NS TOOL

For Crafting Tomorrow

MUGEN COATING PREMIUM Plus
2-Flute Long Neck Ball End Mill
with Short Shank for Hardened Steel and High accuracy cutting

MRBSH230SF

High precision and long tool life even for hardened steel up to 70 HRC

MRBSH230SF R0.05 ~ R3 Total 83 sizes

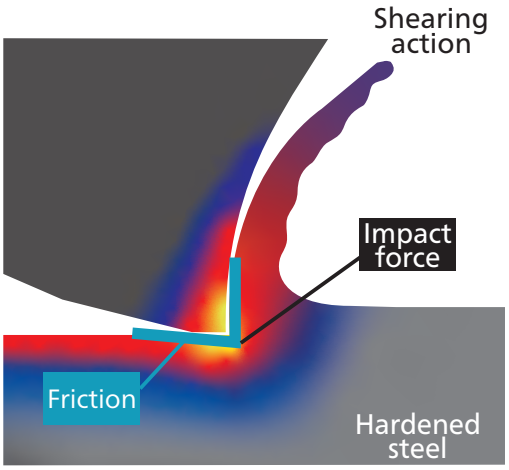
MUGEN COATING PREMIUM Plus

New developed coating realized cutting hardened steel up to 70HRC with high oxidation resistance and abrasion resistance

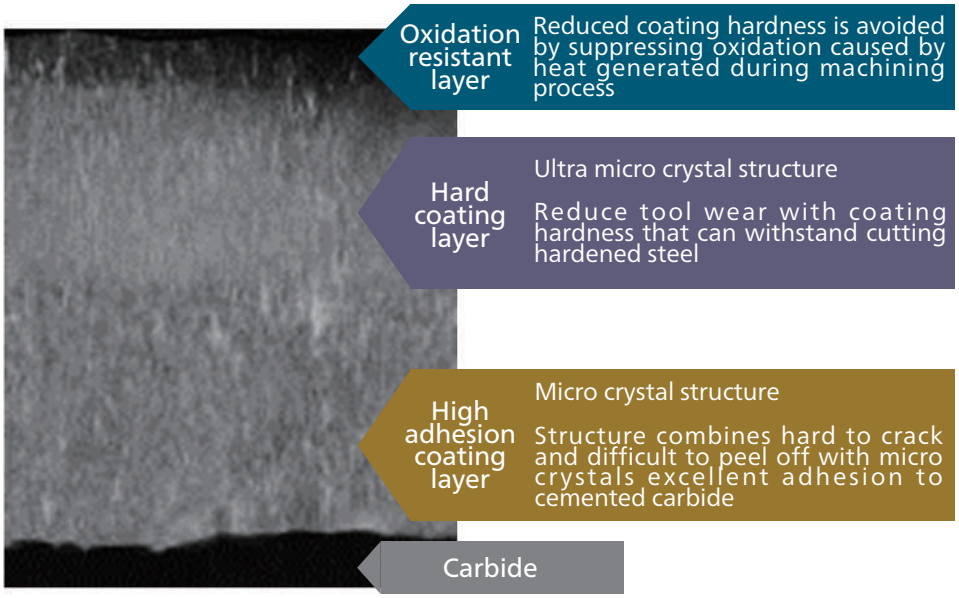
Features of hardened steel

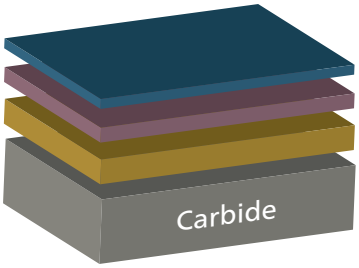
As a phenomenon when machining hardened steel of 60 to **70 HRC**, the cutting load during processing is extremely high because hardness and toughness of work material are high. Therefore, the "shearing action" at tool edge cause that…

- Tools to wear easily causing frict
- Tools tends to wear to reduced hardness of material on coating oxidizes of cutting heat
- Tool is easily damaged if impact force is large



Coating structure





Work material hardness

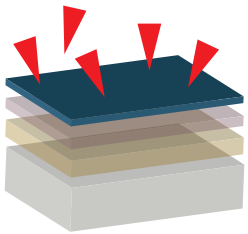
MUGEN COATING	MUGEN COATING PREMIUM	MUGEN COATING PREMIUM Plus

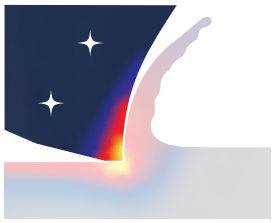
Optimized for cutting 60 to 70 HRC material

Work Material Hardness	50 HRC	60 HRC	70 HRC

Role of coating

Oxidation resistant layer





Prevents oxidation due to heat generated during cutting

Hard coating layer (Ultra micro crystal structure)

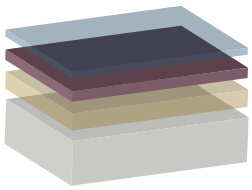
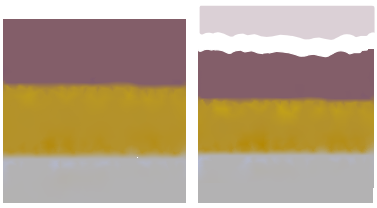


Image of wear progress cross section of coating



Tool wear can be reduced when machining on high hardened steel

High adhesion coating layer (micro crystal structure)

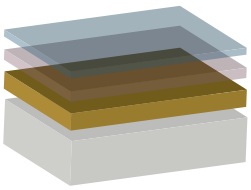
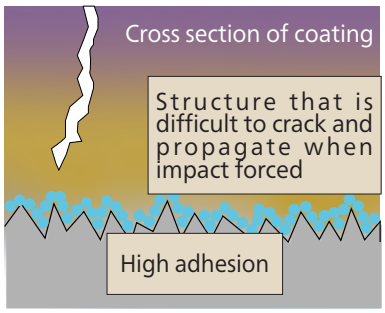
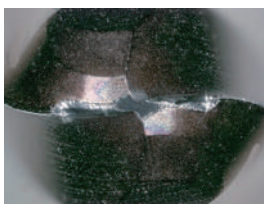
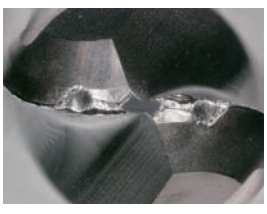
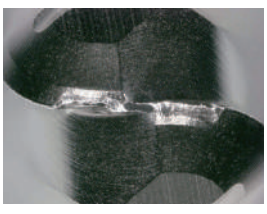


Image diagram of crack growth and adhesion



Tool life comparison for HAP40 (64HRC)

Cutting condition:
n= 20,000 min^{-1}, Vf= 1,600mm/min, ap 0.15×ae 0.3mm, Coolant: Oil mist

	MRBSH230SF	Other tool brand A	Other tool brand B	Other tool brand C
Wear pictures	 Wear width : 0.102mm	 Wear width : 0.137mm	 Wear width : 0.190mm	 Wear width : 0.157mm
Cutting time	70 min			

High precision and long tool life even for hardened steel up to 70 HRC

MRBSH230SF R0.05 ～ R3 Total 83 sizes

Achieves long tool life and high precision cutting even for 70HRC hardened steel

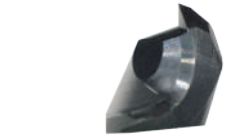
R accuracy is based on a half value of actual diameter

