MITSUBISHI MATERIALS

IMPACT MIRACLE

End Mill Series

REVOLUTIONARY
MACHINING OF
HARDENED STEEL

TOOL NEWS **B231A**

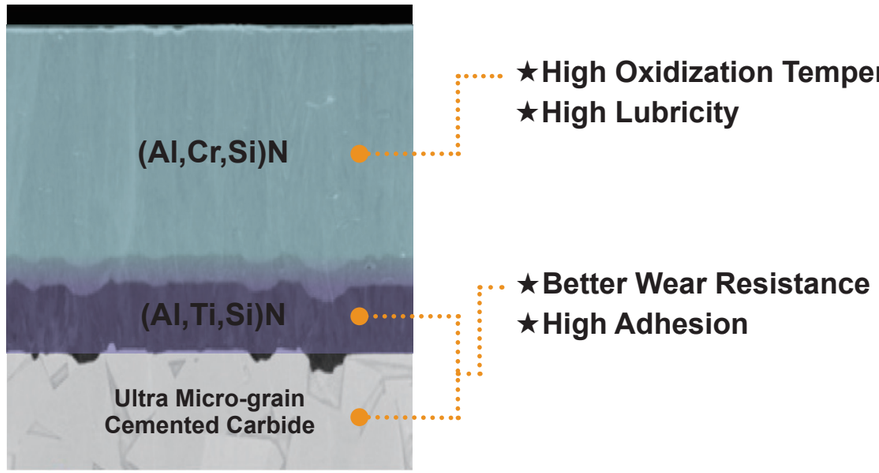
For Machining of Hardened Steel

ĺMPACT MIRACLE End Mill Series

IMPACT MIRACLE REVOLUTION

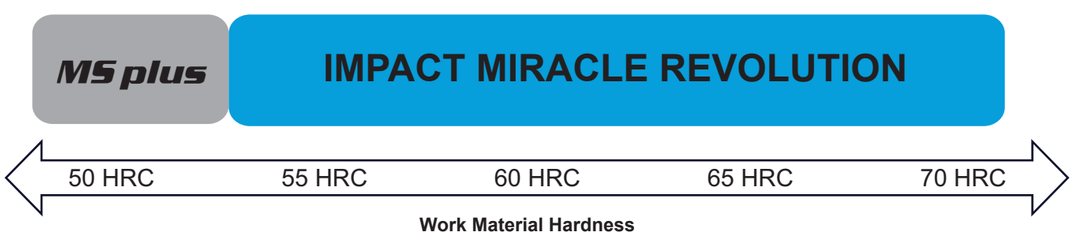
IMPACT MIRACLE REVOLUTION Coating

The combination of the newly developed(Al, Cr, Si)N coating with improved lubricity and a high oxidization temperature, together with the (Al, Ti, Si)N coating layer which provides excellent wear and adhesion to inner coating layer, enables efficient and reliable machining of hardened steels.



Due to manufacturing adjustments, differences in the color of the coating for different diameters may occur. This has no adverse effect on performance.

Selection according to Hardness of Work Material



SERIES SELECTION CHART

(inch)

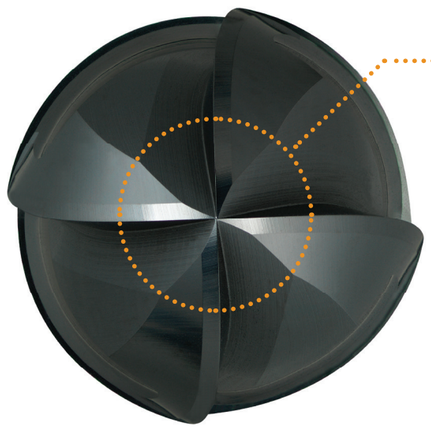
No. of Flutes	Type	Specifications	Shape	Corner Radius RE Min.	Corner Radius RE Max.	Dia. DC Min.	Dia. DC Max.	Depth of Cut APMX Max. DC	Size	Workpiece Material P: Tool Steel ≤45HRC	Workpiece Material H: Hardened Steel ≤55HRC	Workpiece Material H: Hardened Steel >55HRC	Page
Ball Nose													
2	VFR2SSB	Strong S Curve Short Shank Type		.020	.236	.039	.472	.472	12	○	◎	◎	P.9
2	VFR2SB	Strong S Curve		.004	.394	.008	.787	1.496	36	○	◎	◎	P.10
2	VFR2SBF	For Mirror Finishes		.020	.118	.039	.236	.472	8	○	◎	◎	P.12
2	VFR2XLB	Long Neck Type For Machining of Vertical Walls		.004	.118	.008	.236	.236	74	○	◎	◎	P.14
4	NEW VFR4MB	For High Speed and High Efficiency machining		.020	.236	.039	.472	.866	9	○	◎	◎	P.7
Corner Radius													
4	VFRPSRB	Completely Seamless Curved R Edge DC≥1.5 For High Precision Machining. 1.5≤DC≤5		.002	.118	.020	.472	.709	97	○	◎	◎	P.18

Ball nose, Medium cut length, 4-Flute

VFR4MB NEW

Enables high efficiency machining via increased feed rate during finish machining.

Shorter machining times while maintaining good surface finishes.

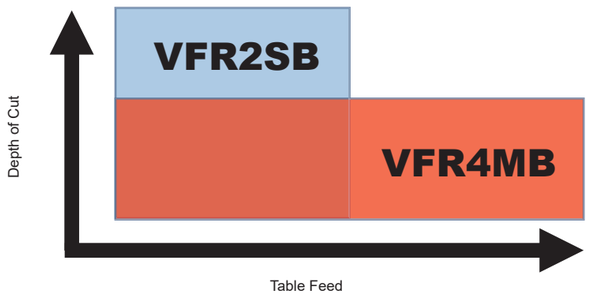


Versatile 4-flute design

All 4 flutes extend from the center to the periphery. This enables high feeds at any cutting angle and negates the need to calculate different machining conditions.

Correct Use of 2- and 4-Flute Geometries

2-flute geometries usually have a larger chip pocket and are better for rough machining with greater depths of cut that produce a larger volume of chips.
4-flute geometries can increase efficiency and reduce wear when used for finishing at small depths of cut. Additionally, using a 4-flute geometry is advantageous when machining harder materials at reduced depths of cut.

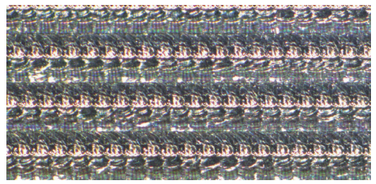


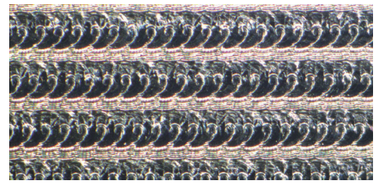
Cutting Performance

Comparison of the Surface Finish - Machining ASP23 (62HRC)

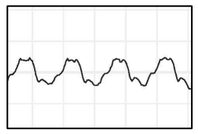
The 4-flute type is superior for high efficiency machining, but when used at the same feed rate as a 2-flute type, the quality of the finished surface can be improved.

VFR4MB

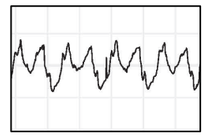




2-Flute conventional product



Ra:0.27
Rz:1.01

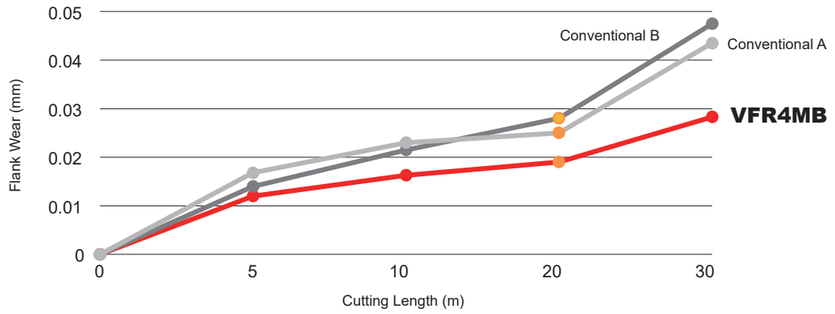


Ra:0.32
Rz:1.62

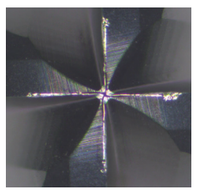
<Cutting Conditions>
Workpiece Material : ASP23(62HRC)
Tool : VFR4MBR0400 DC=8mm
Revolution : n=12000min^{-1}
Table Feed : f=3600mm/min
Depth of Cut : ap=0.2mm
ae=0.8mm
Overhang Length : 20mm
Cutting Mode : Air blow
Down Cut

Comparison of Wear Resistance Surface - Machining HAP72 (69HRC)

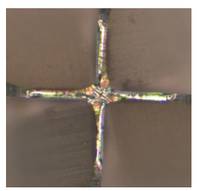
IMPACT MIRACLE REVOLUTION end mills demonstrate excellent wear resistance even when machining high hardness workpiece materials.



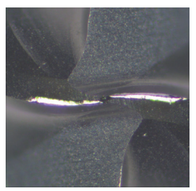
Taken after a cutting length of 20 m



VFR4MB



Conventional A



Conventional B

<Cutting Conditions>
Workpiece Material : HAP72(69HRC)
Tool : VFR4MBR0100 DC=2mm
Revolution : n=16000min^{-1}
Table Feed : f=1200mm/min
Depth of Cut : ap=0.06mm
ae=0.2mm
Overhang Length : 17mm
Cutting Mode : Air blow
Down Cut
Machine : Vertical MC

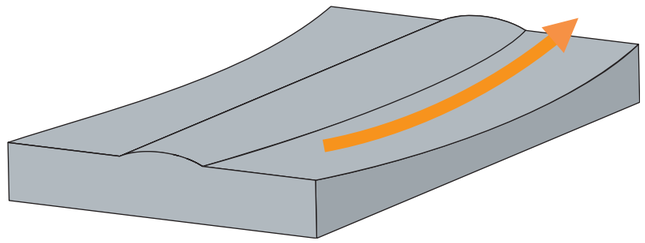
Ball nose, Medium cut length, 4-Flute

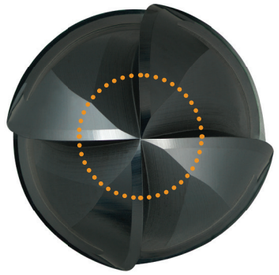
VFR4MB

High efficiency and high precision finishing of press mold parts (60HRC)

Customer Issues with Conventional End Mills

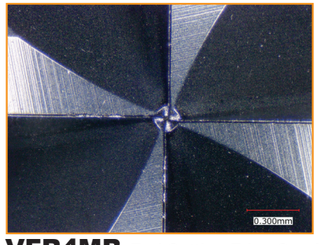
①Issue with machining efficiency due to the curvature of the workpiece material so a corner radius end mill cannot be used.
②A 4-flute type was used to machine, but at the tip, the chip discharge was poor and resulted in a torn surface finish. The tool was changed to a 2-flute type.
③The 2-flute type showed excessive wear after a long cut length and necessitated a tool change because the surface finish accuracy could not be maintained.





<Cutting Conditions>
Workpiece Material : AISI D2(60HRC)
Revolution : n=6000min-1
Table Feed : f=2800mm/min
Depth of Cut : ap=0.02mm
ae=Setting surface roughness 6.3z
Cutting Mode : Dry Cutting
Machine : Vertical MC(BBT50)
Cutting Time : 120min

Results after machining for 120m



VFR4MB End Cutting Edge Condition
Flank Wear : 17μm

Comments from Customer Evaluation of VFR4MB

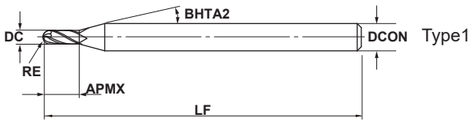
· VFR4MB showed almost no wear and no change in surface roughness even though the tip was overworked on the contours of a press mold.
· By making it possible to machine with a single end mill, the costs were reduced and the time problems which required a tool change every 2 hours of machining or more were resolved. In addition, the feed rate could be increased by 1.5 which shortened the machining time.

VFR4MB NEW

Ball nose, Medium cut length, 4-Flute

UWC VFR γ 30°

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
	○	◎	◎				



RE				
±0.010				
DCON=6	8≦DCON≦10	DCON=12		
0 - 0.008	0 - 0.009	0 - 0.011		

● The 4 flute geometry with a cutting edge extending to the center achieves a long tool life and enables high efficiency machining.

(mm)

Order Number	RE	DC	APMX	LF	BHTA2	DCON	No.F *	Stock	Type
VFR4MBR0050	0.5	1	2.5	50	15	6	4	●	1
VFR4MBR0100	1	2	6	60	15	6	4	●	1
VFR4MBR0150	1.5	3	8	70	15	6	4	●	1
VFR4MBR0200	2	4	8	70	15	6	4	●	1
VFR4MBR0250	2.5	5	12	80	15	6	4	●	1
VFR4MBR0300	3	6	12	80	—	6	4	●	2
VFR4MBR0400	4	8	14	90	—	8	4	●	2
VFR4MBR0500	5	10	18	100	—	10	4	●	2
VFR4MBR0600	6	12	22	110	—	12	4	★	2

* Number of Flutes

RE = Corner Radius
DC = Cutting Dia.
APMX = Depth of Cut Max.
LF = Functional Length
BHTA2 = Body Half Taper Angle
DCON = Connection Dia.

