MITSUBISHI MATERIALS

VFR Impact Miracle

REVOLUTIONARY MACHINING OF HARDENED STEEL





TOOL NEWS **B231A**

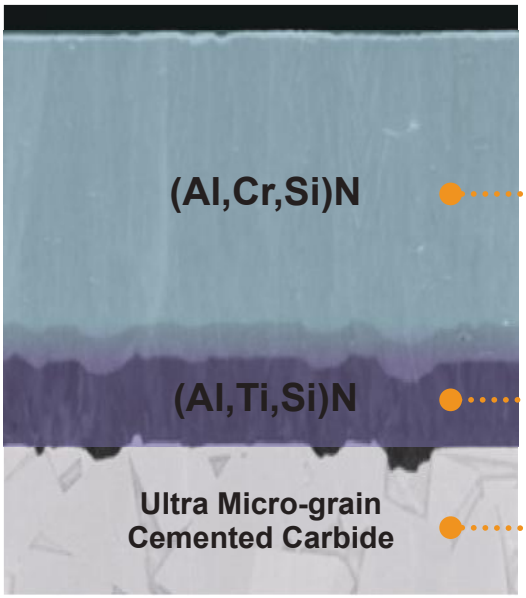
For Machining of Hardened Steel

iMPACT MIRACLE End Mill Series

IMPACT MIRACLE REVOLUTION

IMPACT MIRACLE REVOLUTION Coating

A combination of the (Al, Cr, Si) N coating with improved lubricity and a high oxidization temperature, together with the (Al, Ti, Si) N coating layer that displays excellent wear and adhesion to other coating layers, enables efficient and reliable machining of hardened steels.



The coating may appear to be a different color, but this does not affect performance.

Selection According to the Hardness of the Workpiece Material



SERIES SELECTION CHART

Flutes	Type	Use	Specifications	Shape	Units	Dia. DC Min.	Dia. DC Max.	Corner Radius RE Min.	Corner Radius RE Max.	Max. DC APMX	DC≤.239" Shank Size	Number of Items	Material P Tool Steel≤45HRC	Material H Hardened Steel≤55HRC	Material H Hardened Steel>55HRC	Page
Square																
2	VFR2MV	For high efficiency	Low resistance and irregular helix		mm	0.5	6.0	—	—	15	4, 6	9	○	◎	◎	P.7
4	VFR4MV	For high efficiency	Low resistance and irregular helix		mm	6.0	20.0	—	—	50	6	6	○	◎	◎	P.9
4, 6	VFRSD	For high speed machining	High fracture resistance		mm	1.0	12.0	—	—	24	6	12	○	◎	◎	P.10
4, 6	VFRMD	For high speed machining	High fracture resistance		in	.031	.500	—	—	1.094	.250	10	○	◎	◎	P.12
					mm	1.0	25.0	—	—	60	6	18	○	◎	◎	P.14
6	VFRLD	For high speed machining	High fracture resistance		mm	6.0	25.0	—	—	92	6	7	○	◎	◎	P.16
Ball Nose																
2	VFR2SSB	For general purpose	Short Shank Type		mm	1.0	12.0	0.5	6.0	12	4, 6	12	○	◎	◎	P.17
2	VFR2SB	For general purpose	High fracture resistance		mm	0.2	20.0	0.1	10.0	38	3, 4 6	36	○	◎	◎	P.18
2	VFR2SBF	For mirror finishes	Special geometry for mirror machining		mm	1.0	6.0	0.5	3.0	12	4, 6	8	○	◎	◎	P.20
2	VFR2XLB	For high-precision vertical machining	Long neck type		mm	0.2	6.0	0.1	3.0	6	4, 6	74	○	◎	◎	P.22 | P.24
4	VFR4MB	For high-efficiency finishing machining	Versatile 4-flute design		mm	1.0	12.0	0.5	6.0	22	6	9	○	◎	◎	P.26
Corner Radius																
4	VFRPSRB	For strong and high-precision machining	Completely seamless curved R edge DC≥1.5 For high precision machining. 1.5≤DC≤5		mm	0.5	12.0	0.05	3.0	18	6	97	○	◎	◎	P.28 | P.30
6	VFRSDRB	For high speed machining	High helix and fracture resistance		mm	3.0	12.0	0.3	1.0	12	6	13	○	◎	◎	P.33
6	VFRMDRB	For high speed machining	High helix and fracture resistance		mm	3.0	20.0	0.3	2.0	45	6	21	○	◎	◎	P.35

= NEW

For High Speed Machining

Square End Mill

VFRSD/MD/LD NEW

Corner Radius End Mill

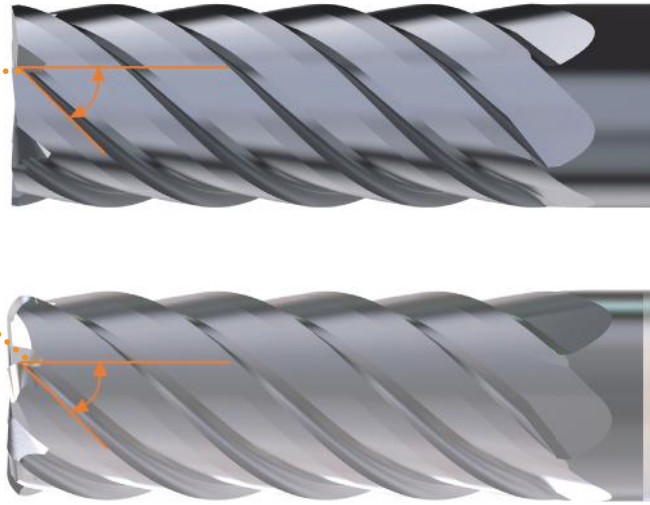
VFRSDRB/MDRB NEW

Ideal Choice for High-Efficiency Machining of High-Hardness Materials

To successfully acheive high-speed machining with multi-flute end mills, high helix angle flute geometry provided the sharpness and negative rake end cutting edges provided the strength and reliability.

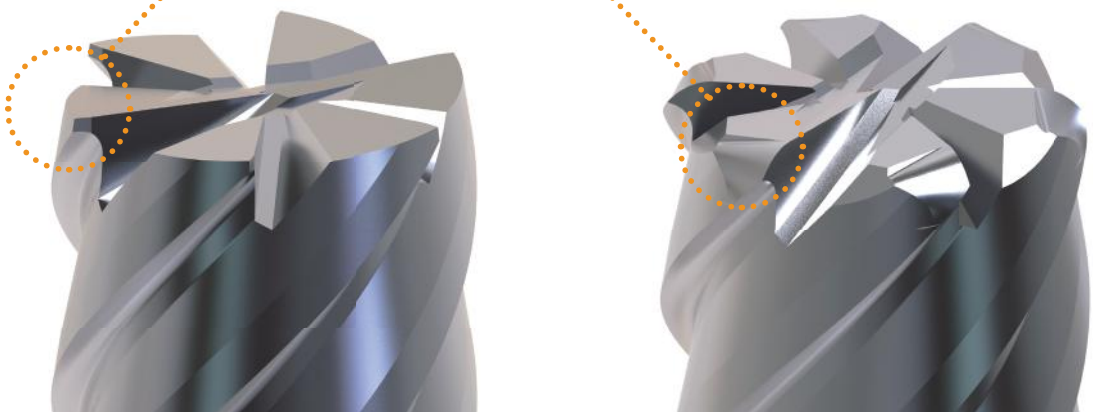
High Helix Angle 45°

Improved sharper geometry for to high-hardness steel.



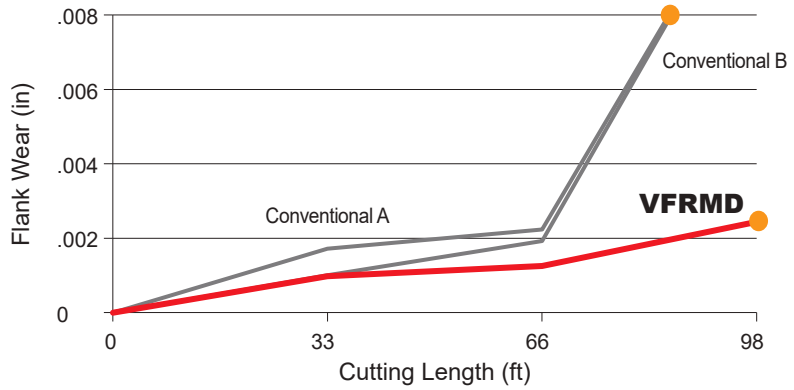
Negative Rake Angle Cutting Edges

Improved chipping resistance.



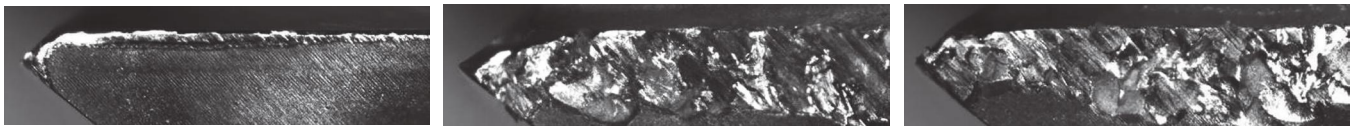
HAP72 (67.0 HRC) Tool Life Comparison

Compared to conventional products, more than 1.5 times longer tool life during stable machining was achieved.



<Cutting Conditions>
Material : HAP72 (67.0 HRC)
Tool : VFRMDD0600
DC= .236"
Revolution : n=5300 min^{-1}
Cutting Speed : vc=330 SFM
Table Feed : vf=70.9 IPM
Depth of Cut : ap=.236"
ae=.004"
Overhang : .866"
Cutting Mode : Air blow
Down(climb) Cut
Machine : Vertical MC (BT30)

●: Photo taken at this length of cutting.

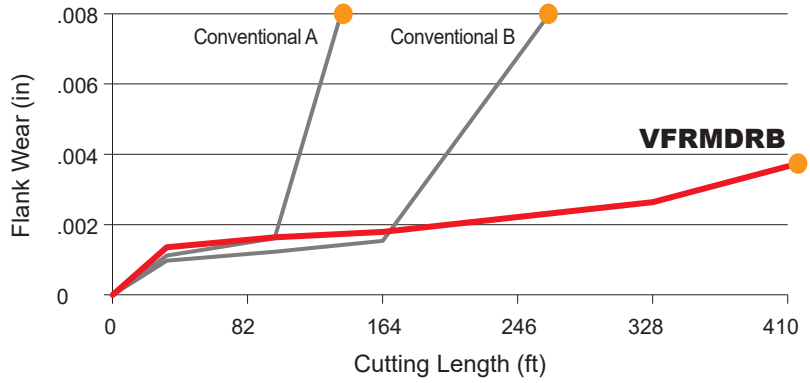


VFRMD Conventional A Conventional B

Stable machining time: In the graph, the sudden increase in wear is interpreted as an indication that the tool damage is preventing stable machining of the workpiece.

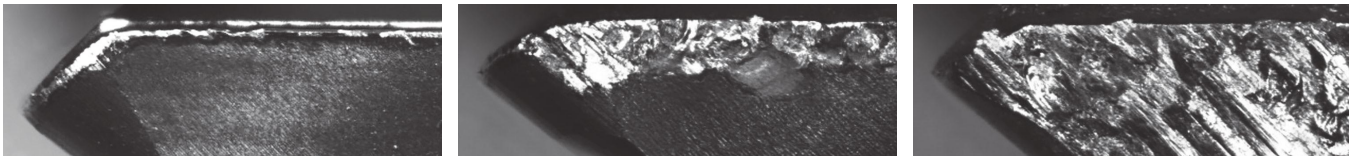
SKD11 (59.2 HRC) Tool Life Comparison

Compared to conventional products, more than 2 times longer tool life during stable machining was achieved.



<Cutting Conditions>
Material : JIS SKD11 (59.2 HRC)
Tool : VFRMDRBD0600R050
DC= .236"
Revolution : n=8000 min^{-1}
Cutting Speed : vc=490 SFM
Table Feed : vf=94.5 IPM
Depth of Cut : ap=.197"
ae=.004"
Overhang : .866"
Cutting Mode : Air blow
Down(climb) Cut
Machine : Horizontal MC (BT40)

●: Photo taken after this length of cutting.



VFRMDRB Conventional A Conventional B

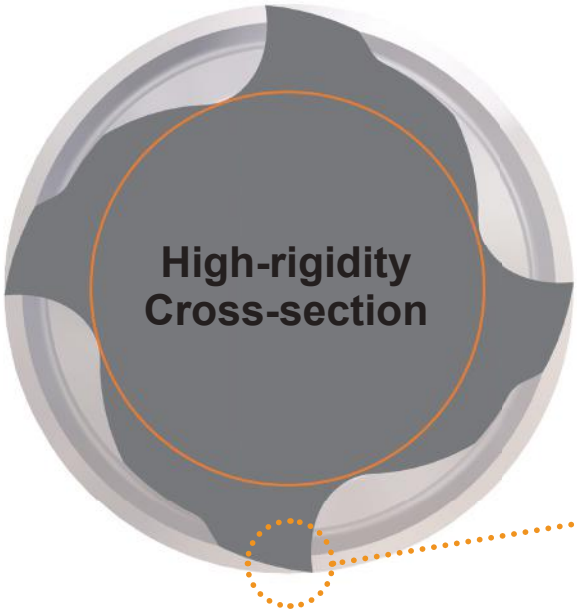
Compatible with high-speed Machining

Square End Mill

VFR2MV/4MV NEW

Suppresses Chatter and Vibration and Provides Consistent Surface Finishes

Chatter and vibrations are suppressed through the use of irregular helix flutes and irregular pitch flute geometry pitch, combined with a highly rigid center cross section.





