

Smart Miracle

VQN Series

END MILLS FOR HEAT
RESISTANT SUPER ALLOYS



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

VQN4/6MVRB NEW

Featuring the new (Al, Ti, Si)N-based coating which provides excellent wear resistance combined with the optimal number of irregular helix flutes to greatly dampen vibration enabling stable, efficient machining.

Features

Optimal Number of Flutes

The number of flutes has been optimized in relation to the outer diameter to achieve excellent chip evacuation and increased tool rigidity.

Corner R-geometry with Improved Fracture Resistance

The negative shape of the rake angle for the R cutting edge allows the smooth flow of chips, thereby improving chipping resistance.



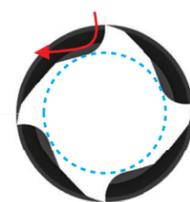
Irregular Helix Flutes

Helix angles vary from flute to flute by up to 4°.

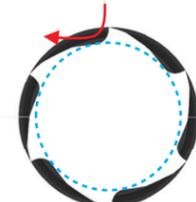


Special Flute Shape

The flute shape is specifically designed for machining of heat resistant super alloys to provide excellent chip evacuation and high wear resistance.



VQN4MVRB

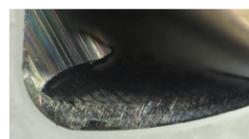


VQN6MVRB

VQN4/6MVRB



Conventional



Defect due to high load

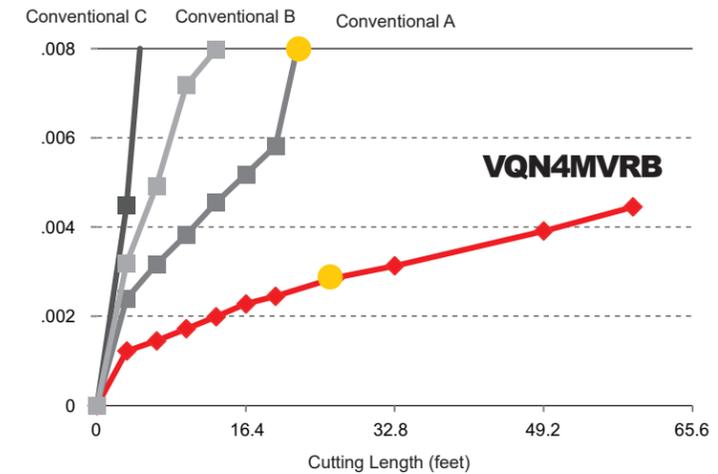


Defect due to lack of strength

Cutting Performance

Machining Inconel 718 - Comparison of Wear Resistance

Excellent wear resistance when machining heat resistant super alloys.



<Cutting Conditions>
 Workpiece Material : Inconel718
 Tool : DC=ø6mm, .236 inch, R1 mm, R.039 inch, 4 flutes
 Cutting Speed : vc=130 SFM
 Revolution : n=2100min⁻¹
 Table Feed : f=9.8 IPM
 Depth of Cut : ap=.118 inch
 ae=.024 inch
 Overhang Length : .787 inch
 Cutting Mode : Wet Cutting (Emulsion)
 Machine : Vertical MC

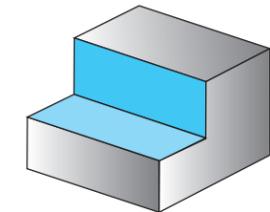
After Cutting 26.2 feet



VQN4MVRB



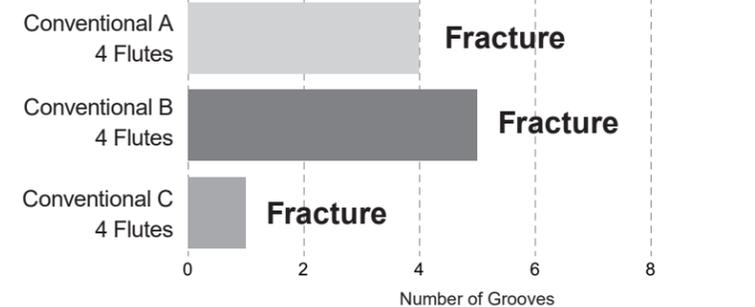
Conventional A



Machining Inconel 718 - Comparison of Fracture Resistance

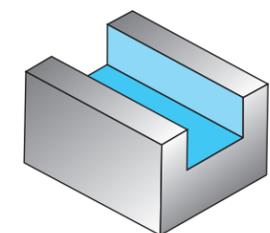
Due to the optimized number of flutes and the enhanced R corner shape, fracture resistance is improved and tool life is more than doubled compared to conventional products.