Features

Coating

1	New coating MUGEN COATING PREMIUM Plus with high Oxidation resistance and abrasion resistance

Introduced in the previous page



Tolerance range 0.002 mm

Shape

2-1	Cutting edge shape with reduced cutting load
2-2	Achieves high rigidity with optimal tool overhung
	High accuracy precision shank supported shrink fit chuck
2-3	Highly accurate R shape that is smooth and seamless

Material

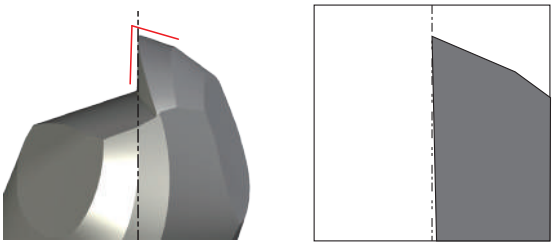
3	Super micro grain carbide with improved fracture resistance

Feature 2-1 Improved machinability — Shape: Cutting edge

Sharp cutting edge with reduced cutting load and new material with fracture resistance realizes long tool life and high precision for hardened steel

MRBSH230SF

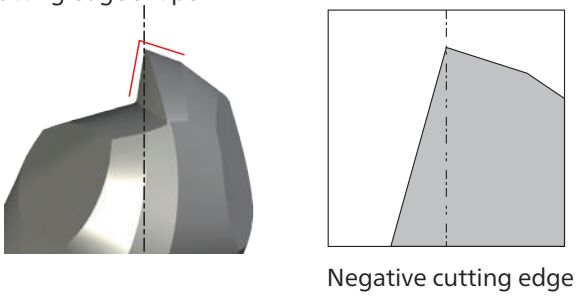
Cutting edge shape



Cutting load is reduced by positive cutting edge and by adopting a new material Super micro grain carbide prevent chipping even with hardened steel

General end mill for hardened steel

Cutting edge shape



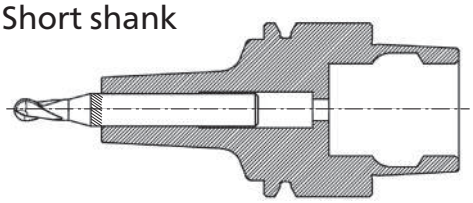
Negative cutting edge shape with high cutting load

Feature 2-2 Improved cutting accuracy — Shape: Optimal overhung length

MRBSH230SF

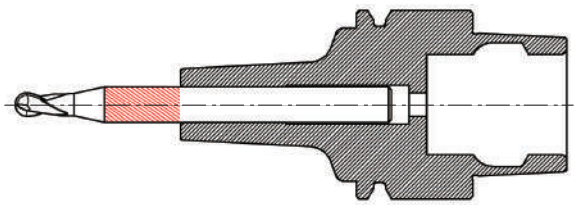
Possible to machining with high rigidity, and short tool overhung

Short shank



Normal shank length

Tool overhung length is long, and tool rigidity is low



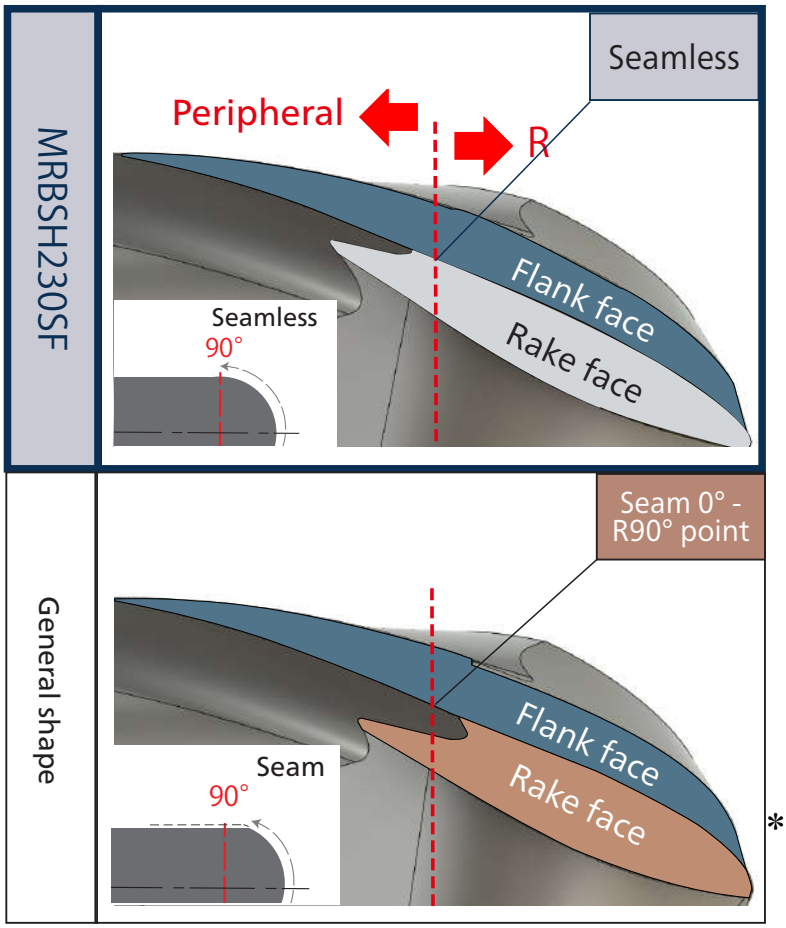
Feature 2-2 Compatible with high accuracy shrink-fit chuck — Shape: High accuracy shank

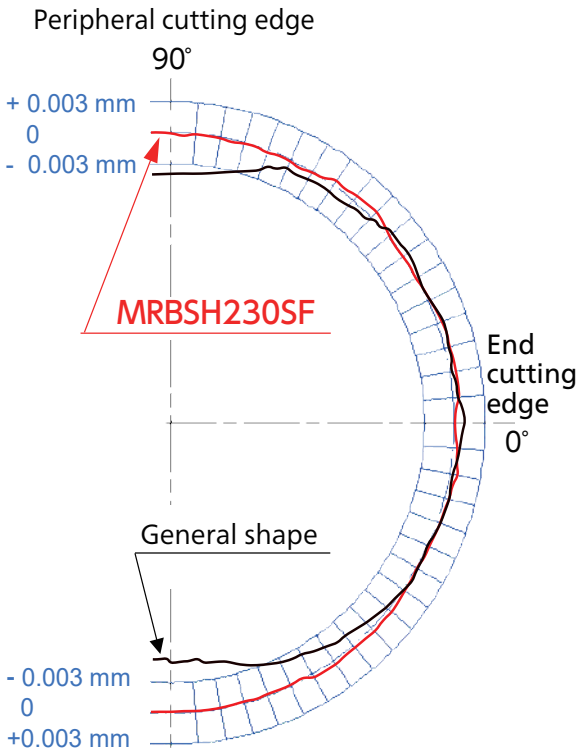
Tolerance range **0.002 mm**

High precision and long tool life even for hardened steel up to 70 HRC

Feature 2-3 | High accuracy R | Shape Highly accurate R

Seamless design on rake face and flank face from R-curve to peripheral cutting edge realized high precision R accuracy





✻ R accuracy is based on a half value of acutal diameter.

