MITSUBISHI MATERIALS

VQN Smart Miracle

END MILLS FOR HEAT RESISTANT SUPER ALLOYS





TOOL NEWS **B251A**

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.



Irregular Helix Flutes

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

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.



VQN4/6MVRB



Conventional







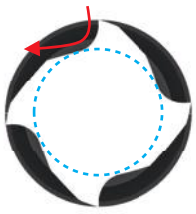
Defect due to high load



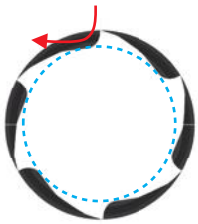
Defect due to lack of strength

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

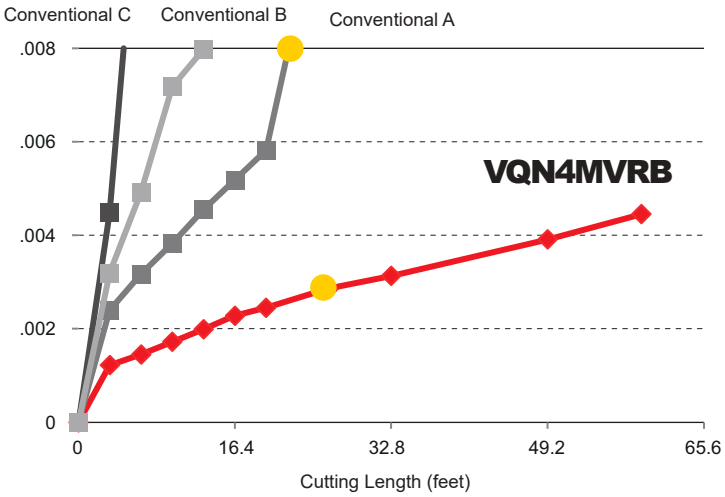


VQN6MVRB

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

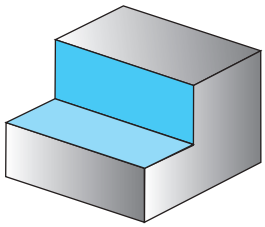
After Cutting 26.2 feet



VQN4MVRB

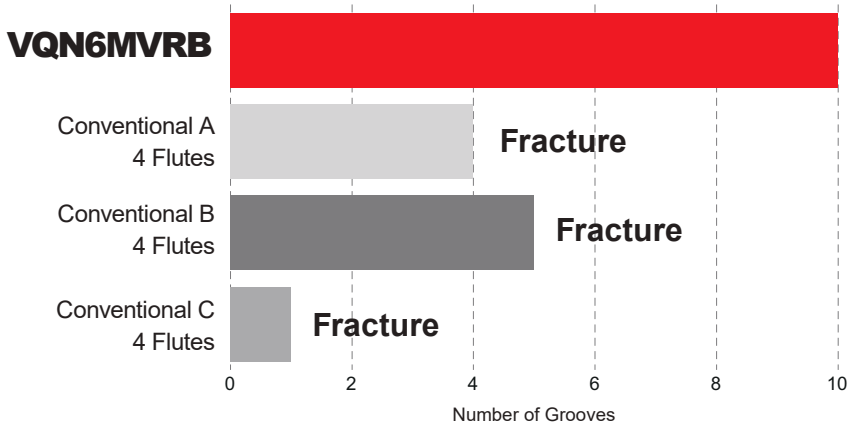


Conventional A



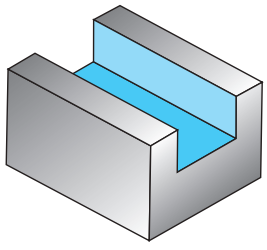
Machining Inconel 718 - Comparison of Fracture Resistance

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.



