UNION TOOL

Tungsten Carbide End Mills
UNIMAX Series

Vol.3
Published November 2023

HMWCOAT 2 Flutes　Long Neck Ball End Mills

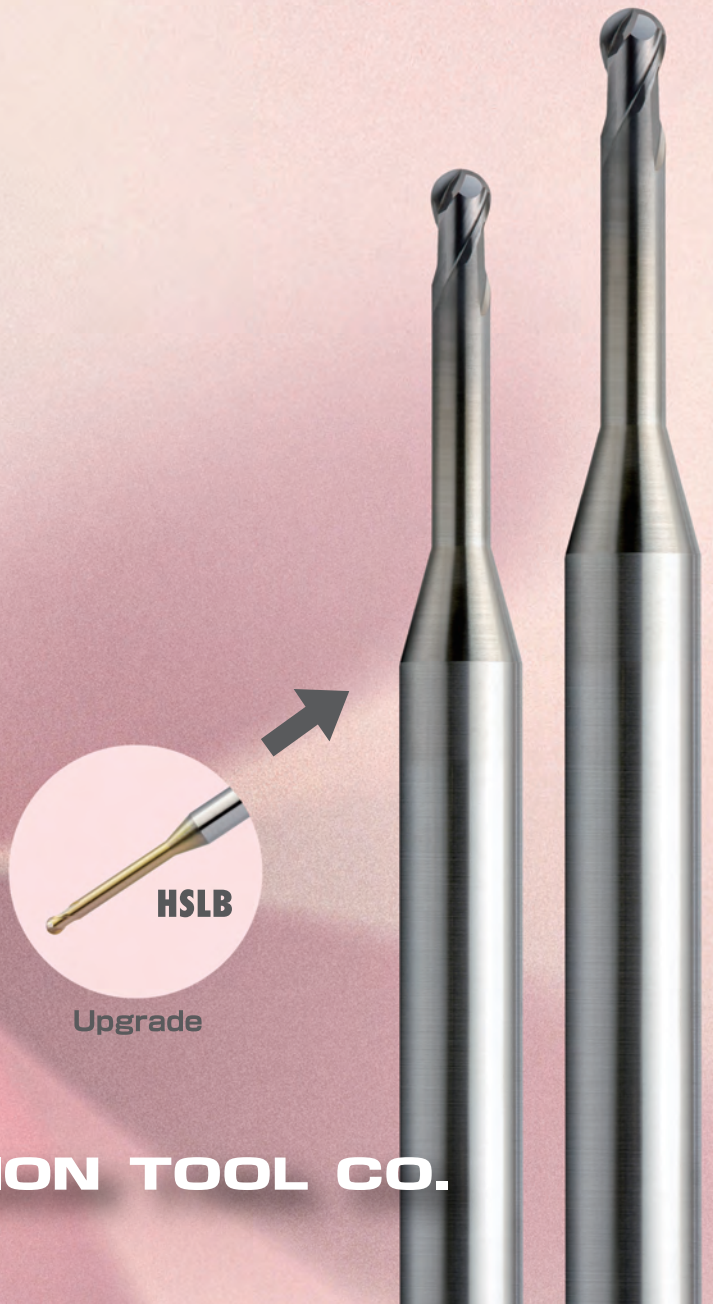
Add 81
Total 201 Models

HWLB

Best performance at 50-60HRC

Suitable for a wide range of materials

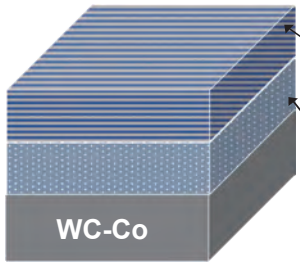
Cost-efficient



UNION TOOL CO.

New coating HMWCOAT

Upgraded version of HARDMAX coating with improved wear resistance.



Ultra-high hardness layer

- Increased numbers of layers by nano-laminated structure.
- Longer tool life due to wear resistance and the suppression of crack propagation.

Shock absorption layer

New nanocomposite structure improves hardness and toughness.

Tool Design

With the same tool shape as our long-selling HSLB, the transition from HSLB is made easy.

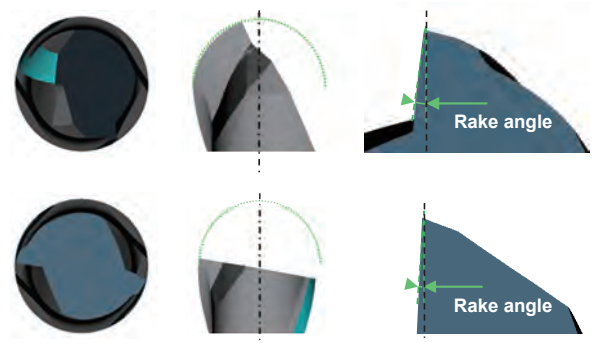
Variable rake angle design

Tip point

Negative rake angle design prevents fracture and chipping.

Peripheral cutting edge

Slightly negative rake angle design reduces cutting resistance and prevents chattering.



High Precision

Even higher accuracy than before!

Conventional HSLB

Radius of Ball Nose	Ball Radius Accuracy	Diameter Tolerance	Shank Diameter Tolerance
R0.05 ～ R0.075	± 0.002	0/-0.01	0/-0.005
R0.1 ～ R3	± 0.005	0/-0.015	

HWLB

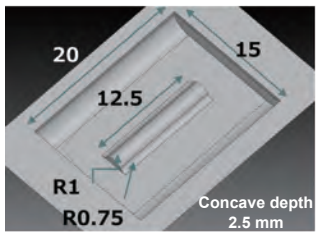
Unit (mm)

Radius of Ball Nose	Ball Radius Accuracy	Diameter Tolerance	Shank Diameter Tolerance	Helix Angle
R0.05 ～ R0.075	± 0.002	0/-0.006	h4	0°
R0.1 ～ R1.25	± 0.003			
R1.5 ～ R3		0/-0.009		

Improved wear resistance (50 HRC)

Relief wear width comparison
R0.5 × EL2.5

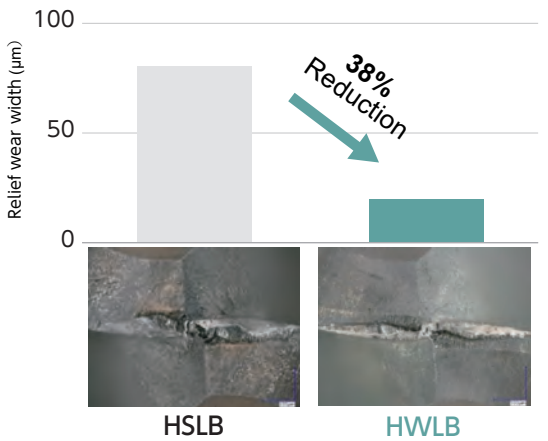
STAVAX（52 HRC）/SKD61（50 HRC）



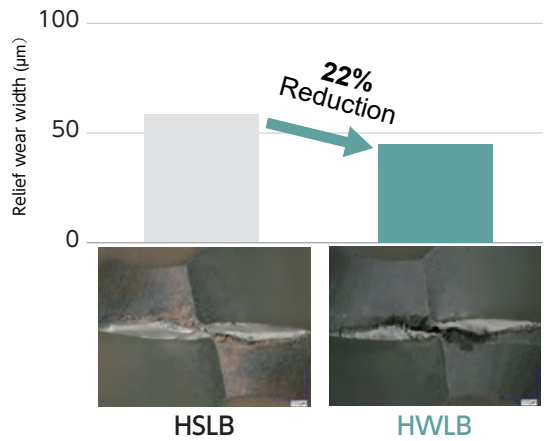
Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Allowance (mm)	Cycle Time 1pc (m:s)
30,000	1,750	0.1	0.3	0.03	22:50

Coolant: Air Blow

STAVAX（52 HRC）120 min

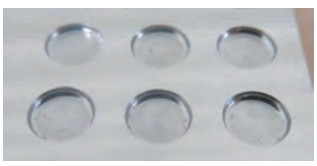


SKD61（50 HRC）60 min



Comparison with competitor's tool for hard materials
R0.5 × EL12

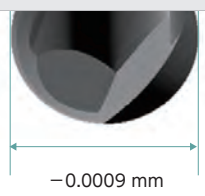
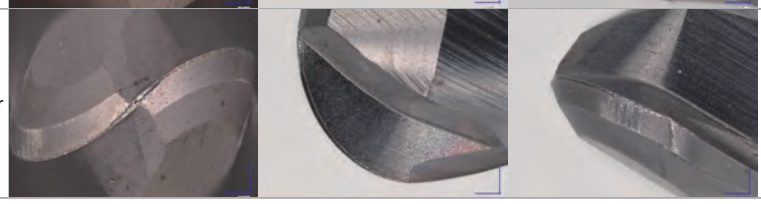
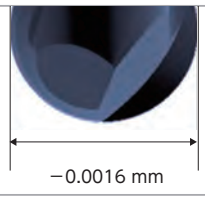
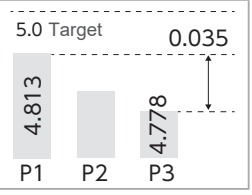
STAVAX（52 HRC）



Pocket Size
Ø5 × Depth 0.7 mm

Coolant:
Air Blow

Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Cycle Time 1 Pocket
14,150	320	0.015	0.12	20 min

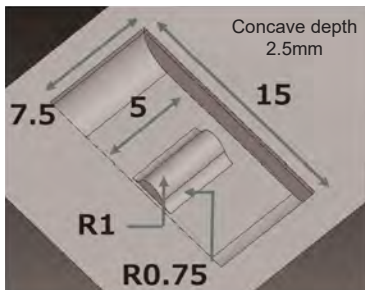
	Tool after milling 20 min x 3 pockets	**Diameter reduction amount** 20 min x 3 pockets	**Work piece dimensional change** **Actual measurements of circle pocket (mm)** 20 min x 3 pockets
HWLB		 −0.0009 mm	
Competitor		 −0.0016 mm	

HWLB achieves less wearing at the peripheral cutting edge which results in smaller dimensional changes on the work piece and excellent milling accuracy.

