

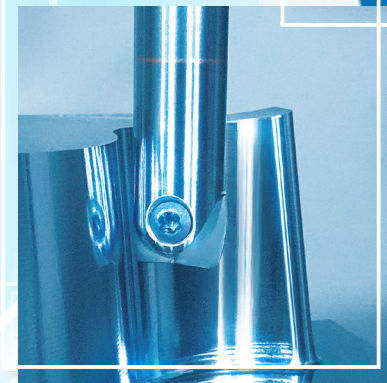
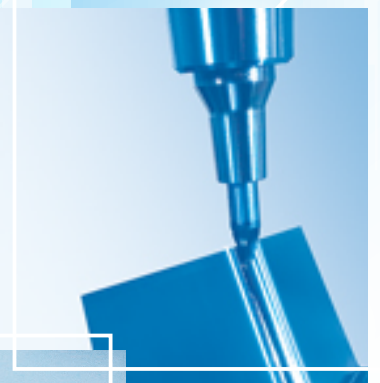
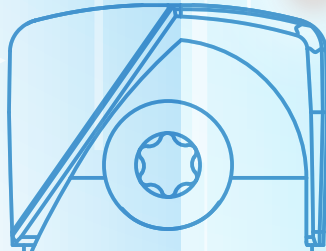
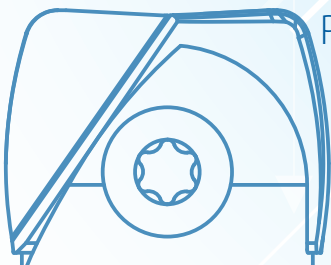


Variant Shape Tool for Finishing

VU-R

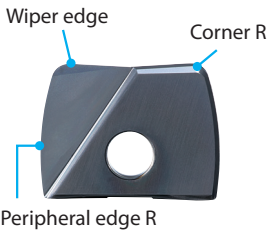
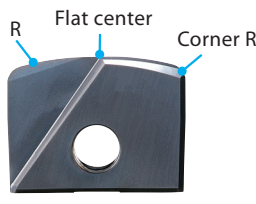
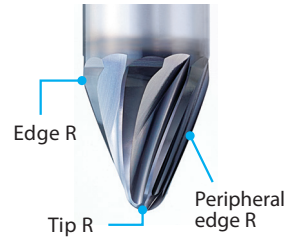
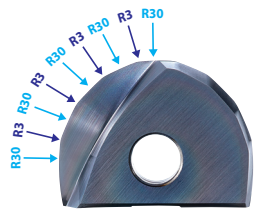
PFB-BR • PFB-LZ • VU-TBR • VU-EGG • VU-EGG-H

Volume 1



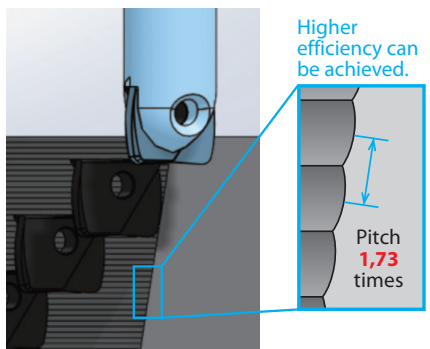
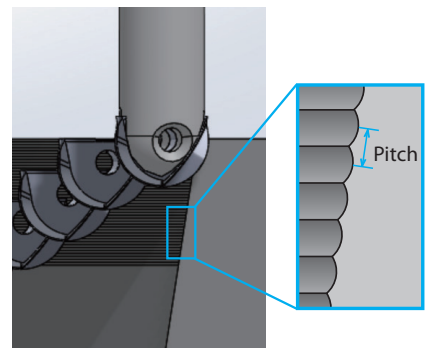
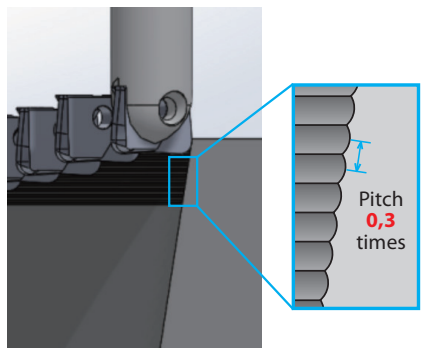
VU-R SERIES VARIANT SHAPE TOOL FOR FINISHING

Improved machining efficiency and surface quality with large radius configuration

Indexable Type (PFB)		Solid Type	Composite Radius Shape Type
Barrel Type Insert PFB-BR <ul style="list-style-type: none"> Contour milling of vertical slope Flat bottom milling 	Lens Type Insert PFB-LZ <ul style="list-style-type: none"> Contour milling of horizontal slope Copy milling of curved surface 	Taper Barrel Type VU-TBR <ul style="list-style-type: none"> Contour milling of vertical slope High-efficiency multi-flute specification 	PolyBall (special tool) <ul style="list-style-type: none"> Improves machined surface quality and reduces processing time for complex shapes with inclined and curved surfaces.  <p>Example of combination of Rs.</p>

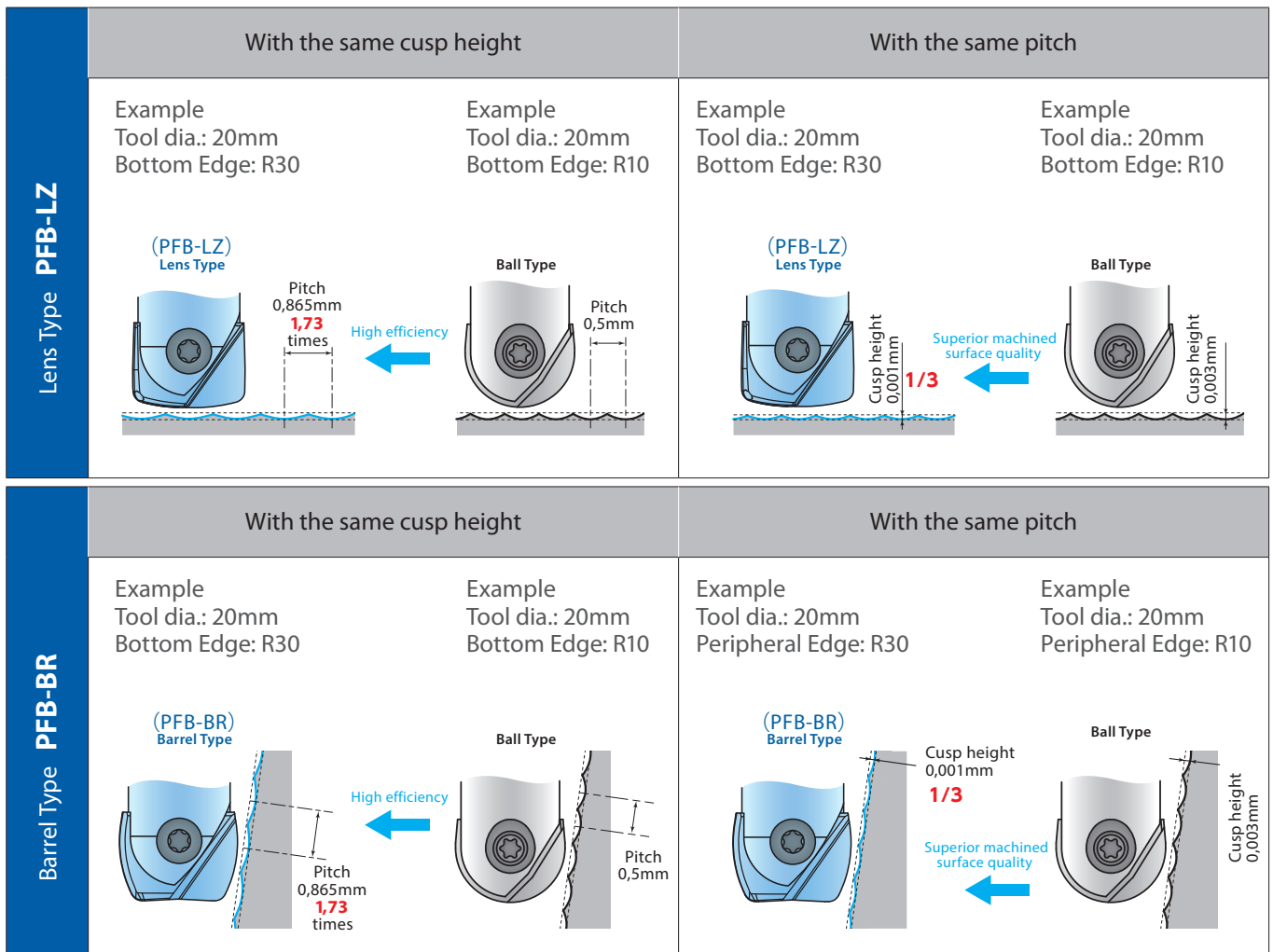
1 Capability to mill with a larger pitch

The barrel type (PFB-BR) can be used with a larger pitch than with the ball type and corner radius type when contour milling with the same theoretical cusp height value.

