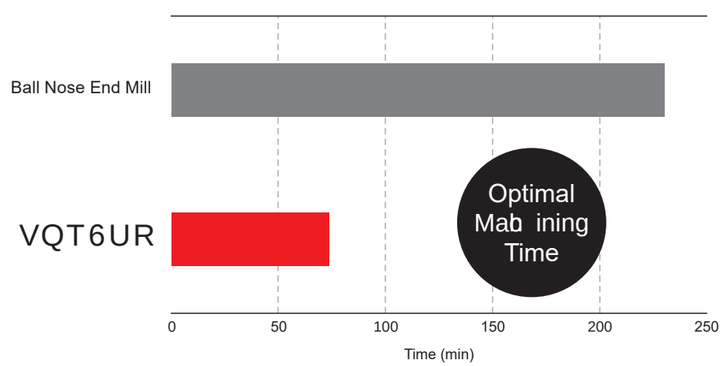



Nose and tangential form part has two distinct radii.




Shorter cutting distance contributes to longer tool life.

### Comparison of Machining Time by CAM Simulation




Tools for Simulation
Ball Nose End Mill : R.197
ø.394 inch
VQT6URR020R085S10 : R.079xR3.346
ø.394 inch

# Barrel End Mill for Finish Cutting of Titanium Alloys

## VQT6UR

Barrel, Medium cut length, 6 flute

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


Type1

| RE1≤4 | RE2≤100 | | | |
|---|---|---|---|---|
| ±0.01 | ±0.01 | | | |
| DCON≤10 | DCON=12 | | | |
| 0<br>- 0.009 | 0<br>- 0.011 | | | |

- Nose and tangential form part has two distinct radii.
- Irregular pitch design prevents chattering.

(mm)

| Order Number | DC | RE1 | RE2 | APMX | LF | DCON | No.F * | Stock | Type |
|---|---|---|---|---|---|---|---|---|---|
| **VQT6URR020R075S08** | 8 | 2 | 75 | 21 | 90 | 8 | 6 | ● | 1 |
| **VQT6URR020R085S10** | 10 | 2 | 85 | 26 | 100 | 10 | 6 | ● | 1 |
| **VQT6URR030R075S10** | 10 | 3 | 75 | 22 | 100 | 10 | 6 | ● | 1 |
| **VQT6URR040R100S12** | 12 | 4 | 100 | 25 | 110 | 12 | 6 | ● | 1 |

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

* Number of Flutes

**DC** = Cutting Dia.
**RE1** = Nose Radius
**RE2** = Tangential Form Radius
**APMX** = Depth of Cut Max.
**LF** = Functional Length
**DCON** = Connection Diameter

● : USA Stock

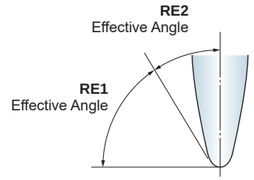
# Recommended Cutting Conditions

## ■ Effective Angle

Please refer to the table below for the use of the nose radius (RE1) and tangential form radius (RE2).

(inch)

| Order Number | Nose Radius | | Tangential Form Radius | |
|---|---|---|---|---|
| | **RE1** | Effective Angle | **RE2** | Effective Angle |
| **VQT6URR020R075S08** | .079 (2mm) | 76.6° | 2.953 ( 75mm) | 13.4° |
| **VQT6URR020R085S10** | .079 (2mm) | 74.5° | 3.346 ( 85mm) | 15.5° |
| **VQT6URR030R075S10** | .118 (3mm) | 76.4° | 2.953 ( 75mm) | 13.6° |
| **VQT6URR040R100S12** | .157 (4mm) | 78.3° | 3.937 (100mm) | 11.7° |