● : USA Stock ★ : Stocked in Japan

VFR4MB

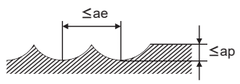
Ball nose, Medium cut length, 4-Flute

Recommended Cutting Conditions

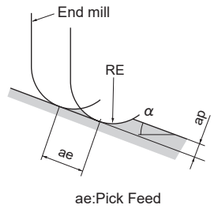
(inch)

Workpiece Material		Hardened Steel (45－55HRC)						Hardened Steel (55－65HRC)						Hardened Steel (65－70HRC)					
Corner Radius RE		α≤15°		α>15°		Depth of cut ap	Depth of cut ae	α≤15°		α>15°		Depth of cut ap	Depth of cut ae	α≤15°		α>15°		Depth of cut ap	Depth of cut ae
(mm)	(inch)	Revolution (min^{-1})	Feed rate (IPM)	Revolution (min^{-1})	Feed rate (IPM)			Revolution (min^{-1})	Feed rate (IPM)	Revolution (min^{-1})	Feed rate (IPM)			Revolution (min^{-1})	Feed rate (IPM)	Revolution (min^{-1})	Feed rate (IPM)		
0.5	.020	40000	315.0	40000	149.6	.0024	.004	40000	220.5	40000	122.0	.0020	.004	40000	185.0	32000	66.9	.0012	.004
1.0	.039	40000	378.0	40000	220.5	.0043	.008	40000	315.0	28000	122.0	.0039	.008	24000	196.9	16000	47.2	.0024	.008
1.5	.059	40000	472.4	32000	220.5	.0051	.012	32000	303.2	19000	114.2	.0047	.012	16000	165.4	11000	43.3	.0028	.012
2.0	.079	32000	433.1	24000	185.0	.0059	.016	24000	244.1	14000	98.4	.0051	.016	12000	122.0	8000	39.4	.0031	.016
2.5	.098	25000	354.3	19000	149.6	.0079	.020	19000	208.7	12000	86.6	.0059	.020	9600	106.3	6000	30.7	.0031	.020
3.0	.118	21000	330.7	15000	133.9	.0098	.024	16000	189.0	9600	78.7	.0079	.024	8000	90.6	5000	30.7	.0035	.024
4.0	.157	16000	252.0	12000	102.4	.0118	.031	12000	141.7	7200	63.0	.0079	.031	6000	74.8	4000	24.4	.0035	.031
5.0	.197	13000	204.7	9600	86.6	.0197	.039	10000	126.0	5800	51.2	.0079	.039	4800	59.1	3000	21.7	.0039	.039
6.0	.236	9000	141.7	7200	66.9	.0197	.047	7000	86.6	4300	37.0	.0118	.047	3600	43.3	2200	15.7	.0039	.047

Depth of cut



Note 1) If the depth of cut is shallow, the revolution and feed rate can be increased.
Please reduce the feed rate when the surface finish is important.
Note 2) If the rigidity of the machine or the workpiece materials installation is very low, or chattering and noise are generated, please adjust the revolution, feed rate and depth of cut.
Note 3) α is the inclination angle of the machined surface.

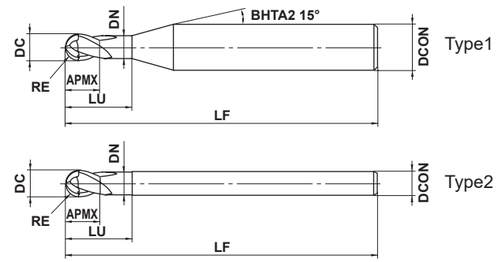


ae:Pick Feed

VFR2SSB

Ball nose, Short cut length, 2-Flute, Short shank

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
	○	◎	◎				



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

h5

●Opimization of the flute geometry, helix and rake angles have improved the overall edge strength.

(mm)

Order Number	RE	DC	APMX	LU	DN	LF	DCON	No.F *	Stock	Type
VFR2SSBR0050S04	0.5	1	1	2	0.94	40	4	2	●	1
VFR2SSBR0050	0.5	1	1	2	0.94	40	6	2	●	1
VFR2SSBR0075S04	0.75	1.5	1.5	3	1.44	40	4	2	●	1
VFR2SSBR0075	0.75	1.5	1.5	3	1.44	40	6	2	●	1
VFR2SSBR0100	1	2	2	4	1.9	45	6	2	●	1
VFR2SSBR0150	1.5	3	3	6	2.9	45	6	2	●	1
VFR2SSBR0200	2	4	4	8	3.9	45	6	2	●	1
VFR2SSBR0250	2.5	5	5	10	4.9	50	6	2	●	1
VFR2SSBR0300	3	6	6	12	5.85	50	6	2	●	2
VFR2SSBR0400	4	8	8	14	7.85	60	8	2	●	2
VFR2SSBR0500	5	10	10	18	9.7	70	10	2	●	2
VFR2SSBR0600	6	12	12	22	11.7	75	12	2	●	2

* Number of Flutes

RE = Corner Radius
DC = Cutting Dia.
APMX = Depth of Cut Max.
LU = Usable Length
DN = Neck Dia.
LF = Functional Length
DCON = Connection Dia.

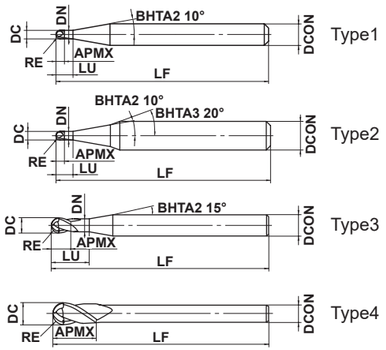
● : USA Stock

VFR2SB

Ball nose, Short 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	Titanium Alloy, Heat Resistant Alloy	Copper Alloy	Aluminum Alloy
	○	◎	◎				

RE<0.3 RE≥0.3



RE≤6	RE>6			
±0.005	±0.010			
DCON=3	4≤DCON≤6	8≤DCON≤10	DCON=12	DCON=20
0 - 0.004	0 - 0.005	0 - 0.006	0 - 0.008	0 - 0.009

●Optimization of the flute geometry, helix and rake angles have improved the overall edge strength.

(mm)

Order Number	RE	DC	APMX	LU	DN	LF	DCON	*No.F	Stock	Type
VFR2SBR0010	0.1	0.2	0.2	0.4	0.17	45	4	2	●	1
VFR2SBR0010S06	0.1	0.2	0.2	0.4	0.17	50	6	2	●	2
VFR2SBR0015	0.15	0.3	0.3	0.6	0.27	45	4	2	●	1
VFR2SBR0015S06	0.15	0.3	0.3	0.6	0.27	50	6	2	●	2
VFR2SBR0020	0.2	0.4	0.4	0.8	0.36	45	4	2	●	1
VFR2SBR0020S06	0.2	0.4	0.4	0.8	0.36	50	6	2	●	2
VFR2SBR0030	0.3	0.6	0.6	1.2	0.56	45	4	2	●	3
VFR2SBR0030S06	0.3	0.6	0.6	1.2	0.56	50	6	2	●	3
VFR2SBR0040	0.4	0.8	0.8	1.6	0.76	45	4	2	●	3
VFR2SBR0040S06	0.4	0.8	0.8	1.6	0.76	50	6	2	●	3
VFR2SBR0050	0.5	1	1	2	0.94	45	4	2	●	3
VFR2SBR0050S06	0.5	1	1	2	0.94	50	6	2	●	3
VFR2SBR0060	0.6	1.2	1.2	2.4	1.14	45	4	2	●	3
VFR2SBR0060S06	0.6	1.2	1.2	2.4	1.14	50	6	2	●	3
VFR2SBR0070	0.7	1.4	1.4	2.8	1.34	45	4	2	●	3
VFR2SBR0070S06	0.7	1.4	1.4	2.8	1.34	50	6	2	●	3
VFR2SBR0075	0.75	1.5	1.5	3	1.44	45	4	2	●	3
VFR2SBR0075S06	0.75	1.5	1.5	3	1.44	50	6	2	●	3
VFR2SBR0080	0.8	1.6	1.6	3.2	1.54	45	4	2	●	3
VFR2SBR0080S06	0.8	1.6	1.6	3.2	1.54	50	6	2	●	3
VFR2SBR0090	0.9	1.8	1.8	3.6	1.74	45	4	2	●	3
VFR2SBR0090S06	0.9	1.8	1.8	3.6	1.74	50	6	2	●	3
VFR2SBR0100	1	2	2	4	1.9	50	4	2	●	3
VFR2SBR0100S06	1	2	2	4	1.9	60	6	2	●	3
VFR2SBR0125S06	1.25	2.5	2.5	5	2.4	60	6	2	●	3
VFR2SBR0150	1.5	3	3	6	2.9	70	6	2	●	3
VFR2SBR0150S03	1.5	3	3	—	—	60	3	2	●	4
VFR2SBR0200	2	4	4	8	3.9	70	6	2	●	3
VFR2SBR0200S04	2	4	4	—	—	60	4	2	●	4
VFR2SBR0250	2.5	5	5	10	4.9	80	6	2	●	3
VFR2SBR0300	3	6	12	—	—	80	6	2	●	4
VFR2SBR0400	4	8	14	—	—	90	8	2	●	4
VFR2SBR0500	5	10	18	—	—	100	10	2	●	4
VFR2SBR0600	6	12	22	—	—	110	12	2	●	4
VFR2SBR0800	8	16	30	—	—	140	16	2	●	4
VFR2SBR1000	10	20	38	—	—	160	20	2	●	4

* Number of Flutes

RE = Corner Radius **DC** = Cutting Dia. **APMX** = Depth of Cut Max. **LU** = Usable Length **DN** = Neck Dia. **LF** = Functional Length **DCON** = Connection Dia.

● : USA Stock

Ball nose, Short cut length, 2-Flute, Short shank **VFR2SSB**

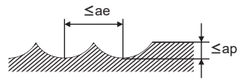
Ball nose, Short cut length, 2-Flute **VFR2SB**

Recommended Cutting Conditions

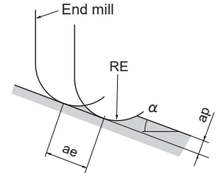
(inch)

Workpiece Material		Hardened Steel (45−55HRC) AISI H13						Hardened Steel (55−62HRC) AISI D2						Hardened Steel (62−70HRC) AISI W1, AISI M2					
Corner Radius RE		α≤15°		α>15°		Depth of cut	Depth of cut	α≤15°		α>15°		Depth of cut	Depth of cut	α≤15°		α>15°		Depth of cut	Depth of cut
(mm)	(inch)	Revolution (min⁻¹)	Feed rate (IPM)	Revolution (min⁻¹)	Feed rate (IPM)	ap	ae	Revolution (min⁻¹)	Feed rate (IPM)	Revolution (min⁻¹)	Feed rate (IPM)	ap	ae	Revolution (min⁻¹)	Feed rate (IPM)	Revolution (min⁻¹)	Feed rate (IPM)	ap	ae
0.1	.004	40000	12.6	40000	9.4	.0001	.0008	40000	12.6	40000	6.3	.0001	.0008	40000	12.6	40000	6.3	.0001	.0008
0.15	.006	40000	25.2	40000	22.0	.0004	.0012	40000	25.2	40000	15.7	.0003	.0012	40000	25.2	40000	15.7	.0002	.0012
0.2	.008	40000	63.0	40000	47.2	.0008	.0016	40000	55.1	40000	39.4	.0006	.0016	40000	47.2	40000	39.4	.0004	.0016
0.3	.012	40000	126.0	40000	63.0	.0012	.0024	40000	110.2	40000	47.2	.0010	.0024	40000	78.7	40000	47.2	.0008	.0024
0.4	.016	40000	252.0	40000	94.5	.0020	.0031	40000	157.5	40000	63.0	.0016	.0031	40000	110.2	40000	63.0	.0012	.0031
0.5	.020	40000	315.0	40000	126.0	.0024	.0039	40000	220.5	40000	94.5	.0020	.0039	40000	141.7	32000	51.2	.0016	.0039
0.75	.030	40000	378.0	40000	157.5	.0035	.0059	40000	283.5	32000	98.4	.0030	.0059	32000	177.2	21000	47.2	.0020	.0059
1	.039	40000	378.0	39000	185.0	.0043	.0079	40000	315.0	24000	94.5	.0039	.0079	24000	149.6	16000	39.4	.0028	.0079
1.25	.049	40000	409.4	32000	177.2	.0047	.0098	37000	318.9	19000	90.6	.0043	.0098	19000	133.9	13000	39.4	.0031	.0098
1.5	.059	40000	472.4	27000	169.3	.0051	.0118	32000	303.1	16000	86.6	.0047	.0118	16000	126.0	11000	34.6	.0035	.0118
2	.079	32000	428.3	20000	141.7	.0059	.0157	24000	244.1	12000	74.8	.0051	.0157	12000	94.5	8000	31.5	.0039	.0157
2.5	.098	25000	354.3	16000	114.2	.0079	.0197	19000	208.7	9600	66.9	.0059	.0197	9600	82.7	6000	23.6	.0039	.0197
3	.118	21000	330.7	13000	102.4	.0098	.0236	16000	189.0	8000	63.0	.0079	.0236	8000	66.9	5000	23.6	.0043	.0236
4	.157	16000	252.0	10000	78.7	.0118	.0315	12000	141.7	6000	47.2	.0079	.0315	6000	55.1	4000	18.9	.0043	.0315
5	.197	13000	204.7	8000	66.9	.0197	.0394	10000	126.0	4800	37.8	.0079	.0394	4800	43.3	3000	16.5	.0047	.0394
6	.236	9000	141.7	6000	51.2	.0197	.0472	7000	86.6	3600	28.3	.0118	.0472	3600	33.9	2200	12.2	.0047	.0472
8	.315	6000	94.5	4000	39.4	.0197	.0630	5000	63.0	2500	19.7	.0118	.0630	2500	25.6	1500	9.4	.0059	.0630
10	.394	4500	70.9	3000	30.7	.0197	.0787	4000	51.2	1800	14.2	.0118	.0787	1800	18.5	1000	6.3	.0059	.0787

Depth of cut



Note 1) If the rigidity of the machine or the work materials installation is very low, or chattering and noise are generated, reduce the revolution and feed rate proportionately.
Note 2) If the depth of cut is shallow, the revolution and feed rate can be increased.
Please reduce the feed rate when the surface finish is important.
Note 3) α is the inclination angle of the machined surface.

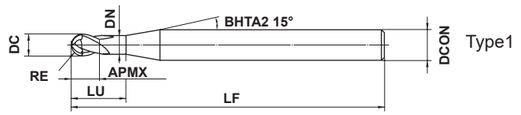


ae:Pick Feed

VFR2SBF

Ball nose, Short cut length, 2-Flute, For mirror finishing

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
	○	◎	◎				



RE≤3				
±0.010				
4≤DCON≤6				
0 - 0.005				

● New ball nose geometry for mirror finishing.