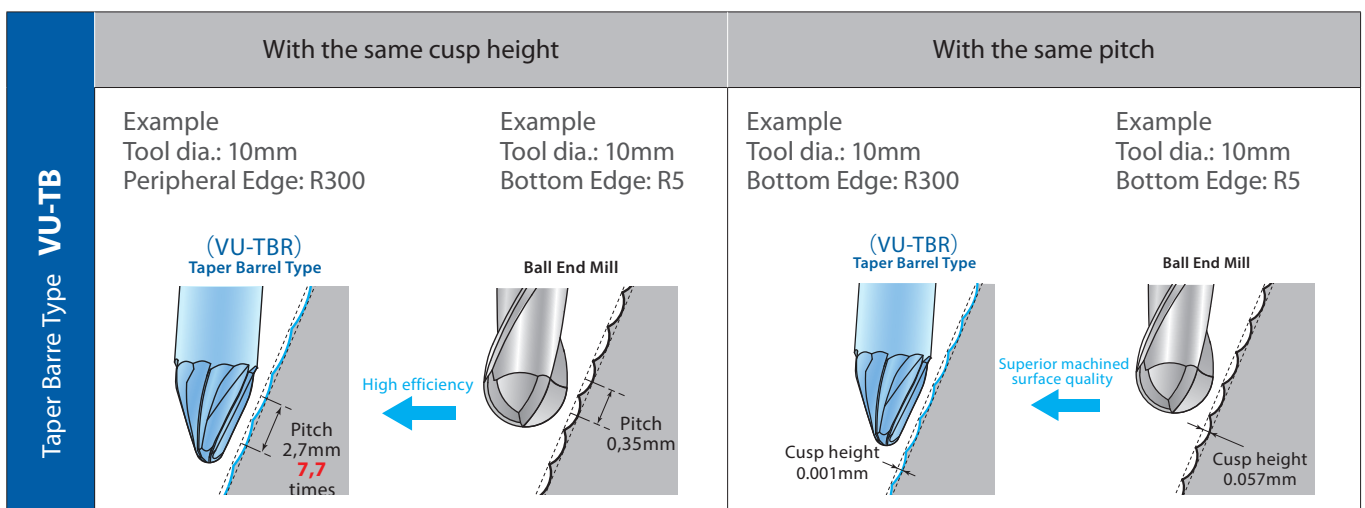
Barrel Type insert (PFB-BR)	Ball Endmill insert	Corner Radius End Mill Insert
Example Tool dia.: 20mm Barrel: R30 	Example Tool dia.: 20mm R10 	Example Tool dia.: 20mm Corner R3 

VU-R SERIES VARIANT SHAPE TOOL FOR FINISHING

2 Large pitch specification greatly improves cutting efficiency



3 Highly efficient finishing with large Peripheral edge R



Barrel Type & Lens Type Inserts

Original geometry that enables smooth machined surface and higher cutting efficiency

Barrel Type Insert PFB-BR	Lens Type PFB-LZ																								
 <ul style="list-style-type: none"> ● Contour milling of vertical slope ● Flat bottom milling ● Applicable to vertical slopes up to 17,1°(see table below) * For 3-axis machining 	 <ul style="list-style-type: none"> ● Contour milling of horizontal slope ● Copy milling of curved surface ● Applicable to horizontal slopes up to 15,7°(see table below) * For 3-axis machining 																								
																									
 <p style="text-align: center;">Vertical slope angle</p> <p style="text-align: center;">Applicable maximum vertical slope angle</p> <table border="1"> <tr><td>Ø10 (R15)</td><td>16,6°</td></tr> <tr><td>Ø12 (R18)</td><td>17,1°</td></tr> <tr><td>Ø16 (R24)</td><td>15,8°</td></tr> <tr><td>Ø20 (R30)</td><td>16,6°</td></tr> <tr><td>Ø25 (R37,5)</td><td>16,6°</td></tr> <tr><td>Ø32 (R48)</td><td>16,7°</td></tr> </table>	Ø10 (R15)	16,6°	Ø12 (R18)	17,1°	Ø16 (R24)	15,8°	Ø20 (R30)	16,6°	Ø25 (R37,5)	16,6°	Ø32 (R48)	16,7°	 <p style="text-align: center;">Horizontal slope angle</p> <p style="text-align: center;">Applicable maximum Horizontal slope angle</p> <table border="1"> <tr><td>Ø10 (R15)</td><td>15°</td></tr> <tr><td>Ø12 (R18)</td><td>15,7°</td></tr> <tr><td>Ø16 (R24)</td><td>14,4°</td></tr> <tr><td>Ø20 (R30)</td><td>14,7°</td></tr> <tr><td>Ø25 (R37,5)</td><td>15,1°</td></tr> <tr><td>Ø32 (R48)</td><td>15,4°</td></tr> </table>	Ø10 (R15)	15°	Ø12 (R18)	15,7°	Ø16 (R24)	14,4°	Ø20 (R30)	14,7°	Ø25 (R37,5)	15,1°	Ø32 (R48)	15,4°
Ø10 (R15)	16,6°																								
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Ø20 (R30)	14,7°																								
Ø25 (R37,5)	15,1°																								
Ø32 (R48)	15,4°																								

Insert grade can be selected according to application

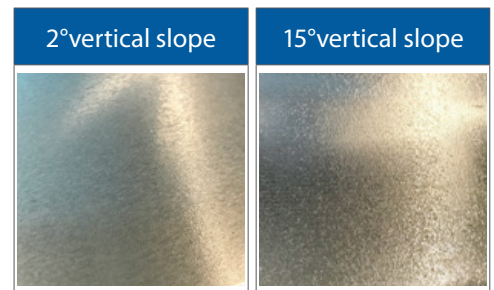
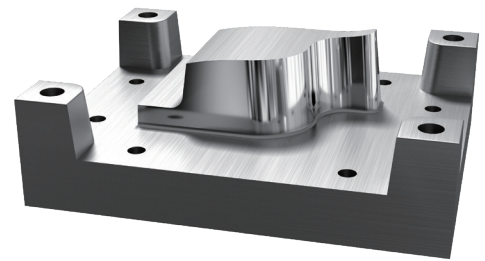
Grade XP3225	Grade XP3310
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- For stable milling of a wide variety of work materials
- Excellent lubricity and wear resistance

- Ideal for dry milling of high hardened steel and cast iron
- Excellent heat and wear resistance

3-axis finishing of mold base vertical slope by barrel type tool (PFB-BR)

Tool	Insert: PFB320R480-BR-ST R48 Shank: PFB-R320SS32-LL300CS	Conventional (Shoulder cutter) Ø40xR3
Work Material	FCD550R	
Cutting Speed	200m/min (1.990min ⁻¹)	125m/min (995min ⁻¹)
Feed Rate	600mm/min (0,15 mm/t)	700mm/min
Pitch	0,7mm	0,35mm
Depth of Cut	0,3mm	
Overhang Length	176mm	
Coolant	None (Air Blow)	
Machining Time	2 Hours 12 minutes 8 seconds	5 Hours 39 minutes 55 seconds
Machining surface	Set to almost the same cusp height	
Machine	Horizontal Machining Center	

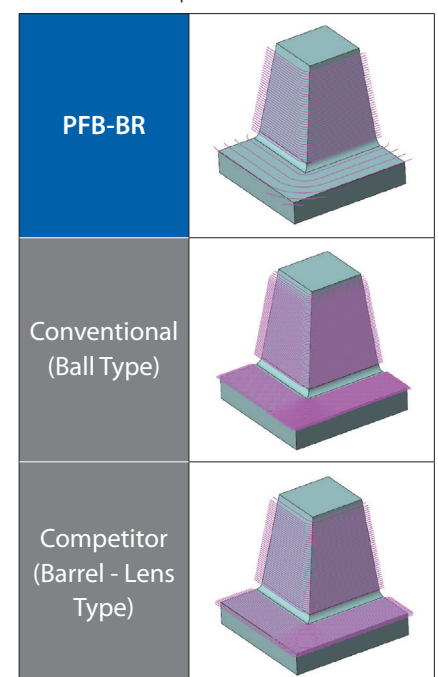


The pitch is set to twice that of conventional tool.
The finished surfaces are extremely satisfactory for both vertical slopes, with the processing efficiency increased by about 30%.

3-axis finishing of die casting mold (engine case) by barrel type tool (PFB-BR)

Tool	Insert: PFB320R480-BR-ST R48 Shank: PFB-R320SS32-LL300CS	Conventional (Ball Type) R10	Competitor (Barrel - Lens Type) R20
Work Material	SKD61 (45HRC)		
Cutting Speed	150m/min (2.387min ⁻¹)		
Feed Rate	477mm/min (0,1 mm/t)		
Pitch	1.01mm	0,59mm	0,86mm
Depth of Cut	0.1mm		
Overhang Length	110mm		
Coolant	Water-Soluble		
Machining Time	27 minutes 20 seconds	46 minutes 19 seconds	31 minutes 53 seconds
Cusp height	0,005mm		
Surface Roughness	Ra=0,49 µm Rz=2,1 µm	Ra=0,88 µm Rz=3,4 µm	Ra=0,65 µm Rz=2,8 µm
Machine	Vertical Machining Center		

Difference in path based on insert shape



Processing time can be reduced with the larger pitch of the barrel type tool's R30. In addition, the wiper edge of the barrel type tool (PFB-BR) enables higher quality of the bottom surface. Moreover, with the bottom pitch of 0.6 DC (12 mm), processing time can be significantly reduced compared to ball shape and other competitors' barrel and lens type tools.

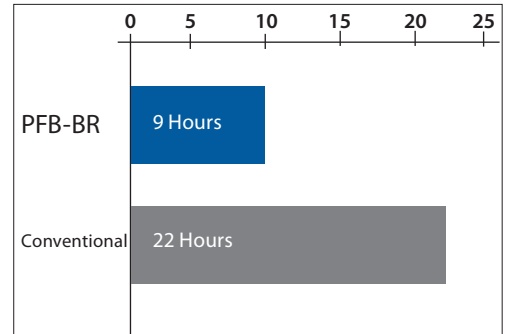


CUTTING DATA

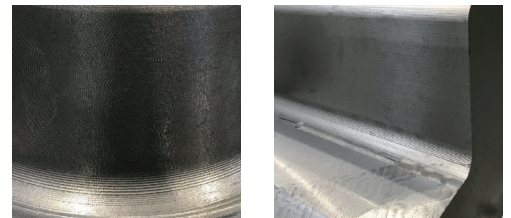
3-axis finishing of mold base vertical slope by barrel type tool (PFB-BR)

Tool	Insert: PFB200R300-BR-ST R30 Shank: Special Order	Conventional (Shoulder cutter) Ø40xR3
Work Material	FCD550R	
Cutting Speed	182m/min (2.900min ⁻¹)	113m/min (900min ⁻¹)
Feed Rate	650mm/min (0,11 mm/t)	500mm/min
Pitch	1mm	0,35mm
Depth of Cut	0,6mm	
Overhang Length	145mm	
Coolant	None (Air Blow)	
Machining Time	9 Hours	22 Hours
Machining surface	Set to almost the same cusp height	
Machine	Horizontal Machining Center	

Machining Time



Machined surface



Achieved significant increase in efficiency.

With the conventional tool, the insert has to be replaced after milling one workpiece.

The PFB-BR, however, can complete two or more workpieces before having to be replaced.

3-axis finishing of fixed die vertical slope by barrel type tool (PFB-BR)

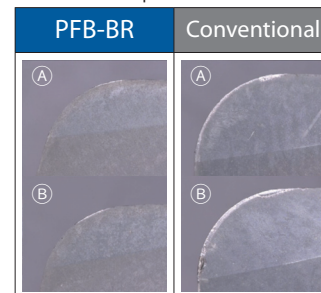
Tool	Insert: PFB200R300-BR-ST R30 Shank: PFB-R200SS20-L180CS	Conventional (Radius Type) Ø20xR3
Work Material	DH31S Equivalent	
Cutting Speed	220m/min (3.510min ⁻¹)	
Feed Rate	983mm/min (0,14 mm/t)	1.750mm/min (0,25 mm/t)
Pitch	0,8mm	0,35mm
Depth of Cut	0,15mm	
Overhang Length	98mm	
Coolant	None (Air Blow)	
Cutting Method	Contour line finish milling	
Machining Time	28 minutes 40 sec.	45 minutes 7 sec.
Cusp height	0,002mm	0,005mm
Machine	Horizontal Machining Center	

Finished surface by PFB-BR



The machined surface quality was so superior that a clear reflection can be seen.