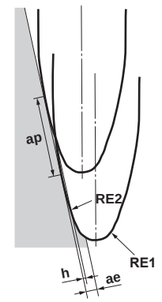



## ■ Side Milling with the Use of the Tangential Form Radius (RE2)

(inch)

| Workpiece Material | | | | Mild Steels (≤180HB) Carbon Steels, Alloy Steels (180—280HB) | | | | Austenitic Stainless Steels (≤200HB) Titanium Alloys | | | | Aluminum Alloys (Si<5%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DC** | | **RE2** | | Revolution ($min^{-1}$) | Feed Rate (IPM) | Depth of Cut **ap** | Depth of Cut **ae** | Revolution ($min^{-1}$) | Feed Rate (IPM) | Depth of Cut **ap** | Depth of Cut **ae** | Revolution ($min^{-1}$) | Feed Rate (IPM) | Depth of Cut **ap** | Depth of Cut **ae** |
| mm | inch | mm | inch | | | | | | | | | | | | |
| 8 | .315 | 75 | 2.953 | 8000 | 94.5 | .031 | .002–.012 | 3200 | 30.3 | .031 | .002–.012 | 16000 | 189.0 | .031 | .002–.012 |
| 10 | .394 | 85 | 3.346 | 6400 | 74.8 | .033 | .002–.012 | 2500 | 23.6 | .033 | .002–.012 | 13000 | 153.5 | .033 | .002–.012 |
| 10 | .394 | 75 | 2.953 | 6400 | 74.8 | .031 | .002–.012 | 2500 | 23.6 | .031 | .002–.012 | 13000 | 153.5 | .031 | .002–.012 |
| 12 | .472 | 100 | 3.937 | 5300 | 63.0 | .035 | .002–.012 | 2100 | 19.7 | .035 | .002–.012 | 11000 | 129.9 | .035 | .002–.012 |

Note 1) SMART MIRACLE coating has very low electrical conductivity; therefore, an external contact type of tool setter (electric transmitted) may not work.
When measuring the tool length, an internal contact/non-electric type or laser tool setter is recommended.
Note 2) Recommended for finish cutting only.
Note 3) The tool contact part differs between the nose radius and tangential form radius depending on machining geometries and tilt angles. Select suitable cutting conditions according to tool contact parts.




## ■ Depth of Cut Calculation Table Based on Tangential Form Radius (RE2) and Cusp Height (h)

(inch)

| Order Number | RE2 | Cusp Height **h** | .000004 | .000012 | .000020 | .000031 | .000039 | .000118 | .000197 | .000315 |
|---|---|---|---|---|---|---|---|---|---|---|
| **VQT6URR020R075S08** | 2.953 ( 75mm) | Depth of Cut **ae** | .0096 | .0167 | .0216 | .0273 | .0305 | .0528 | .0682 | .0863 |
| **VQT6URR030R075S10** | 2.953 ( 75mm) | | .0096 | .0167 | .0216 | .0273 | .0305 | .0528 | .0682 | .0863 |
| **VQT6URR020R085S10** | 3.346 ( 85mm) | | .0103 | .0178 | .0230 | .0291 | .0325 | .0562 | .0726 | .0918 |
| **VQT6URR040R100S12** | 3.937 (100mm) | | .0111 | .0193 | .0249 | .0315 | .0352 | .0610 | .0787 | .0996 |

# Barrel End Mill for Finish Cutting of Titanium Alloys

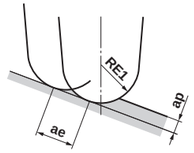
## Recommended Cutting Conditions

### ■ Fillet Milling with the Use of the Nose Radius (RE1)

(inch)

| Workpiece Material | | | | Mild Steels (≤180HB) Carbon Steels, Alloy Steels (180−280HB) | | | | Austenitic Stainless Steels (≤200HB) Titanium Alloys | | | | Aluminum Alloys (Si<5%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | | RE1 | | Revolution ($min^{-1}$) | Feed Rate (IPM) | Depth of Cut **ap** | Depth of Cut **ae** | Revolution ($min^{-1}$) | Feed Rate (IPM) | Depth of Cut **ap** | Depth of Cut **ae** | Revolution ($min^{-1}$) | Feed Rate (IPM) | Depth of Cut **ap** | Depth of Cut **ae** |
| mm | inch | mm | inch | | | | | | | | | | | | |
| 8 | .315 | 2 | .079 | 16000 | 94.5 | .016 | .039 | 6400 | 22.8 | .016 | .039 | 32000 | 189.0 | .016 | .039 |
| 10 | .394 | 2 | .079 | 16000 | 94.5 | .016 | .039 | 6400 | 22.8 | .016 | .039 | 32000 | 189.0 | .016 | .039 |
| 10 | .394 | 3 | .118 | 11000 | 66.9 | .024 | .059 | 4200 | 15.0 | .024 | .059 | 21000 | 126.0 | .024 | .059 |
| 12 | .472 | 4 | .157 | 8000 | 47.2 | .031 | .079 | 3200 | 11.4 | .031 | .079 | 16000 | 94.5 | .031 | .079 |