(mm)

Order Number	RE	DC	APMX	LU	DN	LF	DCON	* No.F	Stock	Type
VFR2SBFR0050	0.5	1	1	2	0.94	45	4	2	●	1
VFR2SBFR0075	0.75	1.5	1.5	3	1.44	45	4	2	●	1
VFR2SBFR0100	1	2	2	4	1.9	60	6	2	●	1
VFR2SBFR0125	1.25	2.5	2.5	5	2.4	60	6	2	●	1
VFR2SBFR0150	1.5	3	3	6	2.9	70	6	2	●	1
VFR2SBFR0200	2	4	4	8	3.9	70	6	2	●	1
VFR2SBFR0250	2.5	5	5	10	4.9	80	6	2	●	1
VFR2SBFR0300	3	6	12	—	—	80	6	2	●	2

* Number of Flutes

RE = Corner Radius
DC = Cutting Dia.
APMX = Depth of Cut Max.
LU = Usable Length
DN = Neck Dia.
LF = Functional Length
DCON = Connection Dia.

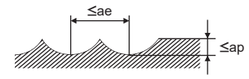
● : **USA Stock**

Recommended Cutting Conditions

(inch)

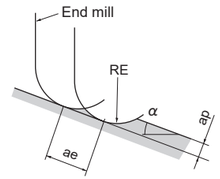
Workpiece Material		Carbon Steel, Alloy Steel (180—280HB) Alloy Steel (≤350HB), Pre-hardened Steel (35—45HRC) Hardened Steel (45— 62HRC) AISI 1045, AISI 4140, SKD, SKT, AISI P21, AISI P20, AISI H13, L6, AISI D2						Hardened Steel (62—70HRC) AISI W1, AISI M2					
Corner Radius **RE**		α≤15°		α>15°		Depth of cut ap	Depth of cut ae	α≤15°		α>15°		Depth of cut ap	Depth of cut ae
(mm)	(inch)	Revolution (min^{-1})	Feed rate (IPM)	Revolution (min^{-1})	Feed rate (IPM)			Revolution (min^{-1})	Feed rate (IPM)	Revolution (min^{-1})	Feed rate (IPM)		
0.5	**.020**	40000	31.5	40000	31.5	.0003	.0003	40000	22.0	40000	22.0	.0002	.0002
0.75	**.030**	40000	31.5	40000	31.5	.0004	.0004	40000	22.0	40000	22.0	.0003	.0003
1	**.039**	35000	41.3	35000	41.3	.0004	.0004	35000	27.6	35000	27.6	.0004	.0004
1.25	**.049**	35000	41.3	35000	41.3	.0005	.0005	35000	27.6	35000	27.6	.0004	.0004
1.5	**.059**	35000	41.3	35000	41.3	.0006	.0006	35000	27.6	35000	27.6	.0005	.0005
2	**.079**	25000	39.4	25000	39.4	.0007	.0007	25000	29.5	25000	29.5	.0006	.0006
2.5	**.098**	25000	39.4	25000	39.4	.0008	.0008	25000	29.5	25000	29.5	.0006	.0006
3	**.118**	25000	39.4	25000	39.4	.0008	.0008	25000	29.5	25000	29.5	.0006	.0006

Depth of cut



Note 1) The tools are recommended for use only in finish machining.
Note 2) Air blowing or oil mist is recommended as coolants.
Note 3) Note the following points when using the tools.
- Avoid using equipment abruptly without proper preparation. After sufficiently energizing equipment, ensure that there will be no changes to the depth of cut such as due to elongation of the main axis during machining.
- If the tools are used immediately after rough machining of a surface, large uneven areas (cusp heights) will cause deflection of the tools and waviness of the machined surface. Therefore, it is recommended to add a medium finish machining process which uses the same value of ae as indicated in the table above.

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

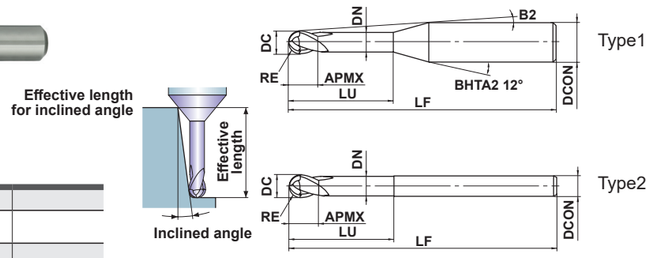


ae:Pick Feed

VFR2XLB

Ball nose, 2-Flute, Long neck

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
	○	◎	◎				



RE≤3					
±0.005					
4≤DCON≤6					
0 - 0.005					

●Precise machining of vertical walls is possible due to a back taper and a strong, seamless ball nose cutting edge geometry.

(mm)

Order Number	RE	DC	APMX	LU	DN	B2	LF	DCON	No.F*	Stock	Type	Effective length for inclined angle 0.5°	1°	2°	3°
VFR2XLBR0010N005	0.1	0.2	0.15	0.5	0.18	11.5°	50	4	2	★	1	0.5	0.5	0.6	0.7
VFR2XLBR0010N010	0.1	0.2	0.15	1	0.18	10.9°	50	4	2	●	1	1	1.1	1.2	1.3
VFR2XLBR0015N010	0.15	0.3	0.24	1	0.28	10.9°	50	4	2	●	1	1	1.1	1.2	1.3
VFR2XLBR0015N015	0.15	0.3	0.24	1.5	0.28	10.4°	50	4	2	●	1	1.6	1.6	1.8	2
VFR2XLBR0015N020	0.15	0.3	0.24	2	0.28	9.9°	50	4	2	●	1	2.1	2.2	2.4	2.6
VFR2XLBR0020N010	0.2	0.4	0.3	1	0.37	11°	50	4	2	●	1	1	1.1	1.2	1.3
VFR2XLBR0020N015	0.2	0.4	0.3	1.5	0.37	10.4°	50	4	2	●	1	1.5	1.6	1.7	1.9
VFR2XLBR0020N020	0.2	0.4	0.3	2	0.37	9.9°	50	4	2	●	1	2.1	2.2	2.3	2.6
VFR2XLBR0020N025	0.2	0.4	0.3	2.5	0.37	9.5°	50	4	2	★	1	2.6	2.7	2.9	3.3
VFR2XLBR0020N030	0.2	0.4	0.3	3	0.37	9.1°	50	4	2	●	1	3.1	3.2	3.5	3.9
VFR2XLBR0020N040	0.2	0.4	0.3	4	0.37	8.4°	50	4	2	★	1	4.2	4.3	4.7	5.2
VFR2XLBR0025N015	0.25	0.5	0.37	1.5	0.47	10.4°	50	4	2	●	1	1.5	1.6	1.7	1.9
VFR2XLBR0025N020	0.25	0.5	0.37	2	0.47	9.9°	50	4	2	●	1	2.1	2.1	2.3	2.6
VFR2XLBR0025N025	0.25	0.5	0.37	2.5	0.47	9.5°	50	4	2	●	1	2.6	2.7	2.9	3.2
VFR2XLBR0025N030	0.25	0.5	0.37	3	0.47	9.1°	50	4	2	●	1	3.1	3.2	3.5	3.9
VFR2XLBR0025N040	0.25	0.5	0.37	4	0.47	8.3°	50	4	2	●	1	4.1	4.3	4.7	5.2
VFR2XLBR0030N020	0.3	0.6	0.45	2	0.57	9.9°	50	4	2	●	1	2.1	2.2	2.4	2.6
VFR2XLBR0030N020S06	0.3	0.6	0.45	2	0.57	10.6°	50	6	2	●	1	2.1	2.2	2.4	2.6
VFR2XLBR0030N030	0.3	0.6	0.45	3	0.57	9°	50	4	2	●	1	3.1	3.3	3.6	4
VFR2XLBR0030N030S06	0.3	0.6	0.45	3	0.57	9.9°	50	6	2	★	1	3.1	3.3	3.6	4
VFR2XLBR0030N040	0.3	0.6	0.45	4	0.57	8.2°	50	4	2	★	1	4.2	4.4	4.8	5.3
VFR2XLBR0030N050	0.3	0.6	0.45	5	0.57	7.6°	50	4	2	★	1	5.2	5.5	6	6.6
VFR2XLBR0030N060	0.3	0.6	0.45	6	0.57	7.1°	50	4	2	●	1	6.3	6.6	7.2	7.9
VFR2XLBR0040N030	0.4	0.8	0.6	3	0.77	8.9°	50	4	2	●	1	3.1	3.3	3.6	3.9
VFR2XLBR0040N040	0.4	0.8	0.6	4	0.77	8.2°	50	4	2	●	1	4.2	4.4	4.8	5.2
VFR2XLBR0040N060	0.4	0.8	0.6	6	0.77	6.9°	50	4	2	●	1	6.3	6.5	7.2	7.9
VFR2XLBR0040N080	0.4	0.8	0.6	8	0.77	6°	50	4	2	★	1	8.4	8.7	9.5	10.6
VFR2XLBR0050N030	0.5	1	0.75	3	0.96	8.7°	50	4	2	●	1	3.2	3.4	3.7	4.1
VFR2XLBR0050N030S06	0.5	1	0.75	3	0.96	9.8°	50	6	2	●	1	3.2	3.4	3.7	4.1
VFR2XLBR0050N040	0.5	1	0.75	4	0.96	7.9°	50	4	2	●	1	4.3	4.5	4.9	5.4
VFR2XLBR0050N040S06	0.5	1	0.75	4	0.96	9.2°	50	6	2	●	1	4.3	4.5	4.9	5.4
VFR2XLBR0050N060	0.5	1	0.75	6	0.96	6.7°	50	4	2	●	1	6.3	6.5	7.2	7.9

* Number of Flutes

● : USA Stock ★ : Stocked in Japan

(mm)

Order Number	RE	DC	APMX	LU	DN	B2	LF	DCON	No.F*	Stock	Type	Effective length for inclined angle 0.5°	1°	2°	3°
VFR2XLBR0050N060S06	0.5	1	0.75	6	0.96	8.2°	50	6	2	●	1	6.3	6.5	7.2	7.9
VFR2XLBR0050N080	0.5	1	0.75	8	0.96	5.8°	50	4	2	●	1	8.5	8.9	9.7	10.7
VFR2XLBR0050N100	0.5	1	0.75	10	0.96	5.1°	50	4	2	●	1	10.6	11.1	12.1	13.4
VFR2XLBR0050N120	0.5	1	0.75	12	0.96	4.6°	50	4	2	●	1	12.7	13.2	14.5	16
VFR2XLBR0075N060	0.75	1.5	1.1	6	1.44	6.3°	50	4	2	●	1	6.3	6.6	7.2	7.9
VFR2XLBR0075N060S06	0.75	1.5	1.1	6	1.44	8°	50	6	2	●	1	6.3	6.6	7.2	7.9
VFR2XLBR0075N080	0.75	1.5	1.1	8	1.44	5.4°	50	4	2	●	1	8.4	8.8	9.6	10.6
VFR2XLBR0075N080S06	0.75	1.5	1.1	8	1.44	7.2°	50	6	2	●	1	8.4	8.8	9.6	10.6
VFR2XLBR0075N100	0.75	1.5	1.1	10	1.44	4.7°	50	4	2	★	1	10.5	11	12	13.2
VFR2XLBR0075N120	0.75	1.5	1.1	12	1.44	4.2°	50	4	2	●	1	12.6	13.1	14.4	15.9
VFR2XLBR0075N140	0.75	1.5	1.1	14	1.44	3.8°	50	4	2	★	1	14.7	15.3	16.8	18.5
VFR2XLBR0075N160	0.75	1.5	1.1	16	1.44	3.4°	60	4	2	★	1	16.8	17.5	19.2	21.2
VFR2XLBR0100N060	1	2	1.5	6	1.94	5.8°	50	4	2	●	1	6.3	6.6	7.1	7.8
VFR2XLBR0100N060S06	1	2	1.5	6	1.94	7.8°	50	6	2	●	1	6.3	6.6	7.1	7.8
VFR2XLBR0100N080	1	2	1.5	8	1.94	4.8°	50	4	2	●	1	8.4	8.8	9.5	10.5
VFR2XLBR0100N080S06	1	2	1.5	8	1.94	6.9°	50	6	2	●	1	8.4	8.8	9.5	10.5
VFR2XLBR0100N100	1	2	1.5	10	1.94	4.2°	50	4	2	★	1	10.5	10.9	11.9	13.1
VFR2XLBR0100N100S06	1	2	1.5	10	1.94	6.2°	50	6	2	●	1	10.5	10.9	11.9	13.1
VFR2XLBR0100N120	1	2	1.5	12	1.94	3.6°	50	4	2	●	1	12.6	13.1	14.3	15.8
VFR2XLBR0100N120S06	1	2	1.5	12	1.94	5.6°	50	6	2	●	1	12.6	13.1	14.3	15.8
VFR2XLBR0100N160	1	2	1.5	16	1.94	2.9°	60	4	2	●	1	16.8	17.5	19.1	*
VFR2XLBR0100N160S06	1	2	1.5	16	1.94	4.7°	60	6	2	★	1	16.8	17.5	19.1	21.1
VFR2XLBR0100N200	1	2	1.5	20	1.94	2.4°	60	4	2	●	1	20.9	21.8	23.9	*
VFR2XLBR0100N200S06	1	2	1.5	20	1.94	4°	60	6	2	★	1	20.9	21.8	23.9	26.4
VFR2XLBR0125N100	1.25	2.5	1.9	10	2.4	3.5°	60	4	2	★	1	10.4	10.8	11.8	12.9
VFR2XLBR0125N150	1.25	2.5	1.9	15	2.4	2.5°	60	4	2	★	1	15.6	16.3	17.8	*
VFR2XLBR0150N100	1.5	3	2.3	10	2.9	5.5°	60	6	2	●	1	10.4	10.8	11.7	12.9
VFR2XLBR0150N120	1.5	3	2.3	12	2.9	4.9°	60	6	2	●	1	12.5	13	14.1	15.5
VFR2XLBR0150N160	1.5	3	2.3	16	2.9	4°	70	6	2	●	1	16.7	17.3	18.9	20.8
VFR2XLBR0150N200	1.5	3	2.3	20	2.9	3.4°	70	6	2	●	1	20.8	21.7	23.7	26.1
VFR2XLBR0150N250	1.5	3	2.3	25	2.9	2.8°	70	6	2	●	1	26.1	27.2	29.7	*
VFR2XLBR0150N300	1.5	3	2.3	30	2.9	2.5°	70	6	2	●	1	31.3	32.6	35.7	*
VFR2XLBR0200N100	2	4	3	10	3.9	4.5°	70	6	2	●	1	10.4	10.8	11.6	12.7
VFR2XLBR0200N120	2	4	3	12	3.9	3.9°	70	6	2	●	1	12.5	12.9	14	15.4
VFR2XLBR0200N160	2	4	3	16	3.9	3.1°	70	6	2	●	1	16.6	17.3	18.8	20.7
VFR2XLBR0200N200	2	4	3	20	3.9	2.6°	70	6	2	●	1	20.8	21.7	23.6	*
VFR2XLBR0200N250	2	4	3	25	3.9	2.1°	70	6	2	●	1	26	27.1	29.6	*
VFR2XLBR0200N300	2	4	3	30	3.9	1.8°	70	6	2	★	1	31.2	32.6	*	*
VFR2XLBR0250N200	2.5	5	3.8	20	4.9	1.5°	70	6	2	●	1	20.8	21.6	*	*
VFR2XLBR0250N250	2.5	5	3.8	25	4.9	1.2°	70	6	2	★	1	26	27.1	*	*
VFR2XLBR0300N180	3	6	6	18	5.85	—	80	6	2	★	2	*	*	*	*
VFR2XLBR0300N300	3	6	6	30	5.85	—	80	6	2	●	2	*	*	*	*

* Number of Flutes

* No interference

RE = Corner Radius
DC = Cutting Dia.
APMX = Depth of Cut Max.
LU = Usable Length
DN = Neck Dia.
LF = Functional Length
DCON = Connection Dia.