Feature 3 | Upgrade abrasion ability | Material Carbide material

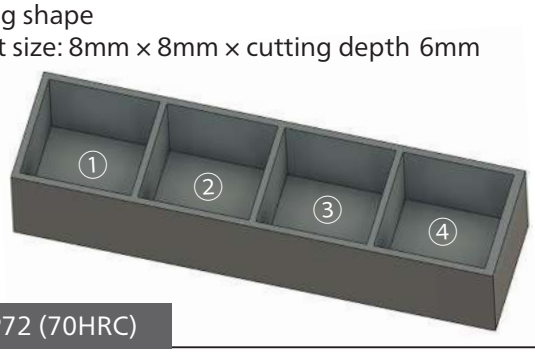
SMG

New material adopted「**Super micro grain carbide**」to specialize abrasion resistance and fracture resistance.

High precision cutting sample 1

HAP72 (70HRC)
Comparison of dimensional accuracy after roughing
Tool : MRBSH230SF R1×6
Cutting content:
Roughing contour lines for 4 pockets
Stock : 0.02mm
Target : 7.960mm
Cutting time : 20min/per pocket
Tool path : Roughing contour line

Cutting shape
Pocket size: 8mm × 8mm × cutting depth 6mm



HAP72 (70HRC)

Roughing

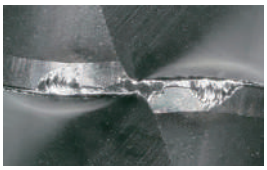
n= 16,000min^{-1}, Vf = 1,200mm/min, ap 0.1 × ae 0.3mm, Oil Mist

Tool wear condition after 80min machining

MRBSH230SF

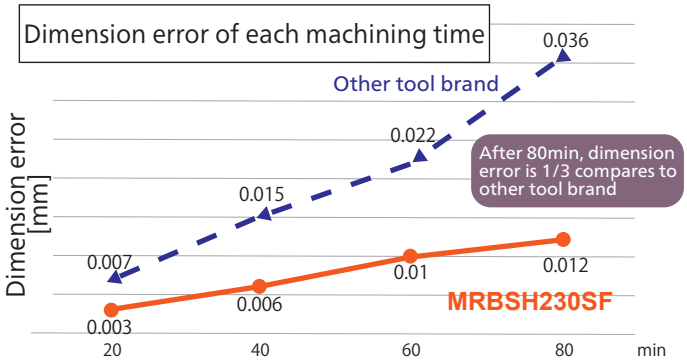
Frank wear width
0.055mm

Other tool brand



Frank wear width
0.102mm

Dimension error of each machining time

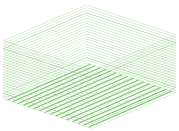


Realized stable dimension accuracy compares to other tool brand

High precision cutting sample 2

HAP72 (70HRC)
Comparison of dimensional accuracy after finishing
Tool : MRBSH230SF R1×6
Cutting content: Finishing for 1 pocket

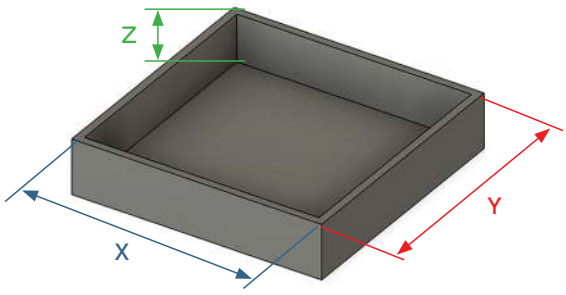
Cutting time : 32min/per pocket
Tool path : Contour line finishing (Side)
Scanning line finishing (Bottom)



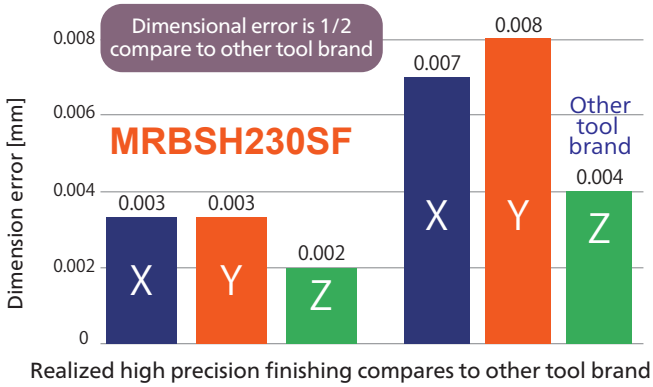
Finishing

n= 16,000min^{-1}, Vf= 1,000mm/min, ap 0.03 × ae 0.03mm, Oil Mist

Cutting shape
Pocket Size: 30mm × 30mm × cutting depth 6mm



HAP72 (70HRC)



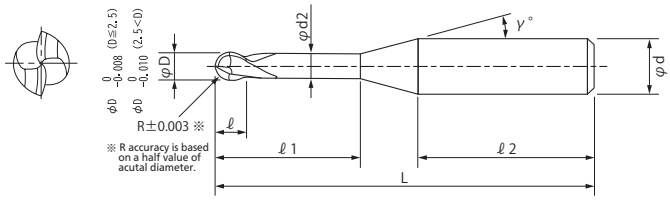
Realized high precision finishing compares to other tool brand

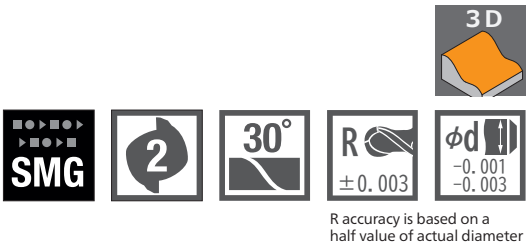
MRBSH230SF

Size R0.05 ～ R3

MUGEN COATING PREMIUM Plus
2-Flute Long Neck Ball End Mill with Short Shank for Hardened Steel

Total 83 Size



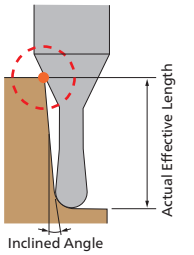


R accuracy is based on a half value of actual diameter

- Realize stable cutting performance even for 70 HRC hardened steels.
- Developed new MUGEN COATING PREMIUM Plus to upgrade oxidation resistance and abration resistance.
- Adopt optimized new tool material and tool design to reduce cutting load.
- R accuracy is ±0.003mm (R accuracy is based on a half value of actual diameter).
- Shank diameter tolerance , high accuracy type, is - 0.001 ～ - 0.003.

