UNION TOOL

CBN End Mills UNIMAX Series

Vol.9
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1 Flute Long Neck Radius End Mills for Super Finishing
CBN - RSF

2 Flutes High-grade Long Neck Radius End Mills
Add 4
CBN - LRF2000

4 Flutes High-grade Long Neck Radius End Mills
NEW
CBN - LRF4000

2 Flutes Long Neck Ball End Mills for Super Finishing
CBN - LBSF

2 Flutes High-grade Long Neck Ball End Mills
Add 6
CBN - LBF

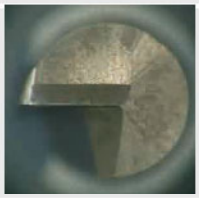
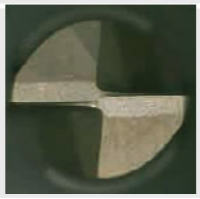
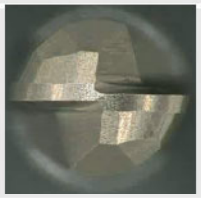
UNION TOOL CO

UNIMAX CBN

The 2 features of UNIMAX CBN series

Various lineup of tools

2 types each for Ball and Radius.
SF series offers shiny milling surfaces.

	Long Neck Radius			Long Neck Ball	
Type	Super surface finish	Long tool life		Super surface finish	Long tool life
Series	CBN-RSF	CBN-LRF 2000	CBN-LRF 4000	CBN-LBSF	CBN-LBF
Flutes	1 Flute	2 Flutes	4 Flutes	2 Flutes	2 Flutes
Helix angle	Non helix angle	Non helix angle	Non helix angle	Helix angle 20°	Non helix angle
Tip geometry					
Detail	P4	P8	P18	P22	P26

High precision milling

Industry-leading high precision.
The tool measurements are printed on the label to support High Precision milling.

	Long Neck Radius			Long Neck Ball	
Type	Super surface finish	Long tool life		Super surface finish	Long tool life
Series	CBN-RSF	CBN-LRF 2000	CBN-LRF 4000	CBN-LBSF	CBN-LBF
R/CR Tolerance	R ±0.002 CR≦ 0.02 / R ±0.003 CR≦ 0.05	R ±0.002 CR≦ 0.03 / R ±0.003 CR≦ 0.05	R ±0.002	R ±0.002	R ±0.003 R0.05 ~ R1.5 / R ±0.005 R2
Label sample	Diameter tolerance / CR tolerance 			R tolerance 	Diameter tolerance / R tolerance 

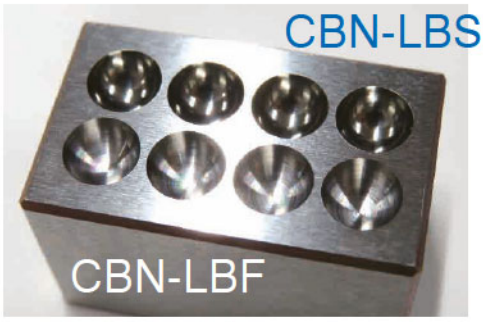
CBN The features of CBN series for super surface finish

CBN-LBSF - CBN-RSF
SF series offers shiny milling surfaces.

SF
The power of SF

Ball

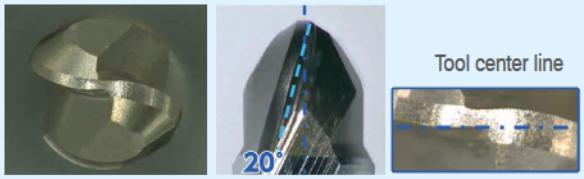
Milling surface comparison of Ball type



ELMAX（60HRC）
Size : ø5 × Depth 2.5 mm

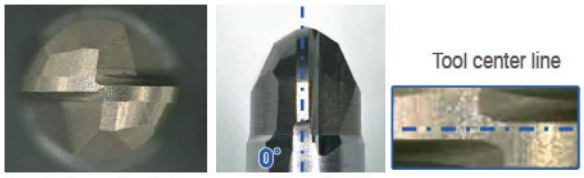
Tool Size	R0.5 × EL1.5
Spindle Speed	30,000 min^{-1}
Feed Rate	750 mm/min
Cusp Height	0.0001 mm
Coolant	Oil Mist

CBN-LBSF For super surface finish



A cutting edge is set at the tip of the tool (zero peripheral speed).
Improved finishing surface by the burnishing effect on relief.

CBN-LBF For long tool life



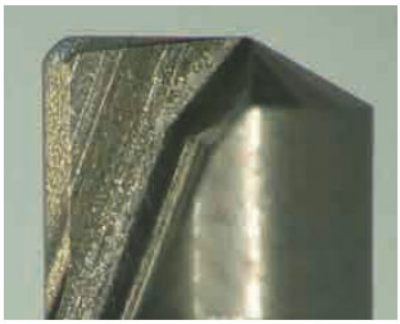
Non helix angle design ensures high rigidity.

Radius

Tool features of Radius type

CBN-RSF For super surface finish

1 flute design enables an even milling amount and prevents chip biting caused by runout.
The tool relief rubs against the milling surface to create a burnished finish.



1 Flute Long Neck Radius End Mills for Super Finishing

Size ø0.2～ø2

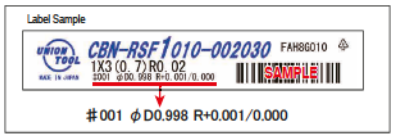
CBN-RSF

CBN | 0° | R | ±0.002 (CR≤0.02) | ±0.003 (CR≥0.05) | Shank Dia 0/-0.004 | Back Taper Geometry

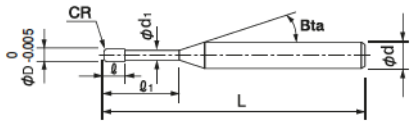
Patent pending

Material Applications (☆ Highly Recommended ◎ Recommended ○ Suggested)

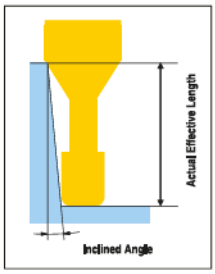
Work Material														
CARBON STEELS S45C S55C	ALLOY STEELS SK / SCM SUS	PREHARDENED STEELS NAK HPM	HARDENED STEELS ～55HRC	HARDENED STEELS ～60HRC	HARDENED STEELS ～70HRC	CAST IRON	ALUMINUM ALLOYS	GRAPHITE	COPPER	PLASTICS	GLASS FILLED PLASTICS	TITANIUM ALLOYS	HEAT RESISTANT ALLOYS	CEMENTED CARBIDE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



Diameter and Corner R accuracy measurements are printed on the label to support High Precision milling.

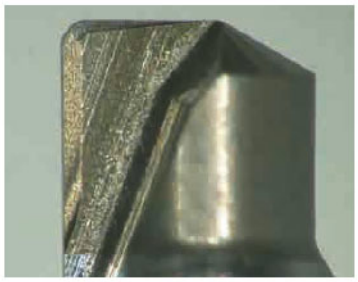


The shank taper angle shown is not an exact value and to avoid contact with the work piece, we recommend the user controls the precise value of this angle. Shank taper angle should not make contact with the work piece.



Features

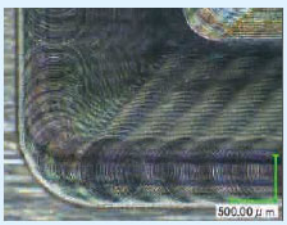
The tool relief rubs against the milling surface to create a burnished finish.
1 flute design enables an even milling amount and prevents chip biting caused by runout.



The cutting edge at the tip point has a burnishing effect. (ELMAX 60HRC)
The unique design on the tool relief offers a shiny surface finish.

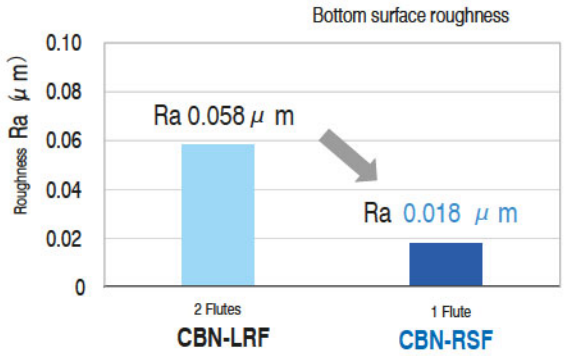
1 Flute
CBN-RSF

2 Flutes



Inclined pocket milling
1 Flute CBN-RSF ø2 × CR0.1 × EL4 — ELMAX (60HRC)

CBN-LRF Conventional **CBN-RSF**

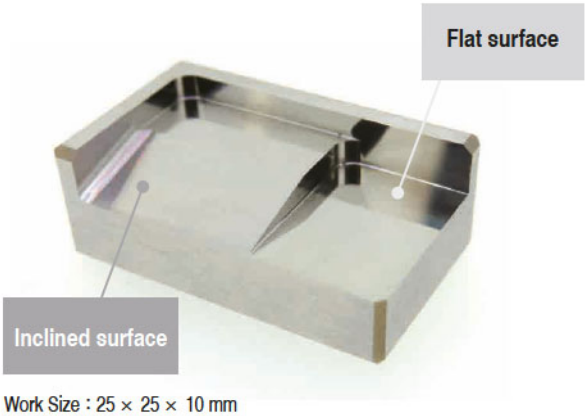


Process	Finishing
Milling Method	Contour Milling
Spindle Speed	30,000 min^{-1}
Feed Rate	375 mm/min
Finishing Allowance	0.01 mm/min
Cusp Height at Inclined Surface	0.00003 mm
Cycle Time	61 min

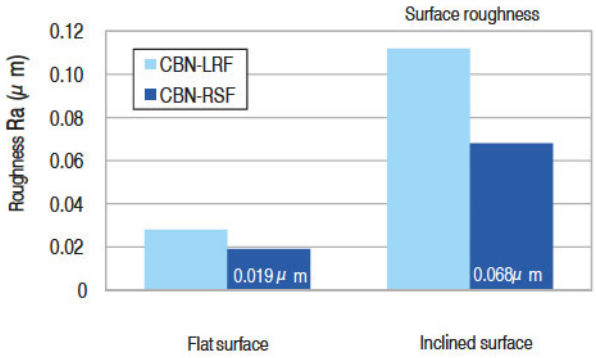
CBN-LRF Improved quality for milling on the bottom, inclined and vertical surfaces as compared to conventional CBN-LRF series.

Milled Size : 9 × 13 × Depth 1 mm
Coolant : Oil Mist

Pocket milling
1 Flute CBN-RSF ø2 × CR0.1 × EL4 — ELMAX (60HRC)



Work Size : 25 × 25 × 10 mm
Coolant : Oil Mist



1 flute CBN-RSF gives excellent surface roughness

No.	Process	Tool	Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Allowance (mm)	Cycle Time (h:m)
1	Roughing	HGLB R1 × EL4	14,000	2,100	0.15	0.5	0.05	0:10:17
2	Semi-finishing	HLRS ø2 × CR0.1 × EL4	11,500	860	0.031	0.36	0.05	1:11:50
					0.02	0.36	0.02	
					0.005	0.1	0.01	
3	Finishing	CBN-RSF ø2 × CR0.1 × EL4	30,000	375	0.01	0.1	0	2:25:01
							Total	3:47:08

1 Flute Long Neck Radius End Mills for Super Finishing

Total 42 models

Shank taper angle Bta is only for reference.

Unit (mm)

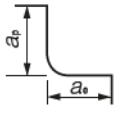
Model Number	Outside Diameter øD	Corner Radius CR	Effective Length ℓ_1	Length of Cut ℓ	Neck Diameter ød_1	Shank Taper Angle Bta	Overall Length L	Shank Diameter ød	Price ¥	Effective Length by Inclined Angles				
										30′	1°	1°30′	2°	3°
CBN-RSF 1002-002003	0.2	R0.02	0.3	0.08	0.19	15°	50	4	36,600	0.30	0.30	0.30	0.31	0.34
CBN-RSF 1002-002005			0.5				50	4	36,600	0.50	0.50	0.52	0.54	0.59
CBN-RSF 1002-005003		R0.05	0.3				50	4	32,900	0.30	0.30	0.30	0.31	0.33
CBN-RSF 1002-005005			0.5				50	4	32,900	0.50	0.50	0.52	0.54	0.58
CBN-RSF 1003-002005	0.3	R0.02	0.5	0.13	0.28	15°	50	4	36,200	0.51	0.53	0.55	0.57	0.62
CBN-RSF 1003-002010			1				50	4	36,600	1.03	1.07	1.11	1.15	1.25
CBN-RSF 1003-005005		R0.05	0.5				50	4	32,500	0.51	0.53	0.55	0.57	0.62
CBN-RSF 1003-005010			1				50	4	32,900	1.03	1.07	1.10	1.15	1.24
CBN-RSF 1004-002005	0.4	R0.02	0.5	0.24	0.38	15°	50	4	34,300	0.51	0.53	0.55	0.57	0.62
CBN-RSF 1004-002015			1.5				50	4	35,000	1.54	1.59	1.65	1.71	1.86
CBN-RSF 1004-005005		R0.05	0.5				50	4	30,900	0.51	0.53	0.55	0.57	0.62
CBN-RSF 1004-005015			1.5				50	4	31,100	1.54	1.59	1.65	1.71	1.85
CBN-RSF 1005-002005	0.5	R0.02	0.5	0.3	0.48	15°	50	4	28,200	0.51	0.53	0.55	0.57	0.62
CBN-RSF 1005-002015			1.5				50	4	28,700	1.54	1.59	1.65	1.71	1.86
CBN-RSF 1005-005005		R0.05	0.5				50	4	25,400	0.51	0.53	0.55	0.57	0.62
CBN-RSF 1005-005015			1.5				50	4	25,800	1.54	1.59	1.65	1.71	1.85
CBN-RSF 1006-002010	0.6	R0.02	1	0.3	0.58	15°	50	4	28,500	1.03	1.07	1.11	1.15	1.25
CBN-RSF 1006-002015			1.5				50	4	28,700	1.54	1.59	1.65	1.71	1.86
CBN-RSF 1006-005010		R0.05	1				50	4	25,600	1.03	1.07	1.10	1.15	1.24
CBN-RSF 1006-005015			1.5				50	4	25,800	1.54	1.59	1.65	1.71	1.85
CBN-RSF 1008-002010	0.8	R0.02	1	0.56	0.78	15°	50	4	28,700	1.03	1.07	1.11	1.15	1.25
CBN-RSF 1008-002020			2				50	4	28,700	2.05	2.13	2.20	2.29	2.48
CBN-RSF 1008-005010		R0.05	1				50	4	25,800	1.03	1.07	1.10	1.15	1.24
CBN-RSF 1008-005020			2				50	4	25,800	2.05	2.12	2.20	2.28	2.47
CBN-RSF 1010-002010	1	R0.02	1	0.7	0.98	15°	50	4	26,400	1.03	1.07	1.11	1.15	1.25
CBN-RSF 1010-002020			2				50	4	26,400	2.07	2.14	2.22	2.30	2.49
CBN-RSF 1010-002030			3				50	4	26,400	3.10	3.21	3.33	3.45	3.73
CBN-RSF 1010-005010		R0.05	1				50	4	23,700	1.03	1.07	1.11	1.15	1.24
CBN-RSF 1010-005020			2				50	4	23,700	2.06	2.14	2.21	2.30	2.48
CBN-RSF 1010-005030			3				50	4	23,700	3.10	3.21	3.32	3.45	3.73
CBN-RSF 1010-010010		R0.1	1				50	4	23,700	1.03	1.06	1.10	1.14	1.23
CBN-RSF 1010-010020			2				50	4	23,700	2.06	2.13	2.21	2.29	2.47
CBN-RSF 1010-010030			3				50	4	23,700	3.10	3.20	3.32	3.44	3.72
CBN-RSF 1015-002030	1.5	R0.02	3	1	1.46	15°	50	4	31,000	3.14	3.25	3.37	3.49	3.78
CBN-RSF 1015-005030		R0.05	3				50	4	27,900	3.14	3.25	3.36	3.49	3.77
CBN-RSF 1015-010030		R0.1	3				50	4	27,900	3.14	3.24	3.36	3.48	3.76
CBN-RSF 1020-002040	2	R0.02	4	1.2	1.97	15°	50	4	32,000	4.15	4.30	4.45	4.62	5.00
CBN-RSF 1020-002060			6				50	4	32,000	6.22	6.44	6.67	6.92	7.49
CBN-RSF 1020-005040		R0.05	4				50	4	28,700	4.15	4.30	4.45	4.62	4.99
CBN-RSF 1020-005060			6				50	4	28,700	6.22	6.44	6.67	6.92	7.48
CBN-RSF 1020-010040		R0.1	4				50	4	28,700	4.15	4.29	4.45	4.61	4.98
CBN-RSF 1020-010060			6				50	4	28,700	6.22	6.43	6.66	6.91	7.47