Irregular Helical Lead and Pitch Flutes

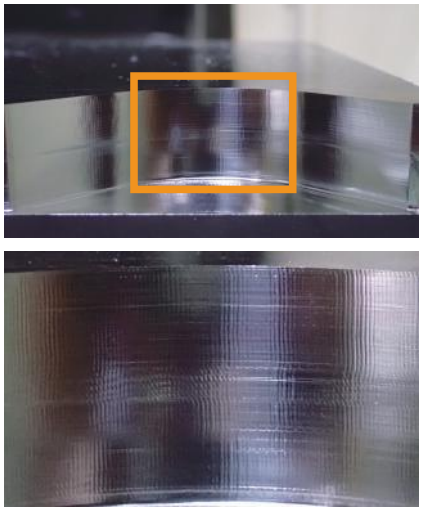


Positive Rake Angle Cutting Edges

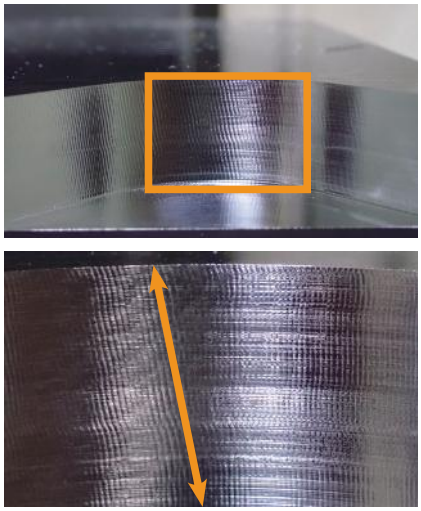
Low cutting resistance contributes to a stable surface finishes.

Comparison of Surface Finishes - Machining SKD61 (53.0 HRC)

Demonstrates excellent chatter resistance when machining hardened steel.



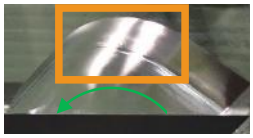
VFR4MV



Conventional

Chatter and vibration occurred

Workpiece geometry with R .709



<Cutting Conditions>

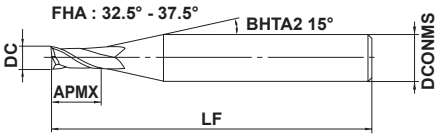
Material	: JIS SKD61 (53.0 HRC)
Tool	: VFR4MVD0600 DC= .236"
Revolution	: n=5300 min^{-1}
Cutting Speed	: vc=330 SFM
Table Feed	: vf=41.7 IPM
Depth of Cut	: ap=.472" ae=.012"
Cutting Mode	: Air blow Down(climb) Cut Corner radius machining
Machine	: Vertical MC (BT30)

VFR2MV NEW

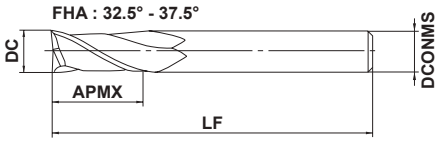
End mill, Medium cut length, 2 flute, Irregular helix flutes, For hardened materials

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 Alloys, Heat Resistant Alloys	Copper Alloys	Aluminum Alloys
	○	◎	◎				





Type1



Type2

DC				
0 - 0.020				
DCONMS				
0 - 0.005				

● Irregular helix angle and irregular pitch flutes, combined with a highly rigid center suppresses chatter and vibration.

(mm)

Order Number	DC	APMX	LF	DCONMS	Flutes	Stock	Type
VFR2MVD0050	0.5	1.3	40	4	2	●	1
VFR2MVD0100	1	2.5	40	4	2	●	1
VFR2MVD0150	1.5	3.8	40	4	2	●	1
VFR2MVD0200	2	5	40	4	2	●	1
VFR2MVD0250	2.5	6.3	40	4	2	●	1
VFR2MVD0300	3	7.5	50	6	2	●	1
VFR2MVD0400	4	10	50	6	2	●	1
VFR2MVD0500	5	12.5	50	6	2	●	1
VFR2MVD0600	6	15	50	6	2	●	2

DC = Cutting Dia.
APMX = Depth of Cut Max.
LF = Functional Length
DCONMS = Connection Dia.

● : USA Stock

VFR2MV

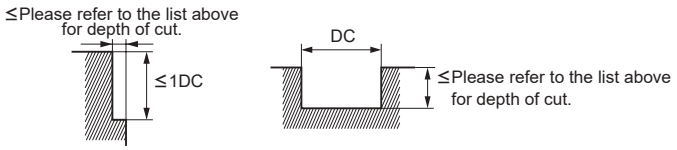
End mill, Medium cut length, 2 flute, Irregular helix flutes, For hardened materials

Recommended Cutting Conditions

(in)

Material		Carbon Steel, Tool Steel Pre-hardened Steel(35— 45HRC)			Hardened Steel (45— 55HRC)			Hardened Steel (55— 62HRC)			Hardened Steel (62— 70HRC)		
Dia. **DC**		Revolution (min^{-1})	Feed rate (IPM)	Depth of Cut **ae, ap**	Revolution (min^{-1})	Feed rate (IPM)	Depth of Cut **ae, ap**	Revolution (min^{-1})	Feed rate (IPM)	Depth of Cut **ae, ap**	Revolution (min^{-1})	Feed rate (IPM)	Depth of Cut **ae, ap**
(mm)	(in)												
.5	**.020**	40000	39.4	.0006	40000	37.8	.0006	30000	23.6	.0004	19100	10.2	.0004
1.0	**.039**	40000	78.7	.0024	32000	63.0	.0024	16000	21.7	.0020	9600	7.1	.0004
1.5	**.059**	40000	118.1	.0047	32000	74.8	.0031	10600	19.7	.0031	6400	6.3	.0020
2.0	**.079**	30000	118.1	.0071	24000	74.8	.0039	8100	15.7	.0039	4800	4.7	.0031
2.5	**.098**	24000	102.4	.0098	19000	63.0	.0051	6400	13.8	.0051	3800	3.9	.0031
3.0	**.118**	20000	90.6	.0118	16000	55.1	.0059	5400	11.8	.0059	3200	3.5	.0031
4.0	**.157**	15000	78.7	.0157	12000	47.2	.0079	4000	9.4	.0079	2400	3.2	.0039
5.0	**.197**	12000	63.0	.0197	9000	35.4	.0098	3200	7.5	.0079	1900	2.8	.0039
6.0	**.236**	10000	55.1	.0236	7000	27.6	.0118	2700	6.3	.0079	1600	2.4	.0039

Depth of cut



DC:Dia.

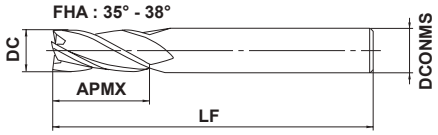
Note 1) When slotting, reduce the revolutions by 50 — 70% and the feed rate by 40 — 60%.
Note 2) If the depth of cut is shallow, the revolution and feed rate can be increased.
Note 3) Vibration damping end mills are more effective in suppressing chatter and vibration compared to general end mills, but these may still occur if the rigidity of the machine or the workpiece material is low. In this case, please adjust the spindle speed, feed rate, and depth of cut according to the table above.

VFR4MV NEW

End mill, Medium cut length, 4 flute, Irregular helix flutes, For hardened materials

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 Alloys, Heat Resistant Alloys	Copper Alloys	Aluminum Alloys
	○	◎	◎				





Type1

DC≤12	DC>12			
0 - 0.020	0 - 0.030			
DCONMS=6	**DCONMS=8, 10**	**DCONMS=12, 16**	**DCONMS=20**	
0 - 0.005	0 - 0.006	0 - 0.008	0 - 0.009	

● Irregular helix angle and irregular pitch flutes, combined with a highly rigid center suppresses chatter and vibration.

(mm)

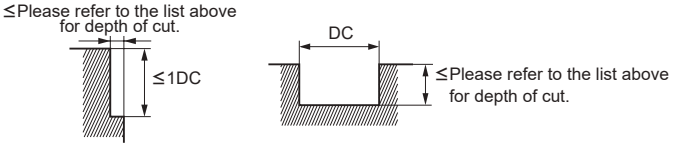
Order Number	DC	APMX	LF	DCONMS	Flutes	Stock	Type
VFR4MVD0600	6	15	50	6	4	●	1
VFR4MVD0800	8	20	60	8	4	●	1
VFR4MVD1000	10	25	70	10	4	●	1
VFR4MVD1200	12	30	90	12	4	●	1
VFR4MVD1600	16	40	100	16	4	●	1
VFR4MVD2000	20	50	110	20	4	●	1

Recommended Cutting Conditions

(in)

Material		Carbon Steel, Tool Steel Pre-hardened Steel(35— 45HRC)			Hardened Steel (45— 55HRC)			Hardened Steel (55— 62HRC)			Hardened Steel (62— 70HRC)		
Dia. **DC**		Revolution (min^{-1})	Feed rate (IPM)	Depth of cut **ae, ap**	Revolution (min^{-1})	Feed rate (IPM)	Depth of cut **ae, ap**	Revolution (min^{-1})	Feed rate (IPM)	Depth of cut **ae, ap**	Revolution (min^{-1})	Feed rate (IPM)	Depth of cut **ae, ap**
(mm)	(in)												
6	**.236**	10000	82.7	.0236	7000	55.1	.0118	2700	12.6	.0079	1600	5.1	.0039
8	**.315**	8000	59.1	.0315	5600	43.3	.0157	2000	9.4	.0079	1200	3.9	.0039
10	**.394**	6400	55.1	.0394	4500	37.4	.0197	1600	8.3	.0118	960	3.2	.0079
12	**.472**	5400	47.2	.0394	3800	33.9	.0197	1300	6.3	.0118	800	2.4	.0079
16	**.630**	2400	21.7	.1181	1200	11.0	.0315	1000	5.1	.0118	600	2.0	.0079
20	**.787**	1900	18.9	.1575	1000	9.4	.0394	800	3.9	.0118	480	1.6	.0079

Depth of cut



DC:Dia.

Note 1) When slotting, reduce the revolutions by 50 — 70% and the feed rate by 40 — 60%.
Note 2) If the depth of cut is shallow, the revolution and feed rate can be increased.
Note 3) Vibration damping end mills are more effective in suppressing chatter and vibration compared to general end mills, but these may still occur if the rigidity of the machine or the workpiece material is low. In this case, please adjust the spindle speed, feed rate, and depth of cut according to the table above.

● : **USA Stock**

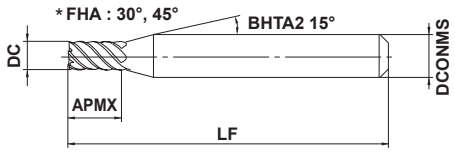
VFRSD NEW

End mill, Short cut length, 4/6 flute, For hardened materials

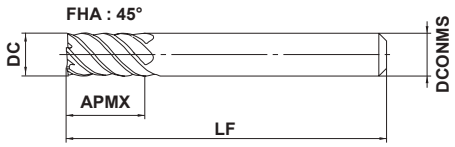
DC<3 DC≥3

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 Alloys, Heat Resistant Alloys	Copper Alloys	Aluminum Alloys
	○	◎	◎				





Type1



Type2

DC				
0 - 0.020				
DCONMS=6	DCONMS=8, 10	DCONMS=12		
0 - 0.005	0 - 0.006	0 - 0.008		

● A sharp cutting edge and improved chipping resistance enable highly efficient machining.

(mm)

Order Number	DC	APMX	LF	DCONMS	Flutes	Stock	Type
VFRSDD0100	1	2	45	6	4	●	1
VFRSDD0150	1.5	3	45	6	4	●	1
VFRSDD0200	2	4	45	6	4	●	1
VFRSDD0250	2.5	5	45	6	4	●	1
VFRSDD0300	3	6	45	6	6	●	1
VFRSDD0350	3.5	7	45	6	6	●	1
VFRSDD0400	4	8	45	6	6	●	1
VFRSDD0500	5	10	50	6	6	●	1
VFRSDD0600	6	12	50	6	6	●	2
VFRSDD0800	8	16	60	8	6	●	2
VFRSDD1000	10	20	70	10	6	●	2
VFRSDD1200	12	24	75	12	6	●	2

* FHA : DC<3 mm=30°, DC≥3 mm=45°

DC = Cutting Dia.
APMX = Depth of Cut Max.
LF = Functional Length
DCONMS = Connection Dia.