● : USA Stock ★ : Stocked in Japan

VFR2XLB

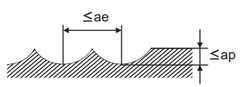
Ball nose, 2 Flute, Long neck

Recommended Cutting Conditions

(inch)

Workpiece Material				Hardened Steel (45—55HRC)				Hardened Steel (55—70HRC)			
Corner Radius **RE**		Neck length **LU**		Revolution (min^{-1})	Feed Rate (IPM)	Depth of Cut **ap**	Width of Cut **ae**	Revolution (min^{-1})	Feed Rate (IPM)	Depth of Cut **ap**	Width of Cut **ae**
(mm)	(inch)	(mm)	(inch)								
0.1	**.004**	**0.5**	**.020**	40000	11.8	.00012	.0004	40000	11.8	.00008	.0004
0.1	**.004**	**1**	**.039**	40000	11.8	.00008	.0004	40000	11.8	.00008	.0004
0.15	**.006**	**1**	**.039**	40000	19.7	.00028	.0006	40000	19.7	.00020	.0006
0.15	**.006**	**1.5**	**.059**	40000	19.7	.00020	.0006	40000	19.7	.00012	.0006
0.15	**.006**	**2**	**.079**	40000	19.7	.00012	.0006	40000	19.7	.00008	.0006
0.2	**.008**	**1**	**.039**	40000	55.1	.00059	.0008	40000	55.1	.00039	.0008
0.2	**.008**	**1.5**	**.059**	40000	39.4	.00039	.0008	40000	39.4	.00024	.0008
0.2	**.008**	**2**	**.079**	40000	39.4	.00039	.0008	40000	39.4	.00024	.0008
0.2	**.008**	**2.5**	**.098**	40000	27.6	.00020	.0008	40000	27.6	.00012	.0008
0.2	**.008**	**3**	**.118**	40000	27.6	.00020	.0008	40000	27.6	.00012	.0008
0.2	**.008**	**4**	**.157**	40000	23.6	.00016	.0008	40000	19.7	.00012	.0008
0.25	**.010**	**1.5**	**.059**	40000	78.7	.00079	.0010	40000	78.7	.00059	.0010
0.25	**.010**	**2**	**.079**	40000	78.7	.00079	.0010	40000	78.7	.00059	.0010
0.25	**.010**	**2.5**	**.098**	40000	59.1	.00059	.0010	40000	59.1	.00039	.0010
0.25	**.010**	**3**	**.118**	40000	47.2	.00059	.0010	40000	47.2	.00039	.0010
0.25	**.010**	**4**	**.157**	36000	35.4	.00394	.0010	36000	35.4	.00028	.0010
0.3	**.012**	**2**	**.079**	40000	110.2	.0012	.0012	40000	110.2	.0008	.0012
0.3	**.012**	**3**	**.118**	40000	110.2	.0012	.0012	40000	110.2	.0008	.0012
0.3	**.012**	**4**	**.157**	35000	78.7	.0008	.0012	35000	78.7	.0006	.0012
0.3	**.012**	**5**	**.197**	30000	39.4	.0004	.0012	30000	39.4	.0003	.0012
0.3	**.012**	**6**	**.236**	30000	31.5	.0003	.0012	30000	31.5	.0002	.0012
0.4	**.016**	**3**	**.118**	40000	118.1	.0016	.0016	40000	118.1	.0012	.0016
0.4	**.016**	**4**	**.157**	40000	118.1	.0008	.0016	40000	118.1	.0006	.0016
0.4	**.016**	**6**	**.236**	30000	63.0	.0008	.0016	30000	63.0	.0004	.0016
0.4	**.016**	**8**	**.315**	25000	39.4	.0004	.0016	25000	39.4	.0003	.0016
0.5	**.020**	**3**	**.118**	40000	157.5	.0020	.0020	40000	157.5	.0016	.0020
0.5	**.020**	**4**	**.157**	40000	157.5	.0020	.0020	40000	157.5	.0016	.0020
0.5	**.020**	**6**	**.236**	35000	78.7	.0012	.0020	35000	78.7	.0008	.0020
0.5	**.020**	**8**	**.315**	30000	63.0	.0008	.0020	30000	63.0	.0004	.0020
0.5	**.020**	**10**	**.394**	20000	39.4	.0004	.0020	20000	39.4	.0004	.0020
0.5	**.020**	**12**	**.472**	20000	39.4	.0004	.0020	20000	31.5	.0003	.0020
0.75	**.030**	**6**	**.236**	40000	196.9	.0028	.0030	40000	157.5	.0024	.0030
0.75	**.030**	**8**	**.315**	40000	196.9	.0028	.0030	40000	137.8	.0024	.0030
0.75	**.030**	**10**	**.394**	40000	177.2	.0024	.0030	40000	94.5	.0024	.0030
0.75	**.030**	**12**	**.472**	32000	133.9	.0016	.0030	32000	78.7	.0016	.0030
0.75	**.030**	**14**	**.551**	16000	59.1	.0016	.0030	16000	47.2	.0012	.0030
0.75	**.030**	**16**	**.630**	13000	47.2	.0012	.0030	13000	47.2	.0008	.0030
1	**.039**	**6**	**.236**	40000	236.2	.0039	.0039	40000	133.9	.0039	.0039
1	**.039**	**8**	**.315**	40000	196.9	.0039	.0039	40000	118.1	.0039	.0039
1	**.039**	**10**	**.394**	40000	196.9	.0031	.0039	40000	118.1	.0028	.0039
1	**.039**	**12**	**.472**	40000	196.9	.0031	.0039	40000	102.4	.0020	.0039
1	**.039**	**16**	**.630**	32000	137.8	.0020	.0039	32000	66.9	.0012	.0039
1	**.039**	**20**	**.787**	10000	39.4	.0016	.0039	10000	39.4	.0012	.0039
1.25	**.049**	**10**	**.394**	36000	196.9	.0047	.0098	36000	102.4	.0043	.0098
1.25	**.049**	**15**	**.591**	36000	181.1	.0031	.0098	36000	78.7	.0030	.0098

Depth of Cut



Note 1) When the inclination angle of machined surface is large, or machining with large cutting load such as in a corner area, reduce the revolution and feed rate.
Note 2) If the depth of cut is shallow, the revolution and feed rate can be increased.
Note 3) Cutting conditions may differ considerably due to the tool overhang, depth of cut and machine tool condition. Please use the table above as a reference starting point.

Recommended Cutting Conditions

(inch)

Workpiece Material				Hardened Steel (45—55HRC)				Hardened Steel (55—70HRC)			
Corner Radius **RE**		Neck length **LU**		Revolution (min^{-1})	Feed Rate (IPM)	Depth of Cut **ap**	Width of Cut **ae**	Revolution (min^{-1})	Feed Rate (IPM)	Depth of Cut **ap**	Width of Cut **ae**
(mm)	(inch)	(mm)	(inch)								
1.5	**.059**	**10**	**.394**	32000	200.8	.0059	.0118	32000	86.6	.0059	.0118
1.5	**.059**	**12**	**.472**	32000	200.8	.0051	.0118	32000	86.6	.0051	.0118
1.5	**.059**	**16**	**.630**	32000	177.2	.0039	.0118	32000	70.9	.0039	.0118
1.5	**.059**	**20**	**.787**	27000	149.6	.0039	.0118	27000	63.0	.0024	.0118
1.5	**.059**	**25**	**.984**	21000	106.3	.0031	.0118	21000	47.2	.0024	.0118
1.5	**.059**	**30**	**1.181**	9000	39.4	.0031	.0118	9000	27.6	.0020	.0118
2	**.079**	**10**	**.394**	24000	189.0	.0079	.0157	24000	86.6	.0079	.0157
2	**.079**	**12**	**.472**	24000	189.0	.0079	.0157	24000	86.6	.0079	.0157
2	**.079**	**16**	**.630**	24000	149.6	.0059	.0157	24000	59.1	.0059	.0157
2	**.079**	**20**	**.787**	24000	149.6	.0059	.0157	24000	59.1	.0059	.0157
2	**.079**	**25**	**.984**	24000	149.6	.0059	.0157	24000	43.3	.0039	.0157
2	**.079**	**30**	**1.181**	24000	118.1	.0039	.0157	24000	43.3	.0031	.0157
2.5	**.098**	**20**	**.787**	19000	133.9	.0079	.0197	19000	55.1	.0079	.0197
2.5	**.098**	**25**	**.984**	19000	133.9	.0079	.0197	19000	55.1	.0079	.0197
3	**.118**	**18**	**.709**	16000	137.8	.0098	.0236	16000	39.4	.0079	.0236
3	**.118**	**30**	**1.181**	16000	137.8	.0079	.0236	16000	39.4	.0079	.0236

Depth of Cut

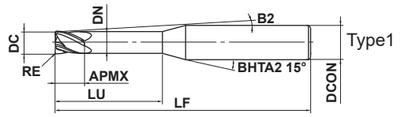
Note 1) When the inclination angle of machined surface is large, or machining with large cutting load such as in a corner area, reduce the revolution and feed rate.
Note 2) If the depth of cut is shallow, the revolution and feed rate can be increased.
Note 3) Cutting conditions may differ considerably due to the tool overhang, depth of cut and machine tool condition. Please use the table above as a reference starting point.

VFRPSRB

Corner radius, Short cut length, 4-Flute

UWC | VFR | γ | 30° | DC≤1.0 | DC≥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	Titanium Alloy, Heat Resistant Alloy	Copper Alloy	Aluminum Alloy
	○	◎	◎				



0.5≤DC≤6	6<DC≤12			
±0.005	±0.007			
0.5≤DC≤6	6<DC≤12			
0 - 0.01	0 - 0.015			
DCON=6	8≤DCON≤10	DCON=12		
0 - 0.005	0 - 0.006	0 - 0.008		

- Completely Seamless Curved R Edge. DC≥1.5
- The wiper edge and strong back taper achieve high precision machining. 1.5≤DC≤5

(mm)

Order Number	DC	RE	APMX	LU	DN	B2	LF	DCON	No.F*	Stock	Type	Effective length for inclined angle			
												0.5°	1°	2°	3°
VFRPSRBD0050R005N020	0.5	0.05	0.5	2	0.47	12.6	50	6	4	★	1	2.1	2.2	2.3	2.5
VFRPSRBD0050R010N020	0.5	0.1	0.5	2	0.47	12.7	50	6	4	★	1	2.1	2.2	2.3	2.5
VFRPSRBD0060R005N020	0.6	0.05	0.6	2	0.57	12.5	50	6	4	●	1	2.1	2.2	2.4	2.6
VFRPSRBD0060R010N020	0.6	0.1	0.6	2	0.57	12.5	50	6	4	★	1	2.1	2.2	2.3	2.6
VFRPSRBD0060R010N040	0.6	0.1	0.6	4	0.57	10.8	50	6	4	★	1	4.2	4.4	4.7	5.1
VFRPSRBD0060R020N020	0.6	0.2	0.6	2	0.57	12.6	50	6	4	●	1	2.1	2.2	2.2	2.6
VFRPSRBD0080R005N040	0.8	0.05	0.8	4	0.77	10.7	50	6	4	★	1	4.2	4.4	4.7	5.1
VFRPSRBD0080R010N040	0.8	0.1	0.8	4	0.77	10.7	50	6	4	●	1	4.2	4.4	4.7	5.1
VFRPSRBD0080R020N040	0.8	0.2	0.8	4	0.77	10.8	50	6	4	●	1	4.2	4.4	4.7	5.1
VFRPSRBD0080R030N040	0.8	0.3	0.8	4	0.77	10.8	50	6	4	●	1	4.2	4.4	4.7	5
VFRPSRBD0100R005N040	1	0.05	1	4	0.96	10.4	50	6	4	★	1	4.3	4.5	4.9	5.4
VFRPSRBD0100R010N040	1	0.1	1	4	0.96	10.4	50	6	4	●	1	4.3	4.5	4.9	5.4
VFRPSRBD0100R010N060	1	0.1	1	6	0.96	9.1	50	6	4	●	1	6.4	6.7	7.3	7.9
VFRPSRBD0100R020N040	1	0.2	1	4	0.96	10.5	50	6	4	●	1	4.3	4.5	4.7	5.3
VFRPSRBD0100R020N060	1	0.2	1	6	0.96	9.2	50	6	4	★	1	6.4	6.7	7.3	7.8
VFRPSRBD0100R030N040	1	0.3	1	4	0.96	10.5	50	6	4	★	1	4.3	4.5	4.6	5.3
VFRPSRBD0100R040N040	1	0.4	1	4	0.96	10.6	50	6	4	★	1	4.3	4.5	4.5	5.3
VFRPSRBD0150R010N040	1.5	0.1	1.5	4	1.42	10.2	50	6	4	●	1	4.2	4.4	4.8	5.2
VFRPSRBD0150R010N060	1.5	0.1	1.5	6	1.42	8.8	50	6	4	●	1	6.3	6.6	7.1	7.7
VFRPSRBD0150R010N100	1.5	0.1	1.5	10	1.42	6.9	50	6	4	★	1	10.5	10.9	11.7	12.7
VFRPSRBD0150R020N040	1.5	0.2	1.5	4	1.42	10.2	50	6	4	●	1	4.2	4.4	4.6	5.2
VFRPSRBD0150R020N060	1.5	0.2	1.5	6	1.42	8.8	50	6	4	●	1	6.3	6.6	7.1	7.7
VFRPSRBD0150R020N100	1.5	0.2	1.5	10	1.42	7	50	6	4	●	1	10.5	10.9	11.7	12.6
VFRPSRBD0150R030N040	1.5	0.3	1.5	4	1.42	10.3	50	6	4	★	1	4.2	4.4	4.5	5.2
VFRPSRBD0150R030N060	1.5	0.3	1.5	6	1.42	8.9	50	6	4	●	1	6.3	6.6	7.1	7.6
VFRPSRBD0150R030N100	1.5	0.3	1.5	10	1.42	7	50	6	4	●	1	10.5	10.9	11.7	12.6
VFRPSRBD0150R050N040	1.5	0.5	1.5	4	1.42	10.5	50	6	4	●	1	4.2	4.4	4.3	5.1
VFRPSRBD0150R050N060	1.5	0.5	1.5	6	1.42	9	50	6	4	●	1	6.3	6.6	7.1	7.6

* Number of Flutes

● : USA Stock

★ : Stocked in Japan

RE = Corner Radius
DC = Cutting Dia.
APMX = Depth of Cut Max.
LU = Usable Length
DN = Neck Dia.
LF = Functional Length
DCON = Connection Dia.