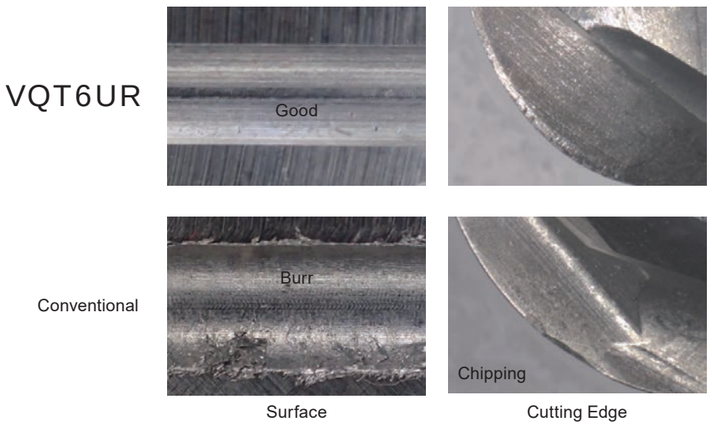
Note 1) SMART MIRACLE coating has very low electrical conductivity; therefore, an external contact type of tool setter (electric transmitted) may not work.
When measuring the tool length, an internal contact/non-electric type or laser tool setter is recommended.
Note 2) Recommended for finish cutting only.
Note 3) The tool contact part differs between the nose radius and tangential form radius depending on machining geometries and tilt angles. Select suitable cutting conditions according to tool contact parts.




# Cutting Performance

## Fillet Milling of Titanium Alloy

Achieves a quality surface finish with no chipping on the cutting edge.

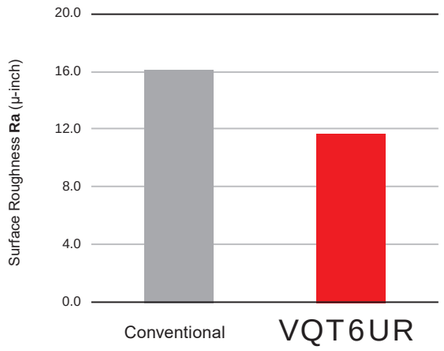


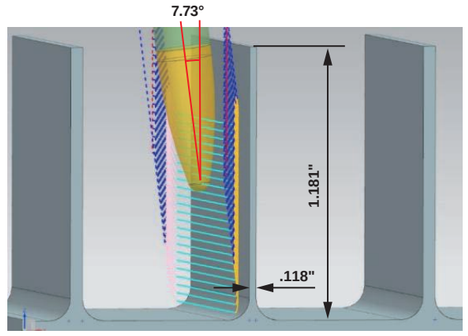

<Cutting Conditions>
Workpiece Material : Ti-6Al-4V
Tool : VQT6URR020R085S10
Cutting Speed : vc=260 SFM
Revolution : n=6770 $min^{-1}$
Feed per Tooth : fz= .001 IPT
Depth of Cut : ap=.039 inch
Cutting Mode : External Coolant (Emulsion)
Machine : 5-axis MC (HSK63)

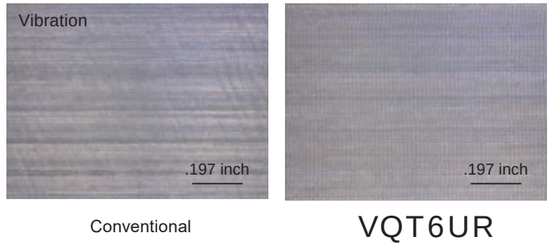
# Cutting Performance

## Deep Wall Machining of Titanium Alloy

High efficiency machining is achieved while maintaining quality of machined surface.