Improved wear resistance (60 HRC)

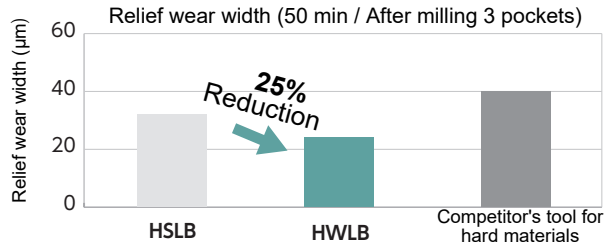
Roughing Wear comparison HWLB, HSLB and competitor's tool for hard materials R0.5 × EL2.5

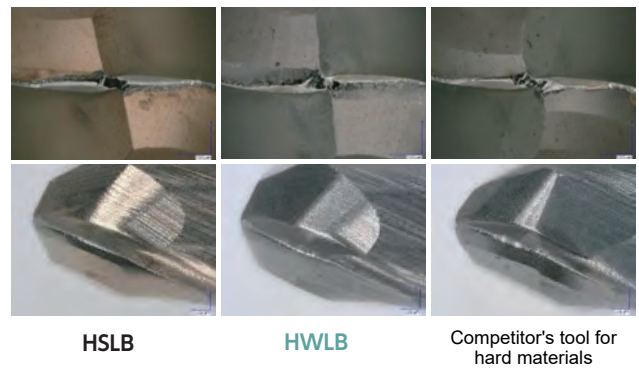
SKD11（60 HRC）



Coolant: Air Blow

Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Allowance (mm)	Cycle Time 1 pc (m:s)
24,000	2,000	0.05	0.2	0.03	16:11

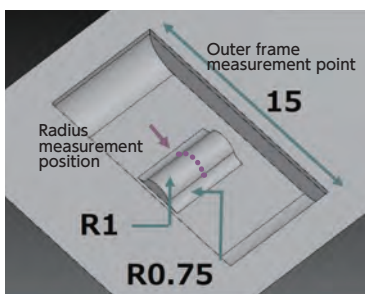




Less tool damage when roughing large areas as compared to the conventional HSLB and the competitor's tool.

Finishing: Milling dimensional error comparison between HWLB, HSLB and competitor's tool for hard materials R0.5 × EL2.5

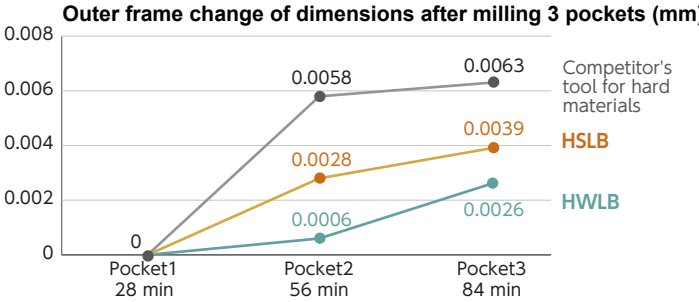
SKD11 (60 HRC)



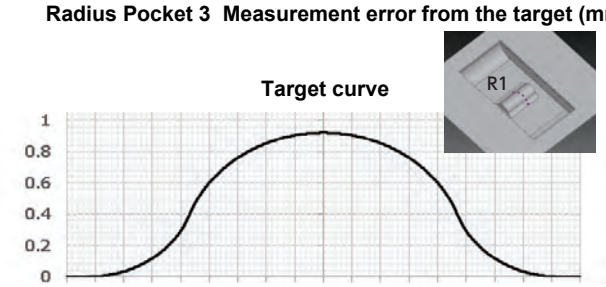
Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Cycle Time 1 pc
24,000	1,000	0.01	0.01	28 min

Coolant: Air Blow

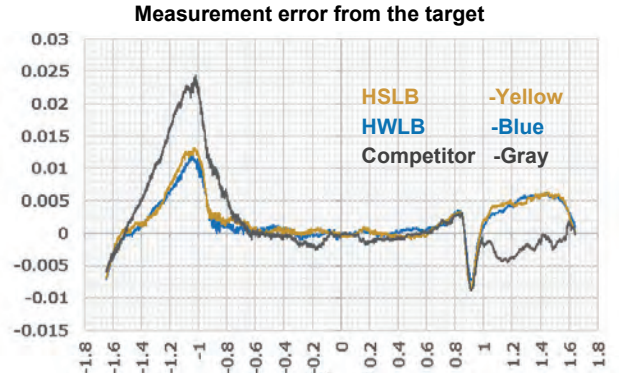
Outer frame change of dimensions after milling 3 pockets (mm)



Radius Pocket 3 Measurement error from the target (mm)



Measurement error from the target

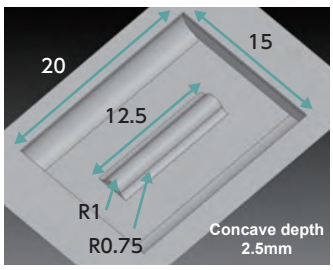


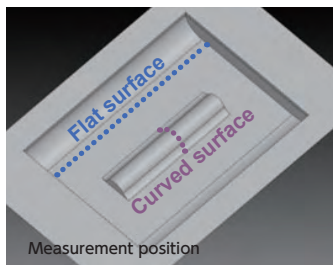
Offers higher milling accuracy as compared to our conventional tools and the competitor's tools, even with hard materials of 60 HRC.

Finishing roughness and dimensional error

**Milled surface quality remains very good.
The finishing roughness is almost the same as conventional tools.**

Finishing after milling 6 pockets (360min) Surface roughness comparison
HWLB and HSLB R0.5 × EL2.5 **STAVAX (52 HRC)**

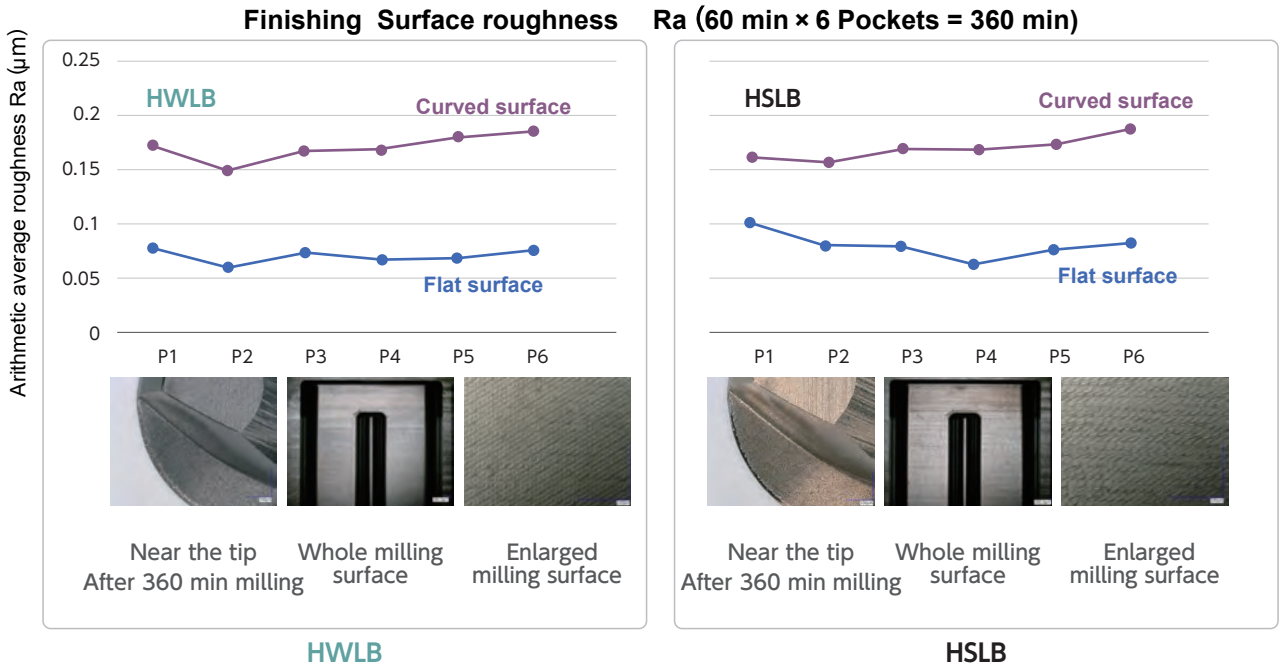




Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Allowance (mm)	Cycle Time 1pc
30,000	1,000	0.01	0.01	0	60 min

Coolant: Oil Mist

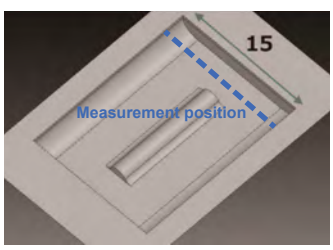
Finishing Surface roughness Ra (60 min × 6 Pockets = 360 min)