(mm)

Order Number	DC	RE	APMX	LU	DN	B2	LF	DCON	No.F	Stock	Type	Effective length for inclined angle			
												0.5°	1°	2°	3°
VFRPSRBD0150R050N100	1.5	0.5	1.5	10	1.42	7.1	50	6	4	●	1	10.5	10.9	11.7	12.6
VFRPSRBD0200R010N060	2	0.1	2	6	1.9	8.4	50	6	4	●	1	6.3	6.6	7.1	7.6
VFRPSRBD0200R010N100	2	0.1	2	10	1.9	6.5	50	6	4	●	1	10.5	10.9	11.7	12.6
VFRPSRBD0200R010N150	2	0.1	2	15	1.9	5.1	50	6	4	★	1	15.7	16.2	17.4	18.8
VFRPSRBD0200R020N060	2	0.2	2	6	1.9	8.4	50	6	4	●	1	6.3	6.6	7.1	7.6
VFRPSRBD0200R020N100	2	0.2	2	10	1.9	6.5	50	6	4	●	1	10.5	10.9	11.7	12.6
VFRPSRBD0200R020N150	2	0.2	2	15	1.9	5.1	50	6	4	●	1	15.7	16.2	17.4	18.8
VFRPSRBD0200R030N060	2	0.3	2	6	1.9	8.5	50	6	4	★	1	6.3	6.6	7	7.6
VFRPSRBD0200R030N100	2	0.3	2	10	1.9	6.6	50	6	4	●	1	10.5	10.8	11.6	12.6
VFRPSRBD0200R030N150	2	0.3	2	15	1.9	5.1	50	6	4	★	1	15.7	16.2	17.4	18.8
VFRPSRBD0200R030N200	2	0.3	2	20	1.9	4.2	60	6	4	★	1	20.8	21.5	23.1	25
VFRPSRBD0200R050N060	2	0.5	2	6	1.9	8.6	50	6	4	●	1	6.3	6.5	7	7.5
VFRPSRBD0200R050N100	2	0.5	2	10	1.9	6.6	50	6	4	●	1	10.5	10.8	11.6	12.5
VFRPSRBD0200R050N150	2	0.5	2	15	1.9	5.2	50	6	4	●	1	15.6	16.2	17.4	18.7
VFRPSRBD0200R050N200	2	0.5	2	20	1.9	4.2	60	6	4	●	1	20.8	21.5	23.1	24.9
VFRPSRBD0250R030N080	2.5	0.3	2.5	8	2.35	6.9	50	6	4	●	1	8.3	8.6	9.2	10
VFRPSRBD0250R030N150	2.5	0.3	2.5	15	2.35	4.7	50	6	4	●	1	15.6	16.1	17.3	18.7
VFRPSRBD0250R050N080	2.5	0.5	2.5	8	2.35	7	50	6	4	●	1	8.3	8.6	9.2	9.9
VFRPSRBD0250R050N150	2.5	0.5	2.5	15	2.35	4.7	50	6	4	★	1	15.6	16.1	17.3	18.6
VFRPSRBD0250R100N080	2.5	1	2.5	8	2.35	7.3	50	6	4	●	1	8.3	8.6	9.1	9.8
VFRPSRBD0300R010N100	3	0.1	3	10	2.85	5.5	60	6	4	●	1	10.4	10.8	11.6	12.5
VFRPSRBD0300R010N150	3	0.1	3	15	2.85	4.2	60	6	4	★	1	15.6	16.1	17.3	18.7
VFRPSRBD0300R020N100	3	0.2	3	10	2.85	5.5	60	6	4	●	1	10.4	10.8	11.6	12.5
VFRPSRBD0300R020N150	3	0.2	3	15	2.85	4.2	60	6	4	●	1	15.6	16.1	17.3	18.7
VFRPSRBD0300R020N200	3	0.2	3	20	2.85	3.4	60	6	4	●	1	20.7	21.5	23.1	24.9
VFRPSRBD0300R030N100	3	0.3	3	10	2.85	5.6	60	6	4	●	1	10.4	10.8	11.5	12.5
VFRPSRBD0300R030N150	3	0.3	3	15	2.85	4.2	60	6	4	●	1	15.6	16.1	17.3	18.7
VFRPSRBD0300R030N200	3	0.3	3	20	2.85	3.4	60	6	4	●	1	20.7	21.5	23	24.9
VFRPSRBD0300R050N100	3	0.5	3	10	2.85	5.6	60	6	4	●	1	10.4	10.7	11.5	12.4
VFRPSRBD0300R050N150	3	0.5	3	15	2.85	4.2	60	6	4	●	1	15.6	16.1	17.3	18.6
VFRPSRBD0300R050N200	3	0.5	3	20	2.85	3.4	60	6	4	●	1	20.7	21.4	23	24.8
VFRPSRBD0300R100N100	3	1	3	10	2.85	5.8	60	6	4	★	1	10.4	10.7	11.4	12.3
VFRPSRBD0300R100N150	3	1	3	15	2.85	4.3	60	6	4	●	1	15.5	16.1	17.2	18.5
VFRPSRBD0300R100N200	3	1	3	20	2.85	3.5	60	6	4	●	1	20.7	21.4	22.9	24.7
VFRPSRBD0400R010N120	4	0.1	4	12	3.85	3.6	60	6	4	●	1	12.5	12.9	13.9	15
VFRPSRBD0400R010N200	4	0.1	4	20	3.85	2.4	60	6	4	●	1	20.7	21.5	23.1	*
VFRPSRBD0400R020N120	4	0.2	4	12	3.85	3.7	60	6	4	★	1	12.5	12.9	13.9	15
VFRPSRBD0400R020N200	4	0.2	4	20	3.85	2.4	60	6	4	●	1	20.7	21.5	23.1	*
VFRPSRBD0400R030N120	4	0.3	4	12	3.85	3.7	60	6	4	●	1	12.5	12.9	13.8	15
VFRPSRBD0400R030N200	4	0.3	4	20	3.85	2.4	60	6	4	●	1	20.7	21.5	23	*
VFRPSRBD0400R030N300	4	0.3	4	30	3.85	1.7	70	6	4	★	1	31.1	32.2	*	*
VFRPSRBD0400R050N120	4	0.5	4	12	3.85	3.7	60	6	4	●	1	12.5	12.9	13.8	14.9
VFRPSRBD0400R050N200	4	0.5	4	20	3.85	2.5	60	6	4	●	1	20.7	21.4	23	*
VFRPSRBD0400R050N300	4	0.5	4	30	3.85	1.7	70	6	4	●	1	31.1	32.1	*	*
VFRPSRBD0400R100N120	4	1	4	12	3.85	3.8	60	6	4	●	1	12.4	12.8	13.7	14.8
VFRPSRBD0400R100N200	4	1	4	20	3.85	2.5	60	6	4	●	1	20.7	21.4	22.9	*

* Number of Flutes

* No interference

VFRPSRB

Corner radius, Short cut length, 4-Flute

(mm)

Order Number	DC	RE	APMX	LU	DN	B2	LF	DCON	No.F*	Stock	Type	Effective length for inclined angle			
												0.5°	1°	2°	3°
VFRPSRBD0400R100N300	4	1	4	30	3.85	1.7	70	6	4	●	1	31.1	32.1	*	*
VFRPSRBD0500R050N150	5	0.5	5	15	4.85	1.7	60	6	4	★	1	15.6	16.1	*	*
VFRPSRBD0500R100N150	5	1	5	15	4.85	1.8	60	6	4	●	1	15.5	16.1	*	*
VFRPSRBD0600R010N180	6	0.1	9	18	5.85	—	70	6	4	●	2	*	*	*	*
VFRPSRBD0600R020N180	6	0.2	9	18	5.85	—	70	6	4	●	2	*	*	*	*
VFRPSRBD0600R030N180	6	0.3	9	18	5.85	—	70	6	4	●	2	*	*	*	*
VFRPSRBD0600R050N180	6	0.5	9	18	5.85	—	70	6	4	●	2	*	*	*	*
VFRPSRBD0600R100N180	6	1	9	18	5.85	—	70	6	4	●	2	*	*	*	*
VFRPSRBD0600R200N180	6	2	9	18	5.85	—	70	6	4	●	2	*	*	*	*
VFRPSRBD0800R020N240	8	0.2	12	24	7.85	—	90	8	4	●	2	*	*	*	*
VFRPSRBD0800R030N240	8	0.3	12	24	7.85	—	90	8	4	●	2	*	*	*	*
VFRPSRBD0800R050N240	8	0.5	12	24	7.85	—	90	8	4	●	2	*	*	*	*
VFRPSRBD0800R100N240	8	1	12	24	7.85	—	90	8	4	●	2	*	*	*	*
VFRPSRBD0800R200N240	8	2	12	24	7.85	—	90	8	4	★	2	*	*	*	*
VFRPSRBD1000R030N300	10	0.3	15	30	9.7	—	100	10	4	●	2	*	*	*	*
VFRPSRBD1000R050N300	10	0.5	15	30	9.7	—	100	10	4	●	2	*	*	*	*
VFRPSRBD1000R100N300	10	1	15	30	9.7	—	100	10	4	●	2	*	*	*	*
VFRPSRBD1000R200N300	10	2	15	30	9.7	—	100	10	4	●	2	*	*	*	*
VFRPSRBD1000R300N300	10	3	15	30	9.7	—	100	10	4	●	2	*	*	*	*
VFRPSRBD1200R050N360	12	0.5	18	36	11.7	—	110	12	4	★	2	*	*	*	*
VFRPSRBD1200R100N360	12	1	18	36	11.7	—	110	12	4	●	2	*	*	*	*
VFRPSRBD1200R200N360	12	2	18	36	11.7	—	110	12	4	★	2	*	*	*	*
VFRPSRBD1200R300N360	12	3	18	36	11.7	—	110	12	4	●	2	*	*	*	*

* Number of Flutes　　* No interference

RE = Corner Radius　　**LU** = Usable Length　　**DCON** = Connection Dia.
DC = Cutting Dia.　　**DN** = Neck Dia.
APMX = Depth of Cut Max.　　**LF** = Functional Length

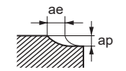
● : USA Stock　★ : Stocked in Japan

Recommended Cutting Conditions

(inch)