Wear comparison



	Machining Time		Amount of Wear
	10	20 30 40 50	
PFB-BR	28Minutes 40Seconds	Normal Wear Still Running	Ⓐ : 0,011mm Ⓑ : 0,014mm
Conventional	45Minutes 7Seconds	Chipping	Ⓐ : 0,046mm Ⓑ : 0,088mm

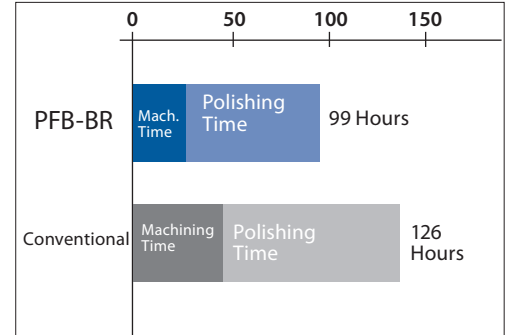
The conventional radius type insert needs to be replaced before finishing one workpiece due to small pitch. With the barrel type insert (PFB-BR), because the cutting distance became shorter due to the larger pitch, it was possible to complete cutting one workpiece without replacing the tool. The level of precision was also high enough to eliminate polishing.



Finishing of large die by barrel type tool (PFB-BR)

Tool	Insert: PFB320R480-BR-SH R48 Shank: PFB-R320SS32-LL300CS	Conventional (Ball Type) R6
Work Material	SC410	
Cutting Speed	250m/min (2.500min ⁻¹)	101m/min (2.680min ⁻¹)
Feed Rate	800mm/min (0,16 mm/t)	1.800mm/min
Pitch	3mm	2mm
Cusp Height	0,023mm	0,084mm
Overhang Length	175mm	
Coolant	None (Air Blow)	
Machining Time	1,5 Hours x 18 work	1 Hour x 18 work
Numbr of Tools	3 tools	6 tools
Polishing Time	4 Hours x 18 work	6 hours x 18 work
Total Machine Time	99 Hours	126 Hours
Machine	Double Column Machining Center	

Machining Time

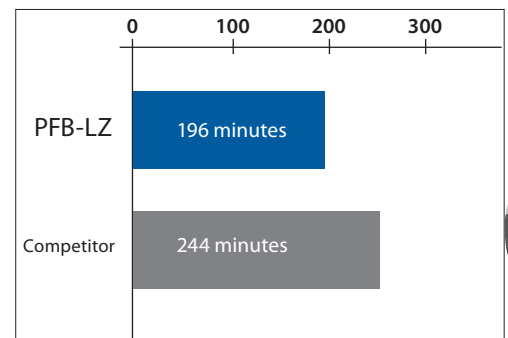


Smooth and considerably high quality surface is achieved due to the effect of the large barrel R. As the surface becomes smoother, polishing time can be significantly reduced and thus the total time required for finishing can also be significantly reduced. By making the pitch larger, the cutting distance is shortened, minimizing the number of tools required for processing.

5-axis finishing of blade with lens type tool (PFB-LZ)

Tool	Insert: PFB200R300-LZ-ST R30 Shank: PFB-R200SF10	Competitor Lens Tool R20
Work Material	SUS430	
Cutting Speed	500m/min (7.961min ⁻¹)	
Feed Rate	2.388mm/min (0,15 mm/t)	2.388mm/min (0,1mm/t)
Pitch	1,24mm	1,01mm
Depth of Cut	0,2mm	
Overhang Length	90mm	
Coolant	Water-Soluble	
Cusp Height	0,006mm	
Machining Time	196 minutes	244 minutes
Numbr of Process	12E	
Machine	Turbine blade processing machine	

Machining Time



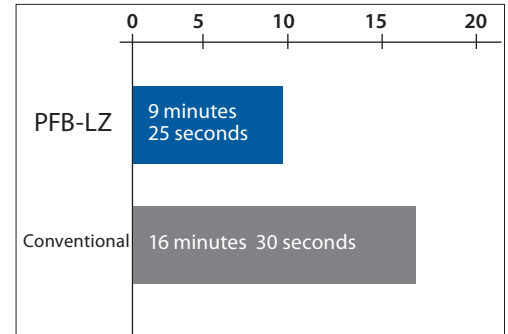
By using PFB-LZ R30 to make the pitch larger, machining time is shortened.



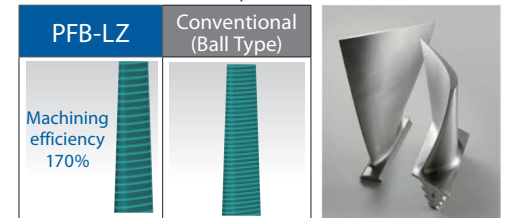
5-axis finishing of turbine blade with lens type tool (PFB-LZ)

Tool	Insert: PFB200R300-LZ-ST R30 Shank: PFB-R200SS20-L180CS		Conventional (Ball Type) R10
Work Material	SUS430		
Cutting Speed	420m/min (6.687min ⁻¹)		
Feed Rate	5.350mm/min (0,4 mm/t)		
Pitch	0,866mm	0,5mm	
Depth of Cut	0,2mm		
Tilt angle of tool	15°		
Overhang Length	90mm		
Coolant	Water-Soluble		
Machining Time	9 minutes 25 seconds	16 minutes 30 seconds	
Cusp Height	0,003mm		
Machine	Vertical machining center for 5-axis machining (BT50)		

Machining Time



Difference in tool path



Significant processing time reduction is achieved.

Finishing of large die parts with lens type tool (PFB-LZ) (workpiece mounting process reduction)

Tool	Insert: PFB320R480-LZ-SH R48 Shank: PFB-R320SS32-LL300CS	
Work Material	PX5	
Cutting Speed	226m/min (2.250min ⁻¹)	
Feed Rate	650mm/min (0,15 mm/t)	
Pitch	0,8mm	
Depth of Cut	0,2mm	
Overhang Length	176mm	
Coolant	None (Air Blow)	
Machining Time	2 Hours 30 minutes	
Cusp Height	0,002mm	
Machine	Vertical machining center	

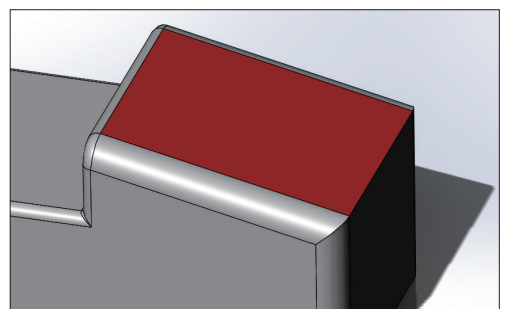


Illustration of a portion of the workpiece (4°horizontal slope)

Machined surface



Conventionally, after roughing was performed by a vertical machining center, the finished surface would be transferred to a horizontal machining center for finishing by face milling with the tooling block tilted at 4°. By using the lens type tool (PFB-LZ), work setup time is greatly reduced to achieve large cost reduction.



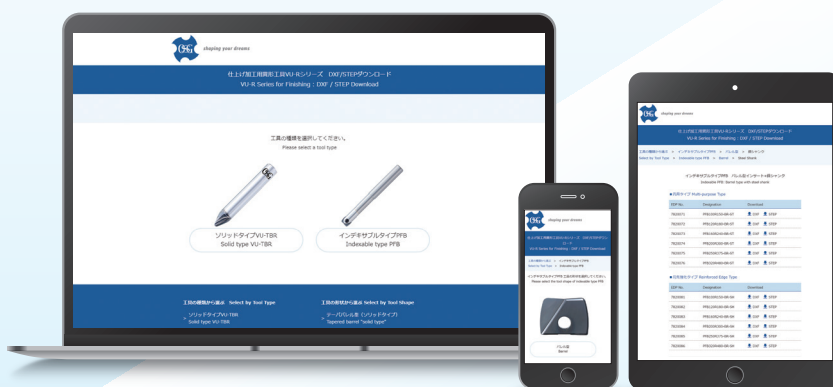
TAILORED SPECIAL TOOLS ARE AVAILABLE TO ACCOMMODATE SPECIFIC MACHINING REQUIREMENT.

Appearance	Surface Treatment
<p>Example</p>  <p>Lens Type Insert : $\varnothing 16$ Bottom edge R60</p> <p>Oval Type Insert : $\varnothing 16$ Composite R40-R8</p>  <p>Oval Type End Mill</p> <p>Barrel Type End Mill</p>	<p>Example</p>  <p>Diamond Coating</p> <p>DLC Coating</p> <p>Exchangeable Head End Mill</p> <p>Example</p>  <p>Barrel Type</p> <p>Lens Type</p>

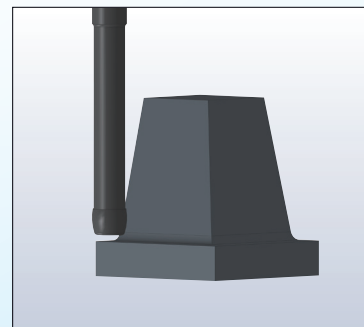
Please contact your local sales representative for details.

VU-R Series Variant Shape Tool for Finishing Website with CAD data for download

- DXF / STEP data conforming to ISO13399
- Accessible from desktop computers and smartphones



Visual image of CAD data



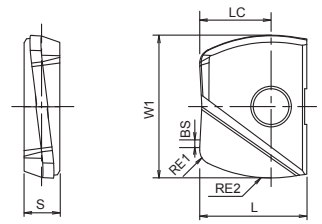
https://www.osg.co.jp/media_dl/vu-r_dl/

Easy access from QR code!