VQN6MVRB



<Cutting Conditions>
 Workpiece Material : Inconel718
 Tool : DC=ø12mm, .472 inch
 Cutting Speed : vc=100 SFM
 Revolution : n=800min⁻¹
 Table Feed : f=5.5 IPM
 Depth of Cut : ap=.472 inch
 Overhang Length : 1.417 inch
 Cutting Mode : Wet Cutting (Emulsion)
 Machine : Vertical MC

Cutting Length: 5.9 inch per groove



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

VQN2MB/4MB/4MBF

(Al, Ti, Si) N-based coating with outstanding wear resistance, combined with optimized cutting edges, provide high machining efficiency and a stable cutting performance.

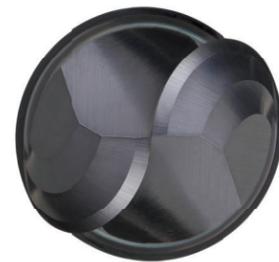
Features

(Al, Ti, Si) N-based Coating

The (Al, Ti, Si)N-based coatings maintain their film hardness and heat resistant properties under the harshest of conditions making it a highly suitable coating for end mills machining heat resistant super alloys.

New Cutting Edge Geometry

The corner radius cutting edge rake angles have been optimized for consistent contact. Additionally the structure of both the 2 and 4 flute end mills have been strengthened.



VQN2MB

Versatile 4 Flute Type

When compared to 2-flute types, end mills with 4 flutes have a longer tool life and provide higher efficiency machining. In addition the new types have a much improved chip disposal rate to prevent clogging. Now available is the new VQN4MBF with a full 4-flute end geometry, ideal for 5 axis machining. The new VQN4MB, with 4 side flutes displays a special end geometry with only 2 flutes, designed with extra space for excellent chip evacuation during rough machining.