CBN-RSF Milling Conditions

WORK MATERIAL				HARDENED STEELS ELMAX (58~62HRC)				HARDENED STEELS HAP10 (62~65HRC)			
Model Number	Outside Diameter (mm)	Corner Radius (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)
1002-002003	0.2	R0.02	0.3	60,000	80 MAX	0.003	0.01	60,000	20 MAX	0.003	0.005
1002-002005			0.5	60,000	80 MAX	0.003	0.01	60,000	20 MAX	0.003	0.005
1002-005003		R0.05	0.3	60,000	80 MAX	0.003	0.01	60,000	20 MAX	0.003	0.005
1002-005005			0.5	60,000	80 MAX	0.003	0.01	60,000	20 MAX	0.003	0.005
1003-002005	0.3	R0.02	0.5	40,000	80 MAX	0.004	0.015	40,000	20 MAX	0.004	0.005
1003-002010			1	40,000	80 MAX	0.004	0.015	40,000	20 MAX	0.004	0.005
1003-005005		R0.05	0.5	40,000	80 MAX	0.004	0.015	40,000	20 MAX	0.004	0.005
1003-005010			1	40,000	80 MAX	0.004	0.015	40,000	20 MAX	0.004	0.005
1004-002005	0.4	R0.02	0.5	30,000	80 MAX	0.005	0.02	30,000	20 MAX	0.005	0.006
1004-002015			1.5	30,000	80 MAX	0.005	0.02	30,000	20 MAX	0.005	0.006
1004-005005		R0.05	0.5	30,000	100 MAX	0.005	0.02	30,000	60 MAX	0.005	0.02
1004-005015			1.5	30,000	100 MAX	0.005	0.02	30,000	60 MAX	0.005	0.02
1005-002005	0.5	R0.02	0.5	30,000	90 MAX	0.005	0.025	30,000	25 MAX	0.005	0.008
1005-002015			1.5	30,000	90 MAX	0.005	0.025	30,000	25 MAX	0.005	0.008
1005-005005		R0.05	0.5	30,000	100 MAX	0.01	0.025	30,000	60 MAX	0.01	0.025
1005-005015			1.5	30,000	100 MAX	0.01	0.025	30,000	60 MAX	0.01	0.025
1006-002010	0.6	R0.02	1	30,000	100 MAX	0.005	0.03	30,000	30 MAX	0.005	0.01
1006-002015			1.5	30,000	100 MAX	0.005	0.03	30,000	30 MAX	0.005	0.01
1006-005010		R0.05	1	30,000	110 MAX	0.01	0.03	30,000	65 MAX	0.01	0.03
1006-005015			1.5	30,000	110 MAX	0.01	0.03	30,000	65 MAX	0.01	0.03
1008-002010	0.8	R0.02	1	30,000	125 MAX	0.005	0.04	30,000	40 MAX	0.005	0.012
1008-002020			2	30,000	125 MAX	0.005	0.04	30,000	40 MAX	0.005	0.012
1008-005010		R0.05	1	30,000	140 MAX	0.01	0.04	30,000	85 MAX	0.01	0.04
1008-005020			2	30,000	140 MAX	0.01	0.04	30,000	85 MAX	0.01	0.04
1010-002010	1	R0.02	1	30,000	150 MAX	0.005	0.05	30,000	50 MAX	0.005	0.015
1010-002020			2	30,000	150 MAX	0.005	0.05	30,000	50 MAX	0.005	0.015
1010-002030			3	30,000	150 MAX	0.005	0.05	30,000	50 MAX	0.005	0.015
1010-005010		R0.05	1	30,000	165 MAX	0.01	0.05	30,000	100 MAX	0.01	0.04
1010-005020			2	30,000	165 MAX	0.01	0.05	30,000	100 MAX	0.01	0.04
1010-005030			3	30,000	165 MAX	0.01	0.05	30,000	100 MAX	0.01	0.04
1010-010010		R0.1	1	30,000	185 MAX	0.01	0.05	30,000	150 MAX	0.01	0.05
1010-010020			2	30,000	185 MAX	0.01	0.05	30,000	150 MAX	0.01	0.05
1010-010030			3	30,000	185 MAX	0.01	0.05	30,000	150 MAX	0.01	0.05
1015-002030	1.5	R0.02	3	30,000	225 MAX	0.005	0.075	30,000	75 MAX	0.005	0.025
1015-005030		R0.05	3	30,000	250 MAX	0.01	0.075	30,000	150 MAX	0.01	0.05
1015-010030		R0.1	3	30,000	280 MAX	0.01	0.075	30,000	225 MAX	0.01	0.075
1020-002040	2	R0.02	4	30,000	300 MAX	0.005	0.1	30,000	100 MAX	0.005	0.03
1020-002060			6	30,000	300 MAX	0.005	0.1	30,000	100 MAX	0.005	0.03
1020-005040		R0.05	4	30,000	330 MAX	0.01	0.1	30,000	200 MAX	0.01	0.07
1020-005060			6	30,000	330 MAX	0.01	0.1	30,000	200 MAX	0.01	0.07
1020-010040		R0.1	4	30,000	375 MAX	0.01	0.1	30,000	300 MAX	0.01	0.1
1020-010060			6	30,000	375 MAX	0.01	0.1	30,000	300 MAX	0.01	0.1

Note:

- Decrease both spindle speed and feed rate proportionally when the milling parameters exceed the machine's maximum spindle speed.
- Recommend oil mist to avoid tool damage.



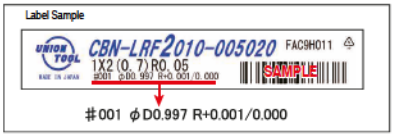
Size ø0.1～ø3

CBN-LRF2000

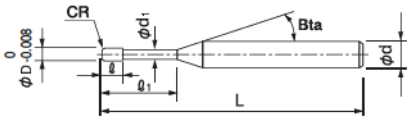
CBN | 0° | R | ± 0.002 CR ≤ 0.03 | ± 0.003 CR ≥ 0.05 | Shank Dia 0/-0.004 | Back Taper Geometry | Additional 4 Models

Material Applications (☆ Highly Recommended ◎ Recommended ○ Suggested)

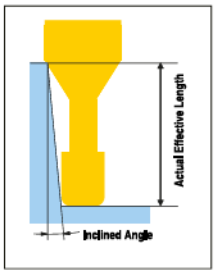
Work Material														
CARBON STEELS S45C S55C	ALLOY STEELS SK / SCM SUS	PREHARDENED STEELS NAK HPM	HARDENED STEELS ～55HRC	HARDENED STEELS ～60HRC	HARDENED STEELS ～70HRC	CAST IRON	ALUMINUM ALLOYS	GRAPHITE	COPPER	PLASTICS	GLASS FILLED PLASTICS	TITANIUM ALLOYS	HEAT RESISTANT ALLOYS	CEMENTED CARBIDE	HARD BRITTLE (NON-METALLIC) MATERIALS
		○	◎	◎	◎ ～68HRC										



Diameter and Corner R accuracy measurements are printed on the label to support High Precision milling.



The shank taper angle shown is not an exact value and to avoid contact with the work piece, we recommend the user controls the precise value of this angle. Shank taper angle should not make contact with the work piece.



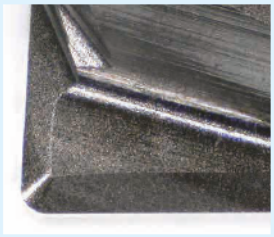
Features

Various lineup from ø0.1 to ø3

CBN-LRF2000/4000 Common features

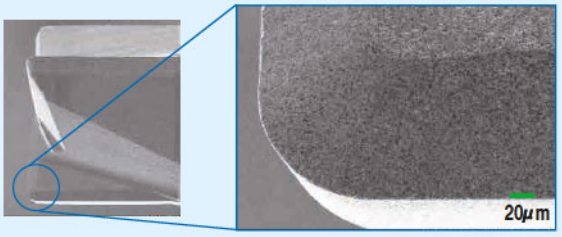
Feature 1 High rigidity cutting edge

Super negative rake angle from the cutting edge at the tip point to peripheral cutting edge.
Less damage when milling hard materials.



Feature 2 Sharp cutting edge

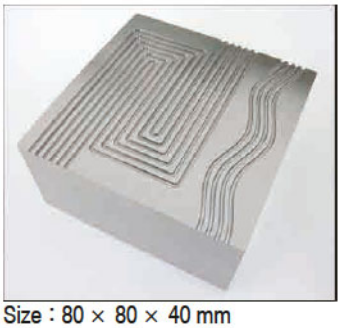
The cutting edge is outstandingly sharp even with the super negative rake angle.



Fuel cell separator mold

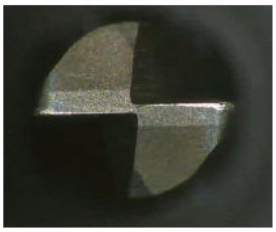
2 Flutes CBN-LRF ø1 × CR0.1 × EL1 SKH51 (63HRC)

CBN-LRF 2000

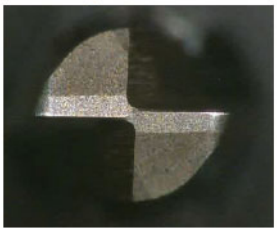


Size : 80 × 80 × 40 mm

After finishing of crank shape
(Milling time 10h 23min)



After finishing of wave shape
(Milling time 2h 58min)



Process	Tool	Spindle Speed (min^{-1})	Feed Rate (mm/min)	Allowance (mm)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Coolant	Cycle Time (h:m)
Roughing	HLRS ø1 × CR0.3 × EL2	10,900	710	—	0.03	0.27	Air Blow	2:43:45
Semi-finishing	HLRS ø1 × CR0.2 × EL2	10,900	710	0.015	0.03	0.1		3:07:09
Finishing	**CBN-LRF** ø1 × CR0.1 × EL1	30,000	525	0.005	0.01	0.1	Oil Mist	13:21:57
							Total	19:12:51

CBN bottom surface finishing

2 Flutes CBN-LRF ø2 × CR0.1 × EL1 STAVAX (52HRC)

Size : 60 × 35 × 20 mm

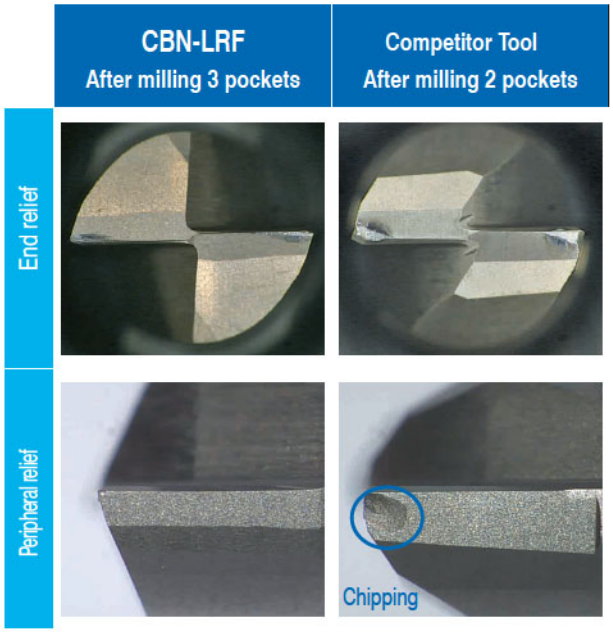
Ra 0.03 μm
Surface roughness

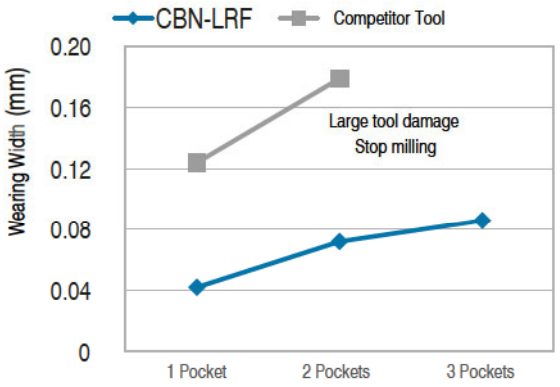
Bottom surface milling

CBN-LRF 2000

Process	Tool	Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Cycle Time (h:m)
Roughing	HRRS ø6 × CR1	6,000	4,000	0.3	2.7	0:03:00
Semi-finishing	HRRS ø6 × CR1	15,000	7,000	0.03	0.03	0:04:00
Semi-finishing	HSB R1.5	30,000	1,200	0.05	0.05	0:13:00
Semi-finishing	HSB R1	30,000	1,000	0.01	0.01	1:20:00
Finishing	CBN-LBSF R1	30,000	1,000	0.003	0.003	4:30:00
Semi-finishing	HLRS ø2 × CR0.1 × EL4	20,000	2,000	0.04	0.2	0:05:00
Semi-finishing	**CBN-LRF** ø2 × CR0.1 × EL4	20,000	1,200	0.02	0.15	0:13:00
Finishing	**CBN-LRF** ø2 × CR0.1 × EL4	25,000	1,000	0.01	0.1	0:38:00
Finishing	HSB R0.1	10,000	50	0.01	—	0:07:00
					Total	7:13:00

Pocket milling
2 Flutes CBN-LRF ø2 × CR0.02 × EL4 — HAP10 (65HRC)



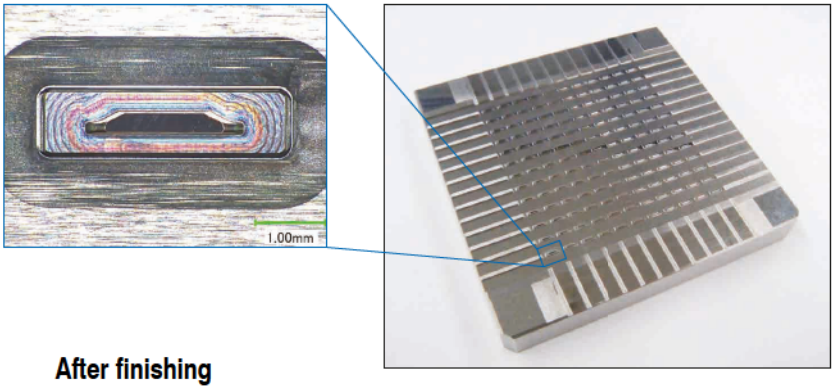


Less tool damage on 65HRC high speed steel!