PFB-BR INSERTS NEW

Milling | Indexable | Inserts



- Barrel type
- Contour milling of vertical slope
- Flat bottom milling
- 10 - 32 mm



EDP	Designation	ZEFP	S	W1	L	RE	RE2	BS	LC	Grade	Body size	P		M		K		N		S		H		
												dry	oil	dry	oil	GG	GGG	dry	oil	dry	oil	dry	oil	
7820071	PFB100R150-BR-ST	2	2,6	10	8,5	1	15	0,3	5	XP3225	3	●		○										
7820072	PFB120R180-BR-ST	2	3	12	10	1	18	0,3	6	XP3225	4	●		○										
7820073	PFB160R240-BR-ST	2	4	16	12	2	24	0,5	8	XP3225	5	●		○										
7820074	PFB200R300-BR-ST	2	5	20	15	2	30	0,5	10	XP3225	6	●		○										
7820075	PFB250R375-BR-ST	2	6	25	18,5	2,5	37,5	0,5	12,5	XP3225	7	●		○										
7820076	PFB320R480-BR-ST	2	7	32	23,5	3	48	0,5	16	XP3225	9	●		○										
7820081	PFB100R150-BR-SH	2	2,6	10	8,5	1	15	0,3	5	XP3310	3					●	●						●	
7820082	PFB120R180-BR-SH	2	3	12	10	1	18	0,3	6	XP3310	4					●	●						●	
7820083	PFB160R240-BR-SH	2	4	16	12	2	24	0,5	8	XP3310	5					●	●						●	
7820084	PFB200R300-BR-SH	2	5	20	15	2	30	0,5	10	XP3310	6					●	●						●	
7820085	PFB250R375-BR-SH	2	6	25	18,5	2,5	37,5	0,5	12,5	XP3310	7					●	●						●	
7820086	PFB320R480-BR-SH	2	7	32	23,5	3	48	0,5	16	XP3310	9					●	●						●	

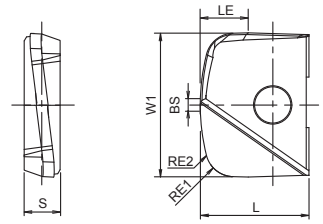
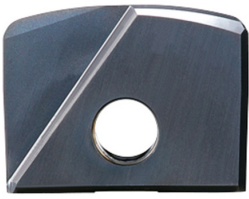
Milling | Indexable



Inserts

PFB-LZ INSERTS NEW

Milling | Indexable | Inserts



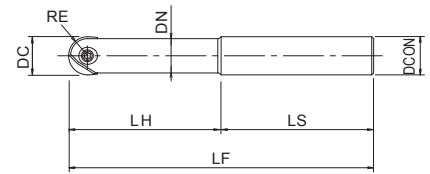
- Lens type
- Copy milling of horizontal slope
- Copy milling of curved surface
- 10 - 32 mm



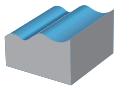
EDP	Designation	ZEFP	S	W1	L	RE	RE2	BS	LC	Grade	Body size	P		M		K		N		S		H		
												dry	oil	dry	oil	GG	GGG	dry	oil	dry	oil	dry	oil	
7820091	PFB100R150-LZ-ST	2	2,6	10	8,5	1	15	0,75	3,3	XP3225	3	●		○										
7820092	PFB120R180-LZ-ST	2	3	12	10	1	18	0,75	4	XP3225	4	●		○										
7820093	PFB160R240-LZ-ST	2	4	16	12	2	24	1	5,3	XP3225	5	●		○										
7820094	PFB200R300-LZ-ST	2	5	20	15	2	30	1,75	6,7	XP3225	6	●		○										
7820095	PFB250R375-LZ-ST	2	6	25	18,5	2,5	37,5	1,75	8,3	XP3225	7	●		○										
7820096	PFB320R480-LZ-ST	2	7	32	23,5	3	48	2	10,7	XP3225	9	●		○										
7820101	PFB100R150-LZ-SH	2	2,6	10	8,5	1	15	0,75	3,3	XP3310	3					●	●						●	
7820102	PFB120R180-LZ-SH	2	3	12	10	1	18	0,75	4	XP3310	4					●	●						●	
7820103	PFB160R240-LZ-SH	2	4	16	12	2	24	1	5,3	XP3310	5					●	●						●	
7820104	PFB200R300-LZ-SH	2	5	20	15	2	30	1,75	6,7	XP3310	6					●	●						●	
7820105	PFB250R375-LZ-SH	2	6	25	18,5	2,5	37,5	1,75	8,3	XP3310	7					●	●						●	
7820106	PFB320R480-LZ-SH	2	7	32	23,5	3	48	2	10,7	XP3310	9					●	●						●	

Milling | Indexable
Inserts





- Finishing ball nose cutter
- Excellent sharpness
- Cylindrical type
- 6 - 32 mm



EDP	Designation	ZEFP	DC	RE	LF	LH	DCON	DN	LS	ULDR	Seat size	Specification
7801429	PFB-R060SS06-S80CS	2	6	3	80	15	6	5,4	65	2,5	1	Carbide
7801439	PFB-R060SS06-L100CS	2	6	3	100	30	6	5,4	70	5	1	Carbide
7801419	PFB-R060SS06-LL120CS	2	6	3	120	42	6	5,4	78	7	1	Carbide
7801430	PFB-R080SS08-S100CS	2	8	4	100	20	8	7	80	2,5	2	Carbide
7801440	PFB-R080SS08-L120CS	2	8	4	120	40	8	7	80	5	2	Carbide
7801420	PFB-R080SS08-LL140CS	2	8	4	140	56	8	7	84	7	2	Carbide
7801431	PFB-R100SS10-S100CS	2	10	5	100	25	10	9	75	2,5	3	Carbide
7801441	PFB-R100SS10-L130CS	2	10	5	130	50	10	9	80	5	3	Carbide
7801421	PFB-R100SS10-LL150CS	2	10	5	150	70	10	9	80	7	3	Carbide
7801432	PFB-R120SS12-S110CS	2	12	6	110	30	12	11	80	2,5	4	Carbide
7801442	PFB-R120SS12-L140CS	2	12	6	140	60	12	11	80	5	4	Carbide
7801422	PFB-R120SS12-LL160CS	2	12	6	160	84	12	11	76	7	4	Carbide
7801433	PFB-R160SS16-S140CS	2	16	8	140	40	16	14	100	2,5	5	Carbide
7801443	PFB-R160SS16-L160CS	2	16	8	160	72	16	14	88	4,5	5	Carbide
7801423	PFB-R160SS16-LL200CS	2	16	8	200	96	16	14	104	6	5	Carbide
7801434	PFB-R200SS20-S160CS	2	20	10	160	50	20	18	110	2,5	6	Carbide
7801444	PFB-R200SS20-L180CS	2	20	10	180	90	20	18	90	4,5	6	Carbide
7801424	PFB-R200SS20-LL240CS	2	20	10	240	120	20	18	120	6	6	Carbide
7801435	PFB-R250SS25-S160CS	2	25	12,5	160	62,5	25	22	97,5	2,5	7	Carbide
7801445	PFB-R250SS25-L200CS	2	25	12,5	200	100	25	22	100	4	7	Carbide
7801425	PFB-R250SS25-LL260CS	2	25	12,5	260	137,5	25	22	122,5	5,5	7	Carbide
7801436	PFB-R300SS32-S170CS	2	30	15	170	75	32	27	95	2,5	8	Carbide
7801446	PFB-R300SS32-L220CS	2	30	15	220	120	32	27	100	4	8	Carbide
7801426	PFB-R300SS32-LL290CS	2	30	15	290	165	32	27	125	5,5	8	Carbide
7801437	PFB-R320SS32-S180CS	2	32	16	180	80	32	29	100	2,5	9	Carbide
7801447	PFB-R320SS32-L230CS	2	32	16	230	128	32	29	102	4	9	Carbide
7801427	PFB-R320SS32-LL300CS	2	32	16	300	176	32	29	124	5,5	9	Carbide
7801400	PFB-R080SS08-S120	2	8	4	120	36	8	7	84	4,5	2	Steel
7801401	PFB-R100SS10-S130	2	10	5	130	45	10	9	85	4,5	3	Steel
7801402	PFB-R120SS12-S130	2	12	6	130	54	12	11	76	4,5	4	Steel
7801403	PFB-R160SS16-S140	2	16	8	140	64	16	14	76	4	5	Steel
7801404	PFB-R200SS20-S160	2	20	10	160	80	20	18	80	4	6	Steel
7801405	PFB-R250SS25-S160	2	25	12,5	160	75	25	22	85	3	7	Steel
7801406	PFB-R300SS32-S170	2	30	15	170	90	32	27	80	3	8	Steel
7801407	PFB-R320SS32-S180	2	32	16	180	96	32	29	84	3	9	Steel

Accessories and spare parts

Applicable cutter DC	EDP	Designation	Torque	Specification
6	7808124	FS20652RB	0,8 N.m	Clamping screw
8	7808123	FS25669RB	1,0 N.m	Clamping screw
10	7808117	FS30686RB	1,2 N.m	Clamping screw
12	7808118	FS35610RB	2,0 N.m	Clamping screw
16	7808119	FS40613RB	3,0 N.m	Clamping screw
20	7808120	FS50615RB	5,0 N.m	Clamping screw
25	7808121	FS60620RB	5,0 N.m	Clamping screw
30 - 32	7808122	FS80624RB	6,0 N.m	Clamping screw
6	7808203	T6-D (Torx 6)	-	Wrench
8	7808204	T7-D (Torx 7)	-	Wrench
10	7808205	T8-D (Torx 8)	-	Wrench
12	7808207	T10-D (Torx 10)	-	Wrench
16	7808208	T15-D (Torx 15)	-	Wrench
20	7808209	T20-D (Torx 20)	-	Wrench
25	7808209	T20-D (Torx 20)	-	Wrench
30 - 32	7808212	T30-T (Torx 30)	-	Wrench



CUTTING CONDITIONS

Milling | Indexables | Cutting conditions

PFB-BR

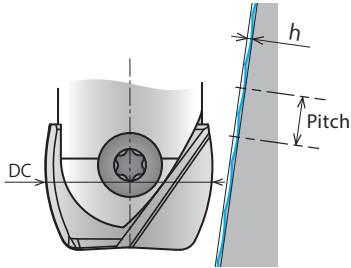
Barrel Type Tool

	Work Material	Tensile Strength / Hardness	Milling Speed Vc (m/min)	Depth of Cut ap (mm)	fz (mm/t)		
					DC		
					Ø 10,12	Ø 16,20	Ø 25-32
P	Mild Steel-Carbon Steel (SS400-S10C)	~180HB	300 (200~400)	0,2 D	0,12	0,14	0,18
	Carbon Steel-Alloy Steel (S50C-SCM440)	~280HB	300 (200~400)	0,2 D	0,1	0,12	0,14
	Die Steel (SKD11-SKD61)	~280HB	250 (150~350)	0,2 D	0,1	0,12	0,14
M	Stainless Steel (Dry) (SUS304-SUS420)	~250HB	250 (150~350)	0,2 D	0,12	0,14	0,17
K	Cast Iron (FC250)	~300N/mm ²	400 (300~500)	0,2 D	0,14	0,18	0,22
	Ductile Cast Iron (FCD400)	~600N/mm ²	300 (200~400)	0,2 D	0,12	0,14	0,18
S	Heat Resistant Alloys (Wet) (Inconel 718)	-	50 (25~80)	0,15 D	0,05	0,06	0,06
	Titanium Alloy (Wet) (Ti-Al-4V)	-	90 (40~120)	0,2 D	0,08	0,11	0,13
H	Pre-hardened Steel (NAK80, STAVAX)	40~43HRC	200 (100~300)	0,15 D	0,07	0,08	0,1
	Steel for Die Casting (DAC55-DH31)	43~48HRC	180 (90~200)	0,15 D	0,06	0,07	0,07
	Hardened Steel (SKD11)	50~60HRC	150 (100~250)	0,1 D	0,06	0,07	0,07

The above cutting conditions are to be used as general guidelines. Adjustments may be necessary depending on actual cutting conditions.