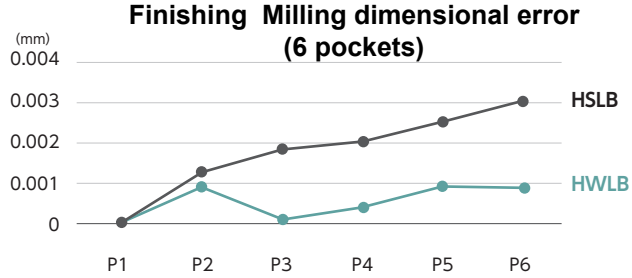
HWLB HSLB

**Both HSLB and HWLB maintain excellent surface roughness on flat/curved surfaces until the 6th pocket.
Minimal wear near the tip of the tool allows for continuous milling.**

Finishing after milling 6 pockets (360 min) Milling dimensional error comparison
HWLB and HSLB R0.5 × EL2.5 **STAVAX (52 HRC)**



Finishing Milling dimensional error (6 pockets)



**Surface roughness between HSLB and HWLB show minor differences.
Meanwhile HWLB makes smaller milling dimensional error due to the improved wear resistance.**

HWLB

Additional 81 models

HMWCOAT 2 Flutes　Long Neck Ball End Mills

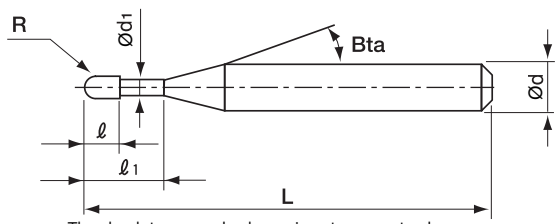
R0.05～R3

Super MG　HMW COAT　Back Taper Geometry

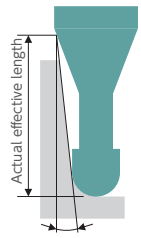
Back taper geometry does not apply below R0.25.
Back taper geometry does not apply on R0.25 ≦ R ≦ R0.45 and ℓ1/D ≦ 10.

Material Applications (★ Highly Recommended ● Recommended ○ Suggested)

Work Material															
CARBON STEELS S45C S55C	ALLOY STEELS SK / SCM SUS	PREHARDENED STEELS NAK HPM	HARDENED STEELS ～50 HRC	～55 HRC	～60 HRC	～65 HRC	～70 HRC	CAST IRON	ALUMINUM ALLOYS	GRAPHITE	COPPER	PLASTICS	GLASS FILLED PLASTICS	TITANIUM ALLOYS	HEAT RESISTANT ALLOYS	CEMENTED CARBIDE	HARD BRITTLE (NON-METALLIC) MATERIALS
○	○	●	★	★	★	●	●	○			○			○	○		



The shank taper angle shown is not an exact value.



• High Accuracy

Even higher accuracy than our conventional tools !

Conventional HSLB

Radius of Ball Nose	Ball Radius Accuracy	Diameter Tolerance	Shank Diameter Tolerance
R0.05 ～ R0.075	± 0.002	0/-0.01	0/-0.005
R0.1 ～ R3	± 0.005	0/-0.015	

HWLB

Unit (mm)

Radius of Ball Nose	Ball Radius Accuracy	Diameter Tolerance	Shank Diameter Tolerance	Helix Angle
R0.05 ～ R0.075	± 0.002	0/-0.006	h4	0°
R0.1 ～ R1.25	± 0.003			30°
R1.5 ～ R3		0/-0.009		

• Upgrade

Wear resistance and tool accuracy have been improved with HWLB and CWLB series.

		CSELB			HSLB			HGLB
Copper	Raw Materials	～30 HRC	～40 HRC	～50 HRC	～55 HRC	～60 HRC	～65 HRC	～70 HRC

		CWLB			HWLB			HGLB
Copper	Raw Materials	～30 HRC	～40 HRC	～50 HRC	～55 HRC	～60 HRC	～65 HRC	～70 HRC

Total 201 models

Unit (mm)

	Model Number	Radius of Ball Nose R	Effective Length ℓ1	Length of Cut ℓ	Neck Diameter Ød1	Shank Taper Angle Bta	Overall Length L	Shank Diameter Ød	Suggested Retail Price ¥	Effective Length by Inclined Angles 30′	1°	1°30′	2°	3°
※	**HWLB 2001-002**		0.2				45	4	9,300	0.22	0.24	0.26	0.28	0.32
	HWLB 2001-003	**R0.05**	0.3	0.08	0.095	11°	45	4	9,300	0.33	0.36	0.38	0.40	0.45
	HWLB 2001-005		0.5				45	4	10,030	0.55	0.58	0.61	0.65	0.73
※	**HWLB 20015-003**		0.3				45	4	10,760	0.37	0.39	0.41	0.43	0.48
※	**HWLB 20015-005**	**R0.075**	0.5	0.12	0.135	11°	45	4	11,400	0.58	0.61	0.64	0.67	0.75
※	**HWLB 20015-010**		1				45	4	11,860	1.10	1.16	1.21	1.28	1.44
	HWLB 2002-003		0.3				45	4	6,470	0.42	0.44	0.46	0.48	0.52
	HWLB 2002-005		0.5				45	4	6,470	0.63	0.66	0.68	0.71	0.76
※	**HWLB 2002-0075**		0.75				45	4	6,470	0.89	0.93	0.96	0.99	1.07
	HWLB 2002-010	**R0.1**	1	0.16	0.19	16°	45	4	6,470	1.15	1.20	1.24	1.28	1.37
※	**HWLB 2002-015**		1.5				45	4	7,020	1.66	1.72	1.78	1.84	1.97
※	**HWLB 2002-020**		2				45	4	7,750	2.18	2.25	2.33	2.41	2.58
※	**HWLB 2002-025**		2.5				45	4	8,480	2.70	2.79	2.88	2.98	3.20
※	**HWLB 2002-030**		3				45	4	9,120	3.22	3.32	3.43	3.55	3.81
	HWLB 2003-005		0.5				45	4	6,380	0.63	0.65	0.68	0.70	0.75
※	**HWLB 2003-0075**		0.75				45	4	6,380	0.89	0.92	0.96	0.99	1.05
	HWLB 2003-010		1				45	4	6,380	1.15	1.19	1.23	1.27	1.36
	HWLB 2003-015	**R0.15**	1.5	0.24	0.29	16°	45	4	6,840	1.66	1.72	1.77	1.83	1.96
	HWLB 2003-020		2				45	4	6,840	2.18	2.25	2.32	2.40	2.57
※	**HWLB 2003-025**		2.5				45	4	7,020	2.70	2.78	2.87	2.97	3.18
※	**HWLB 2003-030**		3				45	4	7,020	3.21	3.32	3.42	3.54	3.80
※	**HWLB 2003-040**		4				45	4	7,300	4.25	4.38	4.52	4.68	5.02
	HWLB 2004-005		0.5				45	4	4,380	0.63	0.65	0.68	0.70	0.74
※	**HWLB 2004-0075**		0.75				45	4	4,380	0.89	0.92	0.95	0.98	1.05
	HWLB 2004-010		1				45	4	4,380	1.15	1.19	1.23	1.27	1.35
※	**HWLB 2004-010-6**		1				50	6	6,380	1.15	1.19	1.23	1.27	1.35
	HWLB 2004-015		1.5				45	4	4,470	1.66	1.72	1.77	1.83	1.95
※	**HWLB 2004-015-6**		1.5				50	6	6,470	1.66	1.72	1.77	1.83	1.95
	HWLB 2004-020		2				45	4	4,560	2.18	2.25	2.32	2.40	2.56
※	**HWLB 2004-020-6**	**R0.2**	2	0.32	0.39	16°	50	6	6,660	2.18	2.25	2.32	2.40	2.56
※	**HWLB 2004-025**		2.5				45	4	4,740	2.70	2.78	2.87	2.96	3.18
	HWLB 2004-030		3				45	4	5,020	3.21	3.31	3.42	3.53	3.79
※	**HWLB 2004-030-6**		3				50	6	7,300	3.21	3.31	3.42	3.53	3.79
※	**HWLB 2004-035**		3.5				45	4	5,470	3.73	3.85	3.97	4.10	4.40
	HWLB 2004-040		4				45	4	5,470	4.25	4.38	4.52	4.67	5.01
※	**HWLB 2004-050**		5				45	4	5,740	5.28	5.44	5.62	5.81	6.24
※	**HWLB 2004-060**		6				45	4	6,660	6.31	6.51	6.72	6.95	7.46