Pocket Size : 15 × 15 × 0.3 mm
Coolant : Oil Mist

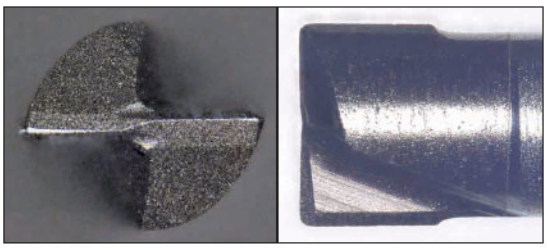
Tool	Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Cycle Time
CBN-LRF ø2 × CR0.02 × EL4	16,000	530	0.005	0.4	59 min / pocket

LED mold
2 Flutes CBN-LRF ø0.4 × CR0.02 × EL1 — ELMAX (62HRC)



Work Size : 80 × 80 × 10 mm
Coolant : Oil Mist

After finishing



Less tool damage after 10 hours milling!

Tool	Process	Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Cycle Time
CBN-LRF ø0.4 × CR0.02 × EL1	Finishing	38,000	600	0.01	0.01	10 h

2 Flute High-grade Long Neck Radius End Mills

Total 143 models

Shank taper angle Bta is only for reference.

Unit (mm)

Model Number	Outside Diameter ø D	Corner Radius CR	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°
CBN-LRF 2001-002002	0.1	R0.02	0.2	0.04	0.09	15°	50	4	44,500	0.20	0.20	0.20	0.20	0.21
CBN-LRF 2001-002003			0.3				50	4	45,200	0.30	0.30	0.30	0.30	0.33
CBN-LRF 2001-002005			0.5				50	4	46,500	0.50	0.50	0.51	0.53	0.58
CBN-LRF 2001-003002		R0.03	0.2				50	4	42,500	0.20	0.20	0.20	0.20	0.21
CBN-LRF 2001-003003			0.3				50	4	43,200	0.30	0.30	0.30	0.30	0.33
CBN-LRF 2001-003005			0.5				50	4	44,500	0.50	0.50	0.51	0.53	0.58
CBN-LRF 20015-002X2	0.15	R0.02	0.2	0.06	0.14	15°	50	4	44,500	0.20	0.20	0.20	0.20	0.21
CBN-LRF 20015-002X3			0.3				50	4	45,200	0.30	0.30	0.30	0.30	0.33
CBN-LRF 20015-002X5			0.5				50	4	46,500	0.50	0.50	0.51	0.53	0.58
CBN-LRF 20015-003X2		R0.03	0.2				50	4	42,500	0.20	0.20	0.20	0.20	0.21
CBN-LRF 20015-003X3			0.3				50	4	43,200	0.30	0.30	0.30	0.30	0.33
CBN-LRF 20015-003X5			0.5				50	4	44,500	0.50	0.50	0.51	0.53	0.58
CBN-LRF 2002-002005	0.2	R0.02	0.5	0.08	0.19	15°	50	4	33,900	0.50	0.50	0.51	0.53	0.58
CBN-LRF 2002-002X75			0.75				50	4	34,400	0.75	0.76	0.79	0.82	0.89
CBN-LRF 2002-002010			1				50	4	34,900	1.00	1.03	1.07	1.11	1.20
CBN-LRF 2002-003005		R0.03	0.5				50	4	30,500	0.50	0.50	0.51	0.53	0.58
CBN-LRF 2002-003X75			0.75				50	4	30,900	0.75	0.76	0.79	0.82	0.89
CBN-LRF 2002-003010			1				50	4	31,400	1.00	1.03	1.07	1.11	1.20
CBN-LRF 2002-005005		R0.05	0.5				50	4	30,500	0.50	0.50	0.51	0.53	0.57
CBN-LRF 2002-005X75			0.75				50	4	30,900	0.75	0.76	0.79	0.82	0.88
CBN-LRF 2002-005010			1				50	4	31,400	1.00	1.03	1.06	1.10	1.19
CBN-LRF 20025-005X5	0.25	R0.05	0.5	0.1	0.24	15°	50	4	30,500	0.50	0.50	0.51	0.53	0.57
CBN-LRF 20025-X5X75			0.75				50	4	30,900	0.75	0.76	0.79	0.82	0.88
CBN-LRF 20025-X5010			1				50	4	31,400	1.00	1.03	1.06	1.10	1.19
CBN-LRF 2003-001010	0.3	R0.01	1	0.13	0.28	15°	50	4	33,900	1.02	1.06	1.10	1.14	1.24
CBN-LRF 2003-002005		R0.02	0.5				50	4	33,500	0.51	0.53	0.55	0.57	0.62
CBN-LRF 2003-002X75			0.75				50	4	33,700	0.77	0.79	0.82	0.86	0.93
CBN-LRF 2003-002010			1				50	4	33,900	1.02	1.06	1.10	1.14	1.24
CBN-LRF 2003-002015			1.5				50	4	34,400	1.54	1.60	1.65	1.72	1.86
CBN-LRF 2003-002020			2				50	4	34,900	2.05	2.12	2.20	2.28	2.47
CBN-LRF 2003-003005		R0.03	0.5				50	4	30,100	0.51	0.53	0.55	0.57	0.62
CBN-LRF 2003-003X75			0.75				50	4	30,300	0.77	0.79	0.82	0.85	0.93
CBN-LRF 2003-003010			1				50	4	30,500	1.02	1.06	1.10	1.14	1.24
CBN-LRF 2003-003015			1.5				50	4	30,900	1.54	1.60	1.65	1.72	1.86
CBN-LRF 2003-003020			2				50	4	31,300	2.05	2.12	2.20	2.28	2.47
CBN-LRF 2003-005005		R0.05	0.5				50	4	30,100	0.51	0.52	0.54	0.56	0.61
CBN-LRF 2003-005X75			0.75				50	4	30,300	0.76	0.79	0.82	0.85	0.92
CBN-LRF 2003-005010			1				50	4	30,500	1.02	1.06	1.10	1.14	1.23
CBN-LRF 2003-005015			1.5				50	4	30,900	1.54	1.59	1.65	1.71	1.85
CBN-LRF 2003-005020			2				50	4	31,300	2.05	2.12	2.20	2.28	2.46
CBN-LRF 2004-002005	0.4	R0.02	0.5	0.24	0.38	15°	50	4	31,800	0.51	0.53	0.55	0.57	0.62
CBN-LRF 2004-002010			1				50	4	32,000	1.02	1.06	1.10	1.14	1.24
CBN-LRF 2004-002015			1.5				50	4	32,400	1.53	1.59	1.64	1.71	1.85
CBN-LRF 2004-002020			2				50	4	32,800	2.05	2.12	2.20	2.28	2.47
CBN-LRF 2004-003005		R0.03	0.5				50	4	28,600	0.51	0.53	0.55	0.57	0.62
CBN-LRF 2004-003010			1				50	4	28,800	1.02	1.06	1.10	1.14	1.24
CBN-LRF 2004-003015			1.5				50	4	28,800	1.53	1.59	1.64	1.71	1.85
CBN-LRF 2004-005005		R0.05	0.5				50	4	28,600	0.51	0.52	0.54	0.56	0.61
CBN-LRF 2004-005010			1				50	4	28,800	1.02	1.06	1.10	1.14	1.23
CBN-LRF 2004-005015			1.5				50	4	28,800	1.53	1.58	1.64	1.70	1.84
CBN-LRF 2004-005020			2				50	4	28,800	2.05	2.12	2.20	2.28	2.46
CBN-LRF 2004-005040			4				50	4	29,800	4.11	4.26	4.41	4.58	4.95
CBN-LRF 2004-010005		R0.1	0.5				50	4	28,600	0.50	0.52	0.54	0.56	0.60
CBN-LRF 2004-010010			1				50	4	28,800	1.02	1.06	1.09	1.13	1.22
CBN-LRF 2004-010015			1.5				50	4	28,800	1.53	1.58	1.64	1.70	1.83

2 Flute High-grade Long Neck Radius End Mills

Model Number	Outside Diameter øD	Corner Radius CR	Effective Length ℓ_1	Length of Cut ℓ	Neck Diameter $\varnothing d_1$	Shank Taper Angle Bta	Overall Length L	Shank Diameter ød	Suggested Retail Price ¥	Effective Length by Inclined Angles				
										30′	1°	1°30′	2°	3°
CBN-LRF 2005-001010	0.5	R0.01	1	0.3	0.48	15°	50	4	26,400	1.02	1.06	1.10	1.14	1.24
CBN-LRF 2005-002005		R0.02	0.5				50	4	26,100	0.51	0.53	0.55	0.57	0.62
CBN-LRF 2005-002010			1				50	4	26,400	1.02	1.06	1.10	1.14	1.24
CBN-LRF 2005-002015			1.5				50	4	26,600	1.53	1.59	1.64	1.71	1.85
CBN-LRF 2005-002020			2				50	4	26,800	2.05	2.12	2.20	2.28	2.47
CBN-LRF 2005-003005		R0.03	0.5				50	4	23,500	0.51	0.53	0.55	0.57	0.62
CBN-LRF 2005-003010			1				50	4	23,700	1.02	1.06	1.10	1.14	1.24
CBN-LRF 2005-003015			1.5				50	4	23,900	1.53	1.59	1.64	1.71	1.85
CBN-LRF 2005-003020			2				50	4	24,100	2.05	2.12	2.20	2.28	2.47
CBN-LRF 2005-005005		R0.05	0.5				50	4	23,500	0.51	0.52	0.54	0.56	0.61
CBN-LRF 2005-005010			1				50	4	23,700	1.02	1.06	1.10	1.14	1.23
CBN-LRF 2005-005015			1.5				50	4	23,900	1.53	1.58	1.64	1.70	1.84
CBN-LRF 2005-005020			2				50	4	24,100	2.05	2.12	2.20	2.28	2.46
CBN-LRF 2005-010005		R0.1	0.5				50	4	23,500	0.50	0.52	0.54	0.56	0.60
CBN-LRF 2005-010010			1				50	4	23,700	1.02	1.06	1.09	1.13	1.22
CBN-LRF 2005-010015			1.5				50	4	23,900	1.53	1.58	1.64	1.70	1.83
CBN-LRF 2005-010020			2				50	4	24,100	2.05	2.12	2.19	2.27	2.45
CBN-LRF 2006-002005	0.6	R0.02	0.5	0.3	0.58	15°	50	4	26,100	0.51	0.53	0.55	0.57	0.62
CBN-LRF 2006-002010			1				50	4	26,400	1.02	1.06	1.10	1.14	1.24
CBN-LRF 2006-002015			1.5				50	4	26,600	1.53	1.59	1.64	1.71	1.85
CBN-LRF 2006-005005		R0.05	0.5				50	4	23,500	0.51	0.52	0.54	0.56	0.61
CBN-LRF 2006-005010			1				50	4	23,700	1.02	1.06	1.10	1.14	1.23
CBN-LRF 2006-005015			1.5				50	4	23,900	1.53	1.58	1.64	1.70	1.84
CBN-LRF 2006-005030			3				50	4	26,100	3.08	3.19	3.30	3.43	3.71
CBN-LRF 2006-010005		R0.1	0.5				50	4	23,500	0.50	0.52	0.54	0.56	0.60
CBN-LRF 2006-010010			1				50	4	23,700	1.02	1.06	1.09	1.13	1.22
CBN-LRF 2006-010015			1.5				50	4	23,900	1.53	1.58	1.64	1.70	1.83
CBN-LRF 2008-002010	0.8	R0.02	1	0.56	0.78	15°	50	4	26,600	1.02	1.06	1.10	1.14	1.24
CBN-LRF 2008-002015			1.5				50	4	26,600	1.53	1.59	1.64	1.71	1.85
CBN-LRF 2008-002020			2				50	4	26,600	2.05	2.12	2.20	2.28	2.47
CBN-LRF 2008-002050			5				50	4	30,100	5.15	5.33	5.52	5.73	6.20
CBN-LRF 2008-005010		R0.05	1				50	4	23,900	1.02	1.06	1.10	1.14	1.23
CBN-LRF 2008-005015			1.5				50	4	23,900	1.53	1.58	1.64	1.70	1.84
CBN-LRF 2008-005020			2				50	4	23,900	2.05	2.12	2.20	2.28	2.46
CBN-LRF 2008-005050			5				50	4	27,000	5.15	5.33	5.52	5.73	6.19
CBN-LRF 2008-010010		R0.1	1				50	4	23,900	1.02	1.06	1.09	1.13	1.22
CBN-LRF 2008-010015			1.5				50	4	23,900	1.53	1.58	1.64	1.70	1.83
CBN-LRF 2008-010020			2				50	4	23,900	2.05	2.12	2.19	2.27	2.45
CBN-LRF 2008-010050			5				50	4	27,000	5.15	5.32	5.52	5.72	6.18
CBN-LRF 2010-002010	1	R0.02	1	0.7	0.98	15°	50	4	24,400	1.03	1.06	1.10	1.15	1.24
CBN-LRF 2010-002020			2				50	4	24,400	2.06	2.13	2.21	2.30	2.48
CBN-LRF 2010-002030			3				50	4	24,400	3.09	3.20	3.32	3.45	3.73
CBN-LRF 2010-002050			5				50	4	27,600	5.16	5.34	5.54	5.74	6.21
CBN-LRF 2010-005010		R0.05	1				50	4	21,900	1.03	1.06	1.10	1.14	1.23
CBN-LRF 2010-005020			2				50	4	21,900	2.06	2.13	2.21	2.29	2.48
CBN-LRF 2010-005030			3				50	4	21,900	3.09	3.20	3.32	3.44	3.72
CBN-LRF 2010-005050			5				50	4	24,800	5.16	5.34	5.53	5.74	6.21
CBN-LRF 2010-010010		R0.1	1				50	4	21,900	1.02	1.06	1.09	1.13	1.22
CBN-LRF 2010-010020			2				50	4	21,900	2.06	2.13	2.20	2.28	2.47
CBN-LRF 2010-010030			3				50	4	21,900	3.09	3.20	3.31	3.43	3.71
CBN-LRF 2010-010050			5				50	4	24,800	5.16	5.34	5.53	5.73	6.20
CBN-LRF 2010-020010		R0.2	1				50	4	21,900	1.02	1.05	1.08	1.12	1.20
CBN-LRF 2010-020020			2				50	4	21,900	2.05	2.12	2.19	2.27	2.44