Theoretical Cusp Height

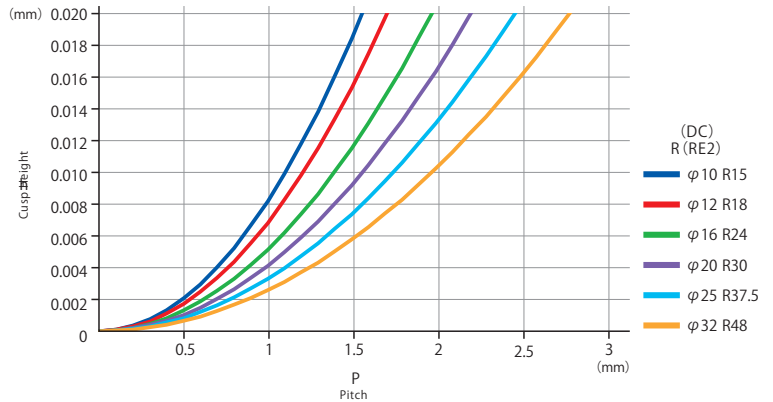
(PFB-BR) Barrel Type Tool



$$h = 0.5 \times (2 \times RE2 - \sqrt{(2 \times RE2)^2 - P^2})$$

h: Cusp height P: Pitch RE2: peripheral edge R

Cusp Height and Pitch



CUTTING CONDITIONS

Milling | Indexables | Cutting conditions

PFB-LZ

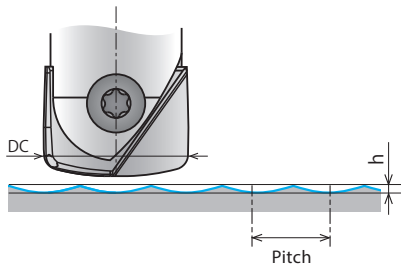
Lens Type Tool

	Work Material	Tensile Strength / Hardness	Milling Speed Vc (m/min)	Depth of Cut ap (mm)	fz (mm/t)		
					DC		
					Ø 10,12	Ø 16,20	Ø 25-32
P	Mild Steel-Carbon Steel (S5400-S10C)	~180HB	300 (200~800)	0,2 D	0,12	0,14	0,18
	Carbon Steel-Alloy Steel (S50C-SCM440)	~280HB	300 (200~800)	0,2 D	0,1	0,12	0,14
	Die Steel (SKD11-SKD61)	~280HB	250 (150~600)	0,2 D	0,1	0,12	0,14
M	Stainless Steel (Dry) (SUS304-SUS420)	~250HB	250 (150~650)	0,2 D	0,12	0,14	0,17
K	Cast Iron (FC250)	~300N/mm ²	400 (300~800)	0,2 D	0,14	0,18	0,22
	Ductile Cast Iron (FCD400)	~600N/mm ²	300 (200~800)	0,2 D	0,12	0,14	0,18
S	Heat Resistant Alloys (Wet) (Inconel 718)	-	50 (25~80)	0,15 D	0,05	0,06	0,06
	Titanium Alloy (Wet) (Ti-Al-4V)	-	90 (40~120)	0,2 D	0,08	0,11	0,13
H	Pre-hardened Steel (NAK80, STAVAX)	40~43HRC	200 (100~350)	0,15 D	0,07	0,08	0,1
	Steel for Die Casting (DAC55-DH31)	43~48HRC	180 (90~350)	0,15 D	0,06	0,07	0,07
	Hardened Steel (SKD11)	50~60HRC	150 (100~300)	0,1 D	0,06	0,07	0,07

The above cutting conditions are to be used as general guidelines. Adjustments may be necessary depending on actual cutting conditions.

Theoretical Cusp Height

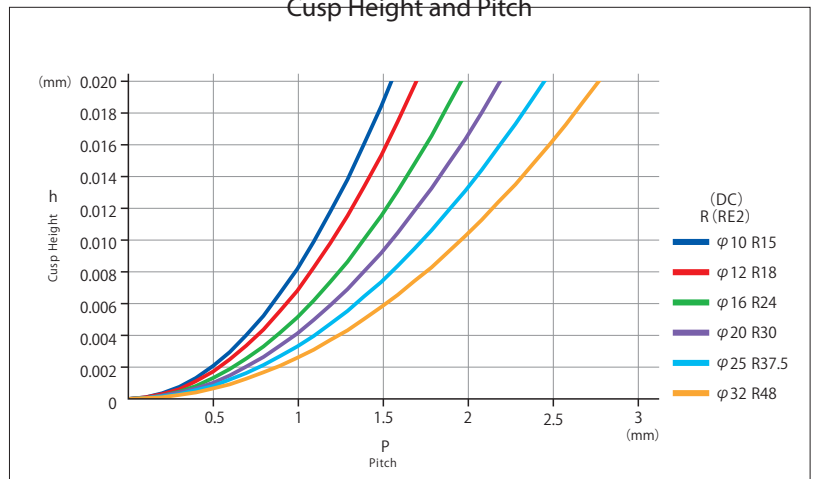
(PFB-LZ) Len Type Tool



$$h = 0.5 \times (2 \times RE2 - \sqrt{(2 \times RE2)^2 - P^2})$$

h: Cusp height P: Pitch RE2: peripheral edge R

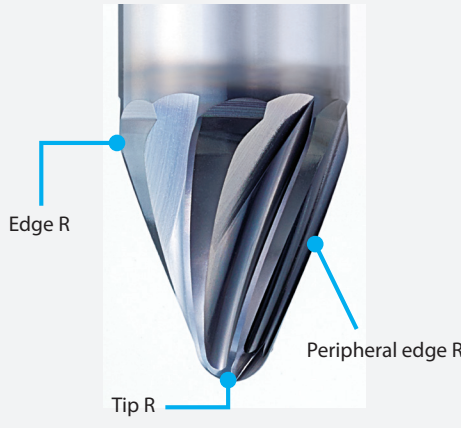
Cusp Height and Pitch



Taper Barrel Type End Mill

Achieves greater processing efficiency by the large peripheral edge R and multi-flute specification

Taper Barrel Type VU-TBR

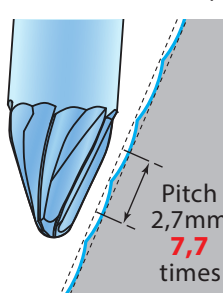


- Contour milling of vertical slope
- 20° tool tilt angle

Multi-flute specification for higher processing efficiency

Highly efficient finishing

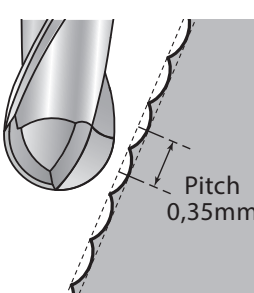
With the same cusp height



Pitch 2,7mm

7,7 times

Example



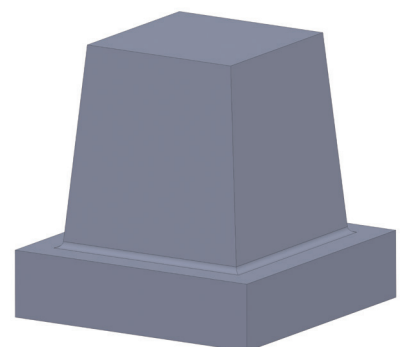
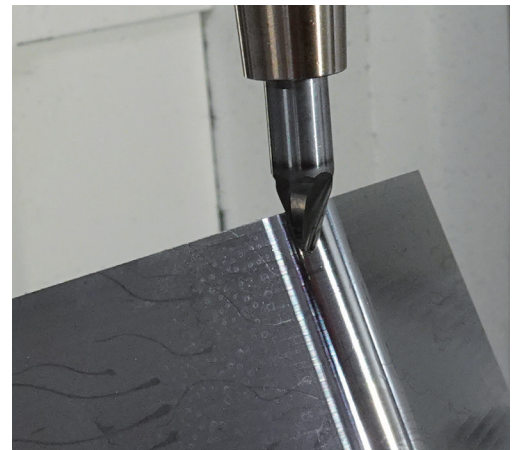
Pitch 0,35mm

← High efficiency

The large Peripheral edge R allows the cusp height to be kept at a minimum level even when the pitch is increased.

High efficiency 5-axis machining on vertical slope

Tool	VU-TBR	Conventional Ball End Mill
Size	R1,5 x R300 x 20°	R5
Number of flutes	4 flutes	2 flutes
Work Material	NAK80 (40HRC)	
Cutting Speed	233m/min (11.937min ⁻¹)	282m/min (9.549min ⁻¹)
Feed Rate	955mm/min (0,2 mm/t)	764mm/min (0,04 mm/t)
Pitch	2,7mm	0,34mm
Depth of Cut	0,3mm	
Overhang Length	35mm	
Cusp height	0,003mm	
Surface Roughness	Ra=0.12µm Rz=1.39µm	Ra=0.61µm Rz=2.59µm
Machining surface	Set to almost the same cusp height	
Coolant	Dry	
Machine	5-axis machining center (BT50)	



By increasing the pitch with a large radius and increasing the feed rate, approximately 10 times the efficiency is achieved.