VQN4MBF

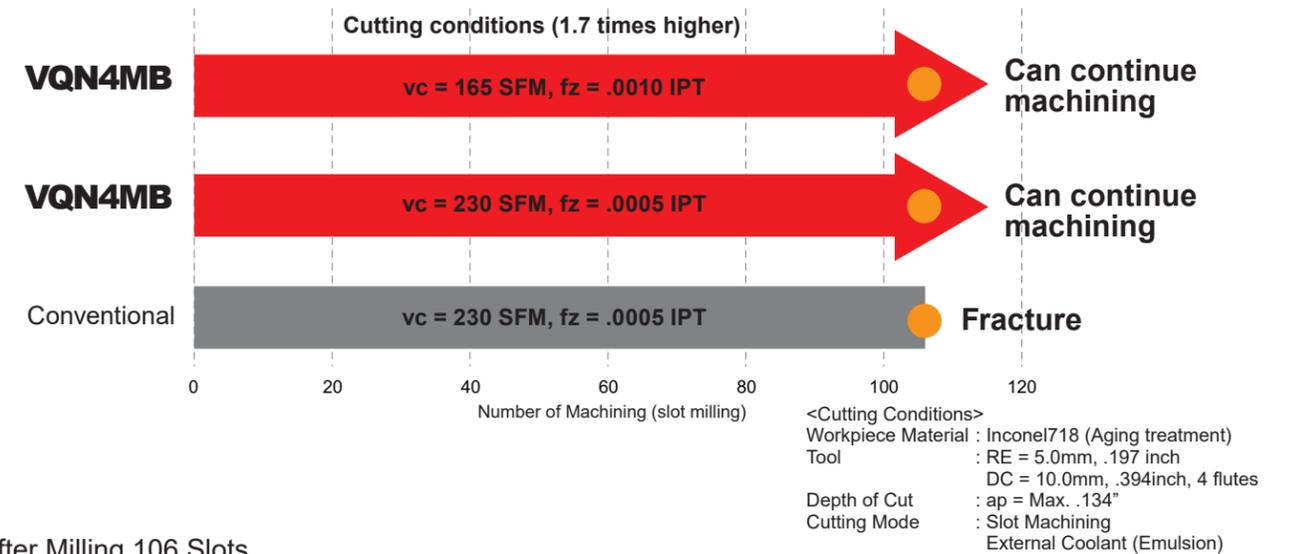


VQN4MB

Cutting Performance

Machining Inconel 718 - Comparison of Fracture Resistance

Cutting time has been reduced due to an increased feed rate and an excellent resistance to fracturing during slotting. Ideal for machining heat resistant alloys typically used in the aerospace industry.

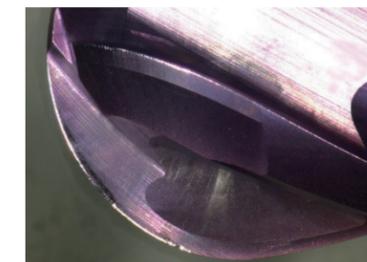


After Milling 106 Slots



VQN4MB

vc = 165 SFM, fz = .0010 IPT



VQN4MB

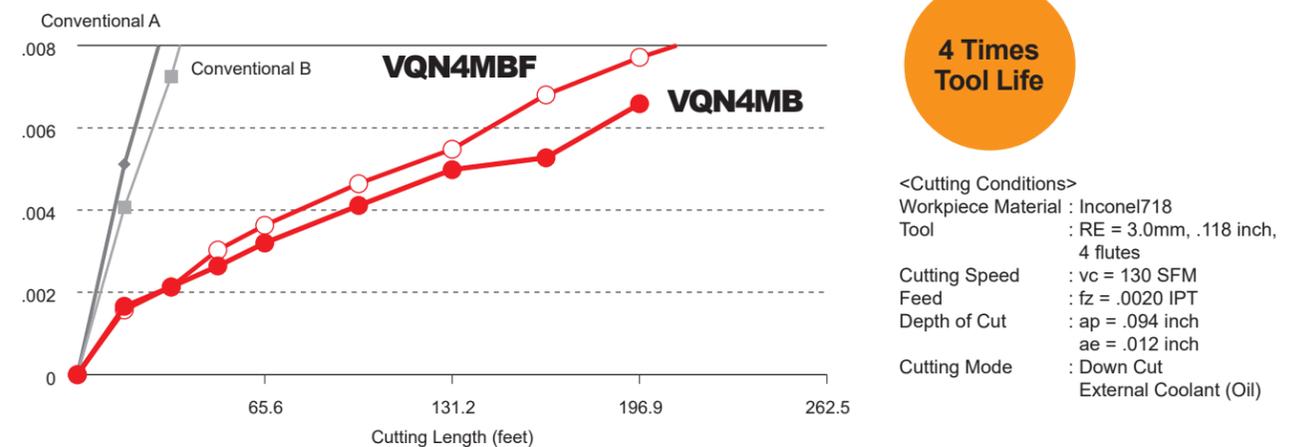
vc = 230 SFM, fz = .0005 IPT



Conventional Fracture
vc = 230 SFM, fz = .0005 IPT

Machining Inconel 718 - Comparison of Wear Resistance

Both VQN4MBF and VQN4MB have more than four times the wear resistance of conventional products.



End Mills for Machining Difficult-to-cut Materials

Product Name	Coating or Substrate	End Mills	Size Range	ap	Neck Length	Flutes	Finish / Rough	Work Materials Upper : 1st Recommendation Lower : 2nd Recommendation	Slot Milling
S									
Radius End Mill									
Medium (ap=3xDC)									
VQN4MVRB			DC 3-6	2.2-2.5 xDC	-	4	F R	S	○
VQN6MVRB			DC 8-12	2.2-2.4 xDC	-	6	F R	S	○
Ball End Mill									
Medium (ap=3xDC)									
VQN2MB			RE 0.5-1.5	DC	-	2	F R	S	○
VQN4MB			RE 2.0-6.0	2-2.4 xDC	-	2	F R	S	○
VQN4MB			RE 1.0-6.0	1-2.4 xDC	-	4	F R	S	○
VQN4MBF			RE 1.0-6.0	1-2.4 xDC	-	4	F R	S	-