2 Flute High-grade Long Neck Radius End Mills

	Model Number	Outside Diameter øD	Corner Radius CR	Effective Length ℓ_1	Length of Cut ℓ	Neck Diameter $\varnothing d_1$	Shank Taper Angle Bta	Overall Length L	Shank Diameter ød	Suggested Retail Price ¥	Effective Length by Inclined Angles				
											30′	1°	1°30′	2°	3°
	CBN-LRF 2015-002030	1.5	R0.02	3	1	1.46	15°	50	4	28,700	3.13	3.24	3.36	3.49	3.77
	CBN-LRF 2015-002040			4				50	4	28,700	4.17	4.31	4.47	4.64	5.02
	CBN-LRF 2015-002060			6				50	4	28,700	6.23	6.45	6.69	6.94	7.50
	CBN-LRF 2015-005030		R0.05	3				50	4	25,800	3.13	3.24	3.36	3.48	3.77
	CBN-LRF 2015-005040			4				50	4	25,800	4.16	4.31	4.47	4.63	5.01
	CBN-LRF 2015-005060			6				50	4	25,800	6.23	6.45	6.68	6.93	7.50
	CBN-LRF 2015-010030		R0.1	3				50	4	25,800	3.13	3.24	3.35	3.48	3.76
	CBN-LRF 2015-010040			4				50	4	25,800	4.16	4.31	4.46	4.63	5.00
	CBN-LRF 2015-010060			6				50	4	25,800	6.23	6.45	6.68	6.93	7.48
	CBN-LRF 2015-030045		R0.3	4.5				50	4	25,800	4.67	4.83	4.99	5.17	5.57
	CBN-LRF 2020-002040	2	R0.02	4	1.2	1.97	15°	50	4	29,600	4.15	4.29	4.45	4.62	4.99
	CBN-LRF 2020-002060			6				50	4	29,600	6.21	6.43	6.67	6.92	7.48
	CBN-LRF 2020-002080			8				50	4	31,300	8.28	8.57	8.88	9.22	9.97
	CBN-LRF 2020-002100			10				50	4	33,000	10.35	10.71	11.10	11.52	12.45
	CBN-LRF 2020-003030		R0.03	3				50	4	26,600	3.11	3.22	3.34	3.47	3.75
	CBN-LRF 2020-005040		R0.05	4				50	4	26,600	4.15	4.29	4.45	4.61	4.99
	CBN-LRF 2020-005060			6				50	4	26,600	6.21	6.43	6.66	6.91	7.47
	CBN-LRF 2020-005080			8				50	4	28,150	8.28	8.57	8.88	9.21	9.96
	CBN-LRF 2020-005100			10				50	4	29,700	10.35	10.71	11.10	11.51	12.45
	CBN-LRF 2020-010040		R0.1	4				50	4	26,600	4.14	4.29	4.44	4.60	4.98
	CBN-LRF 2020-010060			6				50	4	26,600	6.21	6.43	6.66	6.90	7.46
	CBN-LRF 2020-010080			8				50	4	28,150	8.28	8.57	8.87	9.20	9.95
	CBN-LRF 2020-010100			10				50	4	29,700	10.35	10.70	11.09	11.50	12.43
	CBN-LRF 2020-020040		R0.2	4				50	4	26,600	4.14	4.28	4.43	4.59	4.95
	CBN-LRF 2020-020060			6				50	4	26,600	6.21	6.42	6.65	6.89	7.44
	CBN-LRF 2020-020080			8				50	4	28,150	8.28	8.56	8.86	9.19	9.92
	CBN-LRF 2020-020100			10				50	4	29,700	10.34	10.70	11.08	11.49	12.41
	CBN-LRF 2020-050040		R0.5	4				50	4	26,600	4.13	4.26	4.40	4.55	4.88
	CBN-LRF 2020-050060			6				50	4	26,600	6.20	6.40	6.61	6.85	7.37
	CBN-LRF 2020-050080			8				50	4	28,150	8.27	8.54	8.83	9.15	9.85
	CBN-LRF 2020-050100			10				50	4	29,700	10.33	10.68	11.05	11.45	12.34
*	CBN-LRF 2030-005060	3	R0.05	6	0.7	2.94	15°	50	6	34,410	6.27	6.49	6.72	6.98	7.54
*	CBN-LRF 2030-010060		R0.1	6				50	6	34,410	6.27	6.49	6.72	6.97	7.53
*	CBN-LRF 2030-020060		R0.2	6				50	6	34,410	6.27	6.48	6.71	6.95	7.51
*	CBN-LRF 2030-050060		R0.5	6				50	6	34,410	6.26	6.46	6.68	6.91	7.44

* Additional model

CBN-LRF Milling Conditions (2 Flutes)

WORK MATERIAL				HEAT-TREATED STEELS / HARDENED STEELS STAVAX (~52HRC)				HARDENED STEELS SKD11 (~62HRC)				HARDENED STEELS HAP10 / HAP72 (~68HRC)			
Model Number	Outside Diameter (mm)	Corner Radius (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)
2001-002002	0.1	R0.02	0.2	30,000	90	0.002	0.01	30,000	60	0.002	0.01	30,000	30	0.002	0.005
2001-002003			0.3	30,000	90	0.002	0.01	30,000	60	0.002	0.01	30,000	30	0.002	0.005
2001-002005			0.5	30,000	90	0.002	0.01	30,000	60	0.002	0.01	30,000	30	0.002	0.005
2001-003002		R0.03	0.2	30,000	90	0.002	0.01	30,000	60	0.002	0.01	30,000	30	0.002	0.005
2001-003003			0.3	30,000	90	0.002	0.01	30,000	60	0.002	0.01	30,000	30	0.002	0.005
2001-003005			0.5	30,000	90	0.002	0.01	30,000	60	0.002	0.01	30,000	30	0.002	0.005
20015-002X2	0.15	R0.02	0.2	30,000	120	0.003	0.015	30,000	90	0.003	0.015	30,000	60	0.002	0.01
20015-002X3			0.3	30,000	120	0.003	0.015	30,000	90	0.003	0.015	30,000	60	0.002	0.01
20015-002X5			0.5	30,000	120	0.003	0.015	30,000	90	0.003	0.015	30,000	60	0.002	0.01
20015-003X2		R0.03	0.2	30,000	120	0.003	0.015	30,000	90	0.003	0.015	30,000	60	0.002	0.01
20015-003X3			0.3	30,000	120	0.003	0.015	30,000	90	0.003	0.015	30,000	60	0.002	0.01
20015-003X5			0.5	30,000	120	0.003	0.015	30,000	90	0.003	0.015	30,000	60	0.002	0.01
2002-002005	0.2	R0.02	0.5	30,000	140	0.003	0.02	30,000	120	0.003	0.02	30,000	80	0.003	0.01
2002-002X75			0.75	30,000	140	0.003	0.02	30,000	120	0.003	0.02	30,000	80	0.003	0.01
2002-002010			1	30,000	140	0.003	0.02	30,000	120	0.003	0.02	30,000	80	0.003	0.01
2002-003005		R0.03	0.5	30,000	140	0.003	0.02	30,000	120	0.003	0.02	30,000	80	0.003	0.01
2002-003X75			0.75	30,000	140	0.003	0.02	30,000	120	0.003	0.02	30,000	80	0.003	0.01
2002-003010			1	30,000	140	0.003	0.02	30,000	120	0.003	0.02	30,000	80	0.003	0.01
2002-005005		R0.05	0.5	30,000	140	0.003	0.02	30,000	120	0.003	0.02	30,000	80	0.003	0.01
2002-005X75			0.75	30,000	140	0.003	0.02	30,000	120	0.003	0.02	30,000	80	0.003	0.01
2002-005010			1	30,000	140	0.003	0.02	30,000	120	0.003	0.02	30,000	80	0.003	0.01
20025-005X5	0.25	R0.05	0.5	30,000	190	0.004	0.03	30,000	170	0.004	0.03	30,000	140	0.003	0.015
20025-X5X75			0.75	30,000	190	0.004	0.03	30,000	170	0.004	0.03	30,000	140	0.003	0.015
20025-X5010			1	30,000	190	0.004	0.03	30,000	170	0.004	0.03	30,000	140	0.003	0.015
2003-001010	0.3	R0.01	1	30,000	185	0.003	0.045	30,000	160	0.003	0.045	30,000	120	0.003	0.02
2003-002005		R0.02	0.5	30,000	185	0.003	0.045	30,000	160	0.003	0.045	30,000	120	0.003	0.02
2003-002X75			0.75	30,000	185	0.003	0.045	30,000	160	0.003	0.045	30,000	120	0.003	0.02
2003-002010			1	30,000	185	0.003	0.045	30,000	160	0.003	0.045	30,000	120	0.003	0.02
2003-002015			1.5	30,000	185	0.003	0.045	30,000	160	0.003	0.045	30,000	120	0.003	0.02
2003-002020			2	30,000	130	0.003	0.022	30,000	110	0.003	0.022	30,000	80	0.003	0.01
2003-003005		R0.03	0.5	30,000	200	0.004	0.045	30,000	175	0.004	0.045	30,000	150	0.003	0.02
2003-003X75			0.75	30,000	200	0.004	0.045	30,000	175	0.004	0.045	30,000	150	0.003	0.02
2003-003010			1	30,000	200	0.004	0.045	30,000	175	0.004	0.045	30,000	150	0.003	0.02
2003-003015			1.5	30,000	200	0.004	0.045	30,000	175	0.004	0.045	30,000	150	0.003	0.02
2003-003020			2	30,000	140	0.004	0.022	30,000	120	0.004	0.022	30,000	110	0.003	0.01
2003-005005		R0.05	0.5	30,000	240	0.005	0.045	30,000	225	0.005	0.045	30,000	210	0.004	0.02
2003-005X75			0.75	30,000	240	0.005	0.045	30,000	225	0.005	0.045	30,000	210	0.004	0.02
2003-005010			1	30,000	240	0.005	0.045	30,000	225	0.005	0.045	30,000	210	0.004	0.02
2003-005015			1.5	30,000	240	0.005	0.045	30,000	225	0.005	0.045	30,000	210	0.004	0.02
2003-005020			2	30,000	170	0.005	0.022	30,000	160	0.005	0.022	30,000	150	0.004	0.01

CBN-LRF Milling Conditions (2 Flutes)

WORK MATERIAL				HEAT-TREATED STEELS / HARDENED STEELS STAVAX (~52HRC)				HARDENED STEELS SKD11 (~62HRC)				HARDENED STEELS HAP10 / HAP72 (~68HRC)			
Model Number	Outside Diameter (mm)	Corner Radius (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)
2004-002005	0.4	R0.02	0.5	30,000	230	0.005	0.065	30,000	200	0.005	0.065	30,000	160	0.004	0.02
2004-002010			1	30,000	230	0.005	0.065	30,000	200	0.005	0.065	30,000	160	0.004	0.02
2004-002015			1.5	30,000	230	0.005	0.065	30,000	200	0.005	0.065	30,000	160	0.004	0.02
2004-002020			2	30,000	230	0.005	0.065	30,000	200	0.005	0.065	30,000	160	0.004	0.02
2004-003005		R0.03	0.5	30,000	270	0.006	0.065	30,000	230	0.006	0.065	30,000	180	0.004	0.02
2004-003010			1	30,000	270	0.006	0.065	30,000	230	0.006	0.065	30,000	180	0.004	0.02
2004-003015			1.5	30,000	270	0.006	0.065	30,000	230	0.006	0.065	30,000	180	0.004	0.02
2004-005005		R0.05	0.5	30,000	340	0.01	0.065	30,000	300	0.01	0.065	30,000	220	0.005	0.02
2004-005010			1	30,000	340	0.01	0.065	30,000	300	0.01	0.065	30,000	220	0.005	0.02
2004-005015			1.5	30,000	340	0.01	0.065	30,000	300	0.01	0.065	30,000	220	0.005	0.02
2004-005020			2	30,000	340	0.01	0.065	30,000	300	0.01	0.065	30,000	220	0.005	0.02
2004-005040			4	30,000	170	0.01	0.032	30,000	150	0.01	0.032	30,000	110	0.005	0.01
2004-010005		R0.1	0.5	30,000	520	0.01	0.065	30,000	450	0.01	0.065	30,000	320	0.005	0.02
2004-010010			1	30,000	520	0.01	0.065	30,000	450	0.01	0.065	30,000	320	0.005	0.02
2004-010015			1.5	30,000	520	0.01	0.065	30,000	450	0.01	0.065	30,000	320	0.005	0.02
2005-001010	0.5	R0.01	1	30,000	280	0.003	0.09	30,000	240	0.003	0.09	30,000	200	0.003	0.03
2005-002005		R0.02	0.5	30,000	280	0.005	0.09	30,000	240	0.005	0.09	30,000	200	0.005	0.03
2005-002010			1	30,000	280	0.005	0.09	30,000	240	0.005	0.09	30,000	200	0.005	0.03
2005-002015			1.5	30,000	280	0.005	0.09	30,000	240	0.005	0.09	30,000	200	0.005	0.03
2005-002020			2	30,000	280	0.005	0.09	30,000	240	0.005	0.09	30,000	200	0.005	0.03
2005-003005		R0.03	0.5	30,000	330	0.006	0.09	30,000	280	0.006	0.09	30,000	230	0.005	0.03
2005-003010			1	30,000	330	0.006	0.09	30,000	280	0.006	0.09	30,000	230	0.005	0.03
2005-003015			1.5	30,000	330	0.006	0.09	30,000	280	0.006	0.09	30,000	230	0.005	0.03
2005-003020			2	30,000	330	0.006	0.09	30,000	280	0.006	0.09	30,000	230	0.005	0.03
2005-005005		R0.05	0.5	30,000	440	0.01	0.09	30,000	380	0.01	0.09	30,000	280	0.01	0.03
2005-005010			1	30,000	440	0.01	0.09	30,000	380	0.01	0.09	30,000	280	0.01	0.03
2005-005015			1.5	30,000	440	0.01	0.09	30,000	380	0.01	0.09	30,000	280	0.01	0.03
2005-005020			2	30,000	440	0.01	0.09	30,000	380	0.01	0.09	30,000	280	0.01	0.03
2005-010005		R0.1	0.5	30,000	700	0.02	0.09	30,000	600	0.02	0.09	30,000	410	0.01	0.03
2005-010010			1	30,000	700	0.02	0.09	30,000	600	0.02	0.09	30,000	410	0.01	0.03
2005-010015			1.5	30,000	700	0.02	0.09	30,000	600	0.02	0.09	30,000	410	0.01	0.03
2005-010020			2	30,000	700	0.02	0.09	30,000	600	0.02	0.09	30,000	410	0.01	0.03
2006-002005	0.6	R0.02	0.5	30,000	320	0.005	0.11	30,000	270	0.005	0.11	30,000	240	0.005	0.035
2006-002010			1	30,000	320	0.005	0.11	30,000	270	0.005	0.11	30,000	240	0.005	0.035
2006-002015			1.5	30,000	320	0.005	0.11	30,000	270	0.005	0.11	30,000	240	0.005	0.035
2006-005005		R0.05	0.5	30,000	500	0.01	0.11	30,000	430	0.01	0.11	30,000	340	0.01	0.035
2006-005010			1	30,000	500	0.01	0.11	30,000	430	0.01	0.11	30,000	340	0.01	0.035
2006-005015			1.5	30,000	500	0.01	0.11	30,000	430	0.01	0.11	30,000	340	0.01	0.035
2006-005030			3	30,000	500	0.01	0.11	30,000	430	0.01	0.11	30,000	340	0.01	0.035
2006-010005		R0.1	0.5	30,000	800	0.02	0.11	30,000	675	0.02	0.11	30,000	492	0.01	0.035
2006-010010			1	30,000	800	0.02	0.11	30,000	675	0.02	0.11	30,000	492	0.01	0.035
2006-010015			1.5	30,000	800	0.02	0.11	30,000	675	0.02	0.11	30,000	492	0.01	0.035