Work Material

Hardened Steels	
45 ～ 60 HRC	60 ～ 70 HRC
○	◎



Unit [Size : mm]

Code No.	Radius (R)	Under Neck Length (ℓ1)	Length of Cut (ℓ)	Dia. (D)	Neck Dia. (d2)	Neck Taper Angle (γ)	Shank Dia. (d)	Shank Length (ℓ2)	Overall Length (L)	Actual effective length depending on inclined angle of workpiece.				
										30′	1°	1°30′	2°	3°
08-00537-00052	R0.05	0.2	0.07	0.1	0.085	15°	4	27.4	35	0.23	0.24	0.24	0.25	0.27
08-00537-00053		0.3	0.07	0.1	0.085	15°	4	27.3	35	0.33	0.34	0.35	0.36	0.39
08-00537-00055		0.5	0.07	0.1	0.085	15°	4	27.1	35	0.54	0.56	0.57	0.59	0.64
08-00537-00072	R0.075	0.3	0.1	0.15	0.13	15°	4	27.4	35	0.34	0.35	0.36	0.37	0.40
08-00537-00073		0.5	0.1	0.15	0.13	15°	4	27.2	35	0.55	0.56	0.58	0.60	0.65
08-00537-00101	R0.1	0.3	0.15	0.2	0.18	15°	4	27.5	35	0.34	0.35	0.36	0.37	0.39
08-00537-00102		0.5	0.15	0.2	0.18	15°	4	27.3	35	0.55	0.56	0.58	0.60	0.64
08-00537-00103		0.75	0.15	0.2	0.18	15°	4	27.1	35	0.81	0.83	0.86	0.89	0.95
08-00537-00105		1	0.15	0.2	0.18	15°	4	26.8	35	1.06	1.10	1.13	1.17	1.26
08-00537-00150	R0.15	0.5	0.2	0.3	0.28	15°	4	27.5	35	0.55	0.56	0.57	0.59	0.63
08-00537-00151		0.6	0.2	0.3	0.28	15°	4	27.4	35	0.65	0.67	0.69	0.71	0.75
08-00537-00152		0.75	0.2	0.3	0.28	15°	4	27.3	35	0.80	0.83	0.85	0.88	0.94
08-00537-00153		1	0.2	0.3	0.28	15°	4	27.0	35	1.06	1.09	1.13	1.17	1.25
08-00537-00155		1.5	0.2	0.3	0.28	15°	4	26.5	35	1.58	1.63	1.68	1.74	1.87
08-00537-00201	R0.2	0.5	0.3	0.4	0.37	15°	4	27.7	35	0.56	0.58	0.59	0.60	0.64
08-00537-00202		0.8	0.3	0.4	0.37	15°	4	27.4	35	0.87	0.90	0.92	0.95	1.01
08-00537-00203		1	0.3	0.4	0.37	15°	4	27.2	35	1.08	1.11	1.14	1.18	1.26
08-00537-00204		1.5	0.3	0.4	0.37	15°	4	26.7	35	1.60	1.65	1.70	1.75	1.88
08-00537-00205		2	0.3	0.4	0.37	15°	4	26.2	35	2.11	2.18	2.25	2.33	2.50
08-00537-00206		2.5	0.3	0.4	0.37	15°	4	25.7	35	2.63	2.72	2.81	2.90	3.13
08-00537-00252	R0.25	1	0.35	0.5	0.46	15°	4	27.3	35	1.10	1.13	1.16	1.19	1.27
08-00537-00253		1.5	0.35	0.5	0.46	15°	4	26.8	35	1.61	1.66	1.71	1.77	1.89
08-00537-00254		2	0.35	0.5	0.46	15°	4	26.3	35	2.13	2.20	2.27	2.34	2.51
08-00537-00255		2.5	0.35	0.5	0.46	15°	4	25.8	35	2.65	2.73	2.82	2.92	3.14
08-00537-00256		3	0.35	0.5	0.46	15°	4	25.3	35	3.16	3.27	3.38	3.49	3.76
08-00537-00300	R0.3	1	0.45	0.6	0.56	15°	4	27.5	35	1.10	1.12	1.15	1.19	1.26
08-00537-00301		1.5	0.45	0.6	0.56	15°	4	27.0	35	1.61	1.66	1.71	1.76	1.88
08-00537-00302		2	0.45	0.6	0.56	15°	4	26.5	35	2.13	2.19	2.26	2.34	2.50
08-00537-00303		2.5	0.45	0.6	0.56	15°	4	26.0	35	2.65	2.73	2.82	2.91	3.12
08-00537-00304		3	0.45	0.6	0.56	15°	4	25.5	35	3.16	3.26	3.37	3.49	3.75
08-00537-00305		3.5	0.45	0.6	0.56	15°	4	25.0	35	3.68	3.80	3.92	4.06	4.37
08-00537-00306		4	0.45	0.6	0.56	15°	4	29.5	40	4.20	4.33	4.48	4.64	4.99
08-00537-00402	R0.4	2	0.6	0.8	0.76	15°	4	26.9	35	2.13	2.19	2.25	2.32	2.48
08-00537-00403		3	0.6	0.8	0.76	15°	4	25.9	35	3.16	3.26	3.36	3.47	3.72
08-00537-00405		4	0.6	0.8	0.76	15°	4	24.9	35	4.19	4.33	4.47	4.62	4.97
08-00537-00406		5	0.6	0.8	0.76	15°	4	28.9	40	5.23	5.40	5.58	5.77	6.21
08-00537-00501	R0.5	2	0.75	1	0.95	15°	4	27.3	35	2.14	2.20	2.26	2.33	2.48
08-00537-00502		2.5	0.75	1	0.95	15°	4	26.8	35	2.66	2.73	2.82	2.90	3.10
08-00537-00503		3	0.75	1	0.95	15°	4	26.3	35	3.18	3.27	3.37	3.48	3.72
08-00537-00504		4	0.75	1	0.95	15°	4	25.3	35	4.21	4.34	4.48	4.63	4.97
08-00537-00505		5	0.75	1	0.95	15°	4	29.3	40	5.24	5.41	5.59	5.78	6.21
08-00537-00506		6	0.75	1	0.95	15°	4	28.3	40	6.28	6.48	6.69	6.93	7.45

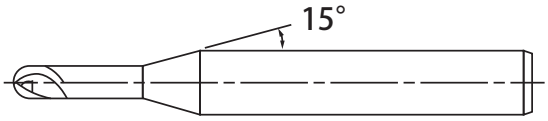
How to order When you order, indicate MRBSH230SF (R)×(ℓ1). ※(γ) is reference value.

Unit [Size : mm]