Workpiece Material						Hardened Steel (45—55HRC)				Hardened Steel (55—65HRC)				Hardened Steel (65—70HRC)			
Dia. DC		Corner Radius RE		Usable Length LU		Revolution (min^{-1})	Feed Rate (IPM)	Depth of Cut **ap**	Width of Cut **ae**	Revolution (min^{-1})	Feed Rate (IPM)	Depth of Cut **ap**	Width of Cut **ae**	Revolution (min^{-1})	Feed Rate (IPM)	Depth of Cut **ap**	Width of Cut **ae**
(mm)	(inch)	(mm)	(inch)	(mm)	(inch)												
0.5	**.020**	**0.05**	**.002**	**2**	**.079**	25000	39.4	.0002	.004	19000	29.9	.0002	.003	13000	20.1	.0001	.003
0.5	**.020**	**0.1**	**.004**	**2**	**.079**	25000	39.4	.0003	.004	19000	29.9	.0002	.003	13000	20.1	.0002	.003
0.6	**.024**	**0.05**	**.002**	**2**	**.079**	21000	39.4	.0002	.004	16000	29.9	.0002	.003	11000	20.1	.0001	.003
0.6	**.024**	**0.1**	**.004**	**2**	**.079**	21000	39.4	.0003	.004	16000	29.9	.0002	.003	11000	20.1	.0002	.003
0.6	**.024**	**0.1**	**.004**	**4**	**.157**	18000	35.0	.0002	.004	16000	29.9	.0002	.003	11000	20.1	.0002	.003
0.6	**.024**	**0.2**	**.008**	**2**	**.079**	24000	43.3	.0004	.004	19000	35.0	.0003	.003	16000	29.9	.0002	.003
0.8	**.031**	**0.05**	**.002**	**4**	**.157**	16000	29.9	.0006	.005	12000	22.4	.0004	.004	7900	15.0	.0004	.004
0.8	**.031**	**0.1**	**.004**	**4**	**.157**	16000	29.9	.0008	.005	12000	22.4	.0006	.004	7900	15.0	.0004	.004
0.8	**.031**	**0.2**	**.008**	**4**	**.157**	20000	37.4	.0012	.005	16000	29.9	.0010	.004	12000	22.4	.0008	.004
0.8	**.031**	**0.3**	**.012**	**4**	**.157**	20000	37.4	.0012	.005	16000	29.9	.0010	.004	12000	22.4	.0008	.004
1	**.039**	**0.05**	**.002**	**4**	**.157**	13000	39.4	.0006	.006	9500	29.9	.0004	.005	6400	20.1	.0004	.005
1	**.039**	**0.1**	**.004**	**4**	**.157**	13000	39.4	.0008	.006	9500	29.9	.0006	.005	6400	20.1	.0006	.005
1	**.039**	**0.1**	**.004**	**6**	**.236**	11000	35.0	.0006	.005	6400	20.1	.0004	.004	6400	20.1	.0004	.004
1	**.039**	**0.2**	**.008**	**4**	**.157**	16000	51.2	.0012	.006	9500	29.9	.0010	.005	6400	20.1	.0008	.005
1	**.039**	**0.2**	**.008**	**6**	**.236**	13000	39.4	.0008	.005	6400	20.1	.0008	.004	6400	20.1	.0006	.004
1	**.039**	**0.3**	**.012**	**4**	**.157**	16000	51.2	.0012	.006	9500	29.9	.0010	.005	6400	20.1	.0008	.005
1	**.039**	**0.4**	**.016**	**4**	**.157**	16000	51.2	.0016	.006	9500	29.9	.0012	.005	6400	20.1	.0010	.005
1.5	**.059**	**0.1**	**.004**	**4**	**.157**	14000	66.9	.0010	.009	11000	36.2	.0006	.008	7200	22.4	.0004	.008
1.5	**.059**	**0.1**	**.004**	**6**	**.236**	11000	55.1	.0010	.007	9200	28.7	.0006	.006	5700	18.1	.0004	.006
1.5	**.059**	**0.1**	**.004**	**10**	**.394**	11000	55.1	.0010	.007	9200	28.7	.0006	.006	5700	18.1	.0004	.006
1.5	**.059**	**0.2**	**.008**	**4**	**.157**	14000	66.9	.0020	.009	11000	36.2	.0014	.008	7200	22.4	.0010	.008
1.5	**.059**	**0.2**	**.008**	**6**	**.236**	11000	55.1	.0020	.007	9200	28.7	.0014	.006	5700	18.1	.0010	.006
1.5	**.059**	**0.2**	**.008**	**10**	**.394**	11000	55.1	.0020	.007	9200	28.7	.0014	.006	5700	18.1	.0010	.006
1.5	**.059**	**0.3**	**.012**	**4**	**.157**	16000	74.8	.0030	.009	13000	39.4	.0020	.008	8000	25.2	.0014	.008
1.5	**.059**	**0.3**	**.012**	**6**	**.236**	13000	59.1	.0030	.007	10000	31.9	.0020	.006	6400	20.1	.0014	.006
1.5	**.059**	**0.3**	**.012**	**10**	**.394**	13000	59.1	.0030	.007	10000	31.9	.0020	.006	6400	20.1	.0014	.006
1.5	**.059**	**0.5**	**.020**	**4**	**.157**	16000	74.8	.0031	.009	13000	39.4	.0022	.008	8000	25.2	.0016	.008
1.5	**.059**	**0.5**	**.020**	**6**	**.236**	13000	59.1	.0031	.007	10000	31.9	.0022	.006	6400	20.1	.0016	.006
1.5	**.059**	**0.5**	**.020**	**10**	**.394**	13000	59.1	.0031	.007	10000	31.9	.0022	.006	6400	20.1	.0016	.006
2	**.079**	**0.1**	**.004**	**6**	**.236**	11000	66.9	.0010	.012	8600	39.4	.0008	.011	5400	25.2	.0006	.011
2	**.079**	**0.1**	**.004**	**10**	**.394**	8600	55.1	.0010	.009	6900	32.7	.0008	.009	4300	20.5	.0006	.009
2	**.079**	**0.1**	**.004**	**15**	**.591**	6400	39.4	.0008	.007	5200	24.4	.0006	.007	3200	15.4	.0004	.007
2	**.079**	**0.2**	**.008**	**6**	**.236**	11000	66.9	.0022	.012	8600	39.4	.0014	.011	5400	25.2	.0010	.011
2	**.079**	**0.2**	**.008**	**10**	**.394**	8600	55.1	.0022	.009	6900	32.7	.0014	.009	4300	20.5	.0010	.009
2	**.079**	**0.2**	**.008**	**15**	**.591**	6400	39.4	.0016	.007	5200	24.4	.0010	.007	3200	15.4	.0008	.006
2	**.079**	**0.3**	**.012**	**6**	**.236**	12000	74.8	.0031	.012	6900	43.3	.0022	.011	6000	16.5	.0016	.011
2	**.079**	**0.3**	**.012**	**10**	**.394**	9500	59.1	.0031	.009	7600	36.2	.0022	.009	4800	22.4	.0016	.009
2	**.079**	**0.3**	**.012**	**15**	**.591**	7200	43.3	.0026	.007	5700	27.2	.0018	.007	3600	16.9	.0012	.006
2	**.079**	**0.3**	**.012**	**20**	**.787**	7200	43.3	.0026	.007	5700	27.2	.0018	.007	3600	16.9	.0012	.006
2	**.079**	**0.5**	**.020**	**6**	**.236**	12000	74.8	.0033	.012	9500	43.3	.0024	.011	6000	28.3	.0016	.011
2	**.079**	**0.5**	**.020**	**10**	**.394**	9500	59.1	.0033	.009	7600	36.2	.0024	.009	4800	22.4	.0016	.009
2	**.079**	**0.5**	**.020**	**15**	**.591**	7200	43.3	.0028	.007	5700	27.2	.0018	.007	3600	16.9	.0014	.006
2	**.079**	**0.5**	**.020**	**20**	**.787**	7200	43.3	.0028	.007	5700	27.2	.0018	.007	3600	16.9	.0014	.006
2.5	**.098**	**0.3**	**.012**	**8**	**.315**	9500	74.8	.0031	.015	7600	55.1	.0022	.014	4800	33.9	.0016	.013
2.5	**.098**	**0.3**	**.012**	**15**	**.591**	7600	59.1	.0031	.012	6100	43.3	.0022	.011	3800	27.2	.0016	.011
2.5	**.098**	**0.5**	**.020**	**8**	**.315**	9500	74.8	.0035	.015	7600	55.1	.0024	.014	4800	33.9	.0016	.013
2.5	**.098**	**0.5**	**.020**	**15**	**.591**	7600	59.1	.0035	.012	6100	43.3	.0024	.011	3800	27.2	.0016	.011
2.5	**.098**	**1**	**.039**	**8**	**.315**	9500	74.8	.0059	.013	7600	55.1	.0035	.012	4800	33.9	.0026	.012

Depth of Cut



Note 1) The cutting conditions above are a guide only to machining with cutting edges with a corner radius. When machining with peripheral cutting edges, use the minimum feed rate as a guide.
Note 2) If depth of cut is shallow, the revolution and feed rate can be increased.
Note 3) For profile machining such as molds, machining conditions may differ considerably depending on the workpiece geometry, machining methods and depth of cut, Reduce the feed rate especially when machining the corner sections of a workpiece.
Note 4) If the rigidity of the machine or the workpiece installation is very low, or chattering and noise are generated, reduce the revolution and feed rate proportionately.

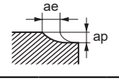
VFRPSRB

Corner radius, Short cut length, 4-Flute

(inch)

Workpiece Material						Hardened Steel (45—55HRC)				Hardened Steel (55—65HRC)				Hardened Steel (65—70HRC)			
Dia. **DC**		Corner Radius **RE**		Usable Length **LU**		Revolution (min^{-1})	Feed Rate (IPM)	Depth of Cut **ap**	Width of Cut **ae**	Revolution (min^{-1})	Feed Rate (IPM)	Depth of Cut **ap**	Width of Cut **ae**	Revolution (min^{-1})	Feed Rate (IPM)	Depth of Cut **ap**	Width of Cut **ae**
(mm)	(inch)	(mm)	(inch)	(mm)	(inch)												
3	**.118**	**0.1**	**.004**	**10**	**.394**	8100	74.8	.0010	.024	6500	47.2	.0008	.022	4100	28.7	.0006	.022
3	**.118**	**0.1**	**.004**	**15**	**.591**	6500	63.0	.0010	.019	5200	37.0	.0008	.017	3200	22.8	.0006	.017
3	**.118**	**0.2**	**.008**	**10**	**.394**	8100	74.8	.0022	.024	6500	47.2	.0016	.022	4100	28.7	.0010	.022
3	**.118**	**0.2**	**.008**	**15**	**.591**	6500	63.0	.0022	.019	5200	37.0	.0016	.017	3200	22.8	.0010	.017
3	**.118**	**0.2**	**.008**	**20**	**.787**	6500	63.0	.0022	.019	5200	37.0	.0016	.017	3200	22.8	.0010	.017
3	**.118**	**0.3**	**.012**	**10**	**.394**	9000	86.6	.0033	.024	7200	51.2	.0022	.022	4500	31.9	.0016	.022
3	**.118**	**0.3**	**.012**	**15**	**.591**	7200	66.9	.0033	.019	5800	39.4	.0022	.017	3600	25.6	.0016	.017
3	**.118**	**0.3**	**.012**	**20**	**.787**	7200	66.9	.0033	.019	5800	39.4	.0022	.017	3600	25.6	.0016	.017
3	**.118**	**0.5**	**.020**	**10**	**.394**	9000	86.6	.0035	.024	7200	51.2	.0024	.022	4500	31.9	.0018	.022
3	**.118**	**0.5**	**.020**	**15**	**.591**	7200	66.9	.0035	.019	5800	39.4	.0024	.017	3600	25.6	.0018	.017
3	**.118**	**0.5**	**.020**	**20**	**.787**	7200	66.9	.0035	.019	5800	39.4	.0024	.017	3600	25.6	.0018	.017
3	**.118**	**1**	**.039**	**10**	**.394**	9000	86.6	.0059	.021	7200	51.2	.0039	.020	4500	31.9	.0028	.020
3	**.118**	**1**	**.039**	**15**	**.591**	7200	66.9	.0059	.017	5800	39.4	.0039	.016	3600	25.6	.0028	.016
3	**.118**	**1**	**.039**	**20**	**.787**	7200	78.7	.0059	.017	5800	39.4	.0039	.016	3600	25.6	.0028	.016
4	**.157**	**0.1**	**.004**	**12**	**.472**	6100	66.9	.0098	.031	4900	38.2	.0008	.029	3000	24.0	.0006	.029
4	**.157**	**0.1**	**.004**	**20**	**.787**	4900	55.1	.0098	.024	3900	30.7	.0008	.024	2400	19.3	.0006	.023
4	**.157**	**0.2**	**.008**	**12**	**.472**	6100	66.9	.0022	.031	4900	38.2	.0016	.029	3000	24.0	.0010	.029
4	**.157**	**0.2**	**.008**	**20**	**.787**	4900	55.1	.0022	.024	3900	30.7	.0016	.024	2400	19.3	.0010	.023
4	**.157**	**0.3**	**.012**	**12**	**.472**	6800	74.8	.0033	.031	5400	43.3	.0022	.030	3400	26.8	.0016	.029
4	**.157**	**0.3**	**.012**	**20**	**.787**	5400	59.1	.0033	.024	4300	34.3	.0022	.024	2700	21.3	.0016	.023
4	**.157**	**0.3**	**.012**	**30**	**1.181**	4100	43.3	.0026	.020	3200	25.6	.0018	.018	2000	16.1	.0014	.017
4	**.157**	**0.5**	**.020**	**12**	**.472**	6800	74.8	.0035	.031	5400	43.3	.0024	.030	3400	26.8	.0018	.029
4	**.157**	**0.5**	**.020**	**20**	**.787**	5400	59.1	.0035	.026	4300	34.3	.0024	.024	2700	21.3	.0018	.023
4	**.157**	**0.5**	**.020**	**30**	**1.181**	4100	43.3	.0030	.020	4300	25.6	.0020	.018	2000	16.1	.0014	.017
4	**.157**	**1**	**.039**	**12**	**.472**	6800	74.8	.0059	.028	5400	43.3	.0039	.026	3400	26.8	.0028	.026
4	**.157**	**1**	**.039**	**20**	**.787**	5400	59.1	.0059	.022	4300	34.3	.0039	.021	2700	21.3	.0028	.021
4	**.157**	**1**	**.039**	**30**	**1.181**	4100	43.3	.0039	.016	3200	25.6	.0030	.016	2000	16.1	.0022	.016
5	**.197**	**0.5**	**.020**	**15**	**.591**	6400	70.9	.0039	.051	5100	39.4	.0026	.047	3200	25.2	.0018	.043
5	**.197**	**1**	**.039**	**15**	**.591**	6400	70.9	.0059	.043	5100	39.4	.0039	.039	3200	25.2	.0030	.039
6	**.236**	**0.1**	**.004**	**18**	**.709**	4800	59.1	.0012	.059	3800	36.2	.0008	.055	2400	22.4	.0006	.051
6	**.236**	**0.2**	**.008**	**18**	**.709**	4800	59.1	.0024	.059	3800	36.2	.0016	.055	2400	22.4	.0012	.051
6	**.236**	**0.3**	**.012**	**18**	**.709**	5300	66.9	.0035	.059	4200	39.4	.0024	.055	2700	25.2	.0018	.051
6	**.236**	**0.5**	**.020**	**18**	**.709**	5300	66.9	.0039	.059	4200	39.4	.0026	.055	2700	25.2	.0018	.051
6	**.236**	**1**	**.039**	**18**	**.709**	5300	66.9	.0059	.055	4200	39.4	.0039	.047	2700	25.2	.0030	.047
6	**.236**	**2**	**.079**	**18**	**.709**	5300	66.9	.0118	.051	4200	39.4	.0079	.043	2700	25.2	.0059	.043
8	**.315**	**0.2**	**.008**	**24**	**.945**	3600	43.3	.0024	.079	2900	27.2	.0016	.071	1800	16.9	.0012	.071
8	**.315**	**0.3**	**.012**	**24**	**.945**	4000	51.2	.0035	.079	3200	29.9	.0024	.071	2000	18.9	.0018	.071
8	**.315**	**0.5**	**.020**	**24**	**.945**	4000	51.2	.0037	.079	3200	29.9	.0026	.071	2000	18.9	.0018	.071
8	**.315**	**1**	**.039**	**24**	**.945**	4000	51.2	.0059	.071	3200	29.9	.0039	.067	2000	18.9	.0030	.063
8	**.315**	**2**	**.079**	**24**	**.945**	4000	51.2	.0118	.067	3200	29.9	.0079	.063	2000	18.9	.0059	.059
10	**.394**	**0.3**	**.012**	**30**	**1.181**	3200	39.4	.0035	.098	2500	24.0	.0024	.091	1600	15.0	.0018	.091
10	**.394**	**0.5**	**.020**	**30**	**1.181**	3200	39.4	.0037	.098	2500	24.0	.0026	.091	1600	15.0	.0018	.091
10	**.394**	**1**	**.039**	**30**	**1.181**	3200	39.4	.0059	.091	2500	24.0	.0039	.083	1600	15.0	.0030	.079
10	**.394**	**2**	**.079**	**30**	**1.181**	3200	39.4	.0118	.083	2500	24.0	.0079	.079	1600	15.0	.0059	.075
10	**.394**	**3**	**.118**	**30**	**1.181**	3200	39.4	.0177	.075	2500	24.0	.0118	.067	1600	15.0	.0079	.067
12	**.472**	**0.5**	**.020**	**36**	**1.417**	2700	37.4	.0039	.118	2100	20.1	.0026	.110	1300	12.6	.0020	.106
12	**.472**	**1**	**.039**	**36**	**1.417**	2700	37.4	.0059	.106	2100	20.1	.0039	.098	1300	12.6	.0030	.094
12	**.472**	**2**	**.079**	**36**	**1.417**	2700	37.4	.0118	.102	2100	20.1	.0079	.094	1300	12.6	.0059	.091
12	**.472**	**3**	**.118**	**36**	**1.417**	2700	37.4	.0177	.091	2100	20.1	.0118	.083	1300	12.6	.0079	.079