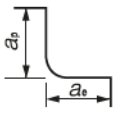
CBN-LRF Milling Conditions (2 Flutes)

WORK MATERIAL				HEAT-TREATED STEELS / HARDENED STEELS STAVAX (~52HRC)				HARDENED STEELS SKD11 (~62HRC)				HARDENED STEELS HAP10 / HAP72 (~68HRC)			
Model Number	Outside Diameter (mm)	Corner Radius (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)
2008-002010	0.8	R0.02	1	30,000	410	0.005	0.16	30,000	350	0.005	0.16	30,000	320	0.005	0.04
2008-002015			1.5	30,000	410	0.005	0.16	30,000	350	0.005	0.16	30,000	320	0.005	0.04
2008-002020			2	30,000	410	0.005	0.16	30,000	350	0.005	0.16	30,000	320	0.005	0.04
2008-002050			5	30,000	290	0.005	0.08	30,000	250	0.005	0.08	30,000	220	0.005	0.02
2008-005010		R0.05	1	30,000	600	0.01	0.16	30,000	510	0.01	0.16	30,000	450	0.01	0.04
2008-005015			1.5	30,000	600	0.01	0.16	30,000	510	0.01	0.16	30,000	450	0.01	0.04
2008-005020			2	30,000	600	0.01	0.16	30,000	510	0.01	0.16	30,000	450	0.01	0.04
2008-005050			5	30,000	420	0.01	0.08	30,000	360	0.01	0.08	30,000	320	0.01	0.02
2008-010010		R0.1	1	30,000	920	0.02	0.16	30,000	790	0.02	0.16	30,000	560	0.01	0.04
2008-010015			1.5	30,000	920	0.02	0.16	30,000	790	0.02	0.16	30,000	560	0.01	0.04
2008-010020			2	30,000	920	0.02	0.16	30,000	790	0.02	0.16	30,000	560	0.01	0.04
2008-010050			5	30,000	640	0.02	0.08	30,000	550	0.02	0.08	30,000	390	0.01	0.02
2010-002010	1	R0.02	1	30,000	500	0.005	0.2	30,000	430	0.005	0.2	30,000	400	0.005	0.05
2010-002020			2	30,000	500	0.005	0.2	30,000	430	0.005	0.2	30,000	400	0.005	0.05
2010-002030			3	30,000	500	0.005	0.2	30,000	430	0.005	0.2	30,000	400	0.005	0.05
2010-002050			5	30,000	500	0.005	0.2	30,000	430	0.005	0.2	30,000	400	0.005	0.05
2010-005010		R0.05	1	30,000	700	0.01	0.2	30,000	600	0.01	0.2	30,000	500	0.01	0.05
2010-005020			2	30,000	700	0.01	0.2	30,000	600	0.01	0.2	30,000	500	0.01	0.05
2010-005030			3	30,000	700	0.01	0.2	30,000	600	0.01	0.2	30,000	500	0.01	0.05
2010-005050			5	30,000	700	0.01	0.2	30,000	600	0.01	0.2	30,000	500	0.01	0.05
2010-010010		R0.1	1	30,000	1,000	0.02	0.2	30,000	850	0.02	0.2	30,000	600	0.01	0.05
2010-010020			2	30,000	1,000	0.02	0.2	30,000	850	0.02	0.2	30,000	600	0.01	0.05
2010-010030			3	30,000	1,000	0.02	0.2	30,000	850	0.02	0.2	30,000	600	0.01	0.05
2010-010050			5	30,000	1,000	0.02	0.2	30,000	850	0.02	0.2	30,000	600	0.01	0.05
2010-020010		R0.2	1	30,000	1,600	0.04	0.2	30,000	1,350	0.04	0.2	30,000	850	0.01	0.05
2010-020020			2	30,000	1,600	0.04	0.2	30,000	1,350	0.04	0.2	30,000	850	0.01	0.05
2015-002030	1.5	R0.02	3	27,000	800	0.005	0.3	27,000	680	0.005	0.3	20,000	470	0.005	0.23
2015-002040			4	27,000	800	0.005	0.3	27,000	680	0.005	0.3	20,000	470	0.005	0.23
2015-002060			6	27,000	800	0.005	0.3	27,000	680	0.005	0.3	20,000	470	0.005	0.23
2015-005030		R0.05	3	27,000	1,200	0.01	0.3	27,000	1,000	0.01	0.3	20,000	520	0.01	0.23
2015-005040			4	27,000	1,200	0.01	0.3	27,000	1,000	0.01	0.3	20,000	520	0.01	0.23
2015-005060			6	27,000	1,200	0.01	0.3	27,000	1,000	0.01	0.3	20,000	520	0.01	0.23
2015-010030		R0.1	3	27,000	1,500	0.02	0.3	27,000	1,300	0.02	0.3	20,000	600	0.01	0.23
2015-010040			4	27,000	1,500	0.02	0.3	27,000	1,300	0.02	0.3	20,000	600	0.01	0.23
2015-010060			6	27,000	1,500	0.02	0.3	27,000	1,300	0.02	0.3	20,000	600	0.01	0.23
2015-030045		R0.3	4.5	27,000	1,800	0.06	0.3	27,000	1,500	0.06	0.3	25,000	930	0.01	0.23

CBN-LRF Milling Conditions (2 Flutes)

WORK MATERIAL				HEAT-TREATED STEELS / HARDENED STEELS STAVAX (~52HRC)				HARDENED STEELS SKD11 (~62HRC)				HARDENED STEELS HAP10 / HAP72 (~68HRC)			
Model Number	Outside Diameter (mm)	Corner Radius (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)
2020-002040	2	R0.02	4	24,000	1,000	0.005	0.4	24,000	850	0.005	0.4	16,000	530	0.005	0.4
2020-002060			6	24,000	1,000	0.005	0.4	24,000	850	0.005	0.4	16,000	530	0.005	0.4
2020-002080			8	24,000	1,000	0.005	0.4	24,000	850	0.005	0.4	16,000	530	0.005	0.4
2020-002100			10	24,000	1,000	0.005	0.4	24,000	850	0.005	0.4	16,000	530	0.005	0.4
2020-003030		R0.03	3	24,000	1,000	0.006	0.4	24,000	850	0.006	0.4	16,000	550	0.005	0.4
2020-005040		R0.05	4	24,000	1,500	0.01	0.4	24,000	1,300	0.01	0.4	16,500	600	0.01	0.4
2020-005060			6	24,000	1,500	0.01	0.4	24,000	1,300	0.01	0.4	16,500	600	0.01	0.4
2020-005080			8	24,000	1,500	0.01	0.4	24,000	1,300	0.01	0.4	16,500	600	0.01	0.35
2020-005100			10	24,000	1,500	0.01	0.4	24,000	1,300	0.01	0.4	16,500	600	0.01	0.3
2020-010040		R0.1	4	24,000	2,000	0.02	0.4	24,000	1,700	0.02	0.4	17,000	700	0.01	0.4
2020-010060			6	24,000	2,000	0.02	0.4	24,000	1,700	0.02	0.4	17,000	700	0.01	0.4
2020-010080			8	24,000	2,000	0.02	0.4	24,000	1,700	0.02	0.4	17,000	700	0.01	0.35
2020-010100			10	24,000	2,000	0.02	0.4	24,000	1,700	0.02	0.4	17,000	700	0.01	0.3
2020-020040		R0.2	4	24,000	2,000	0.04	0.4	24,000	1,700	0.04	0.4	17,700	770	0.01	0.4
2020-020060			6	24,000	2,000	0.04	0.4	24,000	1,700	0.04	0.4	17,700	770	0.01	0.4
2020-020080			8	24,000	2,000	0.03	0.4	24,000	1,700	0.03	0.4	17,700	770	0.01	0.35
2020-020100			10	24,000	2,000	0.025	0.4	24,000	1,700	0.025	0.4	17,700	770	0.01	0.3
2020-050040		R0.5	4	24,000	2,000	0.1	0.4	24,000	1,700	0.1	0.4	20,000	1,000	0.01	0.4
2020-050060			6	24,000	2,000	0.1	0.4	24,000	1,700	0.1	0.4	20,000	1,000	0.01	0.4
2020-050080			8	24,000	2,000	0.075	0.4	24,000	1,700	0.075	0.4	20,000	1,000	0.01	0.35
2020-050100			10	24,000	2,000	0.05	0.4	24,000	1,700	0.05	0.4	20,000	1,000	0.01	0.3
2030-005060	3	R0.05	6	20,000	1,500	0.02	0.6	20,000	1,300	0.02	0.6	13,500	600	0.015	0.6
2030-010060		R0.1	6	20,000	2,000	0.04	0.6	20,000	1,700	0.04	0.6	14,000	700	0.02	0.6
2030-020060		R0.2	6	20,000	2,000	0.06	0.6	20,000	1,700	0.06	0.6	14,500	770	0.02	0.6
2030-050060		R0.5	6	20,000	2,000	0.12	0.6	20,000	1,700	0.12	0.6	16,500	1,000	0.02	0.6

Note:
- Decrease both spindle speed and feed rate proportionally when the milling parameters exceed the machine's maximum spindle speed.
- Recommend oil mist to avoid tool damage.



Size ø0.3～ø2

CBN-LRF4000

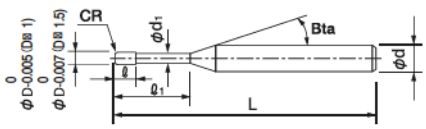
CBN | 0° | R | R ±0.002 | Shank Dia 0/-0.004 | Back Taper Geometry

New

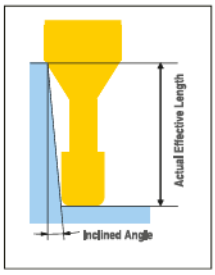
Material Applications (☆ Highly Recommended ◎ Recommended ○ Suggested)

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

Diameter and Corner R accuracy measurements are printed on the label to support High Precision milling.



The shank taper angle shown is not an exact value and to avoid contact with the work piece, we recommend the user controls the precise value of this angle. Shank taper angle should not make contact with the work piece.



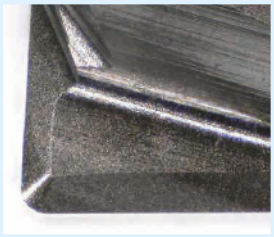
Features

4-flute shape withstands high efficiency milling.
Milling time can be significantly reduced compared to 2-flute.

CBN-LRF2000/4000 Common features

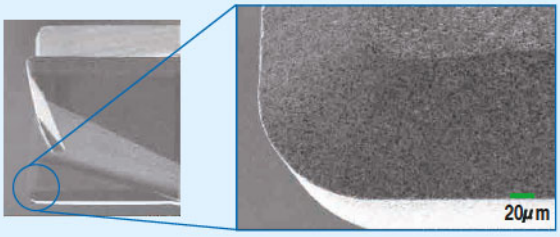
Feature 1 High rigidity cutting edge

Super negative rake angle from the cutting edge at the tip point to peripheral cutting edge.
Less damage when milling hard materials.



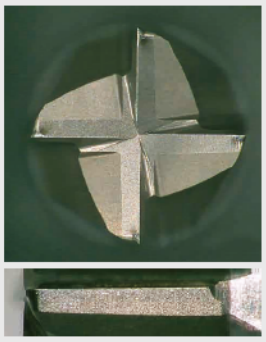
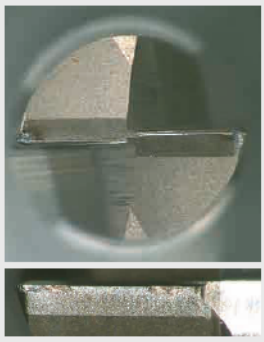
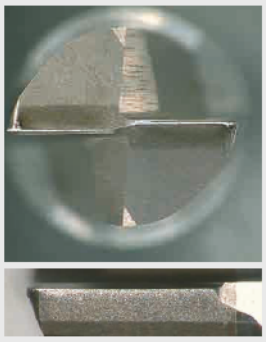
Feature 2 Sharp cutting edge

The cutting edge is outstandingly sharp even with the super negative rake angle.



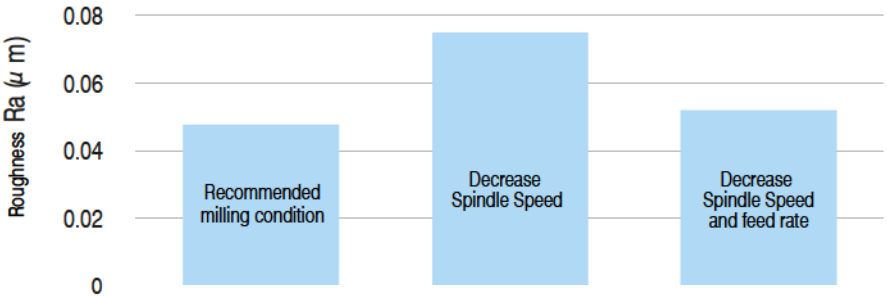
Pocket milling
2/4 Flutes CBN-LRF ø2 × CR0.1 × EL6 — STAVAX (52HRC)

Tool	Flutes	Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Feed per tooth (mm)	Cycle Time
CBN-LRF ø 2 × CR0.1 × EL6	4	28,000	3,300	0.05	0.7	0.029	45 min / 1Pocket
CBN-LRF ø 2 × CR0.1 × EL6	2	28,000	3,300	0.05	0.7	0.059	45 min / 1Pocket
CBN-LRF ø 2 × CR0.1 × EL6	2	28,000	1,650	0.05	0.7	0.029	85 min / 1Pocket

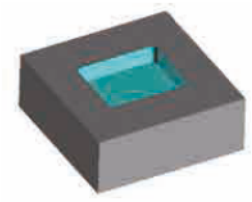
Tool	4 Flutes	2 Flutes	2 Flutes
Feed rate (mm/min)	3,300 mm/min	3,300 mm/min	1,650 mm/min
Cycle time (min)	135 min	135 min	255 min
Tool photo			
Milling results	Mill under higher efficiency conditions than 2-flute. Greatly shortens milling time.	Large damage under the same milling conditions as 4-flute.	When the feed per tooth is the same, the damage is small, but the milling time is about twice as long.

Pocket Size: 50 × 40 × 2 mm Coolant: Oil mist

Surface roughness by different milling conditions
4 Flutes CBN-LRF ø0.3 × CR0.05 × EL0.5 — STAVAX (52HRC)



Spindle speed	60,000	30,000	30,000
Feed rate	950	950	475
Cycle Time	26 min / Pocket	26 min / Pocket	50 min / Pocket



Pocket Size
10 × 4 × 0.2 mm
Coolant: Oil mist
ap : 0.005 mm
ae : 0.08 mm

Achieves high-speed milling that exceeds conventional CBN end mills even for small diameters.

ø0.3 can be used in a machining center equipped with a 30,000 rpm spindle. It is recommended to decrease both the spindle speed and feed rate proportionally.

4 Flute High-grade Long Neck Radius End Mills

Total 35 models

Shank taper angle Bta is only for reference.