● : **USA Stock**

Recommended Cutting Conditions

(in)

Material		Hardened steel (45－55HRC)			Hardened steel (55－62HRC)			Hardened steel (62－70HRC)		
Dia. **DC**		Revolution (min^{-1})	Feed rate (IPM)	Depth of cut **ae**	Revolution (min^{-1})	Feed rate (IPM)	Depth of cut **ae**	Revolution (min^{-1})	Feed rate (IPM)	Depth of cut **ae**
(mm)	(in)									
1	**.039**	40000	47.2	.0020	40000	31.5	.0012	32000	19.7	.0008
2	**.079**	40000	78.7	.0039	24000	39.4	.0020	16000	23.6	.0020
3	**.118**	32000	149.6	.0079	16000	74.8	.0039	11000	47.2	.0020
4	**.157**	24000	173.2	.0079	12000	86.6	.0039	8000	51.2	.0020
6	**.236**	16000	228.3	.0118	8000	114.2	.0079	5300	70.9	.0039
8	**.315**	12000	228.3	.0157	6000	114.2	.0079	4000	70.9	.0039
10	**.394**	9600	228.3	.0197	4800	114.2	.0118	3200	70.9	.0079
12	**.472**	8000	189.0	.0236	4000	94.5	.0118	2700	59.1	.0079
Depth of cut		≤Please refer to the list above for depth of cut. ≤1.5DC			≤Please refer to the list above for depth of cut. ≤1.0DC					

DC:Dia.

Slot milling with small diameter tools

(in)

Material		Hardened steel (45－55HRC)			Hardened steel (55－62HRC)		
Dia. **DC**		Revolution (min^{-1})	Feed rate (IPM)	Depth of cut **ap**	Revolution (min^{-1})	Feed rate (IPM)	Depth of cut **ap**
(mm)	(in)						
1	**.039**	15000	11.8	.0039	9500	4.3	.0020
2	**.079**	8000	12.6	.0079	4800	7.5	.0039
Depth of cut		DC ≤Please refer to the list above for depth of cut.					

DC:Dia.

Note 1) If the depth of cut is shallow, the revolution and feed rate can be increased.

Note 2) If the machine or workpiece material is not rigid, vibration or abnormal noises may occur. In this case, please adjust the spindle speed, feed rate, and depth of cut according to the table above.

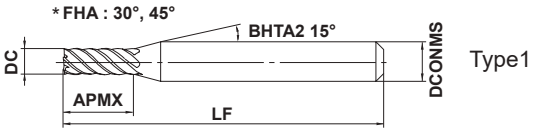
VFRMD NEW - Inch Sizes

End mill, Medium cut length, 4/6 flute, For hardened materials

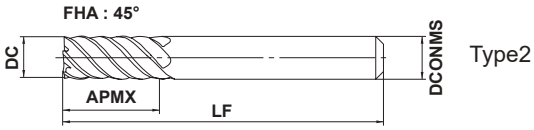
DC<.1250 DC≥.1250

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 Alloys, Heat Resistant Alloys	Copper Alloys	Aluminum Alloys
	○	◎	◎				





Type1



Type2

DC≤ .5000"	DC= .5000"	
0 - .0008	0 - .0012	
DCONMS= .2500"	**DCONMS= .3125", .3750"**	**DCONMS= .5000"**
0 - .005	0 - .006	0 - .008

h5

● A sharp cutting edge and improved chipping resistance enable highly efficient machining.

(in)

Order Number	DC	APMX	LF	DCONMS	Flutes	Stock	Type
VFRMDDU0313	.0313	.0938	2.5	.2500	4	●	1
VFRMDDU0625	.0625	.1875	2.5	.2500	4	●	1
VFRMDDU0938	.0938	.2813	2.5	.2500	4	●	1
VFRMDDU1250	.1250	.3750	2.5	.2500	6	●	1
VFRMDDU1563	.1563	.5000	2.5	.2500	6	●	1
VFRMDDU1875	.1875	.5630	2.5	.2500	6	●	1
VFRMDDU2500	.2500	.5630	3.5	.2500	6	●	2
VFRMDDU3125	.3125	.6875	4.0	.3125	6	●	2
VFRMDDU3750	.3750	.8125	4.0	.3750	6	●	2
VFRMDDU5000	.5000	1.0938	4.5	.5000	6	●	2

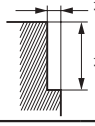
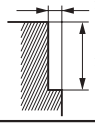
* FHA : DC<.1250"=30°, DC≥.1250"=45°

DC = Cutting Dia. **LF** = Functional Length
APMX = Depth of Cut Max. **DCONMS** = Connection Dia.

● : USA Stock

Recommended Cutting Conditions

(in)

Material	Hardened steel (45—55HRC)			Hardened steel (55—62HRC)			Hardened steel (62—70HRC)		
Dia. **DC** (in)	Revolution (min^{-1})	Feed rate (IPM)	Depth of cut **ae**	Revolution (min^{-1})	Feed rate (IPM)	Depth of cut **ae**	Revolution (min^{-1})	Feed rate (IPM)	Depth of cut **ae**
.0313	40000	43.3	.0016	40000	31.5	.00094	36000	19.6	.00063
.0625	40000	70.8	.0031	30000	37.8	.00190	20000	22.0	.00130
.0938	40000	102.0	.0047	20000	43.0	.00280	13000	26.6	.00190
.1250	30000	161.0	.0063	15000	82.0	.00380	10000	49.6	.00250
.1563	24000	170.0	.0078	12000	86.0	.00470	8000	51.0	.00310
.1875	20000	189.0	.0094	10000	94.5	.00560	6700	55.0	.00380
.2500	15000	228.0	.0130	7500	114.0	.00750	5000	70.8	.00500
.3125	12000	228.0	.0160	6000	114.0	.00940	4000	70.8	.00630
.3750	10000	228.0	.0190	5000	114.0	.01100	3300	70.8	.00750
.5000	7500	177.0	.0250	3800	90.5	.01500	2500	55.0	.01000
Depth of cut	 ≤Please refer to the list above for depth of cut. ≤1.5DC			 ≤Please refer to the list above for depth of cut. ≤1.0DC					

DC:Dia.

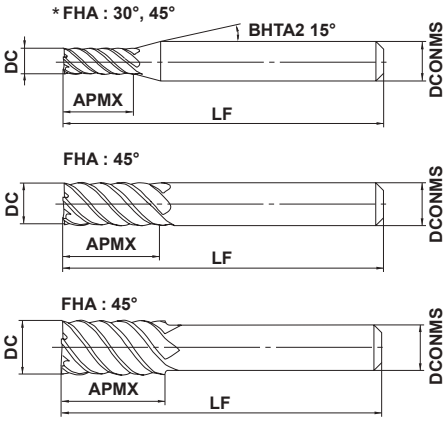
VFRMD NEW

End mill, Medium cut length, 4/6 flute, For hardened materials

DC<3 DC≥3

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 Alloys, Heat Resistant Alloys	Copper Alloys	Aluminum Alloys
	○	◎	◎				





DC≤12	DC>12			
0 - 0.020	0 - 0.030			
DCONMS=6	DCONMS=8, 10	DCONMS=12, 16	DCONMS=20, 25	
0 - 0.005	0 - 0.006	0 - 0.008	0 - 0.009	

●A sharp cutting edge and improved chipping resistance enable highly efficient machining.

(mm)

Order Number	DC	APMX	LF	DCONMS	Flutes	Stock	Type
VFRMDD0100	1	3.5	60	6	4	●	1
VFRMDD0150	1.5	5	60	6	4	●	1
VFRMDD0200	2	7	60	6	4	●	1
VFRMDD0250	2.5	8	60	6	4	●	1
VFRMDD0300	3	10	60	6	6	●	1
VFRMDD0400	4	12	60	6	6	●	1
VFRMDD0500	5	15	60	6	6	●	1
VFRMDD0600	6	15	60	6	6	●	2
VFRMDD0800	8	20	75	8	6	●	2
VFRMDD1000	10	25	80	10	6	●	2
VFRMDD1200	12	30	100	12	6	●	2
VFRMDD1400	14	35	105	12	6	●	3
VFRMDD1500	15	40	110	16	6	●	1
VFRMDD1600	16	40	110	16	6	●	2
VFRMDD1800	18	40	120	16	6	●	3
VFRMDD2000	20	45	125	20	6	●	2
VFRMDD2200	22	45	135	20	6	●	3
VFRMDD2500	25	60	160	25	6	●	2

* FHA : DC<3 mm=30°, DC≥3 mm=45°

DC = Cutting Dia. **LF** = Functional Length
APMX = Depth of Cut Max. **DCONMS** = Connection Dia.

● : USA Stock

Recommended Cutting Conditions

(in)

Material		Hardened steel (45－55HRC)			Hardened steel (55－62HRC)			Hardened steel (62－70HRC)		
Dia. **DC**		Revolution (min^{-1})	Feed rate (IPM)	Depth of cut **ae**	Revolution (min^{-1})	Feed rate (IPM)	Depth of cut **ae**	Revolution (min^{-1})	Feed rate (IPM)	Depth of cut **ae**
(mm)	(in)									
1	**.039**	40000	47.2	.0020	40000	31.5	.0012	32000	19.7	.0008
2	**.079**	40000	78.7	.0039	24000	39.4	.0020	16000	23.6	.0020
3	**.118**	32000	149.6	.0079	16000	74.8	.0039	11000	47.2	.0020
4	**.157**	24000	173.2	.0079	12000	86.6	.0039	8000	51.2	.0020
6	**.236**	16000	228.3	.0118	8000	114.2	.0079	5300	70.9	.0039
8	**.315**	12000	228.3	.0157	6000	114.2	.0079	4000	70.9	.0039
10	**.394**	9600	228.3	.0197	4800	114.2	.0118	3200	70.9	.0079
12	**.472**	8000	189.0	.0236	4000	94.5	.0118	2700	59.1	.0079
16	**.630**	6000	141.7	.0315	3000	70.9	.0197	2000	43.3	.0118
20	**.787**	4800	114.2	.0394	2400	55.1	.0197	1600	34.6	.0118
25	**.984**	3800	90.6	.0394	1900	43.3	.0197	1300	28.3	.0118
Depth of cut		≤Please refer to the list above for depth of cut. ≤1.5DC			≤Please refer to the list above for depth of cut. ≤1.0DC			DC:Dia.		

Slot milling with small diameter tools

(in)

Material		Hardened steel (45－55HRC)			Hardened steel (55－62HRC)		
Dia. **DC**		Revolution (min^{-1})	Feed rate (IPM)	Depth of cut **ap**	Revolution (min^{-1})	Feed rate (IPM)	Depth of cut **ap**
(mm)	(in)						
1	**.039**	15000	11.8	.0039	9500	4.3	.0020
2	**.079**	8000	12.6	.0079	4800	7.5	.0039
Depth of cut		DC ≤Please refer to the list above for depth of cut. DC:Dia.					

Note 1) If the depth of cut is shallow, the revolution and feed rate can be increased.

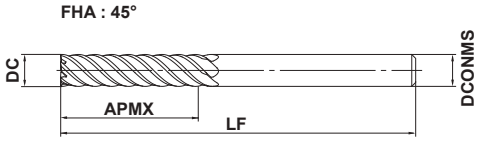
Note 2) If the machine or workpiece material is not rigid, vibration or abnormal noises may occur. In this case, please adjust the spindle speed, feed rate, and depth of cut according to the table above.

VFRLD NEW

End mill, Long cut length, 6 flute, For hardened materials

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 Alloys, Heat Resistant Alloys	Copper Alloys	Aluminum Alloys
	○	◎	◎				





Type1

DC≤12	DC>12			
0 - 0.020	0 - 0.030			
DCONMS=6	DCONMS=8, 10	DCONMS=12, 16	DCONMS=20, 25	
0 - 0.005	0 - 0.006	0 - 0.008	0 - 0.009	

h5

●A sharp cutting edge and improved chipping resistance enable highly efficient machining.

(mm)

Order Number	DC	APMX	LF	DCONMS	Flutes	Stock	Type
VFRLDD0600	6	26	70	6	6	●	1
VFRLDD0800	8	36	90	8	6	●	1
VFRLDD1000	10	46	100	10	6	●	1
VFRLDD1200	12	56	110	12	6	●	1
VFRLDD1600	16	66	130	16	6	●	1
VFRLDD2000	20	76	140	20	6	●	1
VFRLDD2500	25	92	180	25	6	●	1

Recommended Cutting Conditions

(in)

Material		Hardened steel (45－55HRC)			Hardened steel (55－62HRC)			Hardened steel (62－70HRC)		
Dia. **DC**		Revolution (min^{-1})	Feed rate (IPM)	Depth of cut **ae**	Revolution (min^{-1})	Feed rate (IPM)	Depth of cut **ae**	Revolution (min^{-1})	Feed rate (IPM)	Depth of cut **ae**
(mm)	(in)									
6	**.236**	2200	18.1	.0024	1900	13.4	.0012	1500	10.2	.0012
8	**.315**	1700	16.9	.0031	1400	12.6	.0016	1100	9.4	.0016
10	**.394**	1300	15.7	.0039	1100	12.2	.0020	890	8.3	.0020
12	**.472**	1100	14.2	.0047	930	11.0	.0024	740	7.9	.0024
16	**.630**	840	12.2	.0063	700	8.7	.0031	560	6.7	.0031
20	**.787**	670	10.2	.0079	560	7.5	.0039	450	5.9	.0039
25	**.984**	530	9.1	.0098	450	6.7	.0051	360	4.7	.0051
Depth of cut		≤Please refer to the list above for depth of cut. 3DC–4DC			≤Please refer to the list above for depth of cut. 3DC–4DC					

DC:Dia.