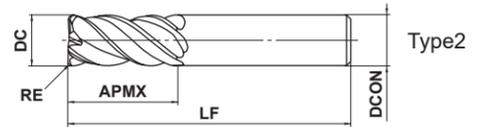
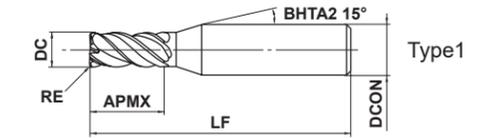
* ap : Depth of Cut
* DC : Cutting Diameter
* RE : Radius of Ball Nose

VQN4/6MVRB NEW

Corner Radius, Medium cut length, 4/6 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
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	VQN4	VQN6			
	±0.015	±0.02			
	DC≤12				
	0 - 0.02				
	DCON=6	DCON=8,10	DCON=12		
	0 - 0.008	0 - 0.009	0 - 0.011		

- (Al, Ti, Si) N-based coating exhibits excellent wear and chipping resistance when machining heat resistant super alloys.
- Optimized number of flutes for efficient and stable machining.

(mm)

Order Number	DC	RE	APMX	LF	DCON	No.F	Stock	Type
VQN4MVRBD0300R030	3	0.3	7	45	6	4	●	1
VQN4MVRBD0300R050	3	0.5	7	45	6	4	●	1
VQN4MVRBD0400R030	4	0.3	10	45	6	4	●	1
VQN4MVRBD0400R050	4	0.5	10	45	6	4	●	1
VQN4MVRBD0500R050	5	0.5	12	50	6	4	●	1
VQN4MVRBD0600R050	6	0.5	13	50	6	4	●	2
VQN4MVRBD0600R100	6	1	13	50	6	4	●	2
VQN6MVRBD0800R050	8	0.5	19	60	8	6	●	2
VQN6MVRBD0800R100	8	1	19	60	8	6	●	2
VQN6MVRBD1000R050	10	0.5	22	70	10	6	●	2
VQN6MVRBD1000R100	10	1	22	70	10	6	●	2
VQN6MVRBD1200R050	12	0.5	26	75	12	6	●	2
VQN6MVRBD1200R100	12	1	26	75	12	6	●	2

* Number of Flutes

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

● : USA Stock

End Mills for Machining Difficult-to-cut Materials

VQN4/6MVRB

Corner Radius, Medium cut length, 4/6 flute

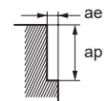
Recommended Cutting Conditions

Side milling

(inch)

DC		Number of Flutes	Revolution (SFM)	Feed Rate (IPM)	Depth of Cut a_p	Depth of Cut a_e
(mm)	(inch)					
3	.118	4	4200	13.4	.177	.012
4	.157	4	3200	10.2	.236	.016
5	.197	4	2500	11.8	.295	.020
6	.236	4	2100	9.8	.354	.024
8	.315	6	1600	11.4	.472	.031
10	.394	6	1300	12.2	.591	.039
12	.472	6	1100	10.2	.709	.047

Workpiece Material
Nickel-based Heat Resistant Super Alloy
Inconel718, Inconel713C, Waspaloy etc.

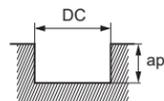


Slot milling

(inch)

DC		Number of Flutes	Revolution (SFM)	Feed Rate (IPM)	Depth of Cut a_p
(mm)	(inch)				
3	.118	4	3200	10.2	.059
4	.157	4	2400	7.5	.079
5	.197	4	1900	9.1	.098
6	.236	4	1600	7.5	.118
8	.315	6	1200	5.5	.157
10	.394	6	1000	4.7	.197
12	.472	6	800	5.5	.236

Workpiece Material
Nickel-based Heat Resistant Super Alloy
Inconel718, Inconel713C, Waspaloy etc.