※ Additional model

HMWCOAT 2 Flutes Long Neck Ball End Mills

	Model Number	Radius of Ball Nose R	Effective Length ℓ1	Length of Cut ℓ	Neck Diameter Ød1	Shank Taper Angle Bta	Overall Length L	Shank Diameter Ød	Suggested Retail Price ¥	Effective Length by Inclined Angles 30′	1°	1°30′	2°	3°
	HWLB 2005-010		1				45	4	4,380	1.15	1.19	1.22	1.26	1.34
	HWLB 2005-015		1.5				45	4	4,380	1.66	1.71	1.76	1.82	1.94
※	**HWLB 2005-015-6**		1.5				50	6	6,380	1.66	1.71	1.76	1.82	1.94
	HWLB 2005-020		2				45	4	4,380	2.18	2.25	2.31	2.39	2.55
※	**HWLB 2005-020-6**		2				50	6	6,380	2.18	2.25	2.31	2.39	2.55
	HWLB 2005-025		2.5				45	4	4,380	2.70	2.78	2.86	2.96	3.17
	HWLB 2005-030		3				45	4	4,380	3.21	3.31	3.42	3.53	3.78
※	**HWLB 2005-030-6**	**R0.25**	3	0.4	0.49	16°	50	6	6,380	3.21	3.31	3.42	3.53	3.78
※	**HWLB 2005-035**		3.5				45	4	4,380	3.73	3.84	3.97	4.10	4.39
	HWLB 2005-040		4				45	4	4,380	4.24	4.38	4.52	4.67	5.00
※	**HWLB 2005-040-6**		4				50	6	6,380	4.24	4.38	4.52	4.67	5.00
	HWLB 2005-050		5				45	4	4,470	5.28	5.44	5.62	5.80	6.22
	HWLB 2005-060		6				45	4	4,560	6.31	6.50	6.72	6.94	7.45
※	**HWLB 2005-080**		8				45	4	5,470	8.37	8.63	8.92	9.22	9.90
※	**HWLB 2005-100**		10				50	4	6,800	10.43	10.76	11.12	11.50	12.34
	HWLB 2006-010		1				45	4	3,740	1.15	1.18	1.22	1.25	1.33
	HWLB 2006-015		1.5				45	4	3,380	1.66	1.71	1.76	1.81	1.93
	HWLB 2006-015-6		1.5				50	6	5,100	1.66	1.71	1.76	1.81	1.93
	HWLB 2006-020		2				45	4	3,380	2.18	2.24	2.31	2.38	2.54
	HWLB 2006-020-6		2				50	6	5,100	2.18	2.24	2.31	2.38	2.54
	HWLB 2006-025		2.5				45	4	3,460	2.69	2.77	2.86	2.95	3.15
	HWLB 2006-030		3				45	4	3,460	3.21	3.31	3.41	3.52	3.77
	HWLB 2006-030-6		3				50	6	5,200	3.21	3.31	3.41	3.52	3.77
※	**HWLB 2006-035**	**R0.3**	3.5	0.48	0.59	16°	45	4	3,560	3.73	3.84	3.96	4.09	4.38
	HWLB 2006-040		4				45	4	3,560	4.24	4.37	4.51	4.66	4.99
	HWLB 2006-040-6		4				50	6	5,380	4.24	4.37	4.51	4.66	4.99
	HWLB 2006-050		5				45	4	3,560	5.27	5.44	5.61	5.80	6.21
	HWLB 2006-060		6				45	4	3,560	6.30	6.50	6.71	6.94	7.44
※	**HWLB 2006-060-6**		6				50	6	5,380	6.30	6.50	6.71	6.94	7.44
	HWLB 2006-080		8				45	4	4,740	8.37	8.63	8.91	9.21	9.88
	HWLB 2006-100		10				50	4	4,830	10.43	10.76	11.11	11.49	12.33
	HWLB 2008-020		2				45	4	3,380	2.17	2.24	2.30	2.37	2.52
※	**HWLB 2008-020-6**		2				50	6	5,100	2.17	2.24	2.30	2.37	2.52
	HWLB 2008-030		3				45	4	3,560	3.21	3.30	3.40	3.51	3.74
※	**HWLB 2008-030-6**		3				50	6	5,380	3.21	3.30	3.40	3.51	3.74
	HWLB 2008-040		4				45	4	3,560	4.24	4.37	4.50	4.65	4.97
※	**HWLB 2008-040-6**	**R0.4**	4	0.64	0.79	16°	50	6	5,380	4.24	4.37	4.50	4.65	4.97
	HWLB 2008-050		5				45	4	3,560	5.27	5.43	5.60	5.78	6.19
	HWLB 2008-060		6				45	4	3,560	6.30	6.50	6.70	6.92	7.42
	HWLB 2008-080		8				45	4	3,560	8.36	8.62	8.90	9.20	9.86
	HWLB 2008-100		10				50	4	4,740	10.43	10.75	11.10	11.48	12.31
※	**HWLB 2008-120**		12				50	4	5,840	12.49	12.88	13.30	13.75	14.76

※ Additional model

	Model Number	Radius of Ball Nose R	Effective Length ℓ1	Length of Cut ℓ	Neck Diameter Ød1	Shank Taper Angle Bta	Overall Length L	Shank Diameter Ød	Suggested Retail Price ¥	Effective Length by Inclined Angles 30′	1°	1°30′	2°	3°
	HWLB 2010-020	R0.5	2	0.8	0.98	16°	45	4	2,820	2.18	2.24	2.30	2.36	2.51
	HWLB 2010-025		2.5				45	4	2,820	2.70	2.77	2.85	2.93	3.12
	HWLB 2010-030		3				45	4	2,820	3.21	3.30	3.40	3.50	3.73
	HWLB 2010-030-6		3				50	6	4,470	3.21	3.30	3.40	3.50	3.73
	HWLB 2010-040		4				45	4	3,190	4.24	4.37	4.50	4.64	4.96
	HWLB 2010-040-6		4				50	6	4,930	4.24	4.37	4.50	4.64	4.96
	HWLB 2010-050		5				45	4	3,190	5.28	5.43	5.60	5.78	6.18
	HWLB 2010-050-6		5				50	6	4,930	5.28	5.43	5.60	5.78	6.18
	HWLB 2010-060		6				45	4	3,460	6.31	6.50	6.70	6.92	7.40
	HWLB 2010-060-6		6				50	6	5,200	6.31	6.50	6.70	6.92	7.40
	HWLB 2010-070		7				45	4	3,460	7.34	7.56	7.80	8.06	8.63
	HWLB 2010-080		8				45	4	3,460	8.37	8.63	8.90	9.20	9.85
	HWLB 2010-080-6		8				50	6	5,200	8.37	8.63	8.90	9.20	9.85
	HWLB 2010-090		9				45	4	3,460	9.40	9.69	10.00	10.34	11.08
	HWLB 2010-100		10				45	4	3,460	10.43	10.76	11.10	11.47	12.30
	HWLB 2010-100-6		10				50	6	5,200	10.43	10.76	11.10	11.47	12.30
	HWLB 2010-120		12				45	4	3,460	12.50	12.89	13.30	13.75	14.75
	HWLB 2010-140		14				50	4	4,020	14.56	15.02	15.51	16.03	17.19
※	HWLB 2010-140-6		14				60	6	5,660	14.56	15.02	15.51	16.03	17.19
	HWLB 2010-160		16				50	4	4,740	16.62	17.15	17.71	18.31	19.64
※	HWLB 2010-180		18				55	4	4,740	18.68	19.28	19.91	20.58	22.09
※	HWLB 2010-200		20				55	4	5,740	20.75	21.41	22.11	22.86	24.54
※	HWLB 2012-030	R0.6	3	0.96	1.19	16°	45	4	4,290	3.07	3.15	3.24	3.33	3.54
	HWLB 2012-040		4				45	4	4,290	4.10	4.21	4.34	4.47	4.76
	HWLB 2012-060		6				45	4	4,650	6.16	6.34	6.54	6.75	7.21
	HWLB 2012-080		8				45	4	4,650	8.22	8.47	8.74	9.02	9.66
※	HWLB 2012-100		10				45	4	4,650	10.29	10.60	10.94	11.30	12.10
	HWLB 2012-120		12				45	4	4,650	12.35	12.73	13.14	13.58	14.55
※	HWLB 2012-160		16				50	4	5,470	16.47	16.99	17.54	18.13	19.45
	HWLB 2015-030	R0.75	3	1.2	1.47	16°	45	4	3,280	3.10	3.18	3.26	3.35	3.55
	HWLB 2015-040		4				45	4	3,280	4.13	4.24	4.36	4.49	4.77
	HWLB 2015-060		6				45	4	3,280	6.19	6.37	6.56	6.76	7.22
	HWLB 2015-060-6		6				50	6	5,290	6.19	6.37	6.56	6.76	7.22
	HWLB 2015-080		8				45	4	3,460	8.25	8.50	8.76	9.04	9.67
※	HWLB 2015-080-6		8				50	6	5,290	8.25	8.50	8.76	9.04	9.67
	HWLB 2015-100		10				45	4	3,740	10.32	10.63	10.96	11.32	12.11
	HWLB 2015-100-6		10				50	6	5,290	10.32	10.63	10.96	11.32	12.11
	HWLB 2015-120		12				45	4	4,020	12.38	12.76	13.16	13.60	14.56
	HWLB 2015-140		14				50	4	4,020	14.44	14.89	15.36	15.87	17.01
	HWLB 2015-160		16				50	4	4,020	16.50	17.02	17.57	18.15	19.46
	HWLB 2015-180		18				55	4	4,020	18.57	19.15	19.77	20.43	21.90
※	HWLB 2015-200		20				55	4	4,020	20.63	21.28	21.97	22.71	24.35
※	HWLB 2015-250		25				65	4	5,600	25.79	26.60	27.47	28.40	No Interference