Note 1) If the depth of cut is shallow, the revolution and feed rate can be increased.

Note 2) If the machine or workpiece material is not rigid, vibration or abnormal noises may occur. In this case, please adjust the spindle speed, feed rate, and depth of cut according to the table above.

● : USA Stock

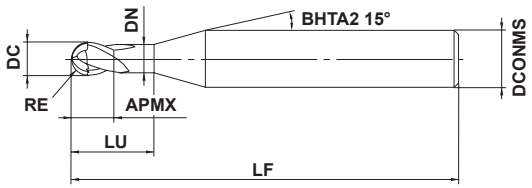
VFR2SSB

Ball nose, Short cut length, Short shank, 2 flute , For hardened materials

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 Alloys, Heat Resistant Alloys	Copper Alloys	Aluminum Alloys
	○	◎	◎				

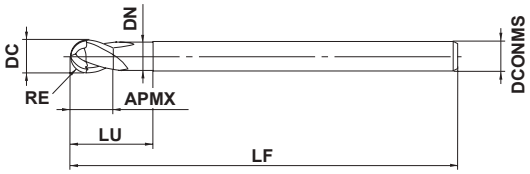


FHA : 20°



Type1

FHA : 20°



Type2

RE				
±0.005				
DCONMS=4, 6	DCONMS=8, 10	DCONMS=12		
0 - 0.005	0 - 0.006	0 - 0.008		

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

(mm)

Order Number	RE	DC	APMX	LU	DN	LF	DCONMS	Flutes	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

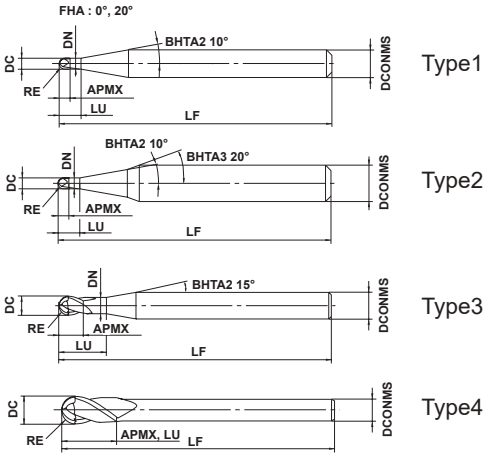
RE = Corner Radius
DC = Cutting Dia.
APMX = Depth of Cut Max.
LU = Usable Length
DN = Neck Dia.
LF = Functional Length
DCONMS = Connection Dia.

VFR2SB

Ball nose, Short cut length, 2 flute , For hardened materials

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 Alloys, Heat Resistant Alloys	Copper Alloys	Aluminum Alloys
	○	◎	◎				





RE≤6	RE>6			
±0.005	±0.010			
DCONMS=3	DCONMS=4, 6	DCONMS=8, 10	DCONMS=12, 16	DCONMS=20
0 - 0.004	0 - 0.005	0 - 0.006	0 - 0.008	0 - 0.009

h5

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

(mm)

Order Number	RE	DC	APMX	LU	DN	LF	DCONMS	Flutes	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

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

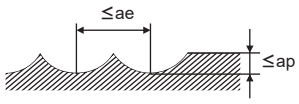
● : USA Stock

Ball nose, Short cut length, Short shank, 2 flute, For hardened materials **VFR2SSB**

Ball nose, Short cut length, 2 flute, For hardened materials **VFR2SB**

Recommended Cutting Conditions

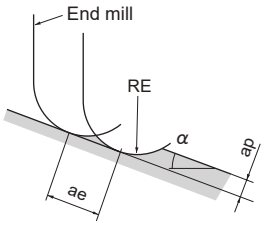
(in)

Material		Hardened Steel (45－55HRC)						Hardened Steel (55－62HRC)						Hardened Steel (62－70HRC)					
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)	(in)	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)		
0.1	**.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 workpiece materials installation is very low, or chattering and noise are generated, please adjust the revolution, feed rate and depth of cut.

Note 2) If the rigidity of the machine or the workpiece materials installation is very low, or chattering and noise are generated, reduce the revolution and feed rate proportionately.

Note 3) α is the inclination angle of the machined surface.



ae:Pick Feed

VFR2SBF

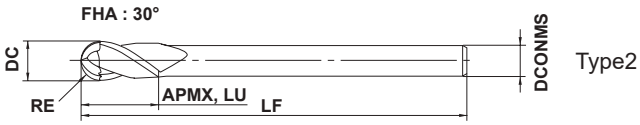
Ball nose, Short cut length, 2 flute, For mirror finishing

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 Alloys, Heat Resistant Alloys	Copper Alloys	Aluminum Alloys
	○	◎	◎				





Type1



Type2

RE				
±0.010				
DCONMS				
0 - 0.005				

●Ball nose geometry for mirror finishing.

(mm)

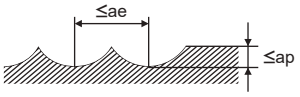
Order Number	RE	DC	APMX	LU	DN	LF	DCONMS	Flutes	Stock	Type
VFR2SBFR0050	0.5	1	1	2	0.94	45	4	2	●	1
VFR2SBFR0075	0.75	1.5	1.5	3	1.44	45	4	2	●	1
VFR2SBFR0100	1	2	2	4	1.9	60	6	2	●	1
VFR2SBFR0125	1.25	2.5	2.5	5	2.4	60	6	2	●	1
VFR2SBFR0150	1.5	3	3	6	2.9	70	6	2	●	1
VFR2SBFR0200	2	4	4	8	3.9	70	6	2	●	1
VFR2SBFR0250	2.5	5	5	10	4.9	80	6	2	●	1
VFR2SBFR0300	3	6	12	—	—	80	6	2	●	2

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

● : **USA Stock**

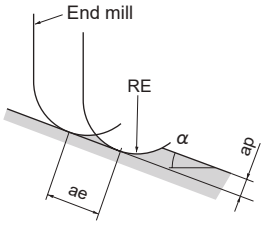
Recommended Cutting Conditions

(in)

Material		Carbon Steel, Alloy Steel (180—280HB) Alloy Steel (≤350HB), Pre-hardened Steel (35— 45HRC) Hardened Steel (45— 62HRC)						Hardened Steel (62—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
(mm)	(in)	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 when finishing.
Note 2) Air blowing or oil mist are 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 due to elongation of the main axis during machining etc.
- 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.



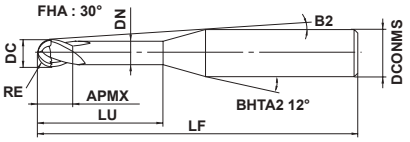
ae:Pick Feed

VFR2XLB

Ball nose, Long neck, 2 flute, For hardened materials

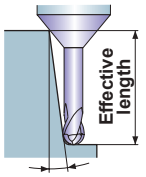
Carbon Steel, Alloy Steel, Cast Iron (<30HRC)	Tool Steel, Pre-Hardened Steel,Hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Hardened Steel (>55HRC)	Austenitic Stainless Steel	Titanium Alloys, Heat Resistant Alloys	Copper Alloys	Aluminum Alloys
	○	◎	◎				

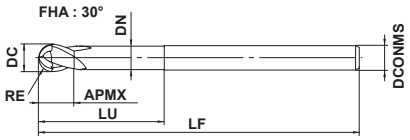




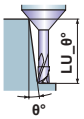
Type1

Effective length for inclined angle





Type2



RE				
±0.005				
DCONMS				
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	DCONMS	Flutes	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

● : USA Stock ★ : Stocked in Japan

(mm)

Order Number	RE	DC	APMX	LU	DN	B2	LF	DCONMS	Flutes	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	*	*	*	*

* No interference

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

VFR2XLB

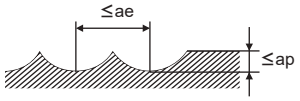
Ball nose, Long neck, 2 flute, For hardened materials

Recommended Cutting Conditions

(in)

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)	(in)	(mm)	(in)								
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.

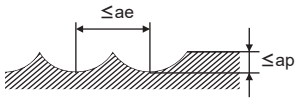
Note 2) If the depth of cut is shallow, the revolution and feed rate can be increased.

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.

(in)

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)	(in)	(mm)	(in)								
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



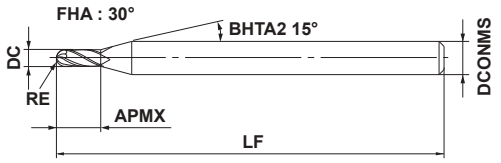
Note 1) When the inclination angle of machined surface is large, or machining with large cutting load such as in a corner area, reduce the revolution and feed rate.
Note 2) If the depth of cut is shallow, the revolution and feed rate can be increased.
Note 3) Cutting conditions may differ considerably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

VFR4MB

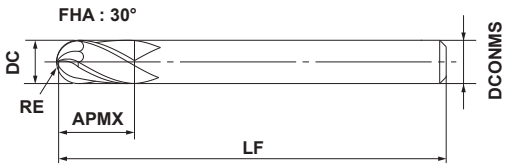
Ball nose, Medium cut length, 4 flute, For hardened materials

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 Alloys, Heat Resistant Alloys	Copper Alloys	Aluminum Alloys
	○	◎	◎				





Type1



Type2

RE				
±0.010				
DCONMS=6	DCONMS=8, 10	DCONMS=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	DCONMS	Flutes	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

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

● : USA Stock ★ : Stocked in Japan

VFR4MB

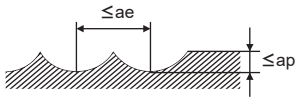
Ball nose, Medium cut length, 4 flute, For hardened materials

Recommended Cutting Conditions

(in)

Material		Hardened Steel (45－55HRC)						Hardened Steel (55－65HRC)						Hardened Steel (65－70HRC)					
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)	(in)	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
0.5	**.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

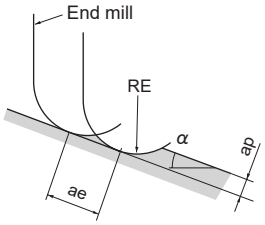
Depth of cut



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

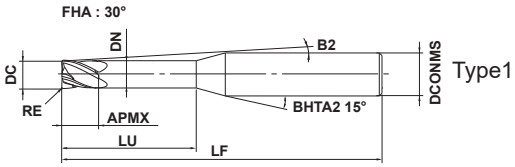
VFRPSRB

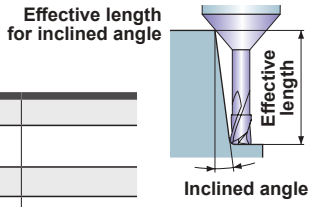
Corner radius, Short cut length, 4 flute, For hardened materials

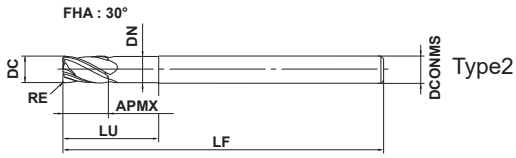
UWC VFR DC≤1.0 DC≥1.5

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 Alloys, Heat Resistant Alloys	Copper Alloys	Aluminum Alloys
	○	◎	◎				









0.5≤DC≤6	6<DC≤12			
±0.005	±0.007			
0.5≤DC≤6	6<DC≤12			
0 - 0.01	0 - 0.015			
DCONMS=6	DCONMS=8, 10	DCONMS=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	DCONMS	Flutes	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

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

● : USA Stock ★ : Stocked in Japan

(mm)

Order Number	DC	RE	APMX	LU	DN	B2	LF	DCONMS	Flutes	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	*

* No interference

VFRPSRB

Corner radius, Short cut length, 4 flute, For hardened materials

(mm)

Order Number	DC	RE	APMX	LU	DN	B2	LF	DCONMS	Flutes	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	*	*	*	*

* No interference

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

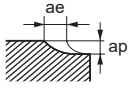
● : USA Stock ★ : Stocked in Japan

Recommended Cutting Conditions

(in)

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)	(in)	(mm)	(in)	(mm)	(in)												
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 materials installation is very low, or chattering and noise are generated, please adjust the revolution, feed rate and depth of cut.

VFRPSRB

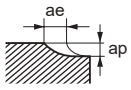
Corner radius, Short cut length, 4 flute, For hardened materials

Recommended Cutting Conditions

(in)

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)	(in)	(mm)	(in)	(mm)	(in)												
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

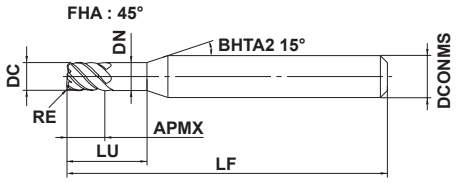


VFRSDRB NEW

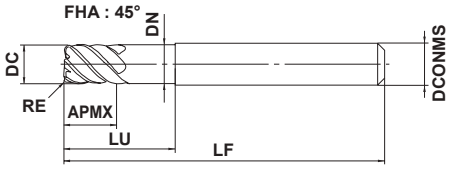
Conner radius, Short cut length, 6 flute, For hardened materials

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 Alloys, Heat Resistant Alloys	Copper Alloys	Aluminum Alloys
	○	◎	◎				





Type1



Type2

DC				
0 - 0.020				
DCONMS=6	DCONMS=8, 10	DCONMS=12		
0 - 0.005	0 - 0.006	0 - 0.008		

●A sharp cutting edge and improved chipping resistance enable highly efficient machining.