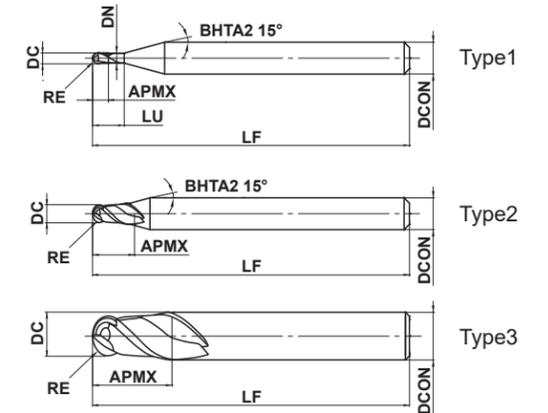
- Note 1) For heat resistant super alloy, the use of water-soluble coolant is effective.
 Note 2) Chattering can still occur if the machine rigidity and clamping method are insufficient. In these cases the feed and speed should be reduced proportionately.
 Note 3) If the depth of cut is shallow, the revolution and feed rate can be increased.

VQN2MB

Ball nose, Medium cut length, 2 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
					◎		



RE ≤ 6		
±0.010		
DCON=6	8 ≤ DCON ≤ 10	DCON=12
0 - 0.005	0 - 0.006	0 - 0.008

- (Al, Ti, Si) N-based coating exhibits excellent wear and chipping resistance when machining heat resistant super alloys.
- The R cutting edge rake angle and ball nose geometry have been optimized to improve strength.

(mm)

Order Number	RE	DC	APMX	LU	DN	LF	DCON	No.F*	Stock	Type
VQN2MBR0050	0.5	1	1	4	0.94	60	6	2	●	1
VQN2MBR0100	1.0	2	2	6	1.9	60	6	2	●	1
VQN2MBR0150	1.5	3	3	8	2.9	60	6	2	●	1
VQN2MBR0200	2.0	4	8	-	-	60	6	2	●	2
VQN2MBR0250	2.5	5	12	-	-	60	6	2	●	2
VQN2MBR0300	3.0	6	12	-	-	60	6	2	●	3
VQN2MBR0400	4.0	8	14	-	-	70	8	2	●	3
VQN2MBR0500	5.0	10	18	-	-	80	10	2	●	3
VQN2MBR0600	6.0	12	22	-	-	80	12	2	●	3

* Number of Flutes

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

● : USA Stock

End Mills for Machining Difficult-to-cut Materials

VQN2MB

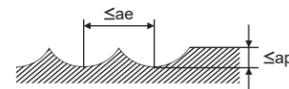
Medium cut length, 2 flute

Recommended Cutting Conditions

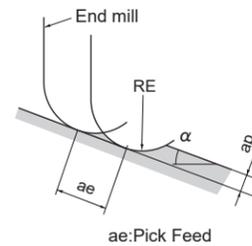
(inch)

Workpiece Material		Nickel-based Heat Resistant Super Alloy Inconel718, Inconel713C, WASPALLOY etc.					
RE		$\alpha \leq 15^\circ$		$\alpha > 15^\circ$		Depth of Cut a_p	Depth of Cut a_e
(mm)	(inch)	Revolution (SFM)	Feed Rate (IPM)	Revolution (SFM)	Feed Rate (IPM)		
0.5	.020	65	25.2	65	29.9	.004	.010
1.0	.039	65	12.6	65	15.0	.008	.020
1.5	.059	65	9.8	65	9.8	.012	.030
2.0	.079	65	7.5	65	8.7	.016	.039
2.5	.098	65	7.1	65	7.9	.020	.049
3.0	.118	65	6.7	65	8.3	.024	.059
4.0	.157	60	5.1	60	6.3	.031	.079
5.0	.197	60	5.1	60	5.5	.039	.098
6.0	.236	60	4.3	60	4.7	.047	.118

Depth of cut



- Note 1) For heat resistant super alloy, the use of water-soluble coolant is effective.
 Note 2) If the depth of cut is shallow, the revolution and feed rate can be increased.
 Note 3) Vibration may occur if the rigidity of machine or workpiece is low. In this case, please reduce the revolution and feed rate proportionately.
 Note 4) α is the inclination angle of the machined surface.



