DIA EDGE
TOOL NEWS
2022.3 Update
B251G

SMART MIRACLE End Mills
VQN Series for Heat Resistant Super Alloys

Series Expansion

Outstanding Wear Resistance Enables Stable Machining of Heat Resistant Super Alloys

MITSUBISHI MATERIALS CORPORATION

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

VQN4/6MVRB NEW

Featuring the new (Al, Ti, Si)N based coating that has excellent wear resistance. Additionally, the optimum number of irregular helix flutes greatly dampens vibration to enable stable, efficient machining.

Features

Optimised Number of Flutes

The number of flutes has been optimised in accordance 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 chip resistance.

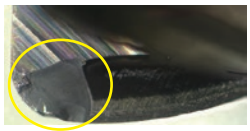
Irregular Helix Flutes

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

VQN4/6MVRB

Conventional

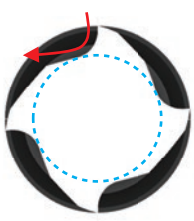
Defect due to high load



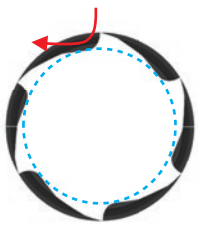
Defect due to lack of strength

Special Flute Shape

The flute shape is specially designed to suit machining of super heat resistant alloys by featuring excellent chip evacuation and wear resistance properties.



VQN4MVRB

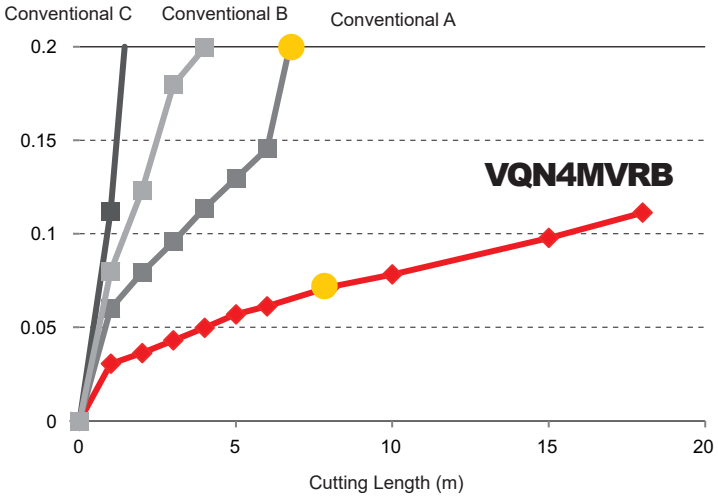


VQN6MVRB

Cutting Performance

Machining Inconel 718 - Comparison of Wear Resistance

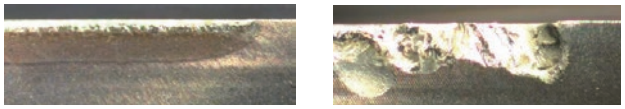
Excellent wear resistance when machining super heat-resistant alloys.



<Cutting Conditions>

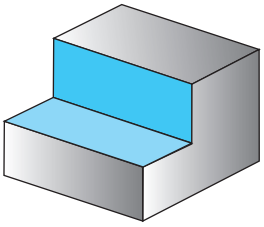
Workpiece Material	: Inconel718
Tool	: DC=ø6mm, R1, 4 flutes
Cutting Speed	: vc=40m/min
Revolution	: n=2100min^{-1}
Table Feed	: f=250mm/min
Depth of Cut	: ap=3.0mm
	ae=0.6mm
Overhang Length	: 20mm
Cutting Mode	: Wet Cutting (Emulsion)
Machine	: Vertical MC