(mm)

Order Number	DC	RE	APMX	LU	DN	LF	DCONMS	Flutes	Stock	Type
VFRSDRBD0300R030	3	0.3	3	9	2.9	45	6	6	●	1
VFRSDRBD0400R030	4	0.3	4	12	3.9	45	6	6	●	1
VFRSDRBD0500R030	5	0.3	5	15	4.9	50	6	6	●	1
VFRSDRBD0600R030	6	0.3	6	18	5.85	50	6	6	●	2
VFRSDRBD0600R050	6	0.5	6	18	5.85	50	6	6	●	2
VFRSDRBD0600R100	6	1	6	18	5.85	50	6	6	●	2
VFRSDRBD0800R030	8	0.3	8	24	7.85	60	8	6	●	2
VFRSDRBD0800R050	8	0.5	8	24	7.85	60	8	6	●	2
VFRSDRBD0800R100	8	1	8	24	7.85	60	8	6	●	2
VFRSDRBD1000R050	10	0.5	10	30	9.7	70	10	6	●	2
VFRSDRBD1000R100	10	1	10	30	9.7	70	10	6	●	2
VFRSDRBD1200R050	12	0.5	12	36	11.7	75	12	6	●	2
VFRSDRBD1200R100	12	1	12	36	11.7	75	12	6	●	2

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

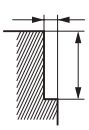
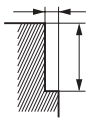
● : USA Stock

VFRSDRB

Conner radius, Short cut length, 6 flute, For hardened materials

Recommended Cutting Conditions

(in)

Material		Hardened steel (45－55HRC)			Hardened steel (55－62HRC)			Hardened steel (62－70HRC)		
Dia. **DC**		Revolution (min^{-1})	Feed rate (IPM)	Depth of cut ae	Revolution (min^{-1})	Feed rate (IPM)	Depth of cut ae	Revolution (min^{-1})	Feed rate (IPM)	Depth of cut ae
(mm)	(in)									
3	**.118**	32000	149.6	.0079	16000	74.8	.0039	11000	47.2	.0020
4	**.157**	24000	173.2	.0079	12000	86.6	.0039	8000	51.2	.0020
6	**.236**	16000	228.3	.0118	8000	114.2	.0079	5300	70.9	.0039
8	**.315**	12000	228.3	.0157	6000	114.2	.0079	4000	70.9	.0039
10	**.394**	9600	228.3	.0197	4800	114.2	.0118	3200	70.9	.0079
12	**.472**	8000	189.0	.0236	4000	94.5	.0118	2700	59.1	.0079
Depth of cut		 Please refer to the list above for depth of cut. ≤1.5DC			 Please refer to the list above for depth of cut. ≤1.0DC					

DC:Dia.

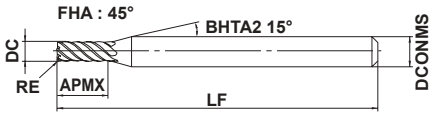
Note 1) If the depth of cut is shallow, the revolution and feed rate can be increased.
Note 2) If the machine or workpiece material is not rigid, vibration or abnormal noises may occur. In this case, please adjust the spindle speed, feed rate, and depth of cut according to the table above.

VFRMDRB NEW

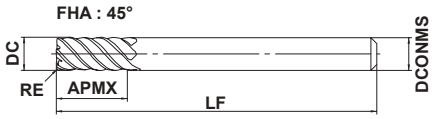
Corner radius, Medium cut length, 6 flute, For hardened materials

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 Alloys, Heat Resistant Alloys	Copper Alloys	Aluminum Alloys
	○	◎	◎				

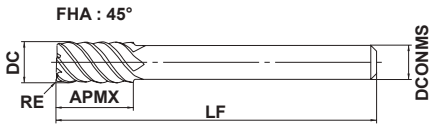




Type1



Type2



Type3

DC≤12	DC>12			
0 - 0.020	0 - 0.030			
DCONMS=6	DCONMS=8, 10	DCONMS=12, 16	DCONMS=20	
0 - 0.005	0 - 0.006	0 - 0.008	0 - 0.009	

h5

●A sharp cutting edge and improved chipping resistance enable highly efficient machining.

(mm)

Order Number	DC	RE	APMX	LF	DCONMS	Flutes	Stock	Type
VFRMDRBD0300R030	3	0.3	10	60	6	6	●	1
VFRMDRBD0400R030	4	0.3	12	60	6	6	●	1
VFRMDRBD0500R030	5	0.3	15	60	6	6	●	1
VFRMDRBD0600R030	6	0.3	15	60	6	6	●	2
VFRMDRBD0600R050	6	0.5	15	60	6	6	●	2
VFRMDRBD0600R100	6	1	15	60	6	6	●	2
VFRMDRBD0800R030	8	0.3	20	75	8	6	●	2
VFRMDRBD0800R050	8	0.5	20	75	8	6	●	2
VFRMDRBD0800R100	8	1	20	75	8	6	●	2
VFRMDRBD1000R030	10	0.3	25	80	10	6	●	2
VFRMDRBD1000R050	10	0.5	25	80	10	6	●	2
VFRMDRBD1000R100	10	1	25	80	10	6	●	2
VFRMDRBD1200R050	12	0.5	30	100	12	6	●	2
VFRMDRBD1200R100	12	1	30	100	12	6	●	2
VFRMDRBD1600R100	16	1	40	110	16	6	●	2
VFRMDRBD1600R150	16	1.5	40	110	16	6	●	2
VFRMDRBD1800R100	18	1	40	120	16	6	●	3
VFRMDRBD1800R150	18	1.5	40	120	16	6	●	3
VFRMDRBD2000R100	20	1	45	125	20	6	●	2
VFRMDRBD2000R150	20	1.5	45	125	20	6	●	2
VFRMDRBD2000R200	20	2	45	125	20	6	●	2

RE = Corner Radius
DC = Cutting Dia.
APMX = Depth of Cut Max.
LF = Functional Length
DCONMS = Connection Dia.

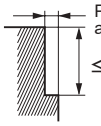
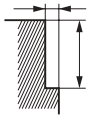
● : USA Stock

VFRMDRB

Corner radius, Medium cut length, 6 flute, For hardened materials

Recommended Cutting Conditions

(in)

Material		Hardened steel (45－55HRC)			Hardened steel (55－62HRC)			Hardened steel (62－70HRC)		
Dia. **DC**		Revolution (min^{-1})	Feed rate (IPM)	Depth of cut ae	Revolution (min^{-1})	Feed rate (IPM)	Depth of cut ae	Revolution (min^{-1})	Feed rate (IPM)	Depth of cut ae
(mm)	(in)									
3	**.118**	32000	149.6	.0079	16000	74.8	.0039	11000	47.2	.0020
4	**.157**	24000	173.2	.0079	12000	86.6	.0039	8000	51.2	.0020
6	**.236**	16000	228.3	.0118	8000	114.2	.0079	5300	70.9	.0039
8	**.315**	12000	228.3	.0157	6000	114.2	.0079	4000	70.9	.0039
10	**.394**	9600	228.3	.0197	4800	114.2	.0118	3200	70.9	.0079
12	**.472**	8000	189.0	.0236	4000	94.5	.0118	2700	59.1	.0079
16	**.630**	6000	141.7	.0315	3000	70.9	.0197	2000	43.3	.0118
20	**.787**	4800	114.2	.0394	2400	55.1	.0197	1600	34.6	.0118
Depth of cut		 Please refer to the list above for depth of cut. ≤1.5DC			 Please refer to the list above for depth of cut. ≤1.0DC					

DC:Dia.

Note 1) If the depth of cut is shallow, the revolution and feed rate can be increased.

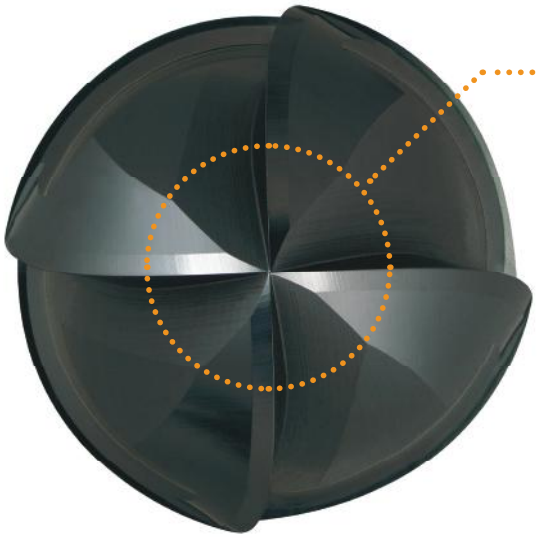
Note 2) If the machine or workpiece material is not rigid, vibration or abnormal noises may occur. In this case, please adjust the spindle speed, feed rate, and depth of cut according to the table above.

Ball nose, Medium cut length, 4-Flute

VFR4MB

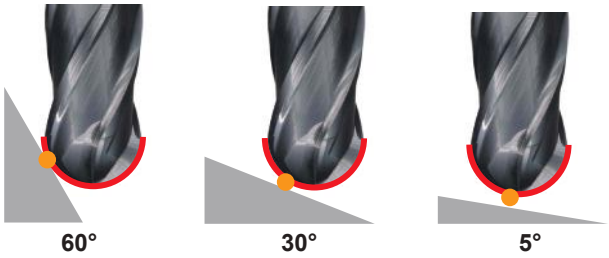
Higher efficiencies from increased feed rates when finish machining.

Shorter machining times while maintaining good surface finishes.



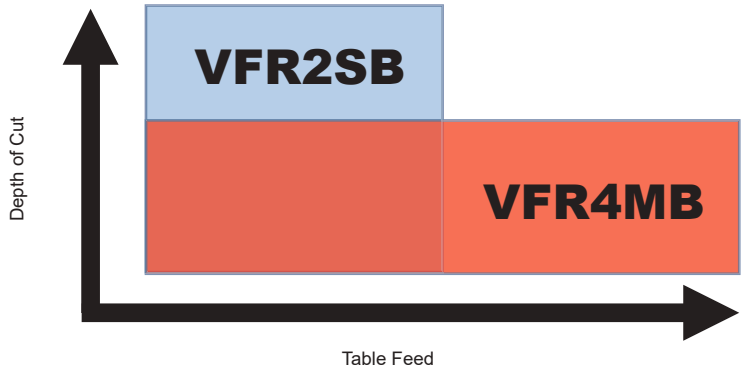
Versatile 4-flute design

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.

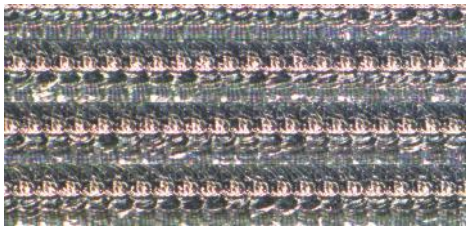


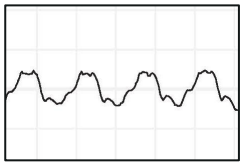
Cutting Performance

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.