CUTTING CONDITIONS

Milling | Indexables | Cutting conditions

VU-TBR

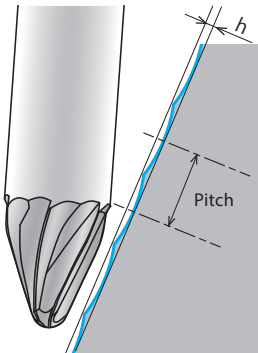
Using peripheral edge R (RE2)

Vc	Carbon Steel • Alloy Steel S55C • SCM • SKT				Hardened Steel • Prehardened Steel SKT • SKD • NAK55 • HPM1				Hardened Steel • Prehardened Steel			
	~30HRC				30~45HRC				45~55HRC			
Ø	S (min ⁻¹)	F (mm/min)	Pitch	Depth of Cut (mm)	S (min ⁻¹)	F (mm/min)	Pitch	Depth of Cut (mm)	S (min ⁻¹)	F (mm/min)	Pitch	Depth of Cut (mm)
R0,5 × R150 × 20°	10.700	3.400	Based on Cusp height (see chart below)	0,3	8.800	2.500	Based on Cusp height (see chart below)	0,3	6.800	1.600	Based on Cusp height (see chart below)	0,3
R1 × R150 × 20°	7.300	2.300		0,3	6.000	1.700		0,3	4.700	1.100		0,3
R1,5 × R300 × 20°	5.600	1.800		0,3	4.600	1.300		0,3	3.600	900		0,3
R2 × R300 × 20°	4.500	2.200		0,3	3.700	1.600		0,3	2.900	1.000		0,3
R2,5 × R500 × 20°	3.400	1.600		0,3	2.800	1.200		0,3	2.200	800		0,3
R3 × R500 × 20°	3.300	1.600		0,3	2.700	1.100		0,3	2.100	800		0,3

1. Use a rigid and precise machine and holder.
2. Use a coolant with low air-blow or fuming property according to the work material. MQL (oil mist coolant) is recommended for cutting hardened steels.
3. "Using tip R (RE1)" is the guide to use the tip R. Please adjust the rotation speed, feed rate and cutting pitch based on the cutting shape, machine rigidity, workpiece and holding conditions.
4. When chattering, vibration or abnormal cutting noise occurs, please adjust the rotation speed, feed rate and cutting pitch.
5. In order to change the rotation speed, both the rotation speed and the feed rate should be changed at the same ratio.

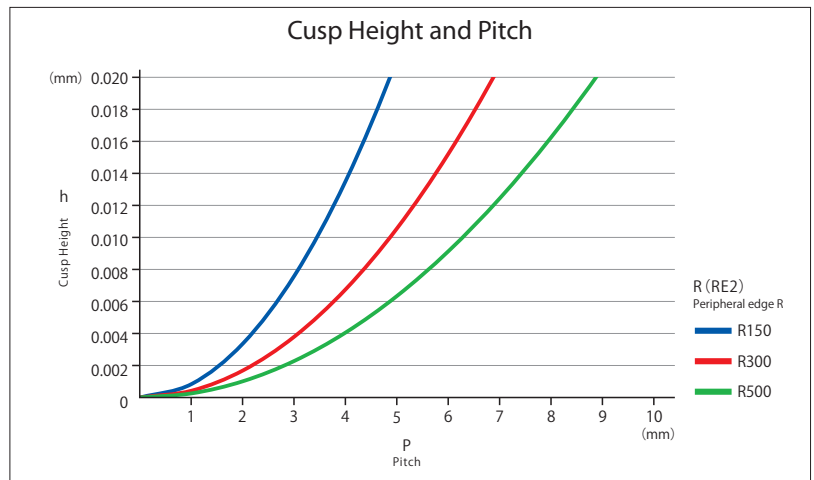
Theoretical Cusp Height

(VU-TBR) Taper Barrel Type



$$h = 0.5 \times \left(2 \times RE2 - \sqrt{(2 \times RE2)^2 - P^2} \right)$$

h: Cusp height P: Pitch RE2: peripheral edge R



CUTTING CONDITIONS

Milling | Indexables | Cutting conditions

VU-TBR

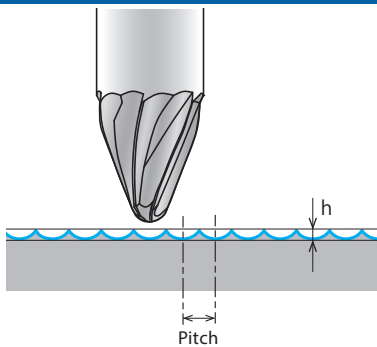
Using Tip R (RE1)

Vc	Carbon Steel • Alloy Steel S55C • SCM • SKT				Hardened Steel • Prehardened Steel SKT • SKD • NAK55 • HPM1				Hardened Steel • Prehardened Steel 45~55HRC			
	S (min ⁻¹)	F (mm/min)	Pitch	Depth of Cut (mm)	S (min ⁻¹)	F (mm/min)	Pitch	Depth of Cut (mm)	S (min ⁻¹)	F (mm/min)	Pitch	Depth of Cut (mm)
~30HRC					30~45HRC				45~55HRC			
∅												
R0,5 × R150 × 20°	19.500	6.200	Based on Cusp height (see chart below)	~0,1	15.600	4.400	Based on Cusp height (see chart below)	~0,1	13.600	3.300	Based on Cusp height (see chart below)	~0,1
R1 × R150 × 20°	13.000	4.300		~0,2	10.700	3.000		~0,2	9.300	2.200		~0,2
R1,5 × R300 × 20°	10.300	3.300		~0,25	8.200	2.300		~0,25	7.200	1.700		~0,25
R2 × R300 × 20°	8.300	4.000		~0,3	6.600	2.800		~0,3	5.800	2.100		~0,3
R2,5 × R500 × 20°	6.300	3.000		~0,3	5.000	2.100		~0,3	4.400	1.600		~0,3
R3 × R500 × 20°	6.000	2.900		~0,3	4.800	2.000		~0,3	4.200	1.500		~0,3

1. Use a rigid and precise machine and holder.
2. Use a coolant with low air-blow or fuming property according to the work material. MQL (oil mist coolant) is recommended for cutting hardened steels.
3. "Using tip R (RE1)" is the guide to use the tip R. Please adjust the rotation speed, feed rate and cutting pitch based on the cutting shape, machine rigidity, workpiece and holding conditions.
4. When chattering, vibration or abnormal cutting noise occurs, please adjust the rotation speed, feed rate and cutting pitch.
5. In order to change the rotation speed, both the rotation speed and the feed rate should be changed at the same ratio.

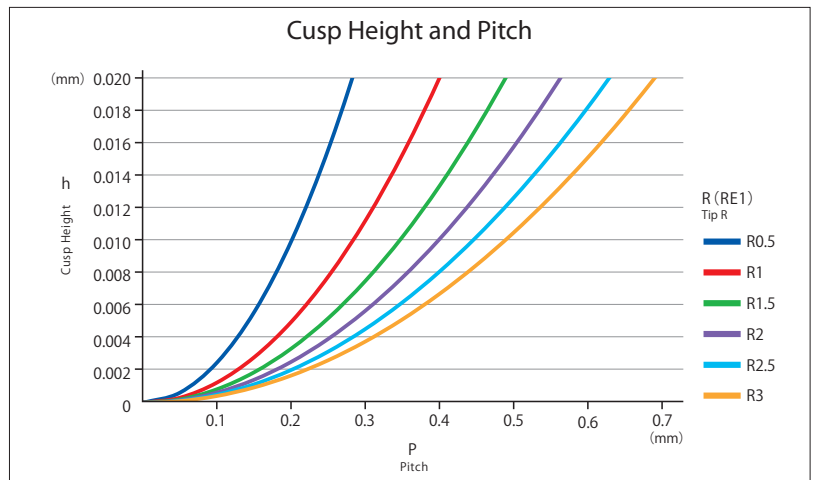
Theoretical Cusp Height

(VU-TBR) Taper Barrel Type



$$h = 0.5 \times (2 \times RE1 - \sqrt{(2 \times RE1)^2 - P^2})$$

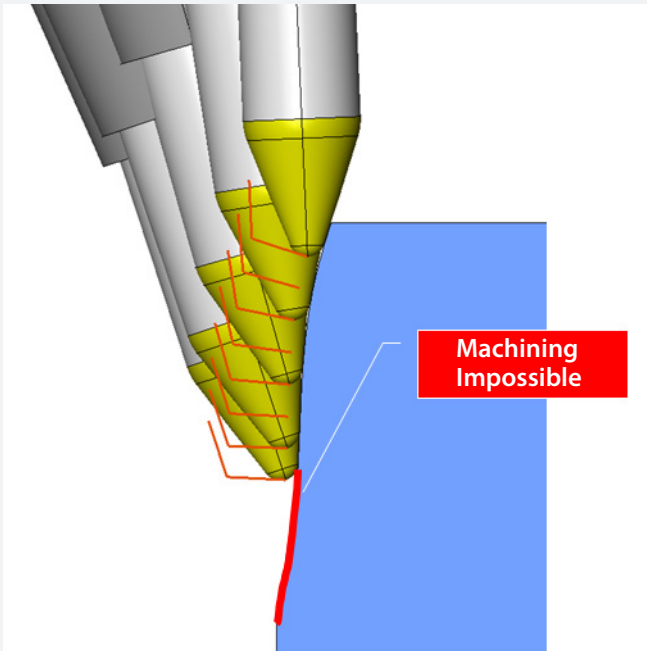
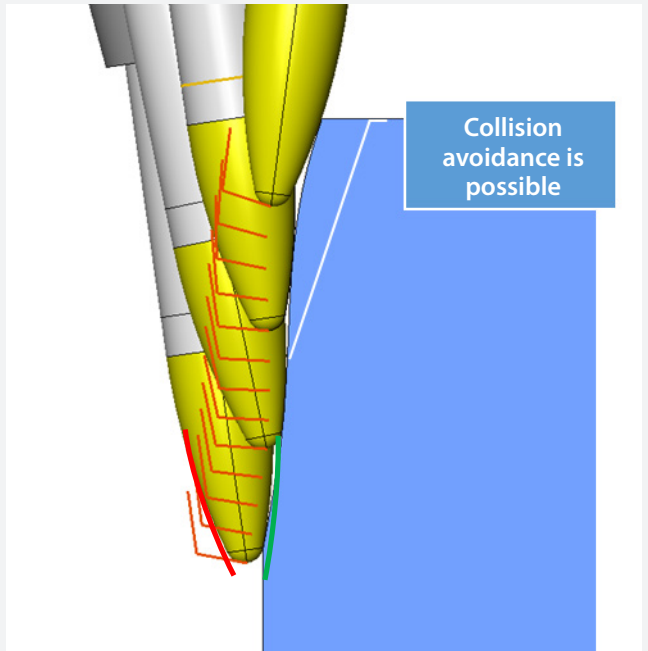
h: Cusp height P: Pitch RE1: peripheral edge R



Oval Shape End Mill

Further flexibility to your material removal on the complex shape.