After Cutting 8 m



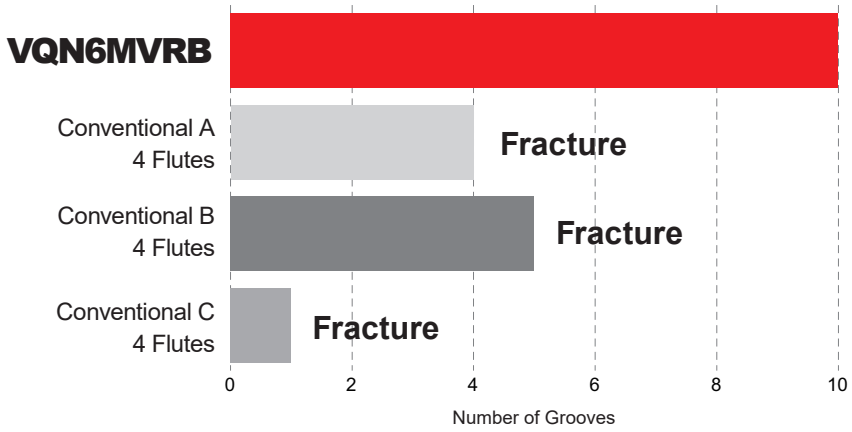
VQN4MVRB

Conventional A



Machining Inconel 718 - Comparison of Fracture Resistance

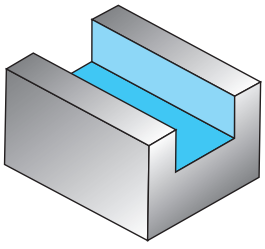
Due to the optimised number of flutes and the enhanced R corner shape, fracture resistance is improved and tool life is more than doubled compared to conventional products.



<Cutting Conditions>

Workpiece Material	: Inconel718
Tool	: DC=ø12mm
Cutting Speed	: vc=30m/min
Revolution	: n=800min^{-1}
Table Feed	: f=140mm/min
Depth of Cut	: ap=12mm
Overhang Length	: 36mm
Cutting Mode	: Wet Cutting (Emulsion)
Machine	: Vertical MC

Cutting Length: 150mm 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 optimised cutting edges, provide high machining efficiency and a stable cutting performance.

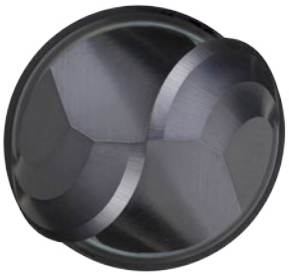
Features

(Al, Ti, Si) N-based Coating

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

New Cutting Edge Geometry

The corner radius cutting edge rake angles have been optimised for consistent contact. Additionally the structure of both the 2 and 4 flutes 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.
Available now 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 2 flute end geometry to provide extra space for excellent chip evacuation during rough machining.

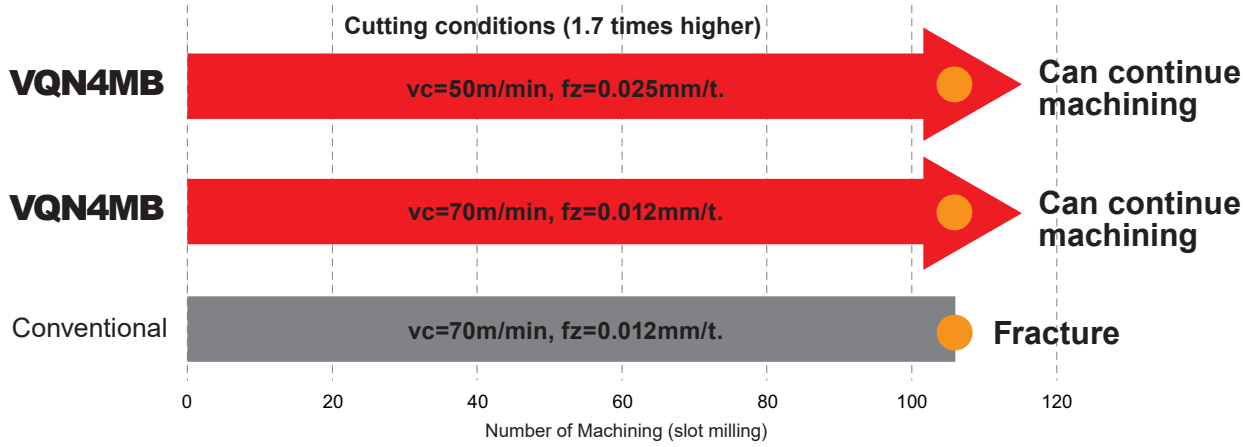
VQN4MBF

VQN4MB

Cutting Performance

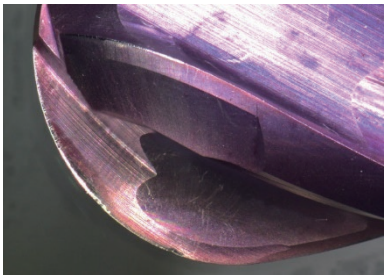
Machining Inconel 718 - Comparison of Fracture Resistance

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.