Unit (mm)

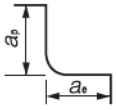
Model Number	Outside Diameter øD	Corner Radius CR	Effective Length ℓ_1	Length of Cut ℓ	Neck Diameter $\varnothing d_1$	Shank Taper Angle Bta	Overall Length L	Shank Diameter ød	Suggested Retail Price ¥	Effective Length by Inclined Angles				
										30′	1°	1°30′	2°	3°
CBN-LRF 4003-002X75	0.3	R0.02	0.75	0.13	0.28	15°	50	4	40,520	0.83	0.86	0.89	0.92	1.00
CBN-LRF 4003-002010			1				50	4	40,850	1.08	1.12	1.17	1.21	1.31
CBN-LRF 4003-005005		R0.05	0.5				50	4	36,300	0.57	0.59	0.61	0.63	0.68
CBN-LRF 4004-002015	0.4	R0.02	1.5	0.24	0.38	15°	50	4	38,880	1.54	1.59	1.65	1.71	1.86
CBN-LRF 4004-003005		R0.03	0.5				50	4	34,320	0.51	0.53	0.55	0.57	0.62
CBN-LRF 4004-005005		R0.05	0.5				50	4	34,320	0.51	0.53	0.55	0.57	0.62
CBN-LRF 4004-005015			1.5				50	4	34,560	1.54	1.59	1.65	1.71	1.85
CBN-LRF 4004-010005		R0.1	0.5				50	4	34,320	0.51	0.53	0.54	0.56	0.61
CBN-LRF 4004-010010			1				50	4	34,560	1.03	1.06	1.10	1.14	1.23
CBN-LRF 4005-002010	0.5	R0.02	1	0.3	0.48	15°	50	4	31,750	1.03	1.07	1.11	1.15	1.25
CBN-LRF 4005-005005		R0.05	0.5				50	4	28,310	0.51	0.53	0.55	0.57	0.62
CBN-LRF 4005-005010			1				50	4	28,530	1.03	1.07	1.10	1.15	1.24
CBN-LRF 4005-005015			1.5				50	4	28,860	1.54	1.59	1.65	1.71	1.85
CBN-LRF 4005-010005		R0.1	0.5				50	4	28,310	0.51	0.53	0.54	0.56	0.61
CBN-LRF 4005-010015			1.5				50	4	28,860	1.53	1.59	1.64	1.70	1.84
CBN-LRF 4006-005005	0.6	R0.05	0.5	0.3	0.58	15°	50	4	28,200	0.51	0.53	0.55	0.57	0.62
CBN-LRF 4006-010005		R0.1	0.5				50	4	28,200	0.51	0.53	0.54	0.56	0.61
CBN-LRF 4006-010010			1				50	4	28,440	1.03	1.06	1.10	1.14	1.23
CBN-LRF 4008-005010	0.8	R0.05	1	0.56	0.78	15°	50	4	28,680	1.03	1.07	1.10	1.15	1.24
CBN-LRF 4008-010010		R0.1	1				50	4	28,680	1.03	1.06	1.10	1.14	1.23
CBN-LRF 4008-010020			2				50	4	28,680	2.05	2.12	2.20	2.28	2.46
CBN-LRF 4008-010050			5				50	4	32,520	5.15	5.33	5.52	5.73	6.19
CBN-LRF 4010-002010	1	R0.02	1	0.7	0.98	15°	50	4	29,300	1.03	1.07	1.11	1.15	1.25
CBN-LRF 4010-002030			3				50	4	29,300	3.10	3.21	3.33	3.45	3.73
CBN-LRF 4010-005010		R0.05	1				50	4	26,420	1.03	1.07	1.11	1.15	1.24
CBN-LRF 4010-005020			2				50	4	26,420	2.06	2.14	2.21	2.30	2.48
CBN-LRF 4010-010010		R0.1	1				50	4	26,420	1.03	1.06	1.10	1.14	1.23
CBN-LRF 4010-010020			2				50	4	26,420	2.06	2.13	2.21	2.29	2.47
CBN-LRF 4010-010030			3				50	4	26,420	3.10	3.20	3.32	3.44	3.72
CBN-LRF 4015-002030	1.5	R0.02	3	1	1.46	15°	50	4	34,520	3.13	3.24	3.36	3.49	3.78
CBN-LRF 4015-010030		R0.1	3				50	4	31,080	3.13	3.24	3.35	3.48	3.76
CBN-LRF 4020-002040	2	R0.02	4	1.2	1.97	15°	50	4	35,630	4.15	4.29	4.45	4.62	5.00
CBN-LRF 4020-002060			6				50	4	35,630	6.22	6.43	6.67	6.92	7.48
CBN-LRF 4020-010040		R0.1	4				50	4	31,970	4.15	4.29	4.44	4.61	4.98
CBN-LRF 4020-010060			6				50	4	31,970	6.21	6.43	6.66	6.91	7.46

CBN-LRF Milling Conditions (4 Flutes)

WORK MATERIAL				HEAT-TREATED STEELS / HARDENED STEELS STAVAX (~52HRC)				HARDENED STEELS SKD11 (~62HRC)				HARDENED STEELS HAP10 / HAP72 (~70HRC)			
Model Number	Outside Diameter (mm)	Corner Radius (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)
4003-002X75	0.3	R0.02	0.75	60,000	750	0.003	0.08	55,000	580	0.003	0.06	50,000	400	0.003	0.03
4003-002010			1	60,000	750	0.003	0.08	55,000	580	0.003	0.06	50,000	400	0.003	0.03
4003-005005		R0.05	0.5	60,000	950	0.005	0.08	55,000	750	0.005	0.06	50,000	550	0.004	0.03
4004-002015	0.4	R0.02	1.5	55,000	850	0.005	0.1	53,000	700	0.005	0.08	50,000	550	0.004	0.05
4004-003005		R0.03	0.5	55,000	1,000	0.006	0.1	53,000	800	0.006	0.08	50,000	600	0.004	0.05
4004-005005		R0.05	0.5	55,000	1,200	0.01	0.1	53,000	1,000	0.01	0.08	50,000	730	0.007	0.05
4004-005015			1.5	55,000	1,200	0.01	0.1	53,000	1,000	0.01	0.08	50,000	730	0.007	0.05
4004-010005		R0.1	0.5	55,000	1,500	0.01	0.1	53,000	1,300	0.01	0.08	50,000	1,000	0.008	0.05
4004-010010			1	55,000	1,500	0.01	0.1	53,000	1,300	0.01	0.08	50,000	1,000	0.008	0.05
4005-002010	0.5	R0.02	1	50,000	950	0.005	0.15	50,000	900	0.005	0.12	50,000	700	0.005	0.08
4005-005005		R0.05	0.5	50,000	1,500	0.01	0.15	50,000	1,300	0.01	0.12	50,000	1,000	0.01	0.08
4005-005010			1	50,000	1,500	0.01	0.15	50,000	1,300	0.01	0.12	50,000	1,000	0.01	0.08
4005-005015			1.5	50,000	1,500	0.01	0.15	50,000	1,300	0.01	0.12	50,000	1,000	0.01	0.08
4005-010005		R0.1	0.5	50,000	1,900	0.02	0.15	50,000	1,700	0.02	0.12	50,000	1,400	0.01	0.08
4005-010015			1.5	50,000	1,900	0.02	0.15	50,000	1,700	0.02	0.12	50,000	1,400	0.01	0.08
4006-005005	0.6	R0.05	0.5	50,000	1,700	0.01	0.2	50,000	1,500	0.01	0.15	50,000	1,200	0.01	0.1
4006-010005		R0.1	0.5	50,000	2,300	0.02	0.2	50,000	2,000	0.02	0.15	50,000	1,700	0.012	0.1
4006-010010			1	50,000	2,300	0.02	0.2	50,000	2,000	0.02	0.15	50,000	1,700	0.012	0.1
4008-005010	0.8	R0.05	1	45,000	1,800	0.01	0.28	44,000	1,600	0.01	0.21	42,000	1,300	0.01	0.13
4008-010010		R0.1	1	45,000	2,400	0.02	0.28	44,000	2,000	0.02	0.21	42,000	1,600	0.015	0.13
4008-010020			2	45,000	2,400	0.02	0.28	44,000	2,000	0.02	0.21	42,000	1,600	0.015	0.13
4008-010050			5	45,000	1,700	0.02	0.14	44,000	1,400	0.02	0.11	42,000	1,100	0.015	0.07
4010-002010	1	R0.02	1	40,000	1,300	0.006	0.35	37,000	1,100	0.006	0.3	34,000	900	0.005	0.2
4010-002030			3	40,000	1,300	0.006	0.35	37,000	1,100	0.006	0.3	34,000	900	0.005	0.2
4010-005010		R0.05	1	40,000	1,900	0.015	0.35	37,000	1,600	0.015	0.3	34,000	1,200	0.01	0.2
4010-005020			2	40,000	1,900	0.015	0.35	37,000	1,600	0.015	0.3	34,000	1,200	0.01	0.2
4010-010010		R0.1	1	40,000	2,600	0.03	0.35	37,000	2,000	0.03	0.3	34,000	1,400	0.015	0.2
4010-010020			2	40,000	2,600	0.03	0.35	37,000	2,000	0.03	0.3	34,000	1,400	0.015	0.2
4010-010030			3	40,000	2,600	0.03	0.35	37,000	2,000	0.03	0.3	34,000	1,400	0.015	0.2
4015-002030	1.5	R0.02	3	30,000	1,500	0.01	0.55	27,000	1,300	0.01	0.5	23,000	1,100	0.005	0.3
4015-010030		R0.1	3	30,000	3,000	0.05	0.55	27,000	2,200	0.05	0.5	23,000	1,400	0.02	0.3
4020-002040	2	R0.02	4	28,000	1,700	0.01	0.7	23,000	1,500	0.01	0.6	18,000	1,200	0.005	0.4
4020-002060			6	28,000	1,700	0.01	0.7	23,000	1,500	0.01	0.6	18,000	1,200	0.005	0.4
4020-010040		R0.1	4	28,000	3,300	0.05	0.7	23,000	2,400	0.05	0.6	18,000	1,500	0.03	0.4
4020-010060			6	28,000	3,300	0.05	0.7	23,000	2,400	0.05	0.6	18,000	1,500	0.03	0.4

Note:

- Decrease both spindle speed and feed rate proportionally when the milling parameters exceed the machine's maximum spindle speed.
- Recommend oil mist to avoid tool damage.



2 Flute Long Neck Ball End Mills for Super Finishing

Size **R0.05～R1**

CBN-LBSF

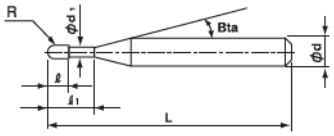
CBN | 20° | R ±0.002 | Shank Dia 0/-0.004 | Back Taper Geometry

Patent pending

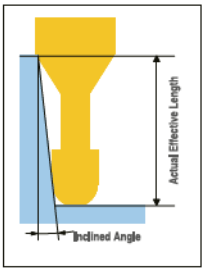
Material Applications (☆ Highly Recommended ◎ Recommended ○ Suggested)

Work Material															
CARBON STEELS S45C S55C	ALLOY STEELS SK / SCM SUS	PREHARDENED STEELS NAK HPM	HARDENED STEELS ～55HRC	HARDENED STEELS ～60HRC	HARDENED STEELS ～70HRC	CAST IRON	ALUMINUM ALLOYS	GRAPHITE	COPPER	PLASTICS	GLASS FILLED PLASTICS	TITANIUM ALLOYS	HEAT RESISTANT ALLOYS	CEMENTED CARBIDE	HARD BRITTLE (NON-METALLIC) MATERIALS
		○	◎	◎	◎ ～68HRC										

Ball Radius accuracy measurments are printed on the label to support High Precision milling.

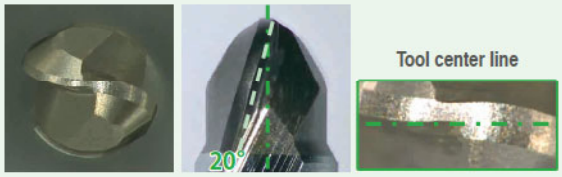


The shank taper angle shown is not an exact value and to avoid contact with the work piece, we recommend the user controls the precise value of this angle. Shank taper angle should not make contact with the work piece.



Features

For higher precision and better surface finish
Ball radius accuracy ± 0.002mm based on Nominal Radius.

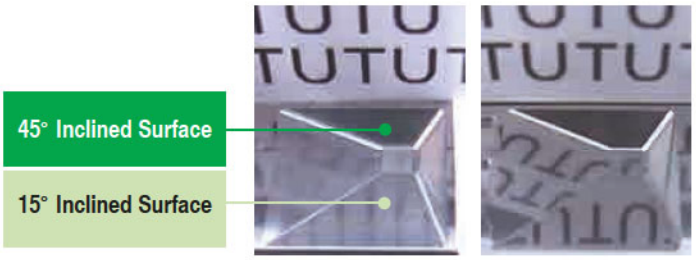


A cutting edge is set at the tip of the tool (zero peripheral speed).
Less tool damage and improved finishing surface.

Inclined surface milling CBN-LBF & CBN-LBSF comparison

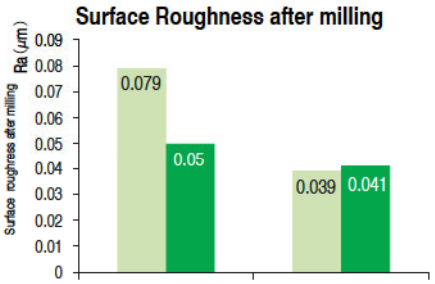
2 Flutes R0.3 × EL1.5 ELMAX (60.5HRC)

Pocket Size : 9 × 9 × Depth 1.5 mm



CBN-LBF For long tool life

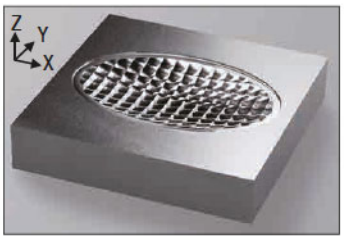
CBN-LBSF For super surface finish

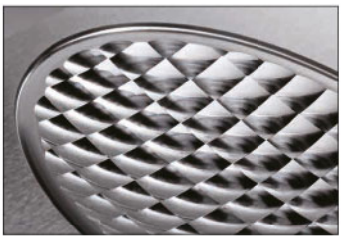


Milling method	Spindle Speed	Feed Rate	Allowance	Cusp height	Coolant	Cycle Time
Contour spiral milling	30,000 min^{-1}	550 mm/min	0.005 mm	0.0001 mm	Oil mist	21.5 min

CBN-LBSF Lens application
2 Flutes R0.3 × EL1 • R1 × EL3

HAP10 (64HRC)





Work Size : 100 × 100 × 20 mm
Coolant : Oil mist, Oil coolant

Shiny surface

Surface Roughness after milling

Measurment point	Ra (μ m)
Y Front point of Y axis	0.0272
Y Center point of Y axis	0.0172
Y Back point of Y axis	0.0304

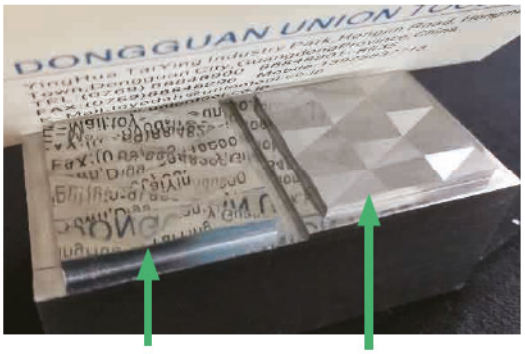
CBN-LBSF
Milling video

No.	Process	Tool	Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Allowance (mm)	Cycle Time (h:m)
1	Roughing	HGB R2	9,480	2,400	0.18	0.75	0.08	1:01
2	Lens part/Semi-roughing		9,480	2,400	0.18	0.375	0.05	0:06
3	Periphery/Semi-roughing	HGB R1	14,700	2,160	0.1	0.35	0.05	0:07
4	Periphery/Semi-finishing 1		14,700	2,160	0.1	0.1	0.02	0:03
5	Lens part/Semi-finishing 1		14,700	2,160	0.03	0.1	0.02	0:36
6	Periphery/Semi-finishing 2	HGB R0.5	21,000	1,750	0.04	0.04	0.005	0:15
7	Lens part/Semi-finishing 2	HGB R1	14,700	2,160	0.015	0.05	0.005	1:13
8	Periphery/Finishing	CBN-LBSF R0.3 × EL1	30,000	600	0.01	0.01	0	2:56
9	Lens part/Finishing	CBN-LBSF R1 × EL3	24,000	750	0.005	0.018	0	4:52

Total 11:09

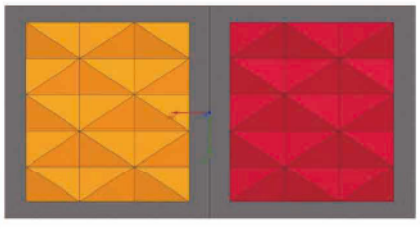
CBN-LBF/CBN-LBSF Surface roughness comparison
2 Flutes R0.5 × EL1.5

STAVAX (52HRC)



CBN-LBSF
For super surface
Ra 0.033 μm

CBN-LBF
For long tool life
Ra 0.159 μm



Size: 55 × 25 × 23 mm
Coolant : Oil mist

Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Cycle Time (h:m)
36,000	600	0.003	0.008	2:17

CBN-LBSF is recommended for excellent milling surface.
The surface finish is of such high quality that the letters reflect perfectly in it.