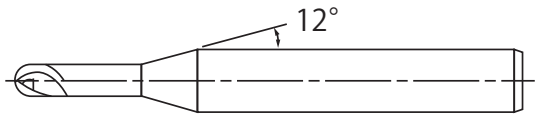
Code No.	Radius (R)	Under Neck Length (ℓ1)	Length of Cut (ℓ)	Dia. (D)	Neck Dia. (d2)	Neck Taper Angle (γ)	Shank Dia. (d)	Shank Length (ℓ2)	Overall Length (L)	Actual effective length depending on inclined angle of workpiece.				
										30′	1°	1°30′	2°	3°
08-00537-00602	R0.6	2.4	0.9	1.2	1.15	15°	4	27.2	35	2.55	2.62	2.69	2.77	2.95
08-00537-00603		4	0.9	1.2	1.15	15°	4	25.6	35	4.21	4.33	4.47	4.61	4.94
08-00537-00605		6	0.9	1.2	1.15	15°	4	28.6	40	6.27	6.47	6.68	6.91	7.43
08-00537-00606		8	0.9	1.2	1.15	15°	4	26.6	40	8.34	8.61	8.90	9.21	9.91
08-00537-00752	R0.75	3	1.1	1.5	1.45	15°	4	27.2	35	3.17	3.25	3.34	3.44	3.66
08-00537-00753		4	1.1	1.5	1.45	15°	4	26.2	35	4.20	4.32	4.45	4.59	4.91
08-00537-00754		6	1.1	1.5	1.45	15°	4	29.2	40	6.27	6.46	6.67	6.89	7.39
08-00537-00755		8	1.1	1.5	1.45	15°	4	27.2	40	8.34	8.60	8.88	9.19	9.88
08-00537-00756		10	1.1	1.5	1.45	15°	4	25.2	40	10.40	10.74	11.10	11.49	12.36
08-00537-00805	R0.8	8	1.2	1.6	1.55	15°	4	27.4	40	8.33	8.60	8.88	9.18	9.87
08-00537-01000	R1	3	1.5	2	1.94	15°	4	28.1	35	3.18	3.25	3.34	3.43	3.63
08-00537-01001		4	1.5	2	1.94	15°	4	27.1	35	4.21	4.32	4.45	4.58	4.87
08-00537-01002		6	1.5	2	1.94	15°	4	25.1	35	6.28	6.46	6.66	6.88	7.36
08-00537-01003		8	1.5	2	1.94	15°	4	28.1	40	8.35	8.60	8.88	9.18	9.84
08-00537-01004		10	1.5	2	1.94	15°	4	26.1	40	10.41	10.74	11.10	11.48	12.33
08-00537-01005		12	1.5	2	1.94	15°	4	29.1	45	12.48	12.88	13.31	13.77	14.82
08-00537-01252	R1.25	6	2.3	2.5	2.4	15°	4	26.0	35	6.35	6.53	6.72	6.92	7.39
08-00537-01253		8	2.3	2.5	2.4	15°	4	29.0	40	8.42	8.67	8.93	9.22	9.88
08-00537-01254		10	2.3	2.5	2.4	15°	4	27.0	40	10.48	10.81	11.15	11.52	12.36
08-00537-01256		15	2.3	2.5	2.4	15°	4	27.0	45	15.65	16.15	16.69	17.27	Free
08-00537-01500	R1.5	6	2.5	3	2.85	15°	6	33.1	45	6.44	6.61	6.79	7.00	7.45
08-00537-01501		8	2.5	3	2.85	15°	6	31.1	45	8.5	8.75	9.01	9.29	9.93
08-00537-01502		10	2.5	3	2.85	15°	6	29.1	45	10.57	10.89	11.23	11.59	12.42
08-00537-01503		12	2.5	3	2.85	15°	6	27.1	45	12.64	13.03	13.44	13.89	14.91
08-00537-01504		14	2.5	3	2.85	15°	6	30.1	50	14.71	15.17	15.66	16.19	17.39
08-00537-01505		16	2.5	3	2.85	15°	6	28.1	50	16.77	17.31	17.88	18.49	19.88
08-00537-01506		20	2.5	3	2.85	15°	6	29.1	55	20.91	21.58	22.31	23.09	24.85
08-00537-02000	R2	8	3	4	3.8	15°	6	32.8	45	8.58	8.81	9.06	9.33	9.93
08-00537-02001		10	3	4	3.8	15°	6	30.8	45	10.65	10.95	11.28	11.63	12.42
08-00537-02002		12	3	4	3.8	15°	6	28.8	45	12.72	13.09	13.49	13.93	14.90
08-00537-02004		15	3	4	3.8	15°	6	30.8	50	15.82	16.30	16.82	17.38	18.63
08-00537-02005		20	3	4	3.8	15°	6	30.8	55	20.99	21.65	22.36	23.13	Free
08-00537-02006		25	3	4	3.8	15°	6	30.8	60	26.16	27.00	27.90	28.88	Free
08-00537-02502	R2.5	10	3.5	5	4.8	15°	6	32.7	45	10.63	10.92	11.22	11.55	Free
08-00537-02503		15	3.5	5	4.8	15°	6	27.7	45	15.8	16.27	16.77	Free	Free
08-00537-02504		20	3.5	5	4.8	15°	6	27.7	50	20.97	21.62	Free	Free	Free
08-00537-03000	R3	10	6	6	5.7	–	6	34.4	45	Free	Free	Free	Free	Free
08-00537-03001		15	6	6	5.7	–	6	29.4	45	Free	Free	Free	Free	Free
08-00537-03002		20	6	6	5.7	–	6	29.4	50	Free	Free	Free	Free	Free
08-00537-03003		25	6	6	5.7	–	6	29.4	55	Free	Free	Free	Free	Free
08-00537-03004		30	6	6	5.7	–	6	29.4	60	Free	Free	Free	Free	Free

How to order When you order, indicate MRBSH230SF (R) ×(ℓ1). ※(γ) is reference value.

● Neck taper angle (γ) of MRBSH230SF is 15°. Our other products have a neck taper angle (γ) of 12°.



MRBSH230SF



Our other products have a neck taper angle (γ) of 12°

MRBSH230SF

Recommended Milling Conditions

Work Material			High Speed Steels / Hardened Steels SKH51・SKD11 (～62HRC)				High Speed Steels SKH55・HAP40 (～66HRC)				High Speed Steels SKH57・HAP72 (～70HRC)			
Radius	Under Neck Length	L/D	Depth of Cut		Feed	Spindle Speed	Depth of Cut		Feed	Spindle Speed	Depth of Cut		Feed	Spindle Speed
			ap mm	ae mm	mm/min	min^{-1}	ap mm	ae mm	mm/min	min^{-1}	ap mm	ae mm	mm/min	min^{-1}
R0.05	**0.2**	2	0.002	0.005	100	40,000	0.002	0.003	70	40,000	0.002	0.003	50	40,000
	0.3	3	0.002	0.005	70	40,000	0.002	0.003	50	40,000	0.002	0.003	40	40,000
	0.5	5	0.001	0.003	50	40,000	0.001	0.002	30	40,000	0.001	0.002	20	40,000
R0.075	**0.3**	2	0.002	0.005	150	40,000	0.002	0.003	100	40,000	0.002	0.003	80	40,000
	0.5	3.3	0.002	0.005	120	40,000	0.002	0.003	70	40,000	0.002	0.003	50	40,000
R0.1	**0.3**	1.5	0.005	0.005	300	40,000	0.003	0.003	200	40,000	0.003	0.003	150	40,000
	0.5	2.5	0.005	0.005	280	40,000	0.003	0.003	180	40,000	0.003	0.003	130	40,000
	0.75	3.75	0.003	0.005	200	40,000	0.002	0.003	150	40,000	0.002	0.003	110	40,000
	1	5	0.002	0.003	160	40,000	0.001	0.002	120	40,000	0.001	0.002	90	40,000
R0.15	**0.5**	1.7	0.007	0.01	300	40,000	0.003	0.005	280	40,000	0.003	0.005	210	40,000
	0.6	2	0.005	0.007	300	40,000	0.003	0.005	250	40,000	0.003	0.005	180	40,000
	0.75	2.5	0.005	0.007	280	40,000	0.003	0.005	230	40,000	0.003	0.005	170	40,000
	1	3.3	0.005	0.007	250	40,000	0.003	0.005	200	40,000	0.003	0.005	150	40,000
	1.5	5	0.003	0.005	180	40,000	0.002	0.003	120	40,000	0.002	0.003	90	40,000
R0.2	**0.5**	1.25	0.03	0.03	720	40,000	0.009	0.02	580	40,000	0.009	0.02	420	35,000
	0.8	2	0.02	0.03	720	40,000	0.008	0.02	580	40,000	0.008	0.02	420	35,000
	1	2.5	0.02	0.03	720	40,000	0.008	0.02	580	40,000	0.008	0.02	400	35,000
	1.5	3.75	0.01	0.02	500	40,000	0.005	0.01	400	40,000	0.005	0.01	280	35,000
	2	5	0.007	0.01	380	40,000	0.005	0.007	300	40,000	0.005	0.007	220	35,000
	2.5	6.25	0.005	0.007	300	40,000	0.003	0.005	260	40,000	0.003	0.005	190	35,000
R0.25	**1**	2	0.02	0.03	860	40,000	0.01	0.02	650	35,000	0.01	0.02	450	30,000
	1.5	3	0.01	0.03	720	40,000	0.007	0.02	520	35,000	0.007	0.02	350	30,000
	2	4	0.01	0.02	650	40,000	0.007	0.01	400	35,000	0.007	0.01	270	30,000
	2.5	5	0.007	0.01	530	40,000	0.005	0.007	360	35,000	0.005	0.007	240	30,000
	3	6	0.007	0.01	420	35,000	0.005	0.007	320	35,000	0.005	0.007	220	30,000
R0.3	**1**	1.7	0.03	0.06	1,000	40,000	0.02	0.05	720	30,000	0.02	0.05	540	25,000
	1.5	2.5	0.03	0.06	1,000	40,000	0.02	0.05	720	30,000	0.02	0.05	540	25,000
	2	3.3	0.03	0.06	1,000	40,000	0.02	0.05	720	30,000	0.02	0.05	540	25,000
	2.5	4.1	0.02	0.04	840	40,000	0.02	0.03	640	30,000	0.02	0.03	480	25,000
	3	5	0.02	0.04	840	40,000	0.02	0.03	600	30,000	0.02	0.03	450	25,000
	3.5	5.9	0.01	0.03	600	30,000	0.01	0.02	420	30,000	0.01	0.02	310	25,000
	4	6.7	0.01	0.03	600	30,000	0.01	0.02	420	30,000	0.01	0.02	310	25,000
R0.4	**2**	2.5	0.07	0.1	1,600	35,000	0.05	0.1	1,200	30,000	0.03	0.1	900	25,000
	3	3.75	0.05	0.1	1,600	35,000	0.05	0.05	1,200	30,000	0.03	0.05	900	25,000
	4	5	0.04	0.06	1,200	30,000	0.03	0.05	860	25,000	0.02	0.05	640	20,000
	5	6.25	0.03	0.05	1,000	25,000	0.02	0.03	620	25,000	0.015	0.03	460	20,000
R0.5	**2**	2	0.1	0.2	2,000	30,000	0.08	0.1	1,400	25,000	0.05	0.1	1,000	20,000
	2.5	2.5	0.1	0.2	2,000	30,000	0.08	0.1	1,400	25,000	0.05	0.1	1,000	20,000
	3	3	0.1	0.2	2,000	30,000	0.08	0.1	1,400	25,000	0.05	0.1	1,000	20,000
	4	4	0.05	0.15	1,600	28,000	0.05	0.1	1,200	25,000	0.03	0.1	900	20,000
	5	5	0.04	0.1	1,400	25,000	0.03	0.05	920	20,000	0.02	0.05	700	16,000
	6	6	0.04	0.05	1,200	22,000	0.02	0.05	740	20,000	0.015	0.05	550	16,000