Depth of Cut



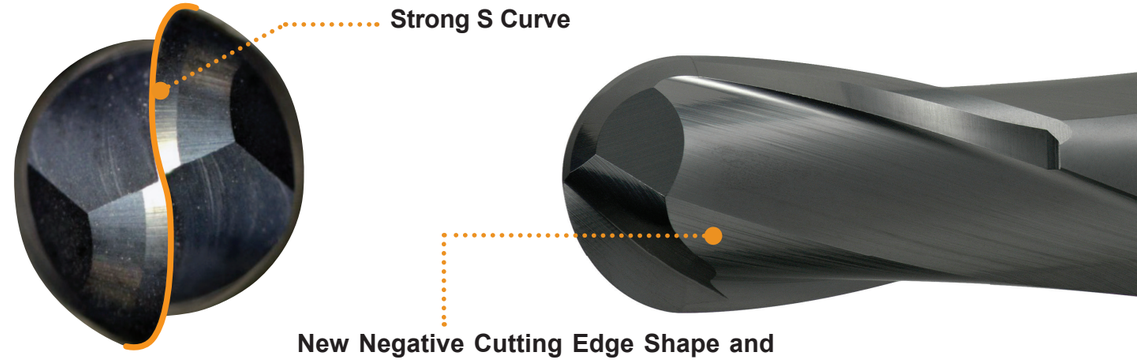
Memo

Memo

Revolutionary Machining of Hardened Steel

VFR2SSB/VFR2SB

2-Flute Ball Nose End Mill



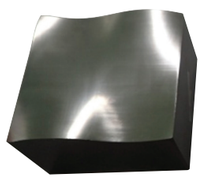
New Cutting Edge : Optimized flute geometry with improved edge strength in all areas of helix and rake angle.
Carbide Substrate : High grade carbide ideal for machining hardened materials.

VFR2SBF

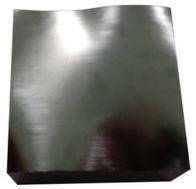
2-Flute Ball Nose End Mill for Mirror Finishes

Application Example

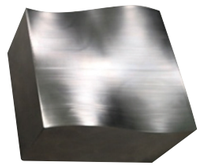
VFR2SB



ASP23
(62 HRC)



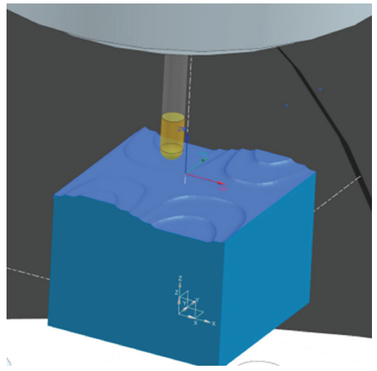
AISI M2
(64 HRC)



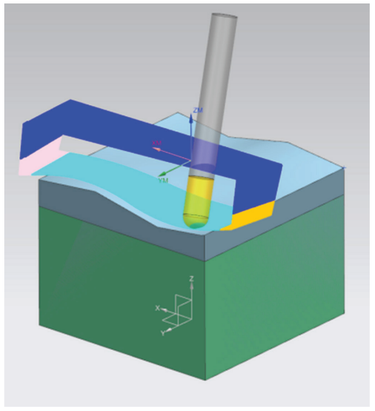
HAP72
(68 HRC)

<Cutting Conditions>
Workpiece : High Speed Steel
1.969"x1.969"x1.969"
Tool : VFR2SBR0300
Cutting Mode : Air Blow
Machine : Vertical MC

Rough Machining Shape



Medium Finish and Finish (Tilt Angle 30°)



Cutting Time : 234 min
Tools Used : 4

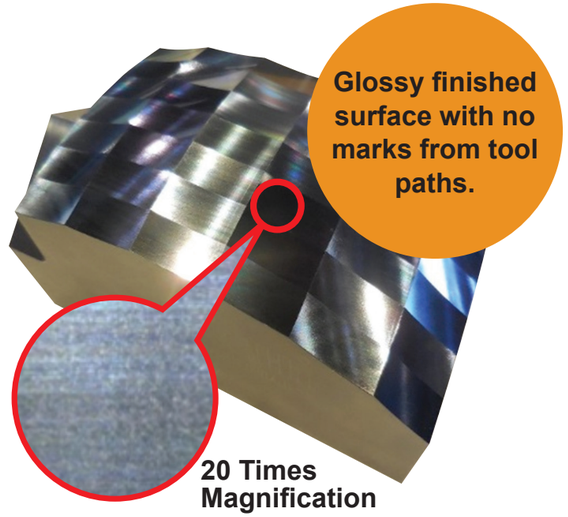
(inch)

Process	RE	n (min^{-1})	vf (IPM)	ap	ae	Finishing Allowance	Cutting Time (h:m:s)	Number of Tools
Rough Machining with Contour Line	3.0mm, .118"	12000	63.0	.014	.039	.008	1:01:45	2
Medium Finish Machining with Scan Line	3.0mm, .118"	8000	19.7	.012	.004	.002	0:49:15	1
Finish Machining with Scan Line	3.0mm, .118"	12000	27.6	.004	.001	—	2:03:19	1

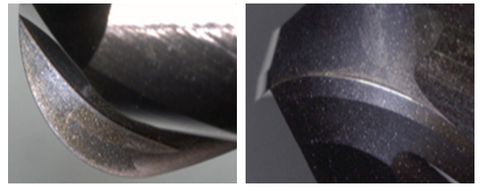
Application Example

VFR2SBF

Workpiece : Pre-hardened Steel

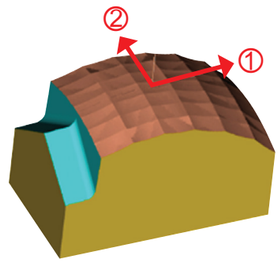


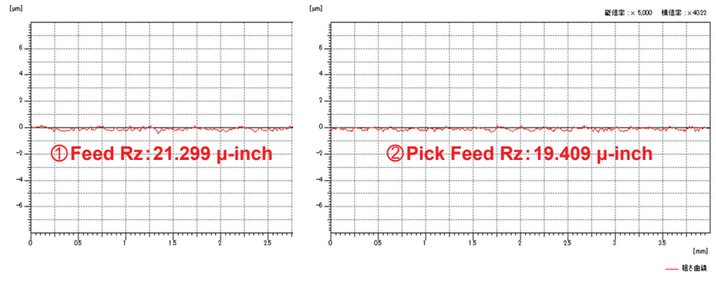
Indexed 5-axis machining can prevent machining at the tips of ball nose end mills.



Excellent tool conditions after 31 hours of finish machining.

A surface roughness of Rz: 31.496 µ-inch or lower can be achieved.





Cutting Conditions Holder : HSK-A63

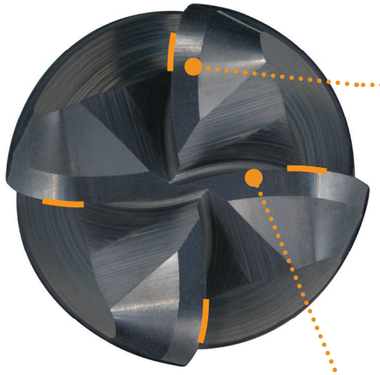
(inch)

Process	Order Number	Coolant	n (min^{-1})	vc (SFM)	vf (IPM)	fz (IPT)	ap	ae	Finishing Allowance	Cutting Time (h : m)
Rough Machining Side Finish Machining	VQMHVRBD1600R500	Air Blow	3000 2000	490 330	70.9 9.4	.0059 .0012	1.260 —	.039 —	.008 0	0:24
Chamfer and Medium Finish Machining on the Top	MP2SBR0300	Air Blow	13000	805	102.4	.0039	Along the Surface p0.1		.001	0:46
Top Finish Machining	VFR2SBFR0300	MQL	20000	1230	23.6	.0006	Along the Surface p0.015		0	31:10

Precision-Corner Radius End Mill, 4-Flute

VFRPSRB

High precision machining is achieved via a seamless shape that suppresses chipping, a strong back taper that reduces chatter and a wiper blade providing improved surface finish.



Equipped with a wiper edge of DC≥1.5mm

Improves the surface finish of the bottom machined face.

Optimal Seamless Shape of DC≥1.5mm

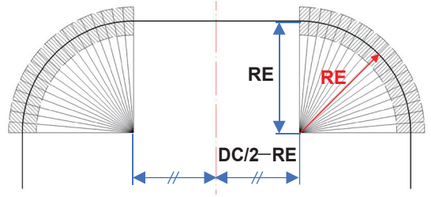
Suppresses chipping.

Strong Back Taper of 1.5≤DC≤5mm

Reduces chatter and vibration when machining vertical walls.

High Precision Corner Radius Accuracy

The corner radius of VFRPSRB is measured as follows, based on the absolute center of the corner radius.



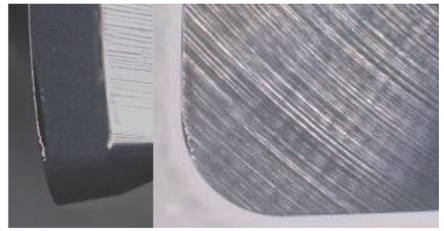
DC : Cutting Dia.
RE : Corner Radius

VFRPSRB	0.5≤DC≤6 mm : ±0.005 8≤DC≤12 mm : ±0.007	Conventional Precision Radius	±0.01

Completely Seamless Curved R Edge, DC≥1.5mm

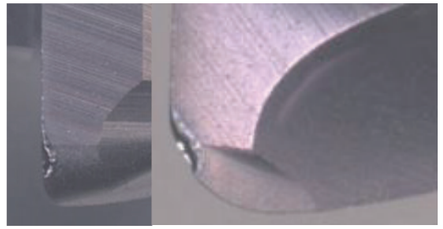
A stable machined surface is achieved by a seamless blend between the radius and flank geometry.

VFRPSRB



Due to the seamless geometry, chipping is suppressed and wear progression is stabilized.

Conventional



Chipping occurs because the load is concentrated on the joint between the flank and corner edge geometry.

Equipped with a Wiper Edge, DC≥1.5mm

A glossy surface finish is possible via the inclusion of a wiper edge.

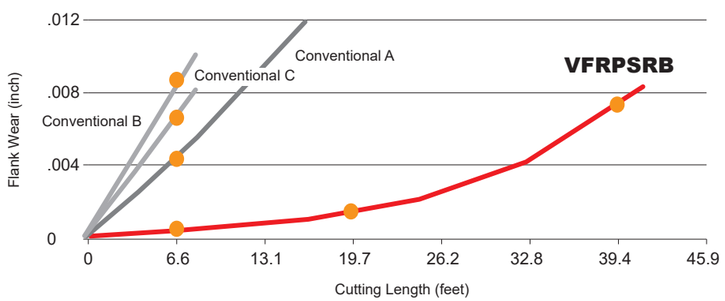
VFRPSRB

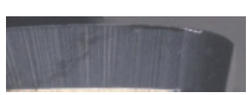
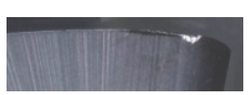
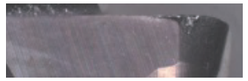
Conventional

Cutting Performance

Wear Resistance Comparison - High Speed Tool Steel (68HRC)

Excellent wear resistance when machining high-hardness steel.



	After Machining 6.6 feet	After Machining 19.7 feet	After Machining 39.4 feet
VFRPSRB			
Conventional A			
Conventional B			
Conventional C			

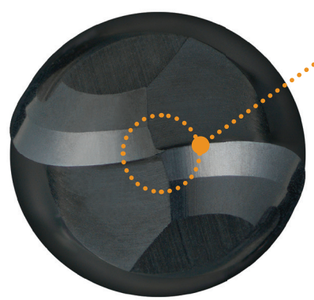
<Cutting Conditions>

Workpiece Material	: Powder High Speed Tool Steel (68HRC)
Tool	: VFRPSRBD0600R050N180
Revolution	: n=5500min^{-1}
Table Feed	: f=26.0 IPM
Feed per Tooth	: .0012 IPT
Depth of Cut	: ap=.004 inch ae=.004 inch
Overhang Length	: .709 inch
Cutting Mode	: Air blow
Machine	: Vertical MC (BT30)

Ball nose, 2-Flute, Long neck

VFR2XLB

Precise machining of vertical walls is possible thanks to a strong back taper combined with seamless ball nose cutting edge geometry.



Ball Nose Optimization

Ideal center flute geometry for finish machining.

Rake Angle Optimization

Optimal geometry combines a sharp edge with fracture resistance enabling excellent surface finishes.

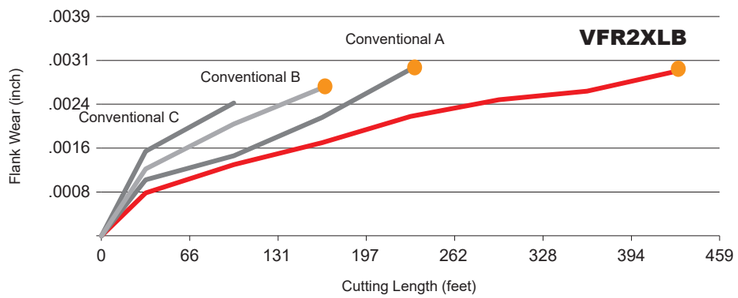
Strong Back Taper

Reduces chatter and vibration when machining vertical walls.