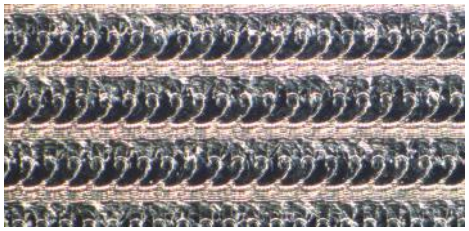
VFR4MB

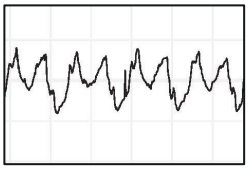




Ra:11 µin
Rz:40 µin

2-Flute conventional product





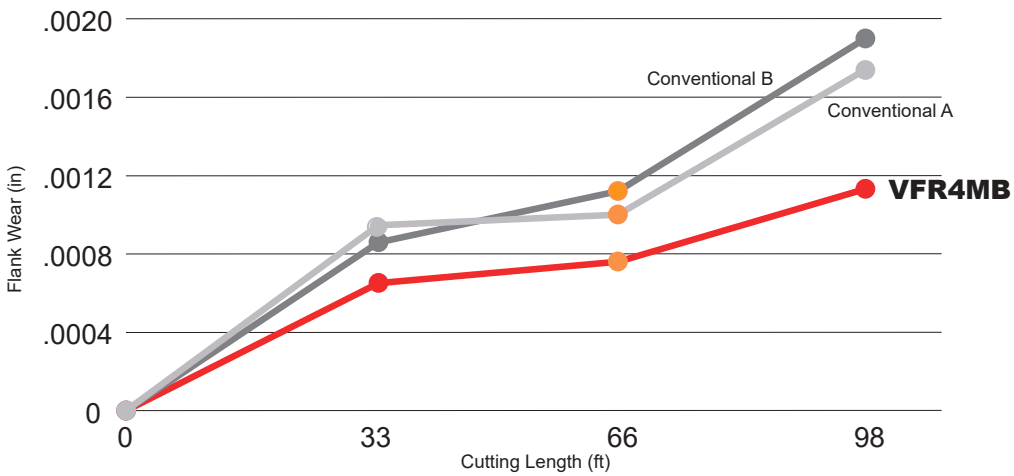
Ra:13 µin
Rz:64 µin

<Cutting Conditions>

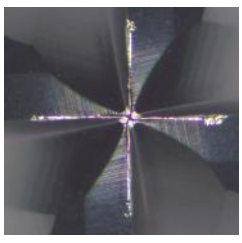
Material	: ASP23(62HRC)
Tool	: VFR4MBR0400 DC=.315"
Revolution	: n=12000 min^{-1}
Table Feed	: vf=141.7 IPM
Depth of Cut	: ap=.008"
	ae=.031"
Overhang Length	: .787"
Cutting Mode	: Air blow
	Down Cut

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

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



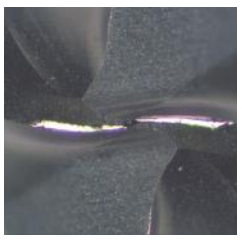
Taken after a cutting length of 66'



VFR4MB



Conventional A



Conventional B

<Cutting Conditions>

Material	: HAP72(69HRC)
Tool	: VFR4MBR0100 DC=2mm
Revolution	: n=16000 min^{-1}
Table Feed	: f=47.2 IPM
Depth of Cut	: ap=.0024"
	ae=.002"
Overhang Length	: .669"
Cutting Mode	: Air blow
	Down Cut
Machine	: Vertical MC

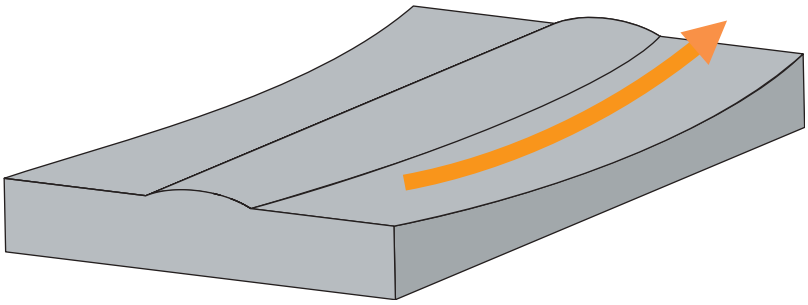
Ball nose, Medium cut length, 4-Flute

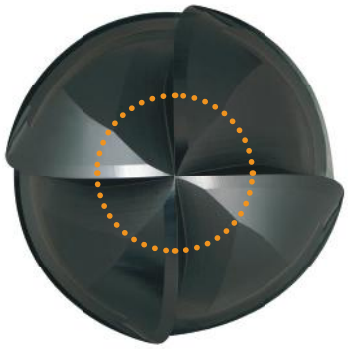
VFR4MB

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

Issues from Customer

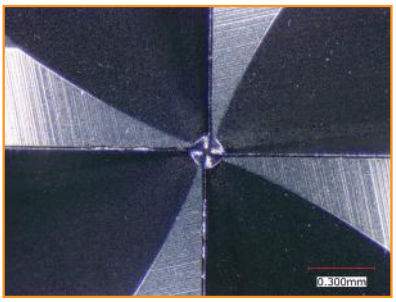
①Issue with machining efficiency due to the curvature of the workpiece material so a corner radius end mill cannot be used.
②A 4-flute type was used to machine, but at the tip, the chip discharge was poor and resulted in a torn surface finish. The tool was changed to a 2-flute type.
③The 2-flute type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





<Cutting Conditions>
Material : AISI D2(60HRC)
Revolution : n=6000 min^{-1}
Table Feed : vf=110.2 IPM
Depth of Cut : ap=.001"
ae=Setting surface roughness 6.3z
Cutting Mode : Dry Cutting
Machine : Vertical MC(BBT50)
Cutting Time : 120 min

Results after machining for 120 min



VFR4MB **End Cutting Edge Condition**
Flank Wear: 669 µin

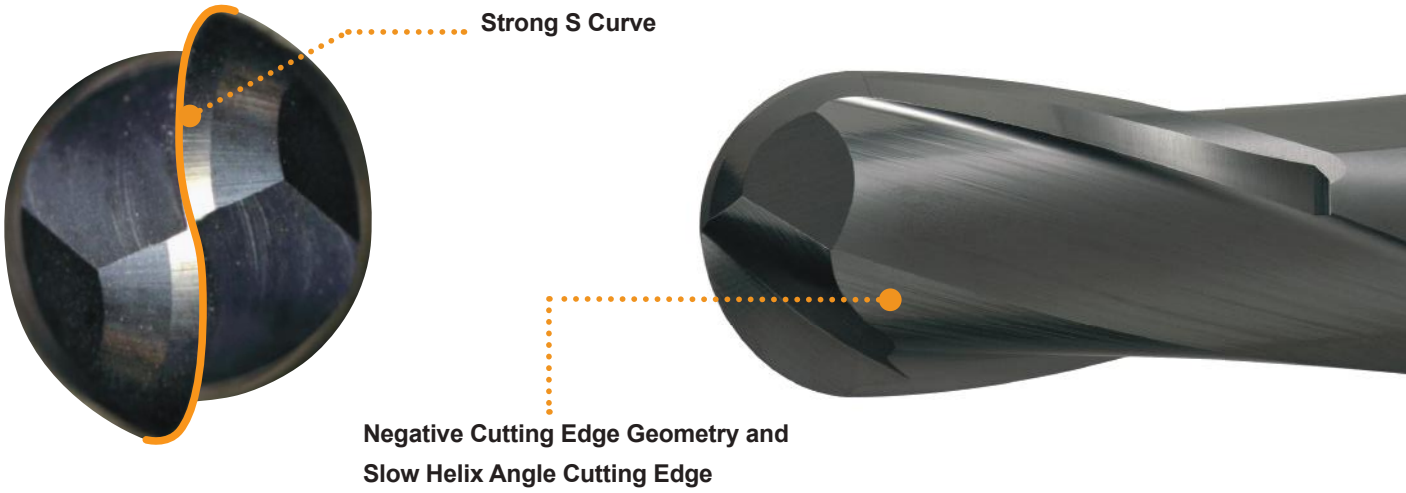
Comments from Customer Evaluation

· 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.

Revolutionary Machining of Hardened Steel

VFR2SSB/VFR2SB

Ball Nose End Mill, 2 flute



Cutting Edge: Optimization of the flute geometry, helix and rake angles have improved the edge strength in all areas.
Carbide Substrate: High grade carbide ideal for machining hardened materials.

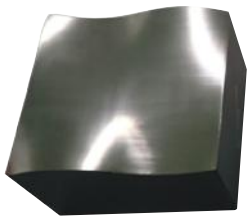
VFR2SBF

Ball Nose End Mill, 2 flute, For mirror finishing

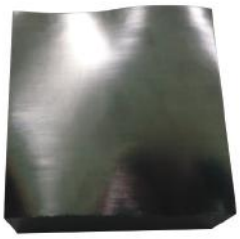


Application Example

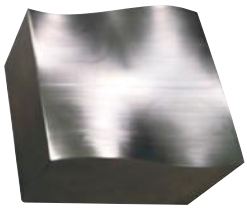
VFR2SB



ASP23 (62 HRC)



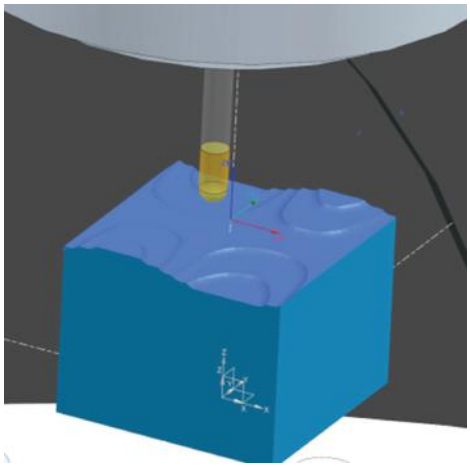
AISI M2 (64 HRC)



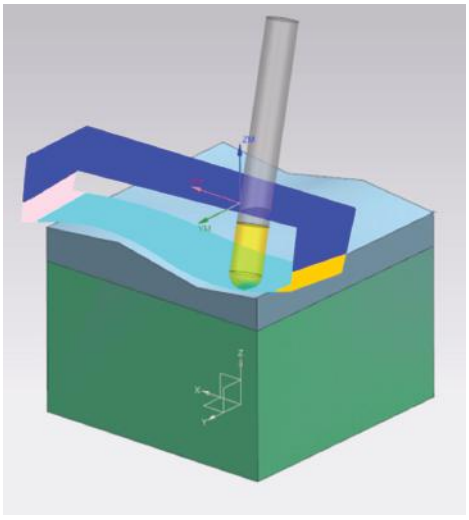
HAP72 (68 HRC)

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

Rough Machining Path



Medium and Finish Machining Path (Tilt Angle 30°)



Cutting Time: 234 min
Tools Used: 4

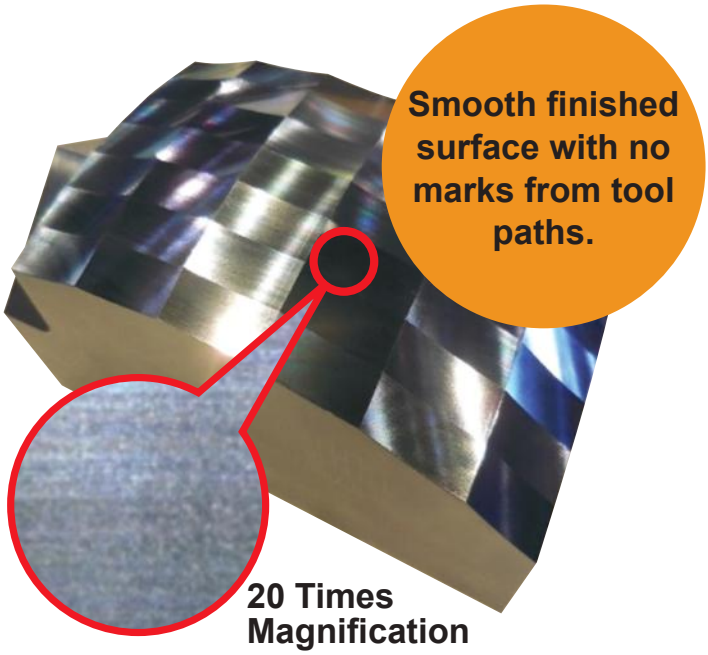
(in)

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

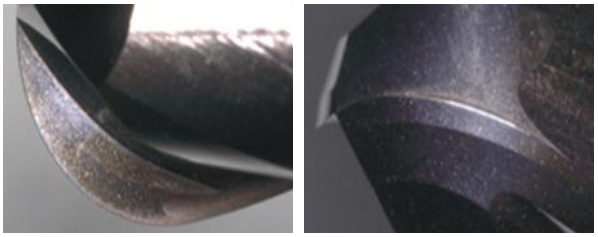
Application Example

VFR2SBF

Material : Pre-hardened Steel

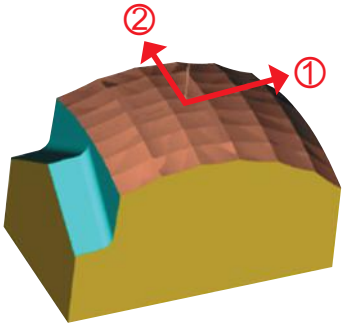


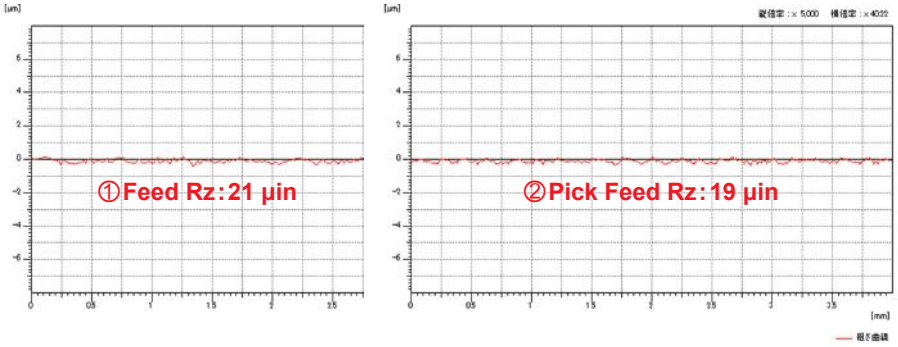
By using 5-axis machining, cutting at the tip of the ball nose can be avoided.



Excellent tool conditions after 31 hours of finish machining.

A surface roughness of Rz: 31 µin or lower can be achieved.