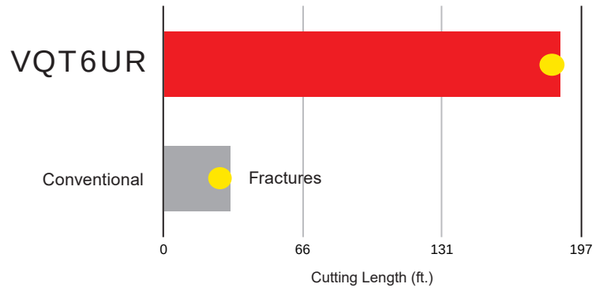


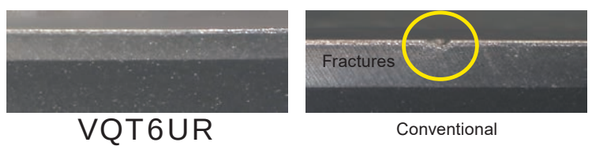




<Cutting Conditions>
Workpiece Material : Ti-6Al-4V
Tool : VQT6URR020R085S10
Revolution : n=2546 $min^{-1}$
Feed per Tooth : fz= .001 IPT
Depth of Cut : ap=.059 inch
: ae=.012 inch
Tilt Angle : 7.73°
Cutting Mode : Side Milling
External Coolant (Emulsion)
Machine : 5-axis MC (HSK63)

## Comparison of Tool Life in Titanium Alloy

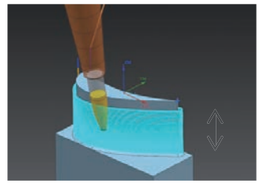


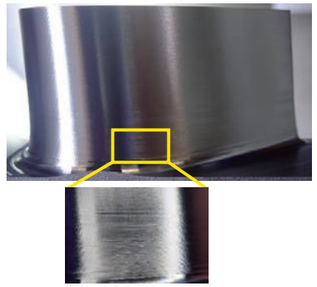




<Cutting Conditions>
Workpiece Material : Ti-6Al-4V
Tool : VQT6URR020R085S10
Revolution : n=2546 $min^{-1}$
Feed per Tooth : fz= .001 IPT
Depth of Cut : ap=.157 inch
: ae=.012 inch
Tilt Angle : 8°
Overhang Length : 1.575 inch
Cutting Mode : External Coolant (Emulsion)
Machine : 5-axis MC (HSK63)

# Machining Example

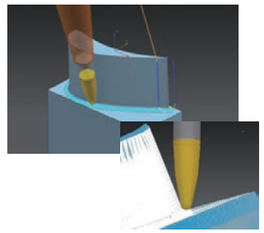
## Blade Surface Machining

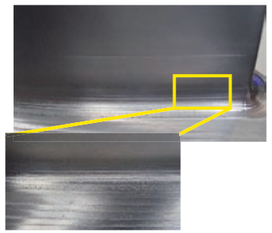




<Cutting Conditions>
Workpiece Material : Ti-6Al-4V
Tool : VQT6URR020R085S10
Cutting Speed : vc=395 SFM
Feed per Rev. : vf=36.22 IPM
Depth of Cut : ap=.056 inch
: ae=.008 inch
Tilt Angle : 10°
Cutting Mode : External Coolant (Emulsion)
Machine : 5-axis MC (HSK63)

## Fillet Milling





<Cutting Conditions>
Workpiece Material : Ti-6Al-4V
Tool : VQT6URR020R085S10
Cutting Speed : vc=260 SFM
Feed per Rev. : vf=29.92 IPM
Depth of Cut : ap=.009 inch
: ae=.008 inch
Tilt Angle : 20°
Cutting Mode : External Coolant (Emulsion)
Machine : 5-axis MC (HSK63)

## Memo

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Novi, MI 48375
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**For Your Safety**

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

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Tools specifications subject to change without notice.

B197A-US-2020.11