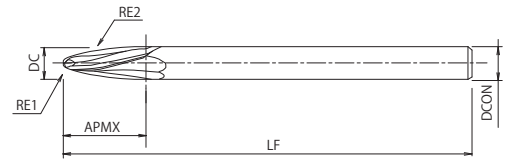
Suitable for overall finishing of standing walls including gentle curved surfaces and corner radius. Able to adjust contacting point and avoid chattering.

End mill form comparison	
Taper Barrel Type (VU-TBR)	Oval Type (VU-EGG)
	
<ul style="list-style-type: none">• Bigger peripheral radius can improve the productivity and surface finish.• Efficient for flat surface, but not suitable for complex curving surface.	<ul style="list-style-type: none">• Oval type works better if the work piece has a non-linear surface.• The end mill may require a suitable CAM software support.



VU-EGG NEW

Milling | Solid carbide



- Oval shape Type
- For General steel, WXL coating
- 2 flutes

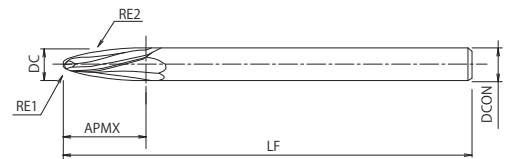


CAD data download link

EDP	ZEFP	DC	Tip RE1	Tip RE2	LF	APMX	DCON	Price
W1901274	2	8	1,5	50	100	16,876	8	

VU-EGG-H NEW

Milling | Solid carbide



- Oval shape Type
- For Hardened material, Durorey coating
- 2 flutes



CAD data download link

EDP	ZEFP	DC	Tip RE1	Tip RE2	LF	APMX	DCON	Price
W1901273	2	8	1,5	50	100	16,876	8	



CUTTING CONDITIONS

Milling | Indexables | Cutting conditions

VU-EGG-(H)

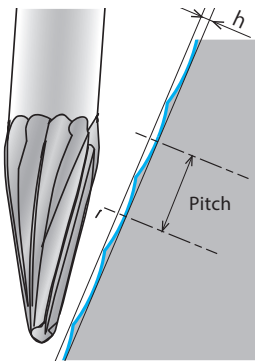
Using peripheral edge R (RE2)

	Carbon Steel • Alloy Steel S55C • SCM • SKT				Hardened Steel • Prehardened Steel SKT • SKD • NAK55 • HPM1				Hardened Steel • Prehardened Steel				Hardened Steel • Prehardened Steel <small>Only VU-EGG-H only, not recommendable for VU-EGG</small>							
Vc	~30HRC				30~45HRC				45~55HRC				55~62HRC							
Ø	S (min ⁻¹)	F (mm/min)	Pitch	Depth of Cut (mm)	S (min ⁻¹)	F (mm/min)	Pitch	Depth of Cut (mm)	S (min ⁻¹)	F (mm/min)	Pitch	Depth of Cut (mm)	S (min ⁻¹)	F (mm/min)	Pitch	Depth of Cut (mm)				
R1,5XR50	7.300	1.400	Based on Cusp height (see chart below)	0,3	6.000	1.100	Based on Cusp height (see chart below)	0,3	4.700	700	Based on Cusp height (see chart below)	0,3	4.000	500	Based on Cusp height (see chart below)	0,3				

1. Use a rigid and precise machine and holder.
2. Use a coolant with low air-blow or fuming property according to the work material. MQL (oil mist coolant) is recommended for cutting hardened steels.
3. "Using tip R (RE1)" is the guide to use the tip R. Please adjust the rotation speed, feed rate and cutting pitch based on the cutting shape, machine rigidity, workpiece and holding conditions.
4. When chattering, vibration or abnormal cutting noise occurs, please adjust the rotation speed, feed rate and cutting pitch.
5. In order to change the rotation speed, both the rotation speed and the feed rate should be changed at the same ratio.

Theoretical Cusp Height

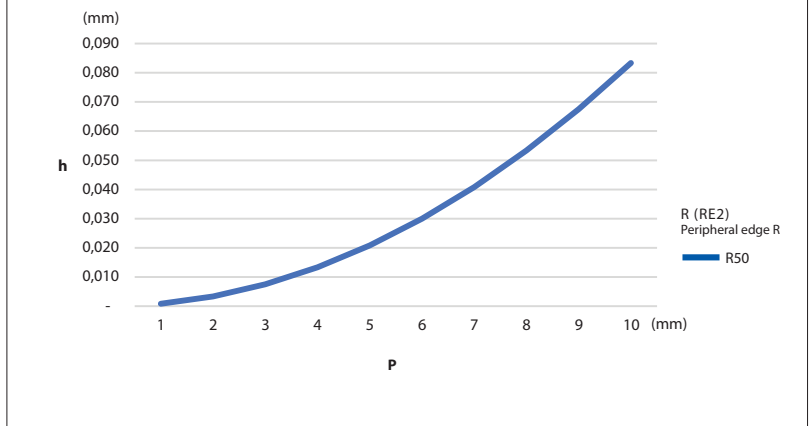
(VU-EGG) Oval shape end-mill



$$h = 0.5 \times \left(2 \times RE2 - \sqrt{(2 \times RE2)^2 - P^2} \right)$$

h: Cusp height P: Pitch RE2: peripheral edge R

Cusp Height and Pitch



CUTTING CONDITIONS

Milling | Indexables | Cutting conditions

VU-EGG-(H)

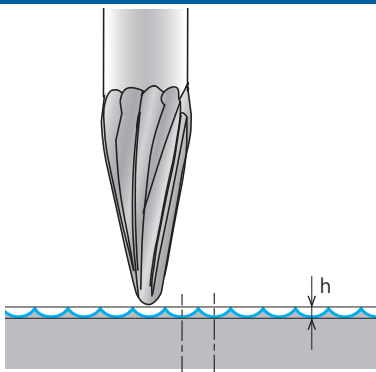
Using Tip R (RE1)

Vc	Carbon Steel • Alloy Steel S55C • SCM • SKT				Hardened Steel • Prehardened Steel SKT • SKD • NAK55 • HPM1				Hardened Steel • Prehardened Steel				Hardened Steel • Prehardened Steel <small>Only VU-EGG-H only, not recommendable for VU-EGG</small>			
	~30HRC				30~45HRC				45~55HRC				55~62HRC			
Ø	S (min ⁻¹)	F (mm/min)	Pitch	Depth of Cut (mm)	S (min ⁻¹)	F (mm/min)	Pitch	Depth of Cut (mm)	S (min ⁻¹)	F (mm/min)	Pitch	Depth of Cut (mm)	S (min ⁻¹)	F (mm/min)	Pitch	Depth of Cut (mm)
R1,5XR50	10.300	1.900	Based on Cusp height (see chart below)	~ 0,25	8.200	1.300	Based on Cusp height (see chart below)	~ 0,25	7.200	1.000	Based on Cusp height (see chart below)	~ 0,25	6.100	610	Based on Cusp height (see chart below)	~ 0,25

1. Use a rigid and precise machine and holder.
2. Use a coolant with low air-blow or fuming property according to the work material. MQL (oil mist coolant) is recommended for cutting hardened steels.
3. "Using tip R (RE1)" is the guide to use the tip R. Please adjust the rotation speed, feed rate and cutting pitch based on the cutting shape, machine rigidity, workpiece and holding conditions.
4. When chattering, vibration or abnormal cutting noise occurs, please adjust the rotation speed, feed rate and cutting pitch.
5. In order to change the rotation speed, both the rotation speed and the feed rate should be changed at the same ratio.

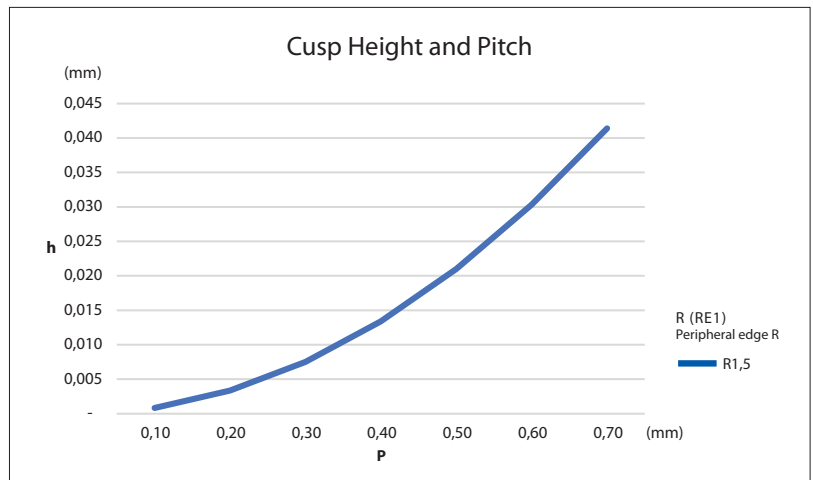
Theoretical Cusp Height

(VU-EGG-H) Oval Type



$$h = 0.5 \times \left(2 \times RE1 - \sqrt{(2 \times RE1)^2 - P^2} \right)$$

h: Cusp height P: Pitch RE1: peripheral edge R



BALL END MILL PFB FOR FINISHING

Composite Radius Shape Type Variant Shape Tool

PolyBall

Finishing by PolyBall

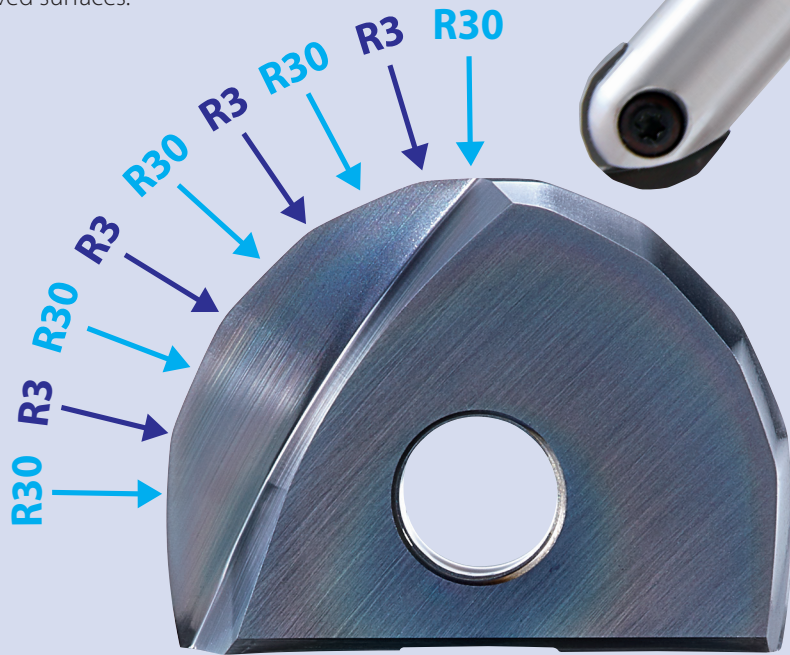
PAT.P in JAPAN

A major feature is that it can be used just like any ball end mill.