2 Flute Long Neck Ball End Mills for Super Finishing

Total 36 models

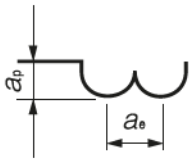
Shank taper angle Bta is only for reference.

Unit (mm)

Model Number	Radius of Ball Nose R	Effective Length ℓ_1	Length of Cut ℓ	Neck Diameter $\varnothing d_1$	Shank Taper Angle Bta	Overall Length L	Shank Diameter $\varnothing d$	Suggested Retail Price ¥	Effective Length by Inclined Angles				
									30′	1°	1°30′	2°	3°
CBN-LBSF 2001-003	R0.05	0.3	0.07	0.09	15°	50	4	46,700	0.30	0.30	0.30	0.30	0.33
CBN-LBSF 2001-005		0.5				50	4	48,600	0.50	0.50	0.51	0.53	0.57
CBN-LBSF 20015-0045	R0.075	0.45	0.1	0.14	15°	50	4	46,700	0.45	0.45	0.46	0.48	0.51
CBN-LBSF 20015-0075		0.75				50	4	48,600	0.75	0.76	0.78	0.81	0.88
CBN-LBSF 2002-003	R0.1	0.3	0.13	0.19	15°	50	4	35,000	0.30	0.30	0.30	0.30	0.32
CBN-LBSF 2002-006		0.6				50	4	35,000	0.60	0.60	0.62	0.64	0.69
CBN-LBSF 2003-005	R0.15	0.5	0.22	0.28	15°	50	4	33,900	0.51	0.53	0.54	0.56	0.60
CBN-LBSF 2003-0075		0.75				50	4	34,400	0.77	0.79	0.82	0.85	0.91
CBN-LBSF 2003-009		0.9				50	4	35,000	0.91	0.94	0.97	1.01	1.08
CBN-LBSF 2004-0075	R0.2	0.75	0.32	0.38	15°	50	4	30,600	0.77	0.79	0.81	0.84	0.90
CBN-LBSF 2004-010		1				50	4	31,200	1.03	1.06	1.09	1.13	1.21
CBN-LBSF 2004-012		1.2				50	4	31,700	1.22	1.26	1.30	1.35	1.44
CBN-LBSF 2005-010	R0.25	1	0.4	0.48	15°	50	4	31,200	1.01	1.04	1.07	1.11	1.18
CBN-LBSF 2005-015		1.5				50	4	32,200	1.53	1.58	1.63	1.68	1.80
CBN-LBSF 2006-010	R0.3	1	0.48	0.58	15°	50	4	28,700	1.01	1.04	1.07	1.10	1.17
CBN-LBSF 2006-015		1.5				50	4	29,300	1.53	1.57	1.62	1.68	1.79
CBN-LBSF 2006-020		2				50	4	29,300	2.05	2.11	2.18	2.25	2.41
CBN-LBSF 2008-020	R0.4	2	0.6	0.78	15°	50	4	29,300	2.04	2.10	2.17	2.24	2.39
CBN-LBSF 2008-040		4				50	4	31,240	4.11	4.24	4.38	4.54	4.88
CBN-LBSF 2010-015	R0.5	1.5	0.7	0.98	15°	50	4	28,700	1.53	1.57	1.61	1.66	1.76
CBN-LBSF 2010-020		2				50	4	28,700	2.05	2.11	2.17	2.23	2.38
CBN-LBSF 2010-025		2.5				50	4	29,300	2.57	2.64	2.72	2.81	3.00
CBN-LBSF 2010-030		3				50	4	29,300	3.09	3.18	3.28	3.38	3.62
CBN-LBSF 2010-040		4				50	4	31,200	4.12	4.25	4.38	4.53	4.87
CBN-LBSF 2010-060		6				50	4	31,200	6.19	6.39	6.60	6.83	7.35
CBN-LBSF 2015-025	R0.75	2.5	0.9	1.46	15°	50	4	30,000	2.60	2.67	2.74	2.81	2.99
CBN-LBSF 2015-030		3				50	4	30,000	3.12	3.20	3.29	3.39	3.61
CBN-LBSF 2015-038		3.8				50	4	30,500	3.94	4.06	4.18	4.31	4.61
CBN-LBSF 2015-060		6				50	4	30,500	6.22	6.41	6.62	6.84	7.34
CBN-LBSF 2015-080		8				50	4	33,200	8.28	8.55	8.83	9.14	9.83
CBN-LBSF 2020-030	R1	3	1.2	1.97	15°	50	4	30,500	3.09	3.16	3.24	3.33	3.53
CBN LBSF 2020 040		4				50	4	30,500	4.12	4.23	4.35	4.48	4.77
CBN-LBSF 2020-050		5				50	4	30,500	5.16	5.30	5.46	5.63	6.01
CBN-LBSF 2020-060		6				50	4	32,200	6.19	6.37	6.57	6.78	7.26
CBN-LBSF 2020-080		8				50	4	33,200	8.26	8.51	8.79	9.08	9.74
CBN-LBSF 2020-100		10				50	4	33,600	10.32	10.65	11.00	11.38	12.23

CBN-LBSF Milling Conditions

WORK MATERIAL			HEAT-TREATED STEELS / HARDENED STEELS STAVAX / ELMAX / HAP10 / HAP72 (~68HRC)			
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)
2001-003	R0.05	0.3	30,000	70	0.003 MAX	0.006 MAX
2001-005		0.5	30,000	70	0.002 MAX	0.006 MAX
20015-0045	R0.075	0.45	30,000	150	0.004 MAX	0.008 MAX
20015-0075		0.75	30,000	125	0.004 MAX	0.008 MAX
2002-003	R0.1	0.3	30,000	240	0.005 MAX	0.01 MAX
2002-006		0.6	30,000	200	0.005 MAX	0.01 MAX
2003-005	R0.15	0.5	30,000	300	0.005 MAX	0.01 MAX
2003-0075		0.75	30,000	250	0.005 MAX	0.01 MAX
2003-009		0.9	30,000	250	0.005 MAX	0.01 MAX
2004-0075	R0.2	0.75	30,000	360	0.005 MAX	0.01 MAX
2004-010		1	30,000	300	0.005 MAX	0.01 MAX
2004-012		1.2	30,000	300	0.005 MAX	0.01 MAX
2005-010	R0.25	1	30,000	420	0.005 MAX	0.01 MAX
2005-015		1.5	30,000	350	0.005 MAX	0.01 MAX
2006-010	R0.3	1	30,000	500	0.01 MAX	0.015 MAX
2006-015		1.5	30,000	500	0.01 MAX	0.015 MAX
2006-020		2	30,000	350	0.01 MAX	0.015 MAX
2008-020	R0.4	2	30,000	620	0.01 MAX	0.015 MAX
2008-040		4	30,000	420	0.01 MAX	0.015 MAX
2010-015	R0.5	1.5	30,000	750	0.01 MAX	0.02 MAX
2010-020		2	30,000	750	0.01 MAX	0.02 MAX
2010-025		2.5	30,000	750	0.01 MAX	0.02 MAX
2010-030		3	30,000	500	0.01 MAX	0.02 MAX
2010-040		4	30,000	500	0.01 MAX	0.02 MAX
2010-060		6	30,000	330	0.01 MAX	0.02 MAX
2015-025	R0.75	2.5	20,000	750	0.01 MAX	0.02 MAX
2015-030		3	20,000	750	0.01 MAX	0.02 MAX
2015-038		3.8	20,000	750	0.01 MAX	0.02 MAX
2015-060		6	20,000	500	0.01 MAX	0.02 MAX
2015-080		8	20,000	500	0.01 MAX	0.02 MAX
2020-030	R1	3	15,000	750	0.01 MAX	0.025 MAX
2020-040		4	15,000	750	0.01 MAX	0.025 MAX
2020-050		5	15,000	750	0.01 MAX	0.025 MAX
2020-060		6	15,000	500	0.01 MAX	0.025 MAX
2020-080		8	15,000	500	0.01 MAX	0.025 MAX
2020-100		10	15,000	500	0.01 MAX	0.025 MAX



Note:

- Decrease both spindle speed and feed rate proportionally when the milling parameters exceed the machine's maximum spindle speed.
- Recommend oil mist to avoid tool damage.

2 Flute High-grade Long Neck Ball End Mills

Size **R0.05～R2**

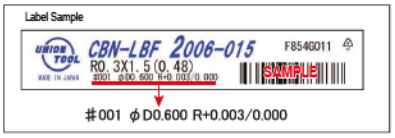
CBN-LBF

CBN | 0° | R ±0.003 (R0.05～R1.5) | R ±0.005 (R2) | Shank Dia 0/-0.004 | Back Taper Geometry

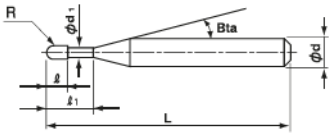
Additional 6 Models

Material Applications (☆ Highly Recommended ◎ Recommended ○ Suggested)

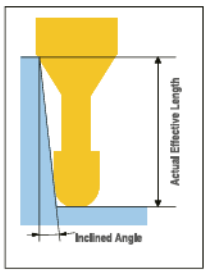
Work Material														
CARBON STEELS S45C S55C	ALLOY STEELS SK / SCM SUS	PREHARDENED STEELS NAK HPM	HARDENED STEELS ～55HRC	HARDENED STEELS ～60HRC	HARDENED STEELS ～70HRC	CAST IRON	ALUMINUM ALLOYS	GRAPHITE	COPPER	PLASTICS	GLASS FILLED PLASTICS	TITANIUM ALLOYS	HEAT RESISTANT ALLOYS	CEMENTED CARBIDE	HARD BRITTLE (NON-METALLIC) MATERIALS
		○	◎	◎	◎ ～68HRC										



Diameter and Ball Radius accuracy measurments are printed on the label to support High Precision milling.



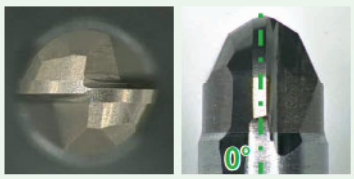
The shank taper angle shown is not an exact value and to avoid contact with the work piece, we recommend the user controls the precise value of this angle. Shank taper angle should not make contact with the work piece.



Features

For long tool life

Various lineup from R0.05 to R2.

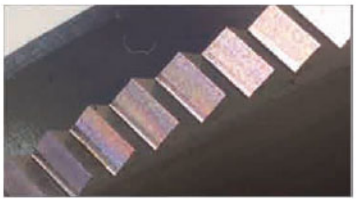


Tool center line

Non helix angle design ensures high rigidity.

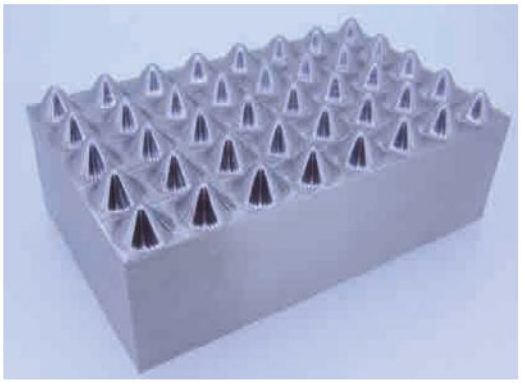
CBN-LBF Finishing Reflector mold
2 Flutes R0.15 × EL0.9

SKD11 (60HRC)



No.	Tool	Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Cycle Time (h:m)
1	HSB R1.5	15,000	800	0.06	0.06	0:25:37
2	HSB R0.5	20,000	500	0.025	0.025	1:11:53
3	HSB R0.25	25,000	350	0.02	0.02	0:34:29
4	HSB R0.15	30,000	300	0.015	0.015	0:30:55
5	CBN-LBF R0.15 × EL0.9	30,000	300	0.008	0.008	3:48:13
					Total	6:31:07

CBN-LBF/CBN-LBSF Convex shaped finishing
2 Flutes R0.3 × EL1.5 **STAVAX (52HRC)**

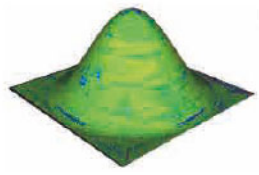


Work Size : 80 × 50 × 30 mm
Coolant : Oil mist

Process	Finishing
Milling Method	Contour spiral milling
Spindle Speed	30,000 min^{-1}
Feed Rate	800 mm/min
Cusp Height	0.0001 mm
a_e Radial Depth	0.015 mm
Cycle Time	9:48 h:m

Work piece dimensional error after milling

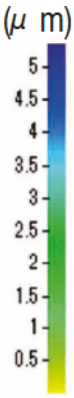
For long tool life CBN-LBF



The 1st ridge The 40th ridge

For super surface finish CBN-LBSF

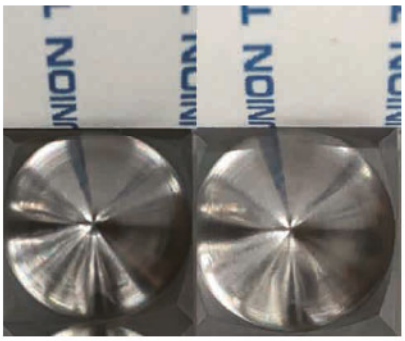
The 1st ridge The 40th ridge



Milling time 1 ridge : 12 min 30 sec, 40 ridges : 8 h 20 min,
Both types are able to mill for a long time while maintaining accuracy.

Milling surface comparison

For long tool life CBN-LBF



The 1st ridge The 40th ridge

CBN-LBF for high efficiency milling and long tool life.