Cutting Conditions Holder: HSK-A63

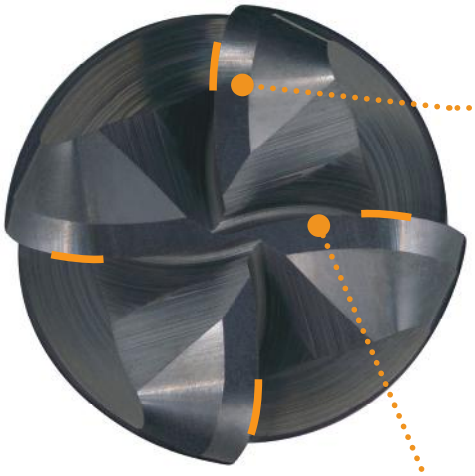
(in)

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	MP2SBR0300	Air Blow	13000	805	102.4	.0039	Along the Surface p0.1		.001	0:46
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

A seamless edge geometry that is resistant to chipping, together with a wiper edge and strong back taper enables high precision machining.



Equipped with a wiper edge of DC≥.059"

Improves the surface finish of the bottom machined face.



Optimal Seamless Shape of DC≥.059"

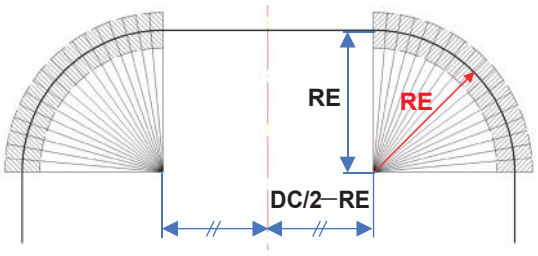
Suppresses chipping.

Strong Back Taper of .059"≤DC≤.197"

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.



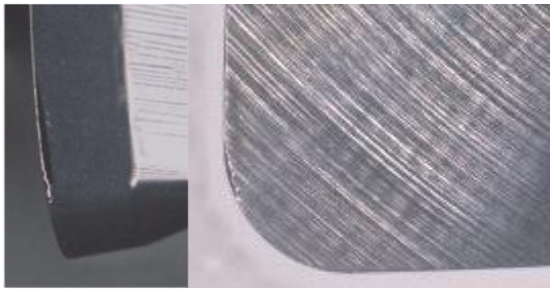
DC: Cutting Dia.
RE: Corner Radius

VFRPSRB	.020"≤DC≤.236"	: ±.0002"	Conventional Precision Radius	±.0004"
	.315"≤DC≤.472"	: ±.0003"		

Completely Seamless Curved R Edge, DC≥.059"

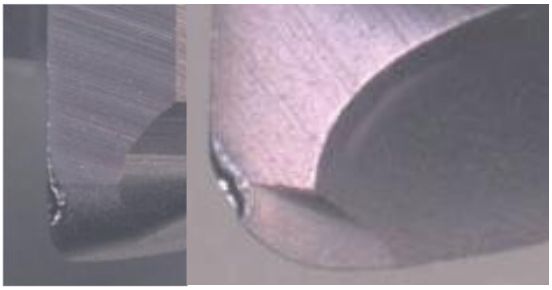
A stable machined surface is achieved by a seamless blend between the radius and flank geometry.

VFRPSRB



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

Conventional

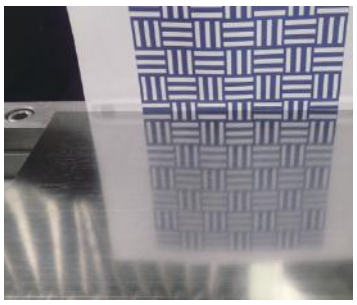


Chipping occurs because the stress is concentrated on the joint between the flank and corner edge geometry.

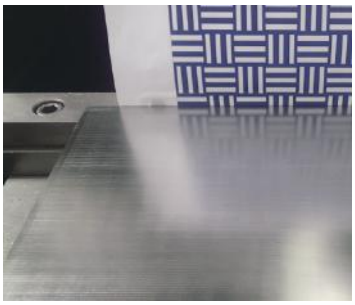
Equipped with a Wiper Edge, DC≥.059"

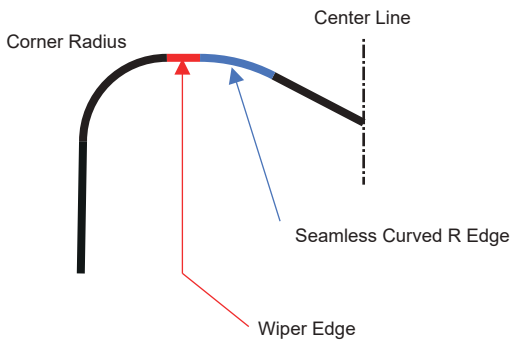
A smooth surface finish is possible by utilising a wiper edge.

VFRPSRB



Conventional

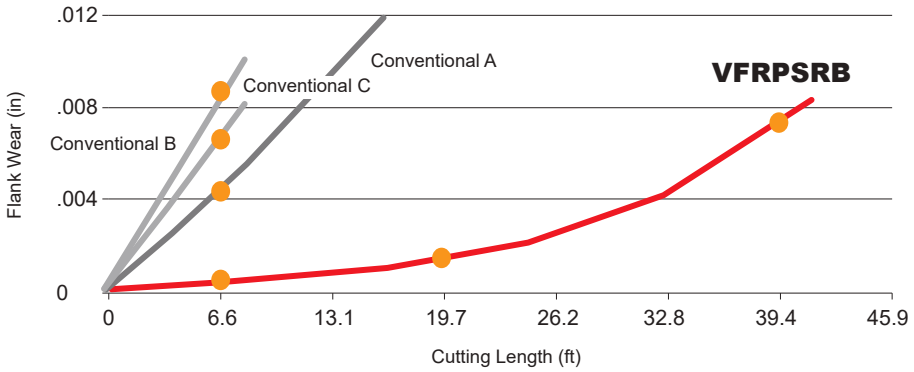




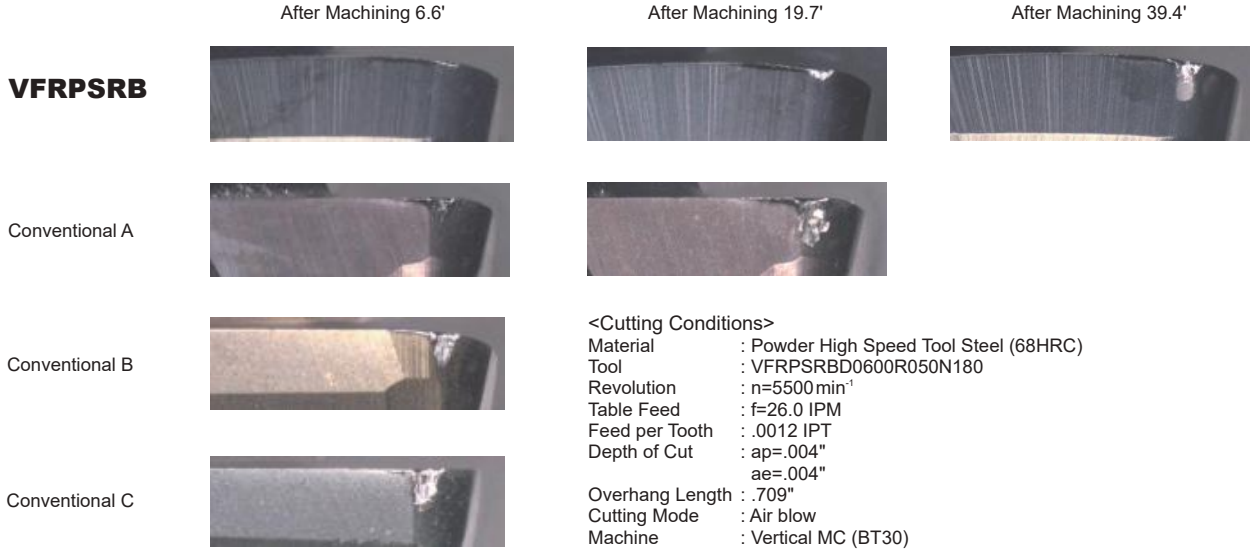
Cutting Performance

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

Excellent wear resistance when machining high-hardness steel.







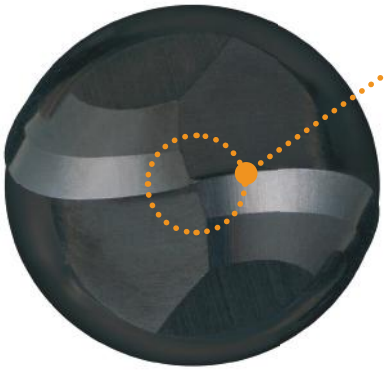
<Cutting Conditions>

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

Ball Nose End Mill, Long Neck, 2 Flute

VFR2XLB

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



Ball Nose Optimization

Ideal center flute geometry for finish machining.



Rake Angle Optimization

Optimum geometry provides a sharp edge together with fracture resistance that enables excellent surface finishes.

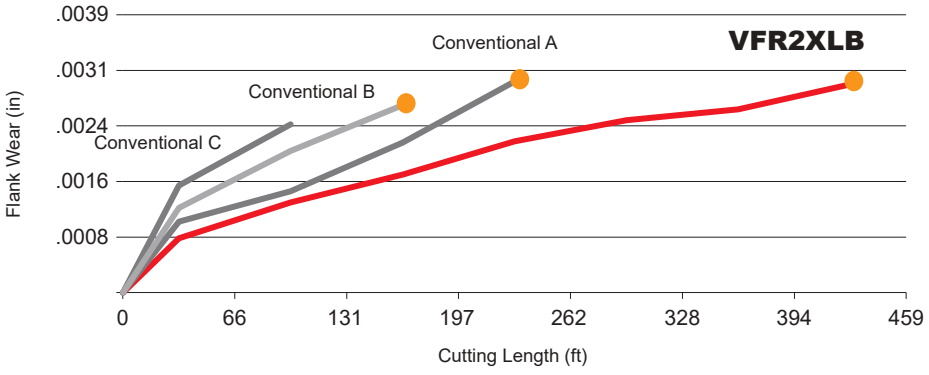
Strong Back Taper

Reduces chatter and vibration when machining vertical walls.

Cutting Performance

Wear Resistance Comparison - Machining ASP23 (62HRC)

Greatly improved wear resistance for high precision machining.



<Cutting Conditions>

Material	: ASP23 (62HRC)
Tool	: VFR2XLBR0100N120
Revolution	: n=16000min^{-1}
Table Feed	: vf=63.0 IPM
Feed per Tooth	: .002 IPT
Depth of Cut	: ap=.002"x10 ae=.004"x10
Overhang Length	: .709"
Cutting Mode	: Air blow
Machine	: Vertical MC (HSK-E32)



VFR2XLB



Conventional A

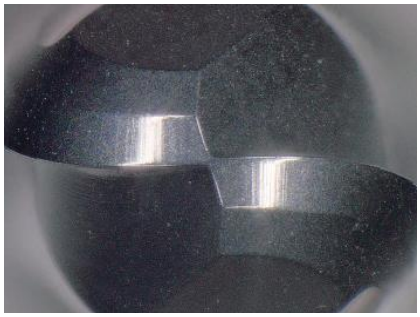


Conventional B

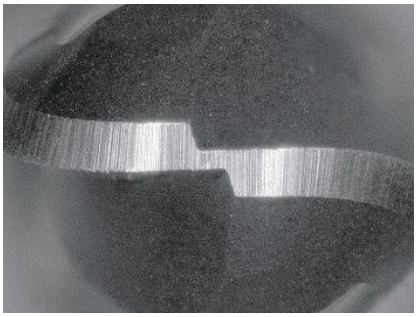
Cutting Edge Geometry for Finishing

Sharp but strong cutting edge enables good surface finishes.

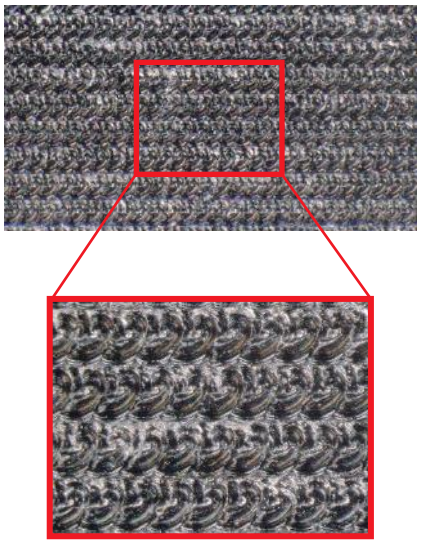
VFR2XLB



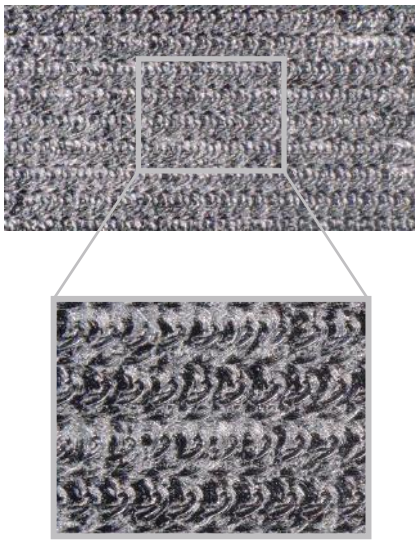
Conventional



Comparison of Surface Finishes

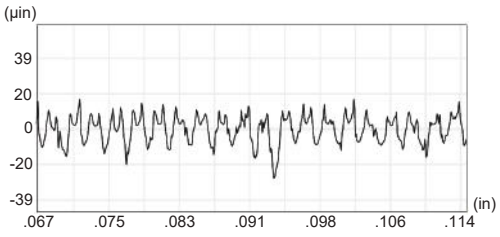


Sharp edges leave a uniform finish.