<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

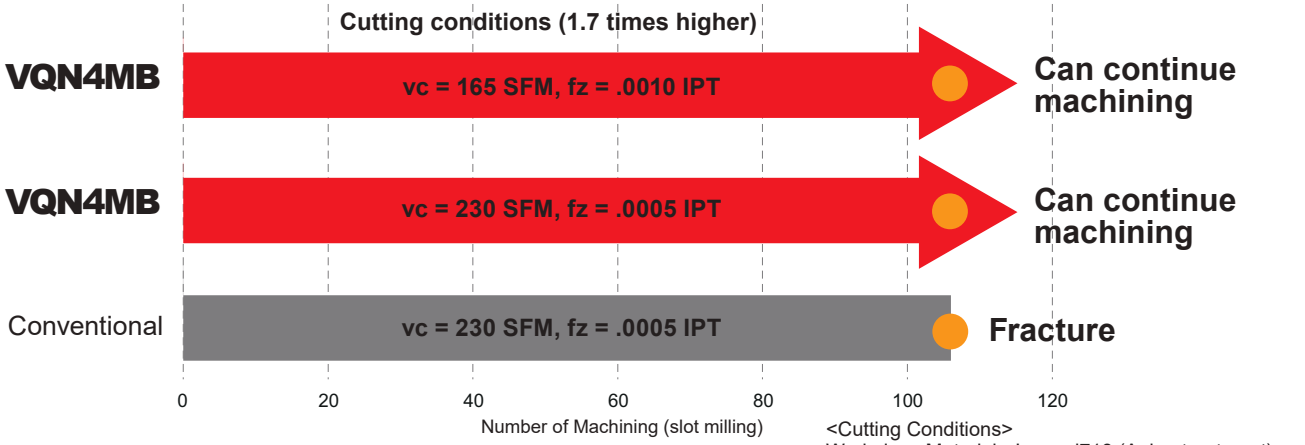


VQN4MB

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.

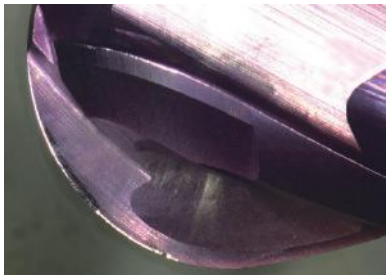


<Cutting Conditions>
Workpiece Material : Inconel718 (Aging treatment)
Tool : RE = 5.0mm, .197 inch
DC = 10.0mm, .394inch, 4 flutes
Depth of Cut : ap = Max. .134"
Cutting Mode : Slot Machining
External Coolant (Emulsion)

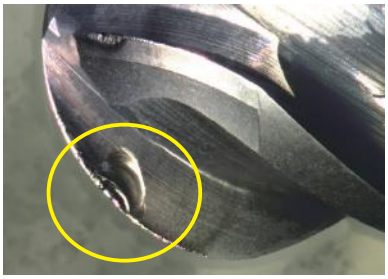
After Milling 106 Slots



VQN4MB
vc = 165 SFM, fz = .0010 IPT



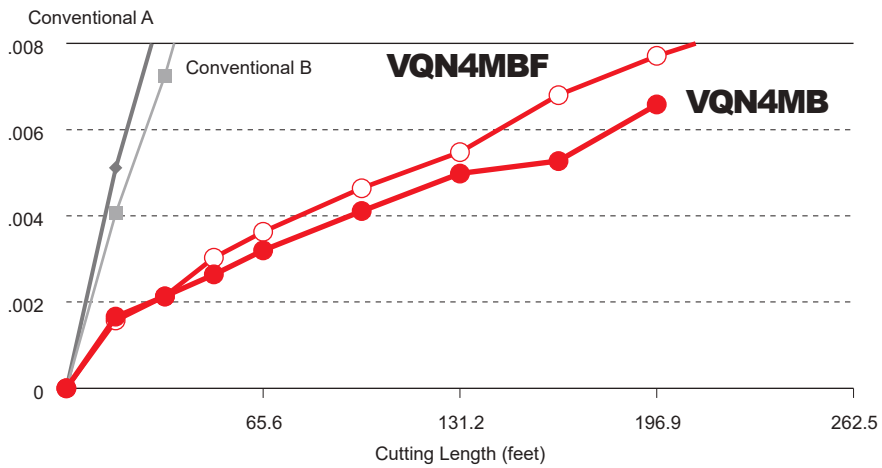
VQN4MB
vc = 230 SFM, fz = .0005 IPT



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.