※ Additional model

	Model Number	Radius of Ball Nose R	Effective Length ℓ1	Length of Cut ℓ	Neck Diameter Ød1	Shank Taper Angle Bta	Overall Length L	Shank Diameter Ød	Suggested Retail Price ¥	Effective Length by Inclined Angles 30′	1°	1°30′	2°	3°
	HWLB 2016-040	R0.8	4	1.28	1.58	16°	45	4	4,560	4.11	4.22	4.34	4.46	4.74
	HWLB 2016-080		8				45	4	4,650	8.23	8.48	8.74	9.02	9.64
	HWLB 2016-120		12				45	4	4,650	12.36	12.74	13.14	13.57	14.53
	HWLB 2016-160		16				50	4	4,650	16.49	17.00	17.54	18.12	19.42
※	HWLB 2016-200		20				55	4	4,650	20.61	21.26	21.94	22.68	No Interference
※	HWLB 2018-060	R0.9	6	1.44	1.78	16°	45	4	3,800	6.17	6.34	6.53	6.72	7.17
※	HWLB 2018-100		10				45	4	4,020	10.29	10.60	10.93	11.28	12.06
※	HWLB 2018-160		16				50	4	4,020	16.48	16.99	17.53	18.11	19.40
※	HWLB 2018-200		20				55	4	4,020	20.61	21.25	21.93	22.67	No Interference
※	HWLB 2018-300		30				70	4	6,340	30.92	31.90	32.94	No Interference	No Interference
	HWLB 2020-030	R1	3	1.6	1.98	16°	45	4	2,820	3.07	3.14	3.21	3.29	3.47
	HWLB 2020-040		4				45	4	2,820	4.10	4.21	4.32	4.43	4.70
	HWLB 2020-040-6		4				50	6	4,470	4.10	4.21	4.32	4.43	4.70
	HWLB 2020-060		6				45	4	3,190	6.17	6.33	6.52	6.71	7.14
	HWLB 2020-060-6		6				50	6	4,830	6.17	6.33	6.52	6.71	7.14
	HWLB 2020-080		8				45	4	3,460	8.23	8.46	8.72	8.99	9.59
	HWLB 2020-080-6		8				50	6	5,200	8.23	8.46	8.72	8.99	9.59
	HWLB 2020-100		10				45	4	3,460	10.29	10.59	10.92	11.27	12.04
	HWLB 2020-100-6		10				50	6	5,200	10.29	10.59	10.92	11.27	12.04
	HWLB 2020-120		12				45	4	3,460	12.35	12.72	13.12	13.54	14.49
	HWLB 2020-120-6		12				50	6	5,200	12.35	12.72	13.12	13.54	14.49
	HWLB 2020-140		14				50	4	3,460	14.42	14.85	15.32	15.82	16.93
	HWLB 2020-160		16				50	4	3,460	16.48	16.98	17.52	18.10	19.38
	HWLB 2020-160-6		16				60	6	5,200	16.48	16.98	17.52	18.10	19.38
	HWLB 2020-180		18				55	4	3,460	18.54	19.11	19.72	20.37	No Interference
	HWLB 2020-200		20				55	4	3,460	20.60	21.24	21.92	22.65	No Interference
	HWLB 2020-200-6		20				70	6	5,200	20.60	21.24	21.92	22.65	24.28
	HWLB 2020-220		22				60	4	4,740	22.67	23.37	24.12	24.93	No Interference
	HWLB 2020-250		25				65	4	4,830	25.76	26.57	27.43	28.35	No Interference
	HWLB 2020-300		30				70	4	5,470	30.92	31.89	32.93	No Interference	No Interference
※	HWLB 2020-350		35				80	4	7,480	36.08	37.21	38.43	No Interference	No Interference
※	HWLB 2020-400		40				80	4	7,480	41.23	42.54	No Interference	No Interference	No Interference
※	HWLB 2025-060	R1.25	6	2	2.45	16°	45	4	3,740	6.21	6.37	6.55	6.74	7.15
※	HWLB 2025-100		10				45	4	3,920	10.34	10.63	10.95	11.29	12.05
※	HWLB 2025-150		15				50	4	4,650	15.49	15.96	16.45	16.98	No Interference
※	HWLB 2025-200		20				55	4	5,470	20.65	21.28	21.96	22.68	No Interference
※	HWLB 2025-250		25				65	4	5,840	25.81	26.61	27.46	No Interference	No Interference

※ Additional model

	Model Number	Radius of Ball Nose R	Effective Length ℓ1	Length of Cut ℓ	Neck Diameter Ød1	Shank Taper Angle Bta	Overall Length L	Shank Diameter Ød	Suggested Retail Price ¥	Effective Length by Inclined Angles 30′	1°	1°30′	2°	3°
	HWLB 2030-060-3	R1.5	6	2.4	2.95	—	60	3	3,190	No Interference	No Interference	No Interference	No Interference	No Interference
	HWLB 2030-060-4		6			16°	60	4	3,190	6.19	6.35	6.51	6.69	7.09
	HWLB 2030-060		6				60	6	3,460	6.19	6.35	6.51	6.69	7.09
	HWLB 2030-080		8				60	6	3,460	8.26	8.48	8.72	8.97	9.54
	HWLB 2030-100		10				60	6	4,020	10.32	10.61	10.92	11.25	11.98
	HWLB 2030-120		12				60	6	4,190	12.38	12.74	13.12	13.52	14.43
※	HWLB 2030-140		14				60	6	4,650	14.45	14.87	15.32	15.80	16.88
	HWLB 2030-160		16				60	6	4,650	16.51	17.00	17.52	18.08	19.33
※	HWLB 2030-180		18				60	6	4,650	18.57	19.13	19.72	20.36	21.77
	HWLB 2030-200		20				70	6	4,470	20.63	21.26	21.92	22.63	24.22
※	HWLB 2030-250		25				70	6	4,470	25.79	26.58	27.42	28.33	30.34
※	HWLB 2030-300		30				70	6	5,100	30.95	31.91	32.93	34.02	No Interference
※	HWLB 2030-350		35				80	6	6,470	36.10	37.23	38.43	39.71	No Interference
※	HWLB 2030-400		40				80	6	8,020	41.26	42.55	43.93	No Interference	No Interference
	HWLB 2040-080-4	R2	8	3.2	3.95	—	70	4	3,340	No Interference	No Interference	No Interference	No Interference	No Interference
	HWLB 2040-080		8			16°	70	6	3,560	8.24	8.45	8.67	8.90	9.43
	HWLB 2040-100		10				70	6	3,560	10.30	10.58	10.87	11.18	11.88
	HWLB 2040-120		12				70	6	4,650	12.37	12.71	13.07	13.46	14.32
※	HWLB 2040-140		14				70	6	4,650	14.43	14.84	15.27	15.73	16.77
	HWLB 2040-160		16				70	6	4,650	16.49	16.97	17.47	18.01	19.22
※	HWLB 2040-180		18				70	6	4,650	18.56	19.10	19.67	20.29	No Interference
	HWLB 2040-200		20				70	6	4,650	20.62	21.22	21.87	22.57	No Interference
	HWLB 2040-250		25				70	6	4,650	25.78	26.55	27.37	28.26	No Interference
※	HWLB 2040-300		30				70	6	4,650	30.93	31.87	32.88	No Interference	No Interference
※	HWLB 2040-350		35				80	6	5,380	36.09	37.20	38.38	No Interference	No Interference
※	HWLB 2040-400		40				90	6	6,020	41.25	42.52	No Interference	No Interference	No Interference
※	HWLB 2040-450		45				90	6	7,750	46.40	47.85	No Interference	No Interference	No Interference
※	HWLB 2050-100	R2.5	10	4	4.95	16°	70	6	5,470	10.29	10.55	10.82	11.11	11.77
※	HWLB 2050-150		15				70	6	7,750	15.45	15.87	16.32	16.81	No Interference
※	HWLB 2050-200		20				70	6	7,750	20.60	21.19	21.82	No Interference	No Interference
※	HWLB 2050-250		25				70	6	7,750	25.76	26.52	No Interference	No Interference	No Interference
※	HWLB 2050-300		30				80	6	8,300	30.92	31.84	No Interference	No Interference	No Interference
	HWLB 2060-100	R3	10	4.8	5.95	—	80	6	5,840	No Interference	No Interference	No Interference	No Interference	No Interference
※	HWLB 2060-150		15				80	6	5,840	No Interference	No Interference	No Interference	No Interference	No Interference
	HWLB 2060-200		20				80	6	5,840	No Interference	No Interference	No Interference	No Interference	No Interference
※	HWLB 2060-250		25				80	6	5,840	No Interference	No Interference	No Interference	No Interference	No Interference
	HWLB 2060-300		30				80	6	6,020	No Interference	No Interference	No Interference	No Interference	No Interference
※	HWLB 2060-350		35				80	6	6,200	No Interference	No Interference	No Interference	No Interference	No Interference
※	HWLB 2060-400		40				90	6	6,570	No Interference	No Interference	No Interference	No Interference	No Interference
※	HWLB 2060-450		45				100	6	7,020	No Interference	No Interference	No Interference	No Interference	No Interference
※	HWLB 2060-500		50				120	6	7,110	No Interference	No Interference	No Interference	No Interference	No Interference
※	HWLB 2060-600		60				120	6	7,540	No Interference	No Interference	No Interference	No Interference	No Interference