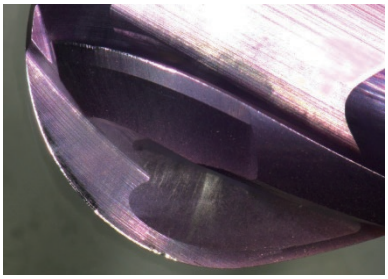
<Cutting Conditions>
Workpiece Material : Inconel718 (Aging treatment)
Tool : RE = 5.0mm, DC=10.0mm, 4 flutes
Depth of Cut : ap = Max. 3.4mm
Cutting Mode : Slot Machining
External Coolant (Emulsion)

After Milling 106 Slots



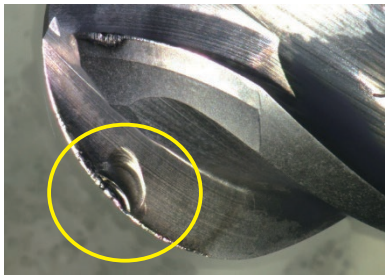
VQN4MB

vc=50m/min, fz=0.025mm/t.



VQN4MB

vc=70m/min, fz=0.012mm/t.

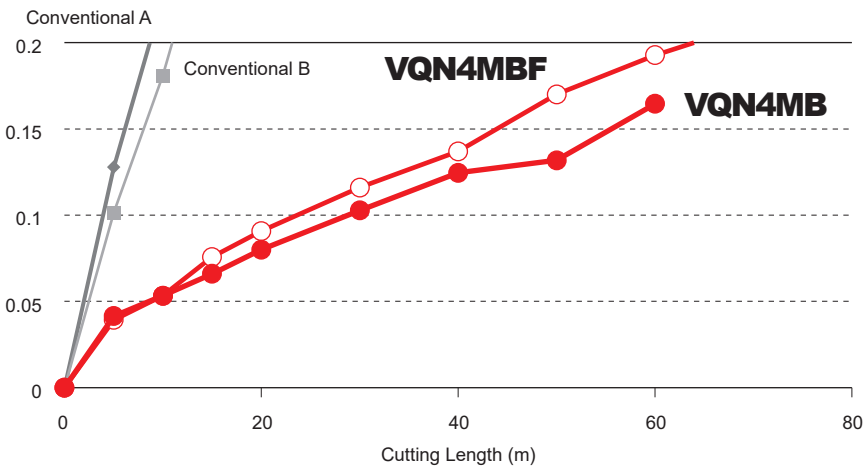


Conventional Fracture

vc=70m/min, fz=0.012mm/t.

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, 4 flutes
Cutting Speed : vc = 40m/min
Feed : fz = 0.05mm/t.
Depth of Cut : ap = 2.4mm
ae = 0.3mm
Cutting Mode : Down Cut
External Coolant (Oil)

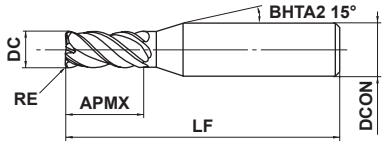
Product Name	Coating or Substrate	End Mills	Size Range	ap	Neck Length	Flutes	Finish / Rough	Work Materials Upper : 1st Recommendation Under : 2nd Recommendation	Slot Milling
S									
Radius End Mill									
Medium (ap−3xDC)									
VQN4MVRB	VQN	 33° 37°	DC 3−6	2.2−2.5 xDC	−	4	F R	S	○
VQN6MBRB	VQN	 34° 36°	DC 8−12	2.2−2.4 xDC	−	6	F R	S	○
Ball End Mill									
Medium (ap−3xDC)									
VQN2MB	VQN	 30°	RE 0.5−1.5	DC	−	2	F R	S	○
	VQN	 45°	RE 2.0−6.0	2−2.4 xDC	−	2	F R	S	○
VQN4MB	VQN	 30°	RE 1.0−6.0	1−2.4 xDC	−	4	F R	S	○
VQN4MBF	VQN	 30°	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

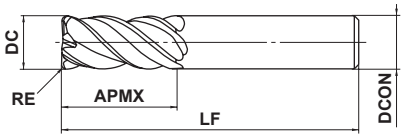
VQN4/6MVRB NEW

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	Aluminium Alloy
					◎		



Type1



Type2

VQN4	VQN6			
±0.015	±0.02			
DC≤12				
0 - 0.02				
DCON=6	DCON=8,12	DCON=12		
0 - 0.008	0 - 0.009	0 - 0.012		

● (Al, Ti, Si) N-based coating exhibits excellent wear and chipping resistance when machining heat resistant super alloys.
● Optimised 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.