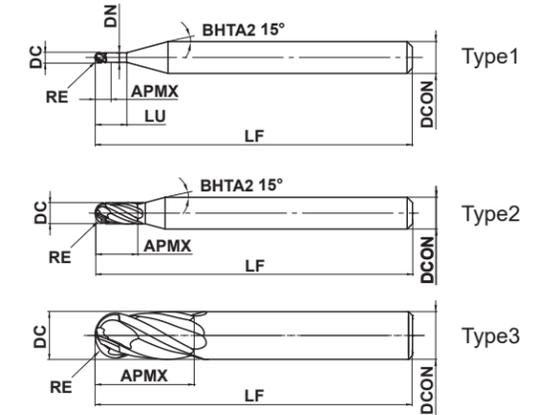
● : USA Stock

VQN4MB

Ball nose, Medium cut length, 4 flute



Carbon Steel, Alloy Steel, Cast Iron (<30HRC)	Tool Steel, Pre-hardened Steel, Hardened Steel ($\leq 45\text{HRC}$)	Hardened Steel ($\leq 55\text{HRC}$)	Hardened Steel ($> 55\text{HRC}$)	Austenitic Stainless Steel	Heat Resistant Alloy	Copper Alloy	Aluminum Alloy
					◎		



RE ≤ 6		
± 0.010		
DCON=6	$8 \leq \text{DCON} \leq 10$	DCON=12
0 $- 0.005$	0 $- 0.006$	0 $- 0.008$

- (Al, Ti, Si) N-based coating exhibits excellent wear and chipping resistance when machining heat resistant super alloys.
- The 2-flute end cutting edge provides excellent chip evacuation and is ideal for rough machining.

(mm)

Order Number	RE	DC	APMX	LU	DN	LF	DCON	No.F*	Stock	Type
VQN4MBR0100	1.0	2	2	6	1.9	60	6	4	●	1
VQN4MBR0150	1.5	3	3	8	2.9	60	6	4	●	1
VQN4MBR0200	2.0	4	8	-	-	60	6	4	●	2
VQN4MBR0250	2.5	5	12	-	-	60	6	4	●	2
VQN4MBR0300	3.0	6	12	-	-	60	6	4	●	3
VQN4MBR0400	4.0	8	14	-	-	70	8	4	●	3
VQN4MBR0500	5.0	10	18	-	-	80	10	4	●	3
VQN4MBR0600	6.0	12	22	-	-	80	12	4	●	3

* Number of Flutes

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

End Mills for Machining Difficult-to-cut Materials

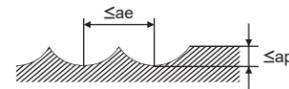
VQN4MB

Medium cut length, 4 flute

Recommended Cutting Conditions

(inch)

Workpiece Material		Nickel-based Heat Resistant Super Alloy Inconel718, Inconel713C, Waspaloy etc.					
RE		$\alpha \leq 15^\circ$		$\alpha > 15^\circ$		Depth of Cut ap	Depth of Cut ae
(mm)	(inch)	Revolution (SFM)	Feed Rate (IPM)	Revolution (SFM)	Feed Rate (IPM)		
1.0	.039	65	15.0	65	20.1	.008	.020
1.5	.059	65	13.4	65	16.5	.012	.030
2.0	.079	65	12.6	65	15.0	.016	.039
2.5	.098	65	9.8	65	12.2	.020	.049
3.0	.118	65	8.3	65	9.8	.024	.059
4.0	.157	60	6.3	60	7.5	.031	.079
5.0	.197	60	5.9	60	7.9	.039	.098
6.0	.236	60	5.9	60	6.7	.047	.118

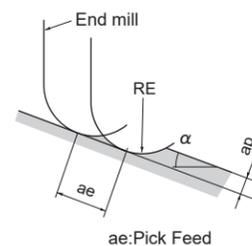


Note 1) For heat resistant super alloy, the use of water-soluble coolant is effective.

Note 2) If the depth of cut is shallow, the revolution and feed rate can be increased.

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

Note 4) α is the inclination angle of the machined surface.