Work Material			High Speed Steels / Hardened Steels SKH51・SKD11 (～62HRC)				High Speed Steels SKH55・HAP40 (～66HRC)				High Speed Steels SKH57・HAP72 (～70HRC)			
Radius	Under Neck Length	L/D	Depth of Cut		Feed	Spindle Speed	Depth of Cut		Feed	Spindle Speed	Depth of Cut		Feed	Spindle Speed
			ap mm	ae mm	mm/min	min^{-1}	ap mm	ae mm	mm/min	min^{-1}	ap mm	ae mm	mm/min	min^{-1}
R0.6	2.4	2	0.1	0.2	2,000	30,000	0.08	0.1	1,600	25,000	0.05	0.1	1,200	20,000
	4	3.3	0.1	0.2	2,000	30,000	0.06	0.1	1,600	25,000	0.05	0.1	1,200	20,000
	6	5	0.05	0.1	1,400	25,000	0.03	0.07	1,000	20,000	0.02	0.07	750	16,000
	8	6.7	0.03	0.07	1,200	22,000	0.02	0.05	850	20,000	0.015	0.05	650	16,000
R0.75	3	2	0.1	0.3	2,500	30,000	0.1	0.2	2,000	25,000	0.06	0.2	1,500	20,000
	4	2.7	0.1	0.3	2,000	25,000	0.1	0.2	1,600	22,000	0.06	0.2	1,200	18,000
	6	4	0.1	0.2	1,600	22,000	0.1	0.1	1,200	20,000	0.06	0.1	950	16,000
	8	5.3	0.05	0.2	1,400	20,000	0.05	0.1	1,000	18,000	0.03	0.1	700	13,000
	10	6.7	0.05	0.1	1,200	18,000	0.05	0.05	850	16,000	0.03	0.05	650	13,000
R0.8	8	5	0.07	0.2	1,400	20,000	0.05	0.1	1,000	16,000	0.03	0.1	750	13,000
R1	3	1.5	0.2	0.5	2,500	25,000	0.15	0.3	2,000	20,000	0.1	0.3	1,500	16,000
	4	2	0.2	0.5	2,500	25,000	0.15	0.3	2,000	20,000	0.1	0.3	1,500	16,000
	6	3	0.2	0.3	2,000	22,000	0.15	0.3	1,600	20,000	0.1	0.3	1,200	16,000
	8	4	0.1	0.2	1,600	18,000	0.1	0.15	1,200	16,000	0.06	0.15	950	13,000
	10	5	0.1	0.2	1,400	16,000	0.1	0.1	1,000	14,000	0.06	0.1	750	11,000
	12	6	0.07	0.1	1,200	14,000	0.05	0.1	850	12,000	0.03	0.1	650	9,500
R1.25	6	2.4	0.2	0.5	2,500	20,000	0.15	0.4	2,000	18,000	0.1	0.4	1,500	14,000
	8	3.2	0.2	0.3	2,100	20,000	0.15	0.3	1,800	18,000	0.1	0.3	1,300	14,000
	10	4	0.15	0.2	1,800	18,000	0.1	0.15	1,500	16,000	0.06	0.15	1,100	13,000
	15	6	0.07	0.15	1,200	14,000	0.05	0.1	900	12,000	0.03	0.1	700	9,500
R1.5	6	2	0.2	0.6	2,500	18,000	0.2	0.5	2,000	15,000	0.12	0.5	1,500	12,000
	8	2.7	0.2	0.6	2,500	18,000	0.2	0.5	2,000	15,000	0.12	0.5	1,500	12,000
	10	3.3	0.2	0.4	2,100	18,000	0.15	0.3	1,800	15,000	0.1	0.3	1,300	12,000
	12	4	0.2	0.4	2,000	18,000	0.1	0.3	1,500	15,000	0.06	0.3	1,100	12,000
	14	4.7	0.1	0.3	1,600	16,000	0.1	0.2	1,200	12,000	0.06	0.2	900	10,000
	16	5.3	0.1	0.3	1,600	16,000	0.1	0.2	1,200	12,000	0.06	0.2	900	10,000
	20	6.7	0.08	0.2	1,200	14,000	0.08	0.1	850	12,000	0.06	0.1	650	9,500
R2	8	2	0.2	0.8	2,500	15,000	0.2	0.6	2,000	12,000	0.15	0.6	1,500	9,500
	10	2.5	0.2	0.8	2,500	15,000	0.2	0.6	2,000	12,000	0.15	0.6	1,500	9,500
	12	3	0.2	0.8	2,500	15,000	0.2	0.6	2,000	12,000	0.15	0.6	1,500	9,500
	15	3.75	0.2	0.8	2,000	15,000	0.15	0.6	1,600	12,000	0.12	0.6	1,200	9,500
	20	5	0.1	0.6	1,700	14,000	0.1	0.4	1,200	10,000	0.08	0.4	900	8,000
	25	6.25	0.1	0.4	1,200	14,000	0.1	0.2	850	10,000	0.08	0.2	650	8,000
R2.5	10	2	0.2	1.2	2,500	12,000	0.2	0.7	2,000	10,000	0.15	0.7	1,500	8,000
	15	3	0.2	1.2	2,500	12,000	0.2	0.7	2,000	10,000	0.15	0.7	1,500	8,000
	20	4	0.2	1	2,000	10,000	0.15	0.6	1,600	8,500	0.12	0.6	1,200	6,500
R3	10	1.7	0.3	1.2	2,500	8,000	0.2	1	2,000	7,000	0.15	1	1,500	5,500
	15	2.5	0.3	1.2	2,500	8,000	0.2	1	2,000	7,000	0.15	1	1,500	5,500
	20	3.3	0.3	1.2	2,500	8,000	0.2	1	2,000	7,000	0.15	1	1,500	5,500
	25	4.1	0.2	1	2,200	8,000	0.15	0.7	1,600	7,000	0.12	0.7	1,200	5,500
	30	5	0.2	1	1,800	7,000	0.15	0.7	1,300	6,500	0.12	0.7	950	5,000