4 Times Tool Life

<Cutting Conditions>
Workpiece Material : Inconel718
Tool : RE = 3.0mm, .118 inch,
4 flutes
Cutting Speed : vc = 130 SFM
Feed : fz = .0020 IPT
Depth of Cut : ap = .094 inch
ae = .012 inch
Cutting Mode : Down Cut
External Coolant (Oil)

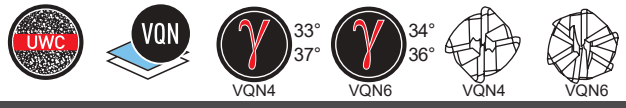
End Mills for Machining Difficult-to-cut Materials

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	VQN		DC 3−6	2.2−2.5 xDC	−	4	F R	S	○
VQN6MVRB	VQN		DC 8−12	2.2−2.4 xDC	−	6	F R	S	○
Ball End Mill									
Medium (ap−3xDC)									
VQN2MB	VQN		RE 0.5−1.5	DC	−	2	F R	S	○
	VQN		RE 2.0−6.0	2−2.4 xDC	−	2	F R	S	○
VQN4MB	VQN		RE 1.0−6.0	1−2.4 xDC	−	4	F R	S	○
VQN4MBF	VQN		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

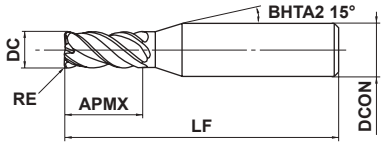
VQN4/6MVRB NEW

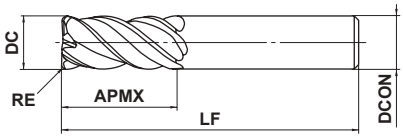
Corner Radius, Medium cut length, 4/6 flute



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
					◎		







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**

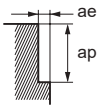
VQN4/6MVRB

Corner Radius, Medium cut length, 4/6 flute

Recommended Cutting Conditions

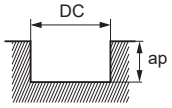
Side milling

(inch)

Workpiece Material			Nickel-based Heat Resistant Super Alloy Inconel718, Inconel713C, WASPALOY etc.			
DC		Number of Flutes	Revolution (SFM)	Feed Rate (IPM)	Depth of Cut ap	Depth of Cut ae
(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
Depth of cut						

Slot milling

(inch)

Workpiece Material			Nickel-based Heat Resistant Super Alloy Inconel718, Inconel713C, WASPALOY etc.		
DC		Number of Flutes	Revolution (SFM)	Feed Rate (IPM)	Depth of Cut ap
(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
Depth of cut					

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.

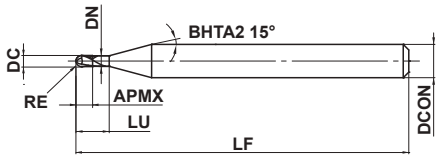
VQN2MB

Ball nose, Medium cut length, 2 flute

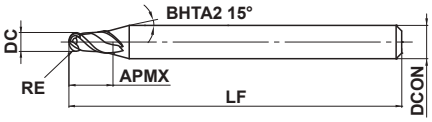


Carbon Steel, Alloy Steel, Cast Iron (<30HRC)	Tool Steel, Pre-hardened Steel,Hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Hardened Steel (>55HRC)	Austenitic Stainless Steel	Heat Resistant Alloy	Copper Alloy	Aluminum Alloy
					◎		

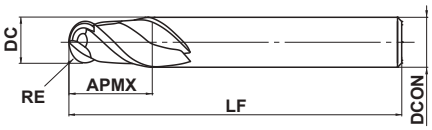




Type1



Type2



Type3



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

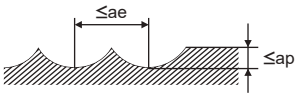
● : **USA Stock**

VQN2MB

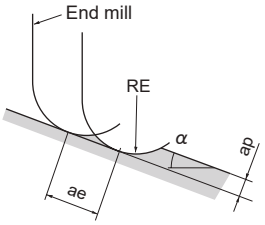
Medium cut length, 2 flute

Recommended Cutting Conditions

(inch)