● : **Inventory maintained in Japan.**

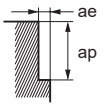
VQN4/6MVRB

Corner Radius, Medium cut length, 4/6 flute

Recommended Cutting Conditions

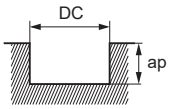
■Side milling

(mm)

Workpiece Material		Nickel-based Heat Resistant Super Alloy Inconel718, Inconel713C, WASPALOY etc.			
DC	Number of Flutes	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap	Depth of cut ae
3	**4**	4200	340	4.5	0.3
4	**4**	3200	260	6	0.4
5	**4**	2500	300	7.5	0.5
6	**4**	2100	250	9	0.6
8	**6**	1600	290	12	0.8
10	**6**	1300	310	15	1
12	**6**	1100	260	18	1.2
Depth of cut					

■Slot milling

(mm)

Workpiece Material		Nickel-based Heat Resistant Super Alloy Inconel718, Inconel713C, WASPALOY etc.		
DC	Number of Flutes	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ap
3	**4**	3200	260	1.5
4	**4**	2400	190	2
5	**4**	1900	230	2.5
6	**4**	1600	190	3
8	**6**	1200	220	4
10	**6**	1000	180	5
12	**6**	800	140	6
Depth of cut				

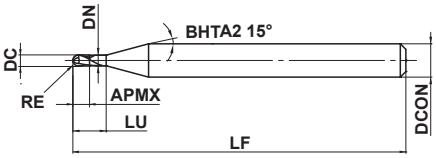
Note 1) For heat resistant super alloy, the use of water-solble coolant is effective.
Note 2) Chattering can still occur if the machine rigidity and clamping method are insufficient.
In these cases the feed and speed should be reduced proportionately.
Note 3) If the depth of cut is shallow, the revolution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

VQN2MB

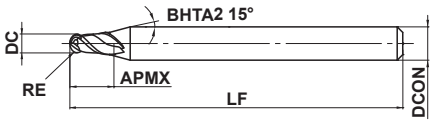
Ball nose, Medium cut length, 2 flute

UWC | VQN | γ 30° RE≤1.5 | γ 45° RE>1.5

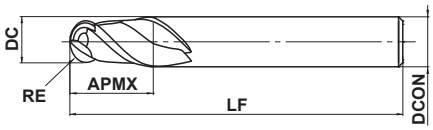
Carbon Steel, Alloy Steel, Cast Iron (<30HRC)	Tool Steel, Pre-hardened Steel,Hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Hardened Steel (>55HRC)	Austenitic Stainless Steel	Heat Resistant Alloy	Copper Alloy	Aluminium Alloy
					◎		



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.

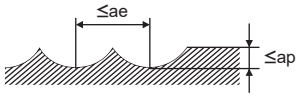
● : **Inventory maintained in Japan.**

VQN2MB

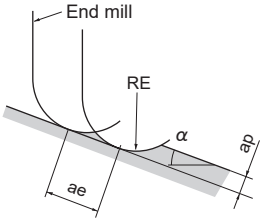
Medium cut length, 2 flute

Recommended Cutting Conditions

(mm)

Workpiece Material	Nickel-based Heat Resistant Super Alloy Inconel718, Inconel713C, WASPALOY etc.					
R **RE**	$\alpha \leq 15°$		$\alpha > 15°$		Depth of cut ap	Depth of cut ae
	Revolution (min^{-1})	Feed rate (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)		
0.5	12700	640	12700	760	0.1	0.25
1.0	6300	320	6300	380	0.2	0.50
1.5	4200	250	4200	250	0.3	0.75
2.0	3100	190	3100	220	0.4	1.00
2.5	2500	180	2500	200	0.5	1.25
3.0	2100	170	2100	210	0.6	1.50
4.0	1500	130	1500	160	0.8	2.00
5.0	1200	130	1200	140	1.0	2.50
6.0	1000	110	1000	120	1.2	3.00
Depth of cut						

Note 1) For heat resistant super alloy, the use of water-solble 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.