Notes

※1 Depth of cut ap indicates Axial Depth of Cut, ae indicates Radial Depth of Cut.

※2 In case of chattering etc., please adjust cutting conditions if necessary.

※3 At point where cutting load is high such as at corners, pay attention to setting cutting conditions and tool paths particularly.

※4 Adjust both spindle speed and feed at the same rate.

※5 A shrink fit type is recommended for holding tool. When using collet type or others, strictly adhere to minimum gripping length.

※6 We recommend using oil mist coolant.

Machining case 1

Material : **HAP72 (70HRC)**

Coolant : **Oil mist**

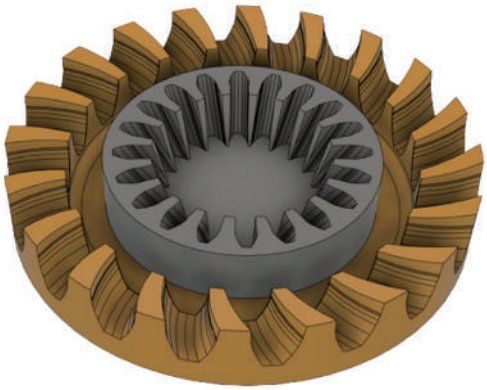
Total machining time : **11hr 33min**

Work size : Φ 40 (Base 50×45 mm)

Cutting depth : 6mm

Peripheral gear

Peripheral gear machining time : **6hr 57min**

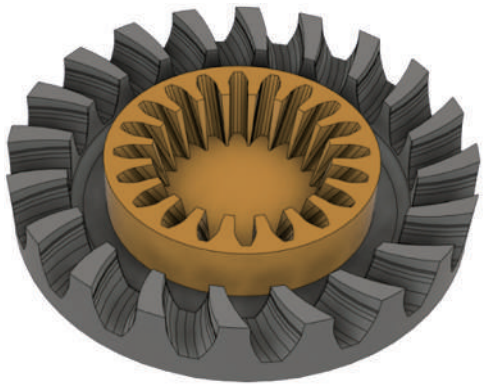


Milling part

Process	Roughing	Semi-finishing	Finishing
Tool	MRBSH230SF R1×6	MRBSH230SF R1×6	MRBSH230SF R1×6
Spindle speed [min^{-1}]	12,000		
Feed [mm/min]	1,800		1,200
Depth of cut [mm]	ap 0.06 ae 0.3	Pick feed 0.1	Pick feed 0.03
Stock [mm]	0.03	0.01	—
Machining time	2hr 36min	51 min	3hr 30min

Inside gear

Inside gear machining time : **4hr 36min**

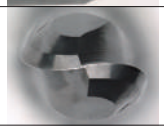
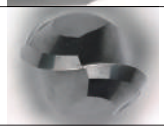


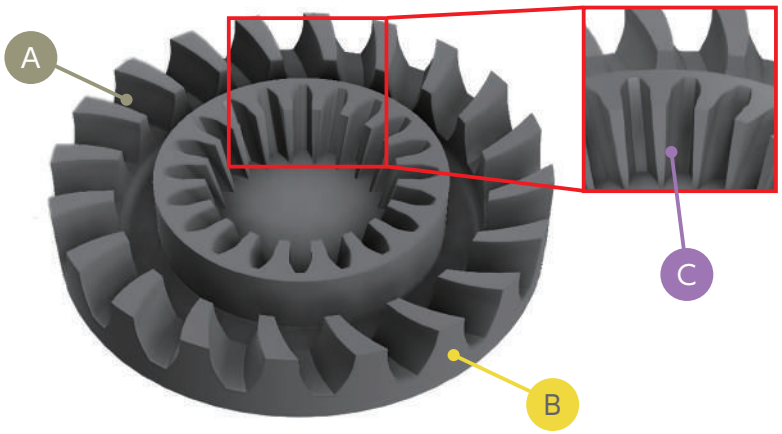
Milling part

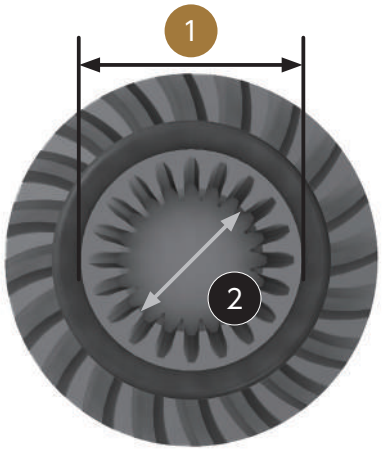
Process	Roughing	Semi-finishing	Finishing
Tool	MRBSH230SF R0.5×6	MRBSH230SF R0.5×6	MRBSH230SF R0.5×6
Spindle speed [min^{-1}]	14,000		
Feed [mm/min]	1,000		700
Depth of cut [mm]	ap 0.03 ae 0.15	Pick feed 0.05	Pick feed 0.02
Stock [mm]	0.03	0.01	—
Machining time	3hr 6min	22 min	1hr 8min

Tool wear

Cutting condition
n= 12,000 min^{-1}, Roughing / Semi-finishing Vf= 1,800 mm/min, Finishing Vf= 1,200 mm/min

Tool wear after cutting on HAP72 (70HRC)	MRBSH230SF R1 × 6		
	Roughing 2hr 36min	Semi-finishing 51 min	Finishing 3hr 30min
Rake face			
Peripheral cutting edge			
R end cutting edge			





Roughness

Unit [μm]

	A	B	C
Tool	MRBSH230SF R1×6		MRBSH230SF R0.5×6
Ra	0.133	0.137	0.282
Rz	0.815	1.336	1.676

Measuring instrument: Keyence VK-X250

Accuracy

Unit [mm]

	1	2
Tool	MRBSH230SF R1×6	MRBSH230SF R0.5×6
Target	24.500	15.480
Actual	24.505	15.472
Error	0.005	0.008