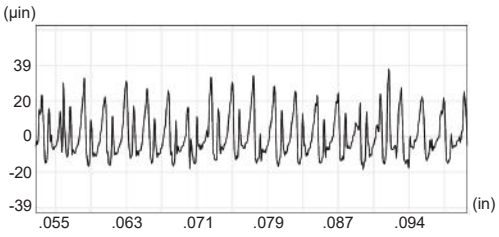


A dull edge leaves an undefined finish.

Comparison of Surface Roughness (Feed Side)



Ra=7 µin, Rz= 44 µin



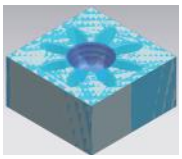
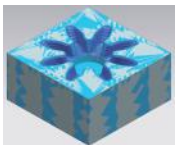
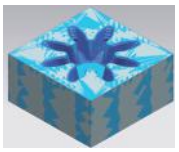
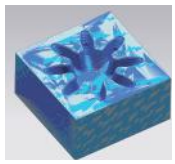
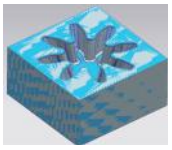
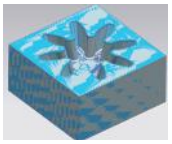
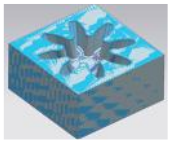
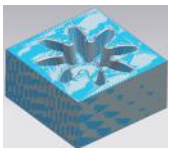
Ra=9 µin, Rz=79 µin

Application Example

Machining of a Bevel Gear Mold

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

(in)

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



Application Example

Comparison of Surface Finishes - Machining of Dies Used for Plastic Molding

Ideal surface finishes of dies can be achieved.

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

(in)

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



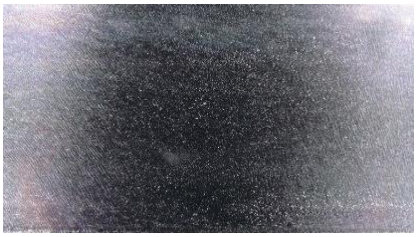
Conventional

Comparison of Surface Finishes - Machining AISI D2

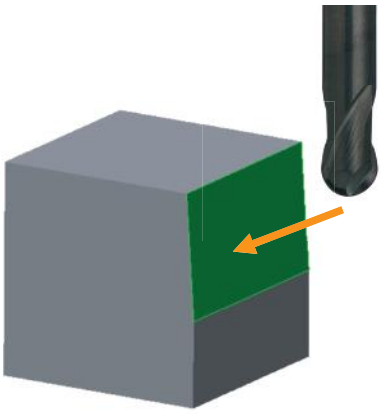
Excellent surface finishes compared to those machined by conventional tools.



VFR2XLB



Conventional: Cloudy surface finish

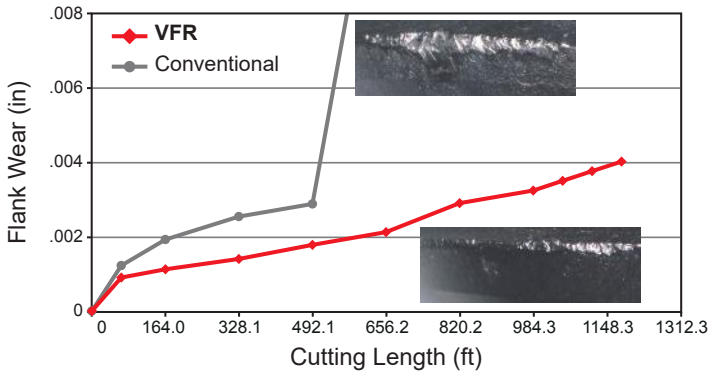


Cutting Form: 1° Taper Cutting

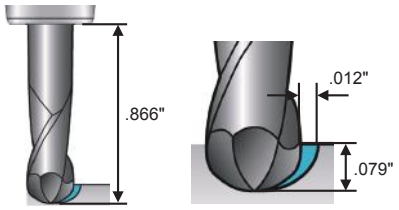
<Cutting Conditions>
Material : AISI D2 (60HRC)
Tool : VFR2XLBR0100N100
Revolution : n=19000 min^{-1}
Table Feed : vf=26.8 IPM
Depth of Cut : ap=.0008"
ae=.0008"
Overhang Length : .630"
Cutting Mode : Air blow
Machine : Vertical MC (HSK-E32)

Cutting Performance

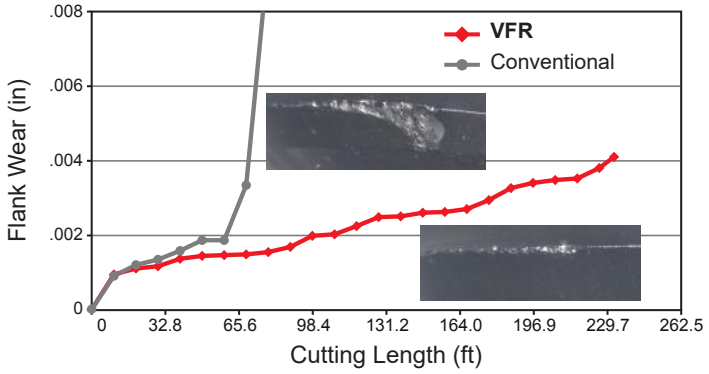
AISI H13 (52HRC)



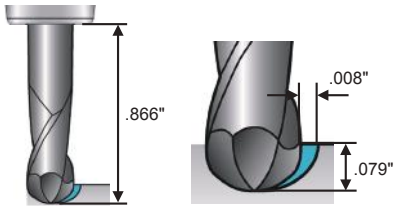
<Cutting Conditions>
Material : AISI H13 (52HRC)
Tool : VFR2SBR0300
Revolution : n=17000 min^{-1}
Table Feed : vf=66.9 IPM
Feed per Tooth : fz=.002 IPT
Depth of Cut : ap=.079", ae=.012"
Overhang Length : .866"
Cutting Mode : Air blow
Machine : Vertical MC (HSK-A63)



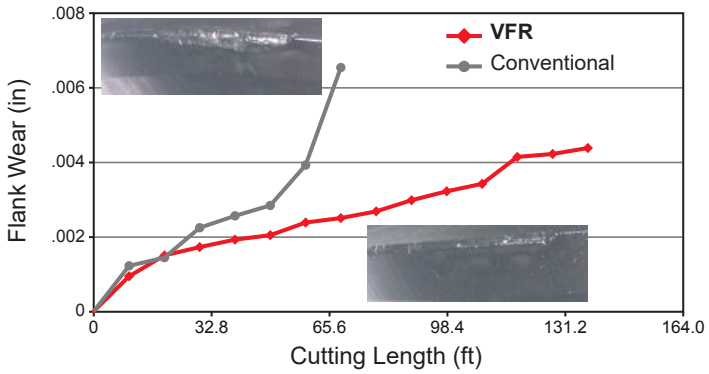
AISI D2 (60HRC)



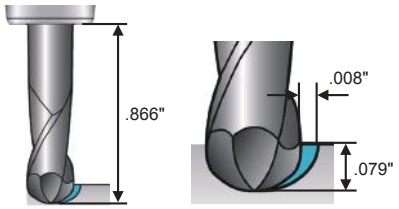
<Cutting Conditions>
Material : AISI D2 (60HRC)
Tool : VFR2SBR0300
Revolution : n=5400 min^{-1}
Table Feed : vf=21.3 IPM
Feed per Tooth : fz=.002 IPT
Depth of Cut : ap=.079", ae=.008"
Overhang Length : .866"
Cutting Mode : Air Blow
Machine : Vertical MC (HSK-A63)



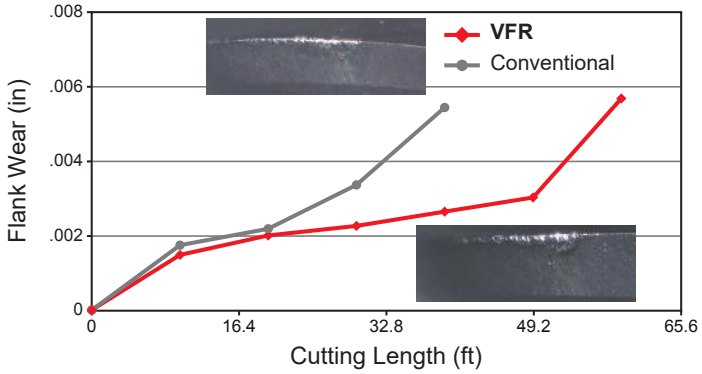
ASP23 (62HRC)



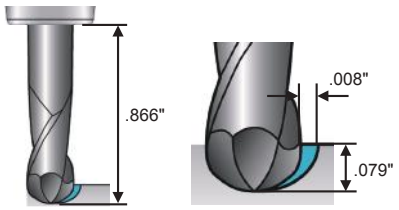
<Cutting Conditions>
Material : ASP23 (62HRC)
Tool : VFR2SBR0300
Revolution : n=5400 min^{-1}
Table Feed : vf=21.3 IPM
Feed per Tooth : fz=.002 IPT
Depth of Cut : ap=.079", ae=.008"
Overhang Length : .866"
Cutting Mode : Air Blow
Machine : Vertical MC (HSK-A63)



AISI M2 (64HRC)

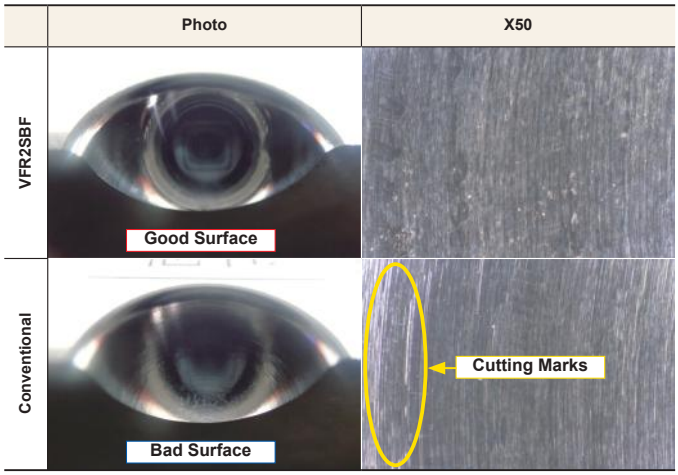


<Cutting Conditions>
Material : AISI M2 (64HRC)
Tool : VFR2SBR0300
Revolution : n=5400 min^{-1}
Table Feed : vf=21.3 IPM
Feed per Tooth : fz=.002 IPT
Depth of Cut : ap=.079", ae=.008"
Overhang Length : .866"
Cutting Mode : Air Blow
Machine : Vertical MC (HSK-A63)

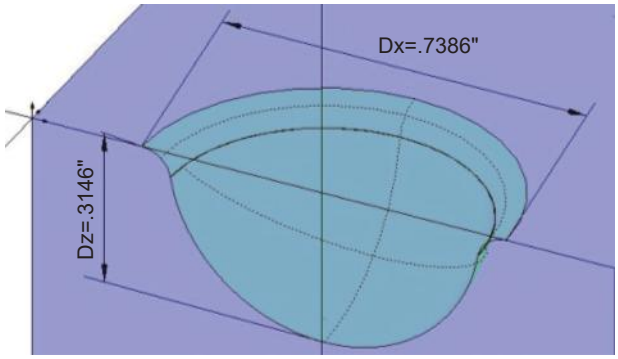


Cutting Performance

AISI H13 (52 HRC) Comparison of Machined Surface



Model Shape



<Cutting Conditions>

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

MITSUBISHI MATERIALS U.S.A.

MITSUBISHI MATERIALS U.S.A. CORPORATION

California Office
(Headquarters)

3535 Hyland Avenue, Suite 200
Costa Mesa, CA 92626
Customer Service: 800.523.0800
Technical Service: 800.486.2341

Chicago Office
(Engineering)

300 N. Martingale Road, Suite 500
Schaumburg, IL 60173
Main: 847.252.6300
Fax: 847.519.1732

MMC Metal de Mexico, S.A. DE C.V.

Av. La Cañada No.16,
Parque Industrial Bernardo
Quintana, El Marques,
Queretaro C.P. 76246 MEXICO
Main: +52.442.221.61.36
Fax: +52.442.221.61.34

North Carolina-MTEC
(Marketing & Technical Center)

105 Corporate Center Drive, Suite A
Mooresville, NC 28117
Main: 980.312.3100
Fax: 704.746.9292

Toronto Office
(Canada Branch)

600 Matheson Blvd. Unit 5 (Office)
Mississauga, ON L5R 4C1
Main: 905.814.0240
Fax: 905.814.0245

Detroit Office
(Moldino CS)

2001 Orndorf Drive
Brighton, MI 48116
Main: 248.308.2620
Fax: 248.308.2627

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.

B231A-US-2026.4