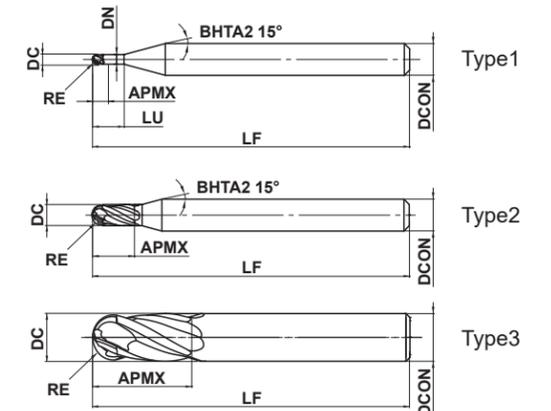
● : USA Stock

VQN4MBF

Ball nose, Medium 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	Heat Resistant Alloy	Copper Alloy	Aluminum Alloy
					◎		



RE	RE ≤ 6		
	±0.010		
h5	DCON=6	8 ≤ DCON ≤ 10	DCON=12
	0	0	0
	-0.005	-0.006	-0.008

- (Al, Ti, Si) N-based coating exhibits excellent wear and chipping resistance when machining heat resistant super alloys.
- The 4-flute end cutting edge is also ideal for 5-axis machining.

Order Number	RE	DC	APMX	LU	DN	LF	DCON	No.F*	Stock	Type
VQN4MBFR0100	1.0	2	2	6	1.9	60	6	4	●	1
VQN4MBFR0150	1.5	3	3	8	2.9	60	6	4	●	1
VQN4MBFR0200	2.0	4	8	-	-	60	6	4	●	2
VQN4MBFR0250	2.5	5	12	-	-	60	6	4	●	2
VQN4MBFR0300	3.0	6	12	-	-	60	6	4	●	3
VQN4MBFR0400	4.0	8	14	-	-	70	8	4	●	3
VQN4MBFR0500	5.0	10	18	-	-	80	10	4	●	3
VQN4MBFR0600	6.0	12	22	-	-	80	12	4	●	3

* Number of Flutes

DC = Cutting Dia. DN = Neck Dia.
 RE = Radius of Ball Nose LF = Overall Length
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 LU = Neck Length

End Mills for Machining Difficult-to-cut Materials

Memo

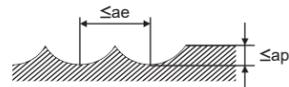
VQN4MBF

Medium cut length, 4 flute

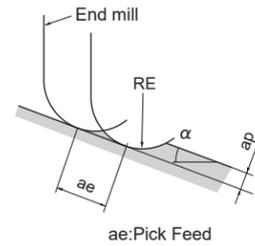
Recommended Cutting Conditions

(inch)

Workpiece Material		Nickel-based Heat Resistant Super Alloy Inconel718, Inconel713C, Waspaloy etc.						
RE		$\alpha \leq 15^\circ$			$\alpha > 15^\circ$			Depth of Cut ap
(mm)	(inch)	Revolution (SFM)	Feed Rate (IPM)	Depth of Cut ae	Revolution (SFM)	Feed Rate (IPM)	Depth of Cut ae	
1.0	.039	65	7.1	.016	65	12.2	.020	.008
1.5	.059	65	6.7	.024	65	13.4	.030	.012
2.0	.079	65	7.5	.031	65	12.6	.039	.016
2.5	.098	65	5.9	.039	65	9.8	.049	.020
3.0	.118	65	6.7	.047	65	9.8	.059	.024
4.0	.157	60	5.1	.063	60	7.5	.079	.031
5.0	.197	60	3.9	.079	60	7.9	.098	.039
6.0	.236	60	5.1	.094	60	6.7	.118	.047



- Note 1) For heat resistant super alloy, the use of water-soluble coolant is effective.
- Note 2) If the depth of cut is shallow, the revolution and feed rate can be increased.
- Note 3) Vibration may occur if the rigidity of machine or workpiece is low. In this case, please reduce the revolution and feed rate proportionately.
- Note 4) α is the inclination angle of the machined surface.



● : USA Stock



MITSUBISHI MATERIALS U.S.A. CORPORATION

California Office (Headquarters)

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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.

www.mmc-carbide.com/us

Tools specifications subject to change without notice.

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