※ Additional model

HWLB Milling Conditions

WORK MATERIAL			PREHARDENED STEELS / HARDENED STEELS NAK / STAVAX (~55HRC)				HARDENED STEELS SKD11 (55~62HRC)				HARDENED STEELS HAP10 (62~66HRC)				HARDENED STEELS HAP72 (66~70HRC)			
Model Number	Radius of Ball Nose (mm)	Effective Length (mm)	Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)
2001	R0.05	0.2	48,000	55	0.002	0.002	48,000	45	0.002	0.002	48,000	45	0.002	0.002	36,000	22	0.002	0.002
		0.3	48,000	55	0.002	0.002	48,000	45	0.002	0.002	48,000	45	0.002	0.002	36,000	22	0.002	0.002
		0.5	48,000	35	0.002	0.002	48,000	35	0.002	0.002	48,000	35	0.002	0.002	36,000	17	0.002	0.002
20015	R0.075	0.3	48,000	90	0.004	0.004	48,000	70	0.004	0.004	48,000	70	0.004	0.004	36,000	35	0.004	0.004
		0.5	48,000	60	0.004	0.004	48,000	50	0.004	0.004	48,000	50	0.004	0.004	36,000	25	0.004	0.004
		1	48,000	60	0.001	0.002	48,000	20	0.001	0.002	48,000	20	0.001	0.002	36,000	10	0.001	0.002
2002	R0.1	0.3	60,000	200	0.003	0.005	60,000	200	0.002	0.003	60,000	130	0.002	0.003	45,000	65	0.002	0.003
		0.5	60,000	200	0.003	0.005	60,000	200	0.002	0.003	60,000	130	0.002	0.003	45,000	65	0.002	0.003
		0.75	60,000	200	0.003	0.005	60,000	200	0.002	0.003	60,000	130	0.002	0.003	45,000	65	0.002	0.003
		1	60,000	200	0.003	0.005	60,000	200	0.002	0.003	60,000	130	0.002	0.003	45,000	65	0.002	0.003
		1.5	60,000	130	0.002	0.003	48,000	80	0.001	0.002	48,000	65	0.001	0.002	36,000	30	0.001	0.002
		2	60,000	90	0.001	0.002	48,000	50	0.001	0.001	48,000	40	0.001	0.001	36,000	20	0.001	0.001
		2.5	46,850	60	0.001	0.001	40,450	30	0.001	0.001	40,450	20	0.001	0.001	30,350	10	0.001	0.001
		3	33,750	30	0.001	0.001	33,600	20	0.001	0.001	33,600	15	0.001	0.001	25,200	7	0.001	0.001
2003	R0.15	0.5	60,000	350	0.006	0.008	45,000	310	0.004	0.007	43,500	180	0.003	0.005	32,500	90	0.003	0.005
		0.75	60,000	350	0.006	0.008	45,000	310	0.004	0.007	43,500	180	0.003	0.005	32,500	90	0.003	0.005
		1	60,000	350	0.006	0.008	45,000	310	0.004	0.007	43,500	180	0.003	0.005	32,500	90	0.003	0.005
		1.5	60,000	350	0.006	0.008	45,000	310	0.004	0.007	43,500	180	0.003	0.005	32,500	90	0.003	0.005
		2	60,000	210	0.004	0.007	45,000	190	0.003	0.005	43,500	110	0.002	0.004	32,500	55	0.002	0.004
		2.5	51,250	175	0.003	0.005	38,500	135	0.002	0.004	37,750	85	0.001	0.003	28,300	40	0.001	0.003
		3	42,500	140	0.002	0.004	32,000	80	0.002	0.004	32,000	65	0.001	0.002	24,000	30	0.001	0.002
		4	23,900	45	0.001	0.001	22,550	30	0.001	0.001	22,300	20	0.001	0.001	16,720	10	0.001	0.001
2004	R0.2	0.5	50,000	500	0.01	0.02	37,500	420	0.007	0.012	35,000	240	0.005	0.008	26,250	120	0.005	0.008
		0.75	50,000	500	0.01	0.02	37,500	420	0.007	0.012	35,000	240	0.005	0.008	26,250	120	0.005	0.008
		1	50,000	500	0.01	0.02	37,500	420	0.007	0.012	35,000	240	0.005	0.008	26,250	120	0.005	0.008
		1.5	50,000	500	0.01	0.02	37,500	420	0.007	0.012	35,000	240	0.005	0.008	26,250	120	0.005	0.008
		2	50,000	500	0.01	0.02	37,500	420	0.007	0.012	35,000	240	0.005	0.008	26,250	120	0.005	0.008
		2.5	45,000	360	0.007	0.012	34,500	300	0.005	0.008	32,500	190	0.004	0.007	24,300	95	0.004	0.007
		3	40,000	250	0.005	0.008	31,900	210	0.004	0.008	30,500	160	0.003	0.005	22,800	80	0.003	0.005
		3.5	36,000	210	0.004	0.007	28,700	180	0.003	0.006	27,400	140	0.002	0.004	20,550	70	0.002	0.004
		4	32,000	180	0.003	0.005	25,500	150	0.002	0.004	24,300	120	0.002	0.004	18,200	60	0.002	0.004
		5	25,000	120	0.002	0.003	21,500	100	0.001	0.002	20,500	80	0.001	0.002	15,350	40	0.001	0.002
		6	18,000	60	0.001	0.002	18,000	60	0.001	0.002	17,000	45	0.001	0.002	12,750	20	0.001	0.002
2005	R0.25	1	44,000	650	0.015	0.04	33,000	530	0.01	0.02	30,000	300	0.007	0.01	22,500	150	0.007	0.01
		1.5	44,000	650	0.015	0.04	33,000	530	0.01	0.02	30,000	300	0.007	0.01	22,500	150	0.007	0.01
		2	44,000	650	0.015	0.04	33,000	530	0.01	0.02	30,000	300	0.007	0.01	22,500	150	0.007	0.01
		2.5	44,000	650	0.015	0.04	33,000	530	0.01	0.02	30,000	300	0.007	0.01	22,500	150	0.007	0.01
		3	40,000	500	0.01	0.02	31,000	400	0.007	0.01	28,550	230	0.005	0.008	21,400	115	0.005	0.008
		3.5	36,350	340	0.007	0.017	29,000	270	0.005	0.008	27,100	160	0.003	0.006	20,300	80	0.003	0.006
		4	32,700	180	0.005	0.015	27,150	150	0.003	0.008	25,650	100	0.002	0.005	19,900	50	0.002	0.005
		5	27,000	135	0.003	0.008	24,200	110	0.002	0.005	23,500	75	0.002	0.004	17,600	35	0.002	0.004
		6	21,350	90	0.002	0.005	21,300	75	0.001	0.003	21,300	50	0.001	0.002	16,000	25	0.001	0.002
		8	15,900	60	0.001	0.003	15,900	40	0.001	0.002	15,900	25	0.001	0.002	11,950	12	0.001	0.002
		10	14,900	50	0.001	0.002	13,600	20	0.001	0.001	13,600	15	0.001	0.001	10,200	7	0.001	0.001