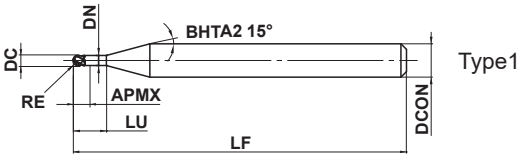


ae:Pick Feed

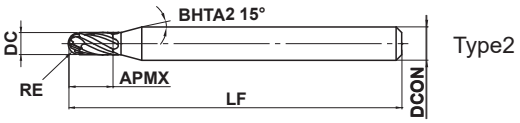
VQN4MB

Ball nose, Medium cut length, 4 flute

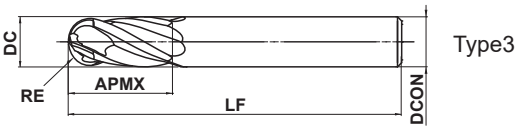
Carbon Steel, Alloy Steel, Cast Iron (<30HRC)	Tool Steel, Pre-hardened Steel,Hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Hardened Steel (>55HRC)	Austenitic Stainless Steel	Heat Resistant Alloy	Copper Alloy	Aluminium Alloy
					◎		



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 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.

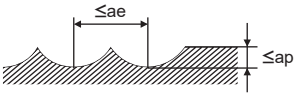
● : **Inventory maintained in Japan.**

VQN4MB

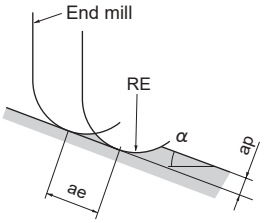
Medium cut length, 4 flute

Recommended Cutting Conditions

(mm)

Workpiece Material	Nickel-based Heat Resistant Super Alloy Inconel718, Inconel713C, WASPALOY etc.					
R **RE**	$\alpha \leq 15°$		$\alpha > 15°$		Depth of cut ap	Depth of cut ae
	Revolution (min^{-1})	Feed rate (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)		
1.0	6300	380	6300	510	0.2	0.50
1.5	4200	340	4200	420	0.3	0.75
2.0	3100	320	3100	380	0.4	1.00
2.5	2500	250	2500	310	0.5	1.25
3.0	2100	210	2100	250	0.6	1.50
4.0	1500	160	1500	190	0.8	2.00
5.0	1200	150	1200	200	1.0	2.50
6.0	1000	150	1000	170	1.2	3.00
Depth of cut						

Note 1) For heat resistant super alloy, the use of water-solble 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.

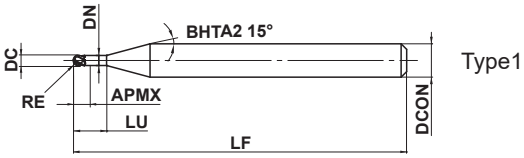


ae:Pick Feed

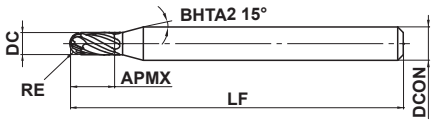
VQN4MBF

Ball nose, Medium cut length, 4 flute

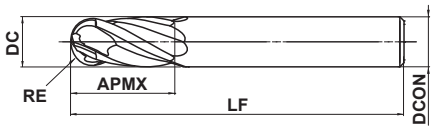
Carbon Steel, Alloy Steel, Cast Iron (<30HRC)	Tool Steel, Pre-hardened Steel,Hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Hardened Steel (>55HRC)	Austenitic Stainless Steel	Heat Resistant Alloy	Copper Alloy	Aluminium Alloy
					◎		



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.

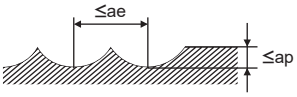
● : **Inventory maintained in Japan.**

VQN4MBF

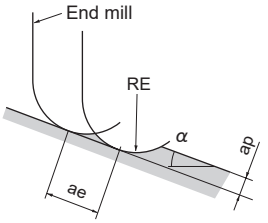
Medium cut length, 4 flute

Recommended Cutting Conditions

(mm)

Workpiece Material	Nickel-based Heat Resistant Super Alloy Inconel718, Inconel713C, WASPALOY etc.						
R **RE**	α≤15°			α>15°			Depth of cut ap
	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ae	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut ae	
1.0	6300	180	0.40	6300	310	0.50	0.2
1.5	4200	170	0.60	4200	340	0.75	0.3
2.0	3100	190	0.80	3100	320	1.00	0.4
2.5	2500	150	1.00	2500	250	1.25	0.5
3.0	2100	170	1.20	2100	250	1.50	0.6
4.0	1500	130	1.60	1500	190	2.00	0.8
5.0	1200	100	2.00	1200	200	2.50	1.0
6.0	1000	130	2.40	1000	170	3.00	1.2
Depth of cut							

Note 1) For heat resistant super alloy, the use of water-solble 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

Memo

SMART MIRACLE End Mills
VQN Series for Heat Resistant Super Alloys

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

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(Tools specifications subject to change without notice.)

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2020.9.(-)