Measuring instrument : Nikon microscope MM-60

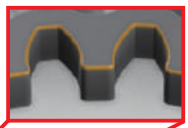
Machining Case 2

Fine blanking machining sample

Material：**YXR3 （61HRC）**
Coolant：**Oil mist**
Total machining time：**7hr 27min**
Work size：60×60mm
Cutting depth：4mm

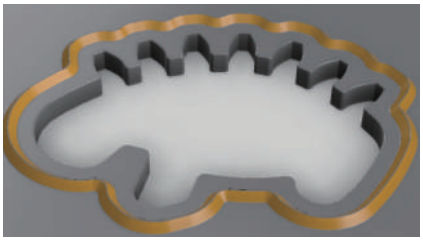
※Total machining time includes WEDM process (white part) both blank holder part and die part

Milling part



Blank holder

Machining time : 5hr 41min



Milling part

Die

Machining time : 1hr 46min

Process		Roughing	Semi-Finishing	Stock removal	Finishing	Stock removal	Stock removal		Roughing	Finishing
Tool	Blank holder	MRBSH230SF R1×4		MRBSH230SF R0.5×2		MRBSH230SF R0.25×1.5	MRBSH230SF R0.2×1	Die	MRBSH230SF R0.25×1.5	MRBSH230SF R0.2×1
Spindle speed [min^{-1}]		25,000		30,000					30,000	
Feed [mm/min]		2,500		1,000		540	540		540	
Depth of cut [mm]		ap 0.2 ae 0.5	Pick feed 0.05		pf:0.03		pf:0.02		ap 0.01 ae 0.03	pf:0.01
Stock [mm]		0.03	0.01		– (Only corner part 0.005)		–		0.003	–
Machining time		39 min	40 min	1hr 3min		47 min	1hr 26min		1hr 11min	35 min

※ pf : pick feed

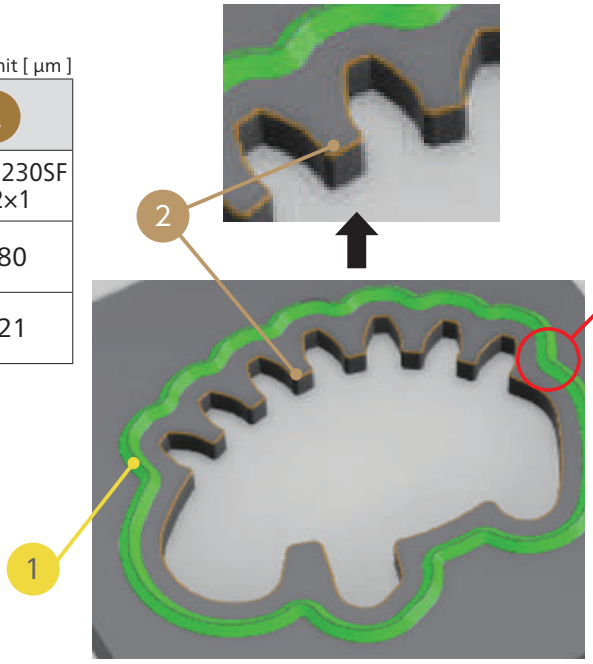
※ pf : pick feed

Roughness

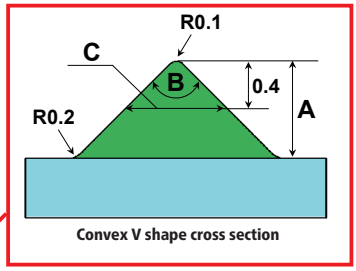
Unit [μm]

	1	2
Tool	MRBSH230SF R0.5×2	MRBSH230SF R0.2×1
Ra	0.145	0.080
Rz	1.192	0.521

Measuring instrument : Keyence VK-X250



Accuracy



	A	B	C
Target	0.958mm	90°0′00″	0.883mm
Actual	0.958mm	90°15′10″	0.888mm
Error	0.000mm	0°15′10″	0.005mm

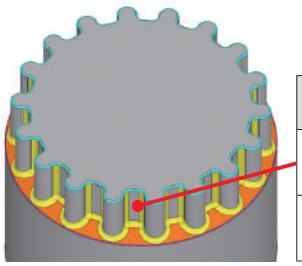
Measuring instrument : Keyence VK-X250

Machining Case 3

Material：**HAP40 （65HRC）**
Coolant：**Oil mist**
Total machining time：**8hr 46min**
Work size：Φ 25×50mm
Cutting depth：6mm

Process	Roughing	Stock removal	Semi-finishing	Finishing
Tool	MRBSH230SF R1×6	MRBSH230SF R0.5×5	MRBSH230SF R0.5×5	MRBSH230SF R0.5×5
Spindle speed [min^{-1}]	20,000			12,000
Feed [mm/min]	1,600	920	920	460
Depth of cut [mm] ap × ae	0.15×0.3	0.03×0.1	Side face: 0.03×0.02 Surface: 0.02×0.05	Pick feed 0.015
Stock [mm]	0.03		0.01	—
Machining time	24 min	3hr 8min	1hr 8min	4hr 6min

Roughness

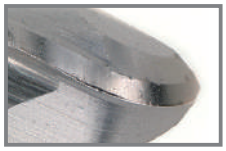


Unit [μm]

	Side face
Ra	0.031
Rz	0.225

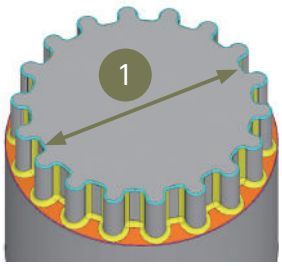
Measuring Instrument : Keyence VK-X250

R edge retreat amount 0.003mm after side finishing for 2 hours



0.003mm

Accuracy

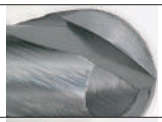
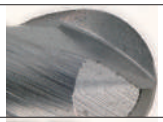


Unit [mm]

	1
Target	20.644
Actual	20.647
Error	0.003

Measuring instrument : Nikon microscope MM-60

Tool wear

Process	Roughing	Stock removal	Semi-finishing	Finishing
Tool	MRBSH230SF R1×6	MRBSH230SF R0.5×5	MRBSH230SF R0.5×5	MRBSH230SF R0.5×5
Rake side				
Peripheral cutting edge				
R end cutting edge				

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CAUTION **Attention on Safety**

1) When removing tools from cases, be careful of getting-out of tools and don't touch directly the cutting edges.
2) Never touch the cutting edges directly with bare hand.
3) Use safety covers and eye protection, as tools may be broken.
4) Use holders, etc. that match the tools and nature of the processing operations. The tool should be firmly attached to the holder to prevent shaking.
5) The work materials clamp firmly.
6) Make sure of dimensions of tools and work pieces before starting operation.
7) It is necessary to adjust conditions according to the dimensions of work materials and the machine.
8) Select a cutting fluid appropriate to the particular usage. Using a non-water cutting fluid could lead to fires due to sparks generated during processing or heat caused by breakage. Ensure that you take proper fire-prevention measures.
9) If abnormal sound, etc. occurs during processing, stop the machine immediately.
10) Don't modify tools.

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ISO 9001 JQA-QM6096 ISO 14001 JQA-EM3712

VEGETABLE OIL INK

■ Specifications may change without notice for improvement.

MRBSH230SF_A1_202207_EN_A