Workpiece Material		Nickel-based Heat Resistant Super Alloy Inconel718, Inconel713C, WASPALOY etc.					
RE		α≤15°		α>15°		Depth of Cut ap	Depth of Cut ae
(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.



ae:Pick Feed

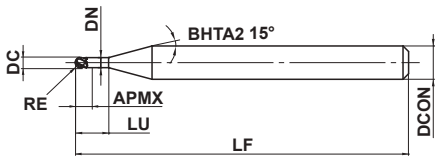
● : USA Stock

VQN4MB

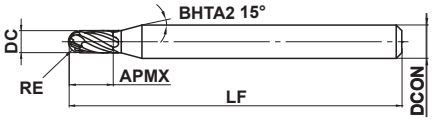
Ball nose, Medium cut length, 4 flute

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
					◎		

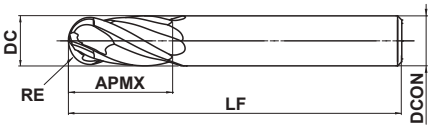




Type1



Type2



Type3

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

h5

- (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

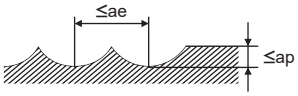
DC = Cutting Dia.
RE = Radius of Ball Nose
APMX = Length of Cut
LU = Neck Length
DN = Neck Dia.
LF = Overall Length
DCON = Shank Dia.

VQN4MB

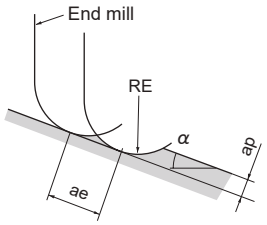
Medium cut length, 4 flute

Recommended Cutting Conditions

(inch)

Workpiece Material		Nickel-based Heat Resistant Super Alloy Inconel718, Inconel713C, WASPALOY etc.					
RE		α≤15°		α>15°		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
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.



ae:Pick Feed

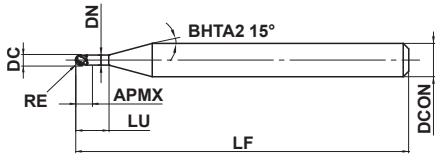
● : USA Stock

VQN4MBF

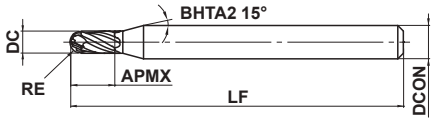
Ball nose, Medium cut length, 4 flute

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
					◎		

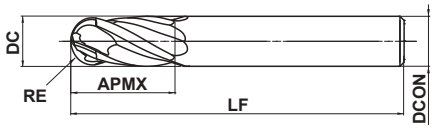




Type1



Type2



Type3

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 4-flute end cutting edge is also ideal for 5-axis machining.

(mm)

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

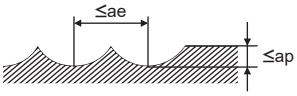
DC = Cutting Dia.
RE = Radius of Ball Nose
APMX = Length of Cut
LU = Neck Length
DN = Neck Dia.
LF = Overall Length
DCON = Shank Dia.

VQN4MBF

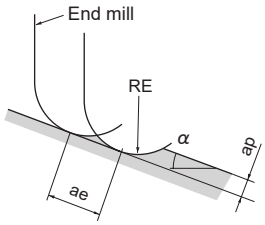
Medium cut length, 4 flute

Recommended Cutting Conditions

(inch)

Workpiece Material	Nickel-based Heat Resistant Super Alloy Inconel718, Inconel713C, WASPALOY etc.							
RE		α≤15°			α>15°			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
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.



ae:Pick Feed

● : USA Stock

Memo

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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.

B251A-US-2023.11