Improves machined surface quality and reduces machining time complex shapes such as inclined and curved surfaces.

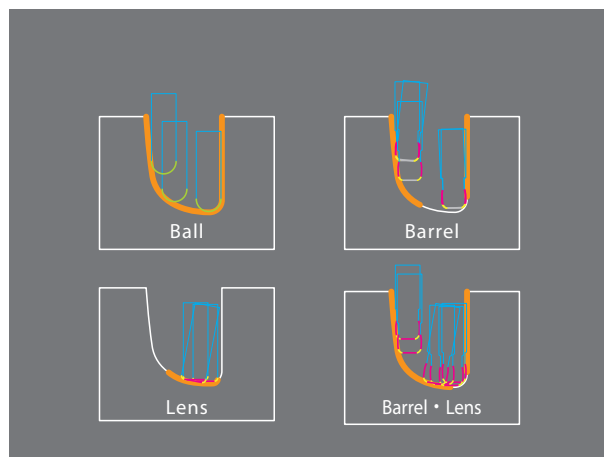
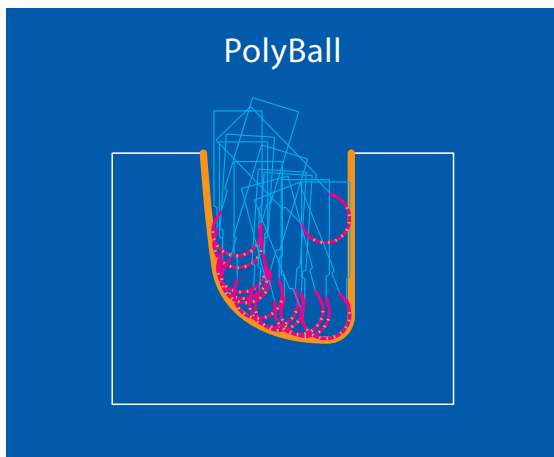


Even with the same $\phi 20$ tool, a typical ball end mill would have a R10-edge whereas the PolyBall is constructed with a R30-edge. As a result, the cusp height can be kept small even if the pitch becomes larger, enabling high precision machining in shorter time.



Example of combination of RS

Compatible with various inclined surfaces

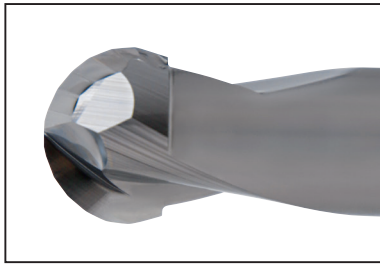


Machined area

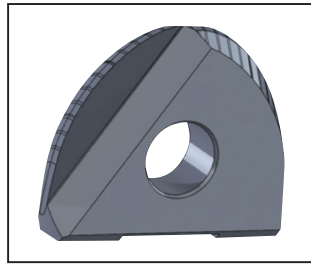
Tailored special tools are available to accommodate specific machining requirement. Please contact your sales representative for details.



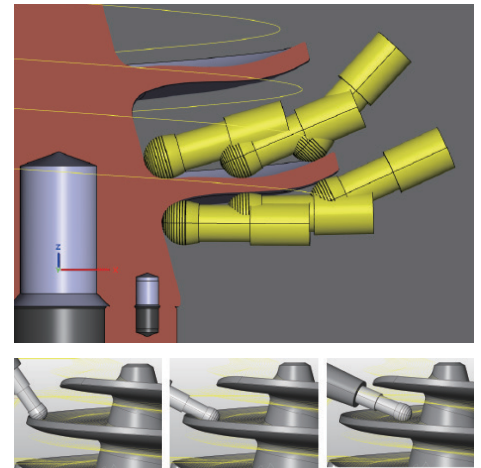
CUTTING DATA



Solid PolyBall
Ø12 R60-R6

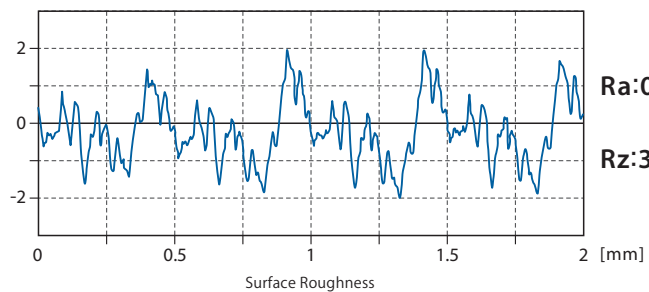


PFB PolyBall
Ø12 R24-R6



Work Material: A7075 T651
Machine: 5-axis Machining center (HSK63)
Coolant: Non-water-soluble coolant

Process	Tool	Cutting Method	Cutting Speed	Feed	Depth of Cut	Overhang Length	Stock to
①	CA-PKE	Roughing	490m/min (13.000min ⁻¹)	8.000mm/min (0,21mm/t)	ap: 1,5mm ae: 8mm	65mm	0,4mm
②	Solid Polyball Ø12 R60-R6	Semi-finishing of blade face and edge	317m/min (8.400min ⁻¹)	3.000mm/min (0,18mm/t)	Pitch: 4mm Depth of cut: 2mm	40mm	0,1mm
③	Solid Polyball Ø12 R24-R6	Finishing of blade face	414m/min (11.000min ⁻¹)	1.700mm/min (0,08mm/t)	Pitch: 0,5mm Depth of cut: 0,5mm	42mm	-
④	DLC-EBD R4	Semi-finishing of blade edge, hub face and fillet part	200m/min (8.000min ⁻¹)	2.400mm/min (0,15mm/t)	Pitch: 0,7mm Depth of cut: 0,5mm	42mm	0,15mm
⑤	DLC-EBD R4	Finishing of blade edge, hub face and fillet part	200m/min (8.000min ⁻¹)	2.400mm/min (0,15mm/t)	Pitch: 0,18mm Depth of cut: 0,18mm	42mm	-



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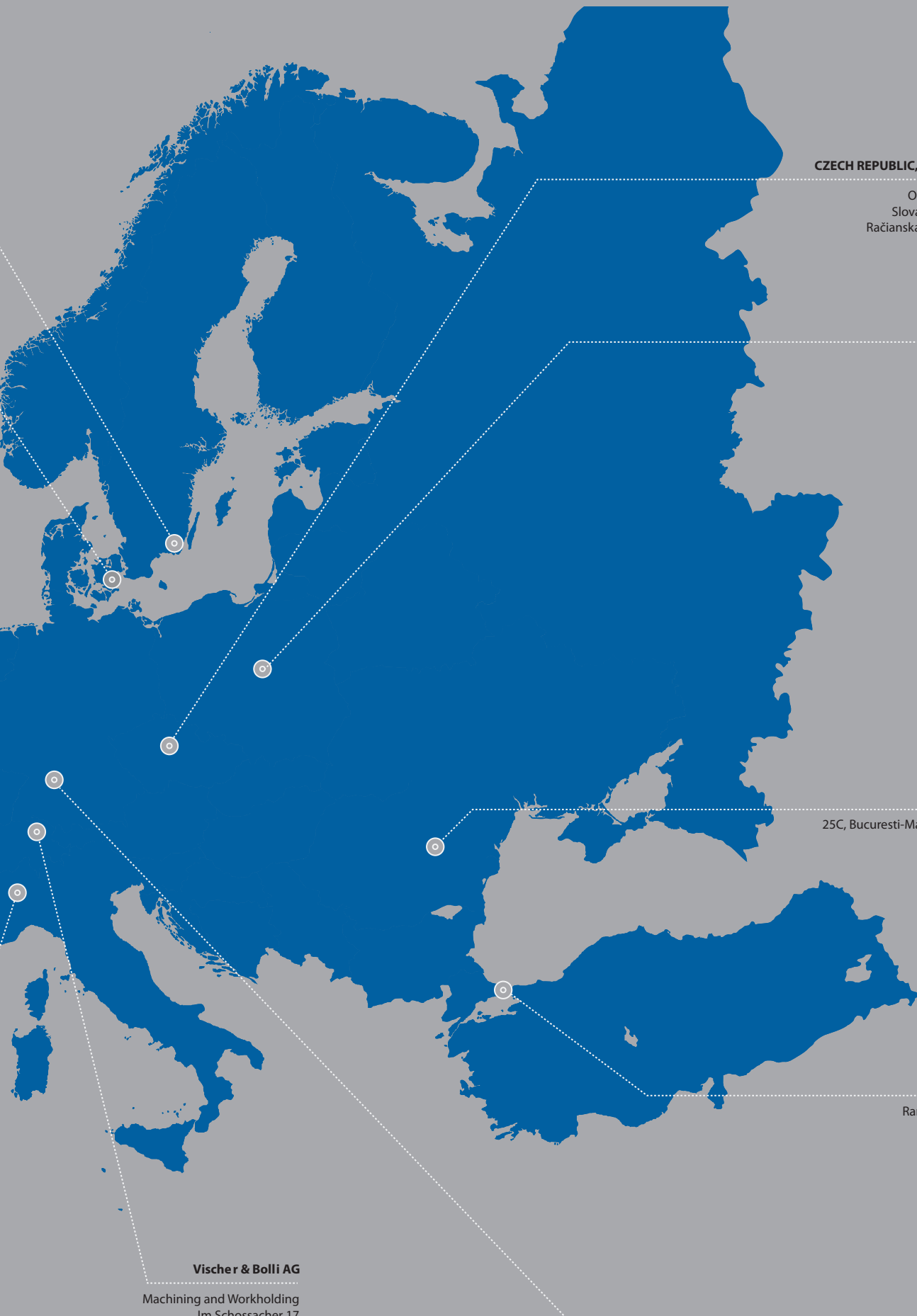
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