HWLB Milling Conditions

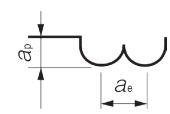
WORK MATERIAL			PREHARDENED STEELS / HARDENED STEELS NAK / STAVAX (~55HRC)				HARDENED STEELS SKD11 (55~62HRC)				HARDENED STEELS HAP10 (62~66HRC)				HARDENED STEELS HAP72 (66~70HRC)			
Model Number	Radius of Ball Nose (mm)	Effective Length (mm)	Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)
2006	R0.3	1	40,000	1,400	0.045	0.15	30,000	1,500	0.03	0.13	26,500	1,000	0.015	0.09	20,000	500	0.015	0.09
		1.5	40,000	1,100	0.03	0.13	30,000	1,200	0.02	0.1	26,500	800	0.01	0.075	20,000	400	0.01	0.075
		2	40,000	1,100	0.03	0.13	30,000	1,200	0.02	0.1	26,500	800	0.01	0.075	20,000	400	0.01	0.075
		2.5	40,000	800	0.02	0.1	30,000	800	0.015	0.09	26,500	520	0.008	0.065	20,000	260	0.008	0.065
		3	40,000	800	0.02	0.1	30,000	800	0.015	0.09	26,500	520	0.008	0.065	20,000	260	0.008	0.065
		3.5	40,000	500	0.015	0.09	30,000	500	0.01	0.075	26,500	340	0.006	0.05	20,000	170	0.006	0.05
		4	40,000	500	0.015	0.09	30,000	500	0.01	0.075	26,500	340	0.006	0.05	20,000	170	0.006	0.05
		5	32,000	400	0.01	0.075	25,000	390	0.007	0.05	23,000	260	0.005	0.04	18,000	130	0.005	0.04
		6	24,000	300	0.007	0.06	21,000	320	0.005	0.04	19,500	210	0.004	0.03	15,000	105	0.004	0.03
		8	16,000	200	0.005	0.05	16,000	240	0.003	0.02	16,000	160	0.003	0.02	12,000	80	0.003	0.02
		10	14,900	175	0.003	0.02	14,900	175	0.002	0.015	14,900	115	0.002	0.015	11,100	55	0.002	0.015
2008	R0.4	2	35,000	1,600	0.06	0.21	27,000	1,600	0.04	0.17	23,500	1,000	0.02	0.12	17,500	500	0.02	0.12
		3	35,000	1,400	0.05	0.19	27,000	1,400	0.03	0.15	23,500	900	0.015	0.1	17,500	450	0.015	0.1
		4	35,000	1,200	0.04	0.17	27,000	1,200	0.025	0.135	23,500	600	0.012	0.095	17,500	300	0.012	0.095
		5	31,500	900	0.03	0.15	25,000	900	0.02	0.12	22,000	500	0.01	0.085	16,500	250	0.01	0.085
		6	28,000	600	0.02	0.12	23,000	600	0.012	0.095	20,500	400	0.006	0.065	15,500	200	0.006	0.065
		8	19,500	330	0.012	0.095	18,000	375	0.007	0.07	17,000	285	0.005	0.06	12,750	140	0.005	0.06
		10	15,000	260	0.01	0.085	14,700	340	0.005	0.06	14,650	225	0.004	0.05	11,000	110	0.004	0.05
		12	14,000	220	0.005	0.06	13,700	290	0.003	0.04	13,650	140	0.002	0.03	10,250	70	0.002	0.03
2010	R0.5	2	30,000	1,750	0.2	0.4	24,000	2,000	0.1	0.3	21,000	1,750	0.05	0.2	16,000	875	0.05	0.2
		2.5	30,000	1,750	0.2	0.4	24,000	2,000	0.1	0.3	21,000	1,750	0.05	0.2	16,000	875	0.05	0.2
		3	30,000	1,750	0.1	0.3	24,000	2,000	0.05	0.2	21,000	1,750	0.03	0.17	16,000	875	0.03	0.17
		4	30,000	1,750	0.1	0.3	24,000	2,000	0.05	0.2	21,000	1,750	0.03	0.17	16,000	875	0.03	0.17
		5	30,000	1,750	0.1	0.3	24,000	2,000	0.05	0.2	21,000	1,750	0.03	0.17	16,000	875	0.03	0.17
		6	30,000	1,150	0.06	0.23	21,500	1,250	0.03	0.17	19,700	1,050	0.025	0.15	14,500	525	0.025	0.15
		7	24,250	800	0.04	0.19	20,000	900	0.02	0.14	19,000	750	0.02	0.14	14,250	375	0.02	0.14
		8	24,000	800	0.025	0.155	18,500	580	0.015	0.12	18,400	480	0.015	0.12	13,800	240	0.015	0.12
		9	23,000	700	0.021	0.14	16,650	500	0.012	0.1	16,550	420	0.012	0.1	12,400	210	0.012	0.1
		10	22,000	600	0.018	0.13	14,800	430	0.01	0.09	14,700	360	0.01	0.09	11,100	180	0.01	0.09
		12	14,150	320	0.015	0.12	13,400	380	0.008	0.08	13,300	290	0.008	0.08	9,950	145	0.008	0.08
		14	13,500	280	0.012	0.1	12,000	350	0.007	0.08	12,000	220	0.007	0.08	9,000	110	0.007	0.08
		16	12,750	240	0.008	0.08	10,500	250	0.005	0.045	10,500	160	0.005	0.045	7,850	80	0.005	0.045
		18	12,350	220	0.006	0.065	9,750	200	0.004	0.035	9,750	130	0.004	0.035	7,300	65	0.004	0.035
		20	12,000	200	0.005	0.03	9,000	150	0.003	0.02	9,000	100	0.003	0.02	6,750	50	0.003	0.02
2012	R0.6	3	30,000	2,000	0.12	0.36	20,000	2,000	0.06	0.24	17,500	1,750	0.036	0.2	13,100	875	0.036	0.2
		4	30,000	2,000	0.12	0.36	20,000	2,000	0.06	0.24	17,500	1,750	0.036	0.2	13,100	875	0.036	0.2
		6	30,000	2,000	0.12	0.36	20,000	2,000	0.06	0.24	17,500	1,750	0.036	0.2	13,100	875	0.036	0.2
		8	20,200	800	0.05	0.23	16,600	900	0.025	0.17	15,850	750	0.025	0.17	11,900	375	0.025	0.17
		10	15,500	480	0.03	0.18	15,500	580	0.015	0.13	15,350	480	0.015	0.13	11,500	240	0.015	0.13
		12	12,400	360	0.02	0.15	12,400	430	0.01	0.095	12,250	360	0.01	0.095	9,200	180	0.01	0.095
		16	11,300	280	0.014	0.12	10,000	360	0.007	0.08	10,000	230	0.007	0.08	7,500	115	0.007	0.08

HWLB Milling Conditions

WORK MATERIAL			PREHARDENED STEELS / HARDENED STEELS NAK / STAVAX (~55HRC)				HARDENED STEELS SKD11 (55~62HRC)				HARDENED STEELS HAP10 (62~66HRC)				HARDENED STEELS HAP72 (66~70HRC)			
Model Number	Radius of Ball Nose (mm)	Effective Length (mm)	Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)
2015	R0.75	3	30,000	2,450	0.25	0.55	17,000	2,000	0.12	0.4	15,000	1,750	0.06	0.29	11,250	875	0.06	0.29
		4	30,000	2,450	0.25	0.55	17,000	2,000	0.12	0.4	15,000	1,750	0.06	0.29	11,250	875	0.06	0.29
		6	30,000	2,450	0.15	0.45	17,000	2,000	0.07	0.31	15,000	1,750	0.04	0.24	11,250	875	0.04	0.24
		8	23,500	1,300	0.1	0.37	15,000	1,250	0.045	0.25	14,000	1,050	0.03	0.21	10,500	525	0.03	0.21
		10	23,500	1,300	0.1	0.37	15,000	1,250	0.045	0.25	14,000	1,050	0.03	0.21	10,500	525	0.03	0.21
		12	13,100	480	0.03	0.21	13,000	580	0.02	0.17	13,000	480	0.02	0.17	9,750	240	0.02	0.17
		14	11,200	400	0.025	0.19	10,900	485	0.015	0.145	10,900	385	0.015	0.145	8,200	190	0.015	0.145
		16	9,350	320	0.02	0.17	8,850	390	0.012	0.13	8,800	290	0.012	0.13	6,600	145	0.012	0.13
		18	9,150	300	0.019	0.165	8,400	370	0.011	0.125	8,400	255	0.011	0.125	6,300	125	0.011	0.125
		20	9,000	280	0.018	0.16	8,000	350	0.01	0.12	8,000	220	0.01	0.12	6,000	110	0.01	0.12
		25	8,100	210	0.01	0.11	6,250	220	0.006	0.09	6,250	120	0.005	0.08	4,700	60	0.005	0.08
2016	R0.8	4	30,000	2,500	0.25	0.58	17,500	2,100	0.12	0.4	15,300	1,800	0.06	0.3	11,500	900	0.06	0.3
		8	30,000	2,500	0.16	0.48	17,500	2,100	0.08	0.32	15,300	1,800	0.05	0.275	11,500	900	0.05	0.275
		12	13,500	500	0.04	0.245	13,500	600	0.024	0.19	13,400	490	0.024	0.19	10,000	245	0.024	0.19
		16	10,800	375	0.03	0.21	10,800	450	0.016	0.15	10,700	370	0.016	0.15	8,000	185	0.016	0.15
		20	10,300	330	0.025	0.19	9,750	400	0.013	0.13	9,650	230	0.013	0.13	8,000	115	0.013	0.13
2018	R0.9	6	30,000	2,700	0.18	0.54	15,000	2,000	0.07	0.34	13,000	1,750	0.04	0.26	9,750	875	0.04	0.26
		10	25,750	2,000	0.14	0.48	14,400	1,650	0.06	0.32	12,900	1,420	0.035	0.24	9,700	713	0.035	0.24
		16	15,550	860	0.065	0.33	11,700	900	0.03	0.22	11,150	730	0.02	0.18	8,400	365	0.02	0.18
		20	9,300	350	0.027	0.21	9,050	420	0.014	0.15	9,000	330	0.009	0.12	6,750	165	0.009	0.12
		30	8,000	240	0.015	0.15	7,000	250	0.009	0.07	7,000	160	0.006	0.06	5,250	80	0.006	0.06
2020	R1	3	28,000	2,900	0.3	0.7	14,000	2,100	0.15	0.5	12,250	1,800	0.08	0.35	9,200	900	0.08	0.35
		4	28,000	2,900	0.3	0.7	14,000	2,100	0.15	0.5	12,250	1,800	0.08	0.35	9,200	900	0.08	0.35
		6	28,000	2,900	0.2	0.6	14,000	2,100	0.1	0.4	12,250	1,800	0.06	0.3	9,200	900	0.06	0.3
		8	28,000	2,900	0.2	0.6	14,000	2,100	0.1	0.4	12,250	1,800	0.06	0.3	9,200	900	0.06	0.3
		10	28,000	2,900	0.2	0.6	14,000	2,100	0.1	0.4	12,250	1,800	0.06	0.3	9,200	900	0.06	0.3
		12	19,500	1,350	0.12	0.45	12,400	1,350	0.06	0.34	11,500	1,100	0.045	0.27	8,650	550	0.045	0.27
		14	19,500	1,350	0.12	0.45	12,400	1,350	0.06	0.34	11,500	1,100	0.045	0.27	8,650	550	0.045	0.27
		16	10,800	500	0.05	0.3	10,800	600	0.03	0.24	10,700	490	0.03	0.24	8,000	245	0.03	0.24
		18	9,700	435	0.04	0.28	9,700	520	0.025	0.22	9,650	430	0.025	0.22	7,250	215	0.025	0.22
		20	8,650	375	0.035	0.25	8,650	450	0.02	0.19	8,560	370	0.02	0.19	6,400	185	0.02	0.19
		22	8,450	350	0.032	0.245	8,200	440	0.018	0.18	8,200	330	0.018	0.18	6,150	165	0.018	0.18
		25	8,250	320	0.03	0.24	7,800	440	0.016	0.16	7,800	290	0.016	0.16	5,850	145	0.016	0.16
		30	7,850	280	0.024	0.2	7,000	350	0.014	0.16	7,000	220	0.014	0.16	5,250	110	0.014	0.16
		35	7,450	240	0.016	0.16	6,150	250	0.01	0.09	6,150	160	0.01	0.09	4,600	80	0.01	0.09
		40	7,000	200	0.01	0.06	5,250	150	0.006	0.04	5,250	100	0.006	0.04	3,950	50	0.006	0.04
2025	R1.25	6	25,000	3,000	0.35	0.85	12,400	2,200	0.17	0.6	11,000	1,850	0.1	0.45	8,250	920	0.1	0.45
		10	25,000	3,000	0.24	0.76	12,400	2,200	0.13	0.51	11,000	1,850	0.08	0.38	8,250	920	0.08	0.38
		15	17,300	1,400	0.145	0.57	11,000	1,400	0.08	0.44	10,300	1,140	0.06	0.35	7,700	570	0.06	0.35
		20	9,600	520	0.06	0.38	9,600	630	0.04	0.31	9,600	510	0.04	0.31	7,200	255	0.04	0.31
		25	6,900	375	0.042	0.32	6,900	450	0.024	0.235	6,840	370	0.024	0.235	5,150	185	0.024	0.235