Cutting Performance

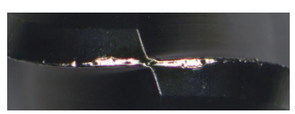
Wear Resistance Comparison - ASP23 (62HRC)

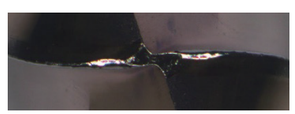
Greatly improved wear resistance for high precision machining.



<Cutting Conditions>

Workpiece Material	: ASP23 (62HRC)
Tool	: VFR2XLBR0100N120
Revolution	: n=16000min^{-1}
Table Feed	: f=63.0 IPM
Feed per Tooth	: .002 IPT
Depth of Cut	: ap=.002 inch×10 ae=.004 inchx10
Overhang Length	: .709 inch
Cutting Mode	: Air blow
Machine	: Vertical MC (HSK-E32)


VFR2XLB

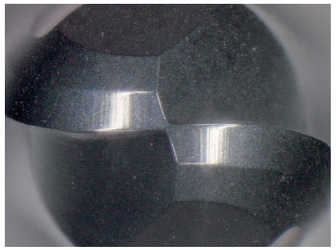

Conventional A


Conventional B

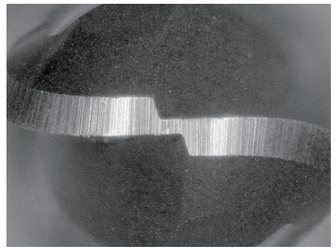
Cutting Edge Geometry for Finishing

Sharp but strong cutting edge enables good surface finishes.

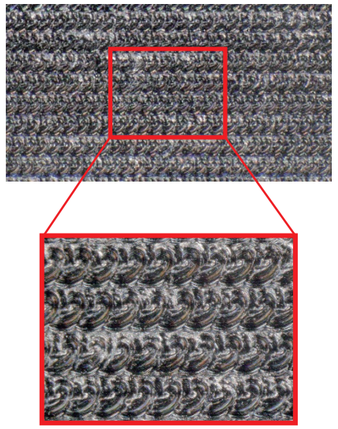
VFR2XLB



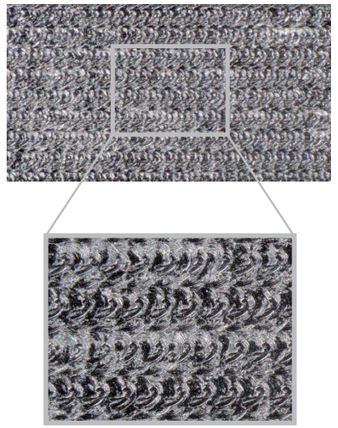
Conventional



Comparison of Surface Finishes

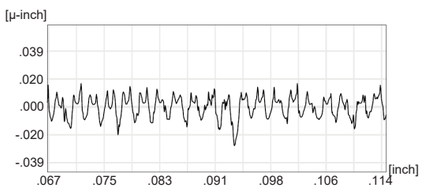


Sharp edges leave a uniform finish.

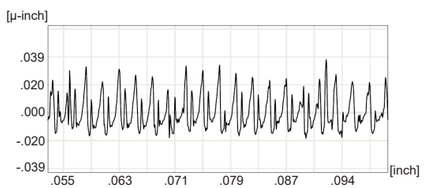


A dull edge leaves an undefined finish.

Comparison of Surface Roughness (Feed Side)



Ra=0.174μm, Rz=1.12μm



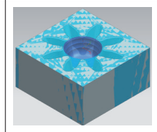
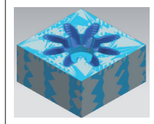
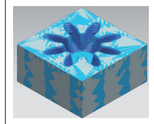
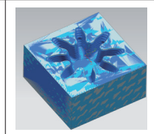
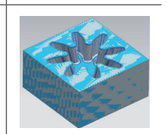
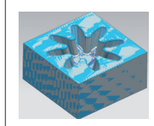
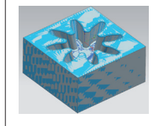
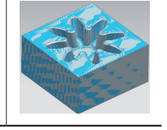
Ra=0.240μm, Rz=2.01μm

Application Example

Machining of a Bevel Gear Mold

Ideal for precision machining of high-hardness, cold forging molds of 65HRC or higher.

(inch)

No.	Process	Tool Used	**vc** (SFM)	**n** (min^{-1})	**vf** (IPM)	**ap**	**ae**	Next Process Finishing Allowance	3D Model Post Machining
1	Rough Machining (Central Helical)	**VFR2SBR0400**	260	3,200	5.1	.118	.024	.004	
2	Rough Pocket Milling①	**VFR2SBR0200**	260	6,300	9.8	.035	.012	.008	
3	Rough Pocket Milling②	**VFR2XLBR0150N100**	195	6,300	7.5	.035	.006	.008	
4	Semi-finish Machining	**VFR2XLBR0100N100**	260	12,700	9.8	.008	.004	.004	
5	Deep Wall Finish Machining	**VFR2XLBR0100N100**	260	12,700	9.8	.004	.0012	0	
6	Bottom Face Finish Machining	**VFRPSRBD0300R050N100**	130	4,500	10.6	.004	.004	0	
7	Upper Surface Milling	**VFRPSRBD0600R050N180**	130	2,100	19.7	.0008	.020	0	
8	Chamfering	**VC2CD0600**	165	2,700	4.3	.020	.008	0	

<Cutting Conditions>
Workpiece Material : SKH51
1.969"x1.969"x.984"
Machine : Vertical MC (HSK-E32)

Application Example

Surface Finish Comparison - Dies Used for Plastic Molding

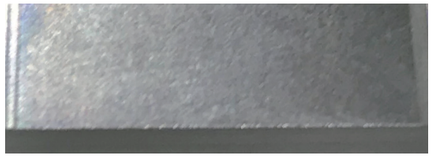
Ideal surface finishes of dies can be achieved.

Workpiece Material : Steel die used for Plastic Molding (M340 58HRC)

(inch)

Process	Tools Used	n (min^{-1})	vf (IPM)	ap	ae	Coolant
Semi-finish Machining	**VFR2XLBR0050N040**	18000	35.4	.0008	.0008	MQL
	VFR2XLBR0100N060	17500	47.2	.0012	.0039	
Finish Machining	**VFR2XLBR0050N040**	18000	35.4	.0008	.0008	
	VFR2XLBR0100N060	17500	47.2	.0012	.0031	

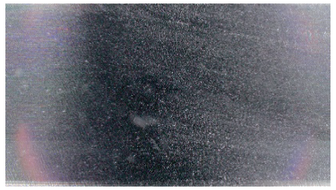
VFR2XLB Has a smooth surface



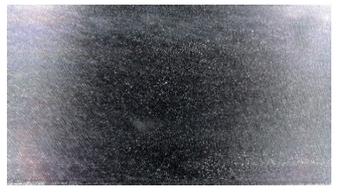
Conventional

Surface Finish Comparison - AISI D2

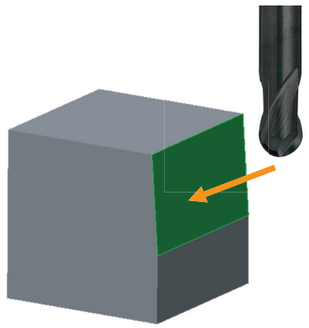
Excellent surface finishes compared to those machined by conventional tools.



VFR2XLB



Conventional: Cloudy surface finish

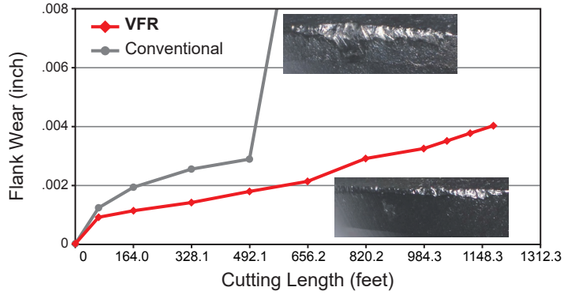


Cutting Form : 1° Taper Cutting

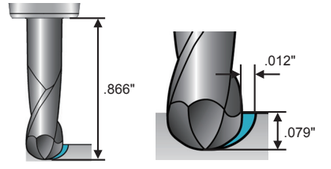
<Cutting Conditions>
Workpiece Material : AISI D2 (60HRC)
Tool : VFR2XLBR0100N100
Revolution : n=19000min^{-1}
Table Feed : f=26.8 IPM
Depth of Cut : ap=.0008 inch
ae=.0008 inch
Overhang Length : .630 inch
Cutting Mode : Air blow
Machine : Vertical MC (HSK-E32)

Cutting Performance

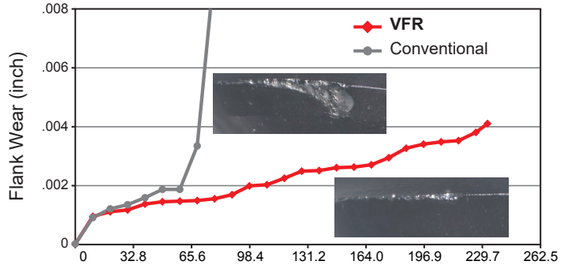
AISI H13 (52HRC)



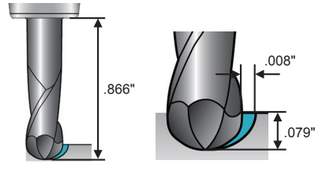
<Cutting Conditions>
Work Material : AISI H13 (52HRC)
Tool : VFR2SBR0300
Revolution : n=17000 min^{-1}
Table Feed : vf=66.9 IPM
Feed per Tooth : fz=.002 IPT
Depth of Cut : ap=.079 inch, ae=.012 inch
Overhang Length : .866 inch
Cutting Mode : Air blow
Machine : Vertical MC (HSK-A63)



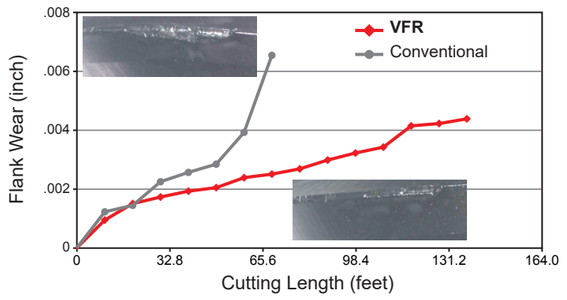
AISI D2 (60HRC)



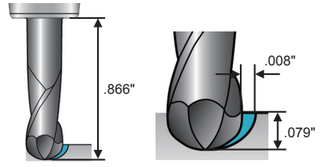
<Cutting Conditions>
Work Material : AISI D2 (60HRC)
Tool : VFR2SBR0300
Revolution : n=5400 min^{-1}
Table Feed : vf=21.3 IPM
Feed per Tooth : fz=.002 IPT
Depth of Cut : ap=.079 inch ae=.008 inch
Overhang Length : .866 inch
Cutting Mode : Air Blow
Machine : Vertical MC (HSK-A63)



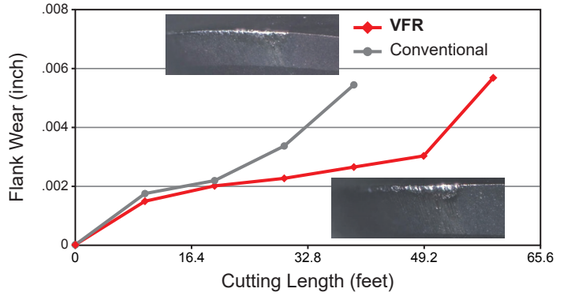
ASP23 (62HRC)



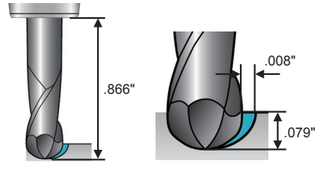
<Cutting Conditions>
Work Material : ASP23 (62HRC)
Tool : VFR2SBR0300
Revolution : n=5400 min^{-1}
Table Feed : vf=21.3 IPM
Feed per Tooth : fz=.002 IPT
Depth of Cut : ap=.079 inch, ae=.008 inch
Overhang Length : .866 inch
Cutting Mode : Air Blow
Machine : Vertical MC (HSK-A63)



AISI M2 (64HRC)

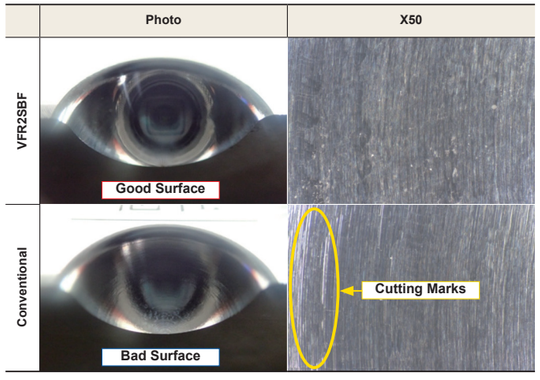


<Cutting Conditions>
Work Material : AISI M2 (64HRC)
Tool : VFR2SBR0300
Revolution : n=5400 min^{-1}
Table Feed : vf=21.3 IPM
Feed per Tooth : fz=.002 IPT
Depth of Cut : ap=.079 inch, ae=.008 inch
Overhang Length : .866 inch
Cutting Mode : Air Blow
Machine : Vertical MC (HSK-A63)

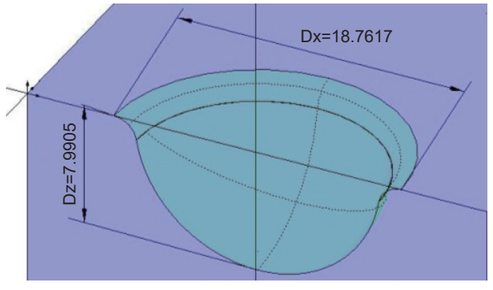


Cutting Performance

AISI H13 (52 HRC) Comparison of Cutting Surface



Model Shape



<Cutting Conditions>

Workpiece	: AISI H13 (52HRC)	Feed per Tooth	: fz=.001 IPT
Tool	: VFR2SBFR0300	Depth of Cut	: ap=.001 inch, ae=.001 inch
Revolution	: n=32000 min^{-1}	Overhang Length	: .591 inch
Cutting Speed	: vc=1980 SFM	Cutting Mode	: Air Blow
Table Feed	: vf=50.4 IPM	Machine	: Vertical MC (HSK-E25)

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.

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