HWLB Milling Conditions

WORK MATERIAL			PREHARDENED STEELS / HARDENED STEELS NAK / STAVAX (~55HRC)				HARDENED STEELS SKD11 (55~62HRC)				HARDENED STEELS HAP10 (62~66HRC)				HARDENED STEELS HAP72 (66~70HRC)			
Model Number	Radius of Ball Nose (mm)	Effective Length (mm)	Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)
2030	R1.5	6	21,000	3,000	0.4	1	10,500	2,200	0.2	0.7	9,200	1,900	0.12	0.55	6,900	950	0.12	0.55
		8	21,000	3,000	0.4	1	10,500	2,200	0.2	0.7	9,200	1,900	0.12	0.55	6,900	950	0.12	0.55
		10	21,000	3,000	0.3	0.9	10,500	2,200	0.15	0.65	9,200	1,900	0.1	0.5	6,900	950	0.1	0.5
		12	21,000	3,000	0.3	0.9	10,500	2,200	0.15	0.65	9,200	1,900	0.1	0.5	6,900	950	0.1	0.5
		14	21,000	3,000	0.3	0.9	10,500	2,200	0.15	0.65	9,200	1,900	0.1	0.5	6,900	950	0.1	0.5
		16	21,000	3,000	0.3	0.9	10,500	2,200	0.15	0.65	9,200	1,900	0.1	0.5	6,900	950	0.1	0.5
		18	17,750	2,180	0.24	0.8	9,800	1,800	0.13	0.57	8,900	1,500	0.08	0.47	6,650	760	0.08	0.47
		20	14,500	1,360	0.18	0.7	9,250	1,400	0.1	0.5	8,600	1,150	0.075	0.45	6,450	575	0.075	0.45
		25	8,000	520	0.07	0.45	8,000	630	0.05	0.38	8,000	510	0.05	0.38	6,000	255	0.05	0.38
		30	5,750	375	0.05	0.38	5,750	450	0.03	0.29	5,700	370	0.03	0.29	4,270	185	0.03	0.29
		35	5,550	335	0.045	0.36	5,350	440	0.025	0.27	5,350	310	0.025	0.27	4,000	155	0.025	0.27
		40	5,350	300	0.04	0.34	4,900	390	0.02	0.24	4,850	250	0.02	0.24	3,650	125	0.02	0.24
2040	R2	8	18,000	3,200	0.5	1.3	9,000	2,300	0.25	0.95	7,900	2,000	0.15	0.75	5,900	1,000	0.15	0.75
		10	18,000	3,200	0.5	1.3	9,000	2,300	0.25	0.95	7,900	2,000	0.15	0.75	5,900	1,000	0.15	0.75
		12	18,000	3,200	0.4	1.2	9,000	2,300	0.2	0.85	7,900	2,000	0.13	0.7	5,900	1,000	0.13	0.7
		14	18,000	3,200	0.4	1.2	9,000	2,300	0.2	0.85	7,900	2,000	0.13	0.7	5,900	1,000	0.13	0.7
		16	18,000	3,200	0.4	1.2	9,000	2,300	0.2	0.85	7,900	2,000	0.13	0.7	5,900	1,000	0.13	0.7
		18	18,000	3,200	0.4	1.2	9,000	2,300	0.2	0.85	7,900	2,000	0.13	0.7	5,900	1,000	0.13	0.7
		20	18,000	3,200	0.4	1.2	9,000	2,300	0.2	0.85	7,900	2,000	0.13	0.7	5,900	1,000	0.13	0.7
		25	12,500	1,500	0.25	0.95	8,000	1,450	0.13	0.7	7,450	1,250	0.09	0.55	5,600	625	0.09	0.55
		30	7,000	550	0.1	0.6	7,000	660	0.06	0.45	7,000	540	0.06	0.45	5,250	270	0.06	0.45
		35	6,000	520	0.09	0.59	6,000	630	0.055	0.43	6,000	510	0.055	0.43	4,500	255	0.055	0.43
		40	4,300	375	0.065	0.5	4,300	450	0.04	0.39	4,300	370	0.04	0.39	3,200	185	0.04	0.39
		45	4,150	330	0.058	0.47	4,000	440	0.033	0.36	4,000	300	0.033	0.36	3,000	150	0.033	0.36
2050	R2.5	10	14,400	3,200	0.5	1.5	7,200	2,300	0.25	1.05	6,350	2,000	0.16	0.88	4,750	1,000	0.16	0.88
		15	14,400	3,200	0.5	1.5	7,200	2,300	0.25	1.05	6,350	2,000	0.16	0.88	4,750	1,000	0.16	0.88
		20	14,400	3,200	0.5	1.5	7,200	2,300	0.25	1.05	6,350	2,000	0.16	0.88	4,750	1,000	0.16	0.88
		25	12,200	2,350	0.4	1.35	6,800	1,850	0.2	0.95	6,250	1,600	0.13	0.8	4,650	800	0.13	0.8
		30	10,000	1,500	0.31	1.2	6,400	1,450	0.16	0.88	6,200	1,250	0.11	0.73	4,650	625	0.11	0.73
2060	R3	10	13,000	3,500	0.6	1.8	6,500	2,500	0.3	1.3	5,700	2,200	0.2	1	4,300	1,100	0.2	1
		15	13,000	3,500	0.6	1.8	6,500	2,500	0.3	1.3	5,700	2,200	0.2	1	4,300	1,100	0.2	1
		20	13,000	3,500	0.6	1.8	6,500	2,500	0.3	1.3	5,700	2,200	0.2	1	4,300	1,100	0.2	1
		25	13,000	3,500	0.6	1.8	6,500	2,500	0.3	1.3	5,700	2,200	0.2	1	4,300	1,100	0.2	1
		30	13,000	3,500	0.6	1.8	6,500	2,500	0.3	1.3	5,700	2,200	0.2	1	4,300	1,100	0.2	1
		35	11,000	2,750	0.48	1.6	6,100	2,050	0.25	1.05	5,500	1,800	0.17	0.8	4,150	900	0.17	0.8
		40	9,000	2,050	0.37	1.35	5,750	1,600	0.2	0.8	5,350	1,400	0.15	0.65	4,000	700	0.15	0.65
		45	7,000	1,300	0.26	1.1	5,350	1,150	0.15	0.55	5,150	1,000	0.12	0.45	3,850	500	0.12	0.45
		50	5,000	600	0.15	0.9	5,000	720	0.1	0.3	5,000	600	0.1	0.3	3,750	300	0.1	0.3
		60	3,600	430	0.1	0.75	3,600	510	0.08	0.22	3,550	435	0.08	0.22	2,650	215	0.08	0.22



Note:

- Decrease the feed rate more than 50% from the milling parameters when slot milling.
- Decrease both spindle speed and feed rate proportionally when the milling parameters exceed the machine's maximum spindle speed, or when chattering and red-hot occur.
- Every coolant offers stable milling.

Advisory for Safe Use of End Mills

Correct application and operation is strongly advised to avoid clogging, abrasion, etc, that could cause serious accidents or injuries.
Ignition or sparks generated during milling could lead to fire or extreme damage to the work piece.
End Mills are made with very sharp cutting edges and must be handled with extra care.

- Never touch the cutting edge with your bare hands, as this could cause serious injury. Special caution is required when opening the package.
- Dropping the tool could cause breakage or flying debris, leading to serious injury.
- During milling, unexpected impact or shock on the tool could cause breakage or flying debris. Ensure to use protective items such as safety glasses and a face guard.
- For best results, fine parameter adjustment may be required, depending on the materials; milling shape and strategy; machine rigidity and spindle capability.
- Use a machine that has high rigidity and generates a low level of vibration. Recommend setting the runout control value at 5μm or below for the small diameter tools ϕ1 or below.
- Do not use flammable cutting oils.

Advisory for Regrinding End Mills

- Never regrind the tool without wearing safety glasses and a face guard.

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Price & Specifications are subject to change without notice.

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