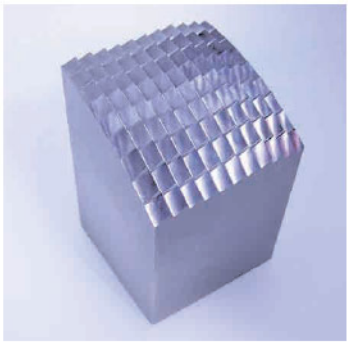
For super surface finish CBN-LBSF

The 1st ridge The 40th ridge

CBN-LBSF offers shiny milling surfaces.

CBN-LBF Reflector mold
2 Flutes CBN-LBF R0.4 × EL2

STAVAX (52HRC)



CBN-LBF

Milling video of reflector mold for finishing

No	Process	Tool	Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Cycle Time (h:m)
1	Roughing	HRRS ø6 × CR1 × EL18	3,500	2,500	0.2	2	0:18:00
2	Semi-roughing	HRRS ø6 × CR1 × EL18	9,000	2,500	0.05	0.1	0:13:35
3	Semi-roughing	HRRS ø2 × CR0.3 × EL6	3,500	1,000	0.04	1	0:33:55
4	Semi-finishing	HSB R1.5	12,000	2,500	0.02	0.07	0:12:24
5	Semi-finishing	HSB R0.75	7,000	1,000	0.04	0.07	0:20:50
6	Semi-finishing	HSB R0.75	7,000	700	0.05	0.05	0:18:08
7	Semi-finishing	HSB R0.5	8,000	500	0.02	0.03	0:23:24
8	Semi-finishing	HSB R0.5	15,000	1,200	0.02	0.03	1:30:33
9	Finishing	CBN-LBF R0.4 × EL2	26,000	800	0.01	0.004	10:12:54

Total 14:03:43

Total 64 models

Shank taper angle Bta is only for reference.

Unit (mm)

Model Number	Radius of Ball Nose R	Effective Length ℓ_1	Length of Cut ℓ	Neck Diameter ød_1	Shank Taper Angle Bta	Overall Length L	Shank Diameter ød	Suggested Retail Price ¥	Effective Length by Inclined Angles				
									30′	1°	1°30′	2°	3°
CBN-LBF 2001-003	R0.05	0.3	0.08	0.09	15°	50	4	42,400	0.30	0.30	0.30	0.30	0.33
CBN-LBF 2001-005		0.5				50	4	44,100	0.50	0.50	0.51	0.53	0.57
CBN-LBF 20015-0045	R0.075	0.45	0.15	0.14	15°	50	4	42,400	0.45	0.45	0.46	0.48	0.51
CBN-LBF 20015-0075		0.75				50	4	44,100	0.75	0.76	0.78	0.81	0.88
CBN-LBF 2002-003	R0.1	0.3	0.16	0.19	15°	50	4	28,800	0.30	0.30	0.30	0.30	0.32
CBN-LBF 2002-006		0.6				50	4	31,700	0.60	0.60	0.62	0.64	0.69
CBN-LBF 2002-010		1				50	4	33,300	1.00	1.03	1.06	1.10	1.19
CBN-LBF 2003-005	R0.15	0.5	0.24	0.28	15°	50	4	28,800	0.51	0.53	0.54	0.56	0.60
CBN-LBF 2003-0075		0.75				50	4	28,800	0.77	0.79	0.82	0.85	0.91
CBN-LBF 2003-009		0.9				50	4	31,700	0.91	0.94	0.96	1.00	1.06
CBN-LBF 2003-015		1.5				50	4	33,300	1.53	1.58	1.63	1.68	1.80
CBN-LBF 2004-005	R0.2	0.5	0.32	0.38	15°	50	4	27,700	0.51	0.52	0.54	0.55	0.58
CBN-LBF 2004-0075		0.75				50	4	27,700	0.77	0.79	0.81	0.84	0.90
CBN-LBF 2004-010		1				50	4	27,700	1.03	1.06	1.09	1.13	1.21
CBN-LBF 2004-012		1.2				50	4	28,800	1.22	1.25	1.29	1.33	1.42
CBN-LBF 2004-020		2				50	4	30,600	2.04	2.10	2.17	2.24	2.40
CBN-LBF 2004-030		3				50	4	33,300	3.07	3.17	3.27	3.38	3.62
CBN-LBF 2005-010	R0.25	1	0.4	0.48	15°	50	4	27,700	1.02	1.05	1.08	1.12	1.19
CBN-LBF 2005-015		1.5				50	4	28,800	1.53	1.57	1.62	1.66	1.78
CBN-LBF 2005-025		2.5				50	4	30,600	2.56	2.63	2.72	2.80	3.00
CBN-LBF 2005-035		3.5				50	4	32,200	3.59	3.70	3.82	3.94	4.22

2 Flute High-grade Long Neck Ball End Mills

	Model Number	Radius of Ball Nose R	Effective Length ℓ_1	Length of Cut ℓ	Neck Diameter $\varnothing d_1$	Shank Taper Angle Bta	Overall Length L	Shank Diameter $\varnothing d$	Suggested Retail Price ¥	Effective Length by Inclined Angles				
										30′	1°	1°30′	2°	3°
	CBN-LBF 2006-010	R0.3	1	0.48	0.58	15°	50	4	26,600	1.02	1.05	1.08	1.11	1.18
	CBN-LBF 2006-015		1.5				50	4	26,600	1.52	1.57	1.61	1.66	1.76
	CBN-LBF 2006-030		3				50	4	28,400	3.07	3.16	3.26	3.37	3.60
	CBN-LBF 2006-040		4				50	4	28,400	4.10	4.23	4.36	4.50	4.82
	CBN-LBF 2006-050		5				50	4	28,800	5.13	5.29	5.46	5.64	6.05
	CBN-LBF 2006-060		6				50	4	31,600	6.17	6.36	6.56	6.78	7.27
	CBN-LBF 2008-020	R0.4	2	0.6	0.78	15°	50	4	26,600	2.04	2.09	2.15	2.21	2.35
	CBN-LBF 2008-040		4				50	4	28,400	4.10	4.22	4.35	4.49	4.80
	CBN-LBF 2008-060		6				50	4	31,100	6.16	6.35	6.55	6.77	7.25
	CBN-LBF 2010-015	R0.5	1.5	0.7	0.98	15°	50	4	26,600	1.53	1.57	1.61	1.66	1.76
	CBN-LBF 2010-020		2				50	4	26,600	2.05	2.11	2.17	2.23	2.38
	CBN-LBF 2010-025		2.5				50	4	26,600	2.56	2.63	2.70	2.78	2.96
	CBN-LBF 2010-040		4				50	4	28,400	4.11	4.23	4.35	4.49	4.79
	CBN-LBF 2010-050		5				50	4	28,400	5.14	5.29	5.45	5.63	6.02
	CBN-LBF 2010-060		6				50	4	28,400	6.17	6.36	6.55	6.77	7.24
	CBN-LBF 2010-080		8				50	4	28,800	8.23	8.49	8.76	9.04	9.69
	CBN-LBF 2010-100		10				50	4	29,500	10.30	10.62	10.96	11.32	12.13
	CBN-LBF 2012-024	R0.6	2.4	0.8	1.18	15°	50	4	27,700	2.46	2.53	2.60	2.68	2.85
	CBN-LBF 2012-030		3				50	4	27,700	3.08	3.17	3.27	3.37	3.60
	CBN-LBF 2012-060		6				50	4	32,200	6.18	6.38	6.59	6.82	7.33
	CBN-LBF 2015-030	R0.75	3	0.9	1.46	15°	50	4	27,700	3.12	3.20	3.29	3.39	3.61
	CBN-LBF 2015-040		4				50	4	27,700	4.15	4.27	4.40	4.54	4.85
	CBN-LBF 2015-060		6				50	4	27,700	6.22	6.41	6.62	6.84	7.34
	CBN-LBF 2015-080		8				50	4	30,600	8.28	8.55	8.83	9.14	9.83
	CBN-LBF 2015-100		10				50	4	32,200	10.35	10.69	11.05	11.44	12.31
	CBN-LBF 2015-120		12				50	4	32,200	12.42	12.83	13.27	13.74	14.80
	CBN-LBF 2015-150		15				50	4	32,200	15.52	16.04	16.59	17.19	18.53
	CBN-LBF 2020-040	R1	4	1.2	1.97	15°	50	4	27,700	4.12	4.23	4.35	4.48	4.77
	CBN-LBF 2020-050		5				50	4	27,700	5.16	5.30	5.46	5.63	6.01
	CBN-LBF 2020-060		6				50	4	27,700	6.19	6.37	6.57	6.78	7.26
	CBN-LBF 2020-080		8				50	4	30,600	8.26	8.51	8.79	9.08	9.74
	CBN-LBF 2020-100		10				50	4	30,600	10.32	10.65	11.00	11.38	12.23
	CBN-LBF 2020-120		12				50	4	32,200	12.39	12.79	13.22	13.68	14.72
	CBN-LBF 2020-140		14				50	4	32,700	14.46	14.93	15.44	15.98	17.20
	CBN-LBF 2020-160		16				50	4	32,700	16.53	17.07	17.65	18.28	19.69
	CBN-LBF 2020-180		18				50	4	32,700	18.59	19.21	19.87	20.58	No Interference
	CBN-LBF 2020-200		20				50	4	32,700	20.66	21.35	22.09	22.88	No Interference
*	CBN-LBF 2030-040	R1.5	4	1.8	2.94	15°	50	6	29,260	4.16	4.26	4.36	4.47	4.72
*	CBN-LBF 2030-060		6				50	6	29,260	6.23	6.40	6.58	6.77	7.21
*	CBN-LBF 2030-080		8				50	6	29,260	8.30	8.54	8.79	9.07	9.70
*	CBN-LBF 2040-060	R2	6	2.4	3.95	15°	50	6	35,320	6.21	6.36	6.52	6.70	7.09
*	CBN-LBF 2040-080		8				50	6	35,320	8.28	8.50	8.74	9.00	9.57
*	CBN-LBF 2040-100		10				50	6	35,320	10.35	10.64	10.96	11.30	12.06

* Additional model

CBN-LBF Milling Conditions

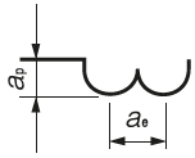
WORK MATERIAL			HEAT-TREATED STEELS / HARDENED STEELS STAVAX (~52HRC)				HARDENED STEELS SKD11 (~62HRC)				HARDENED STEELS HAP10 / HAP72 (~68HRC)			
Model Number	Radius of Ball Nose (mm)	Effective Length (mm)	Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Spindle 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)
2001-003	R0.05	0.3	30,000	200	0.005	0.005	30,000	150	0.003	0.005	30,000	100	0.002	0.005
2001-005		0.5	30,000	150	0.003	0.005	30,000	120	0.003	0.005	30,000	90	0.002	0.005
20015-0045	R0.075	0.45	30,000	350	0.005	0.005	30,000	270	0.004	0.005	30,000	200	0.003	0.005
20015-0075		0.75	30,000	220	0.004	0.005	30,000	160	0.004	0.005	30,000	100	0.003	0.005
2002-003	R0.1	0.3	30,000	660	0.005	0.005	30,000	550	0.005	0.005	30,000	440	0.005	0.005
2002-006		0.6	30,000	500	0.005	0.005	30,000	400	0.005	0.005	30,000	300	0.005	0.005
2002-010		1	30,000	290	0.005	0.005	30,000	200	0.005	0.005	30,000	120	0.005	0.005
2003-005	R0.15	0.5	30,000	1,000	0.005	0.005	30,000	950	0.005	0.005	30,000	620	0.005	0.005
2003-0075		0.75	30,000	850	0.005	0.005	30,000	800	0.005	0.005	30,000	500	0.005	0.005
2003-009		0.9	30,000	760	0.005	0.005	30,000	600	0.005	0.005	30,000	430	0.005	0.005
2003-015		1.5	30,000	460	0.005	0.005	30,000	320	0.005	0.005	30,000	190	0.005	0.005
2004-005	R0.2	0.5	30,000	1,580	0.005	0.01	30,000	1,330	0.005	0.01	30,000	860	0.005	0.005
2004-0075		0.75	30,000	1,390	0.005	0.01	30,000	1,140	0.005	0.01	30,000	800	0.005	0.005
2004-010		1	30,000	1,200	0.005	0.01	30,000	950	0.005	0.01	30,000	730	0.005	0.005
2004-012		1.2	30,000	1,050	0.005	0.01	30,000	800	0.005	0.01	30,000	620	0.005	0.005
2004-020		2	30,000	600	0.005	0.01	30,000	450	0.005	0.01	30,000	330	0.005	0.005
2004-030		3	20,000	400	0.005	0.005	20,000	300	0.005	0.005	20,000	190	0.003	0.003
2005-010	R0.25	1	30,000	1,600	0.01	0.01	30,000	1,300	0.01	0.01	30,000	920	0.005	0.01
2005-015		1.5	30,000	1,300	0.01	0.01	30,000	1,000	0.01	0.01	30,000	760	0.005	0.01
2005-025		2.5	30,000	800	0.01	0.01	30,000	700	0.01	0.01	30,000	480	0.005	0.01
2005-035		3.5	22,000	550	0.01	0.01	22,000	500	0.005	0.01	22,000	330	0.005	0.005
2006-010	R0.3	1	30,000	2,400	0.02	0.03	30,000	1,900	0.02	0.03	30,000	1,080	0.01	0.02
2006-015		1.5	30,000	2,000	0.02	0.03	30,000	1,500	0.02	0.03	30,000	1,000	0.01	0.02
2006-030		3	26,000	1,100	0.02	0.02	26,000	900	0.02	0.02	26,000	760	0.01	0.01
2006-040		4	22,000	750	0.01	0.02	22,000	650	0.01	0.02	22,000	570	0.005	0.01
2006-050		5	18,000	550	0.01	0.01	18,000	450	0.01	0.01	18,000	410	0.005	0.005
2006-060		6	12,000	350	0.005	0.01	12,000	290	0.005	0.005	12,000	260	0.003	0.003
2008-020	R0.4	2	30,000	2,500	0.02	0.03	30,000	2,100	0.02	0.03	30,000	1,700	0.01	0.02
2008-040		4	25,000	1,500	0.02	0.02	25,000	1,350	0.02	0.02	25,000	1,200	0.01	0.01
2008-060		6	18,000	1,000	0.01	0.02	18,000	800	0.01	0.02	18,000	750	0.005	0.01
2010-015	R0.5	1.5	30,000	3,700	0.04	0.05	30,000	3,400	0.03	0.04	30,000	2,300	0.025	0.03
2010-020		2	30,000	3,500	0.04	0.04	30,000	3,200	0.03	0.04	30,000	2,200	0.02	0.03
2010-025		2.5	30,000	3,300	0.04	0.04	30,000	3,000	0.03	0.04	30,000	2,100	0.02	0.03
2010-040		4	27,000	2,700	0.03	0.04	27,000	2,300	0.03	0.03	27,000	1,800	0.02	0.02
2010-050		5	23,000	2,200	0.03	0.03	23,000	1,800	0.03	0.03	23,000	1,450	0.02	0.02
2010-060		6	20,000	1,900	0.02	0.03	20,000	1,500	0.02	0.03	20,000	1,200	0.01	0.02
2010-080		8	14,000	1,300	0.01	0.02	14,000	1,000	0.01	0.02	14,000	800	0.01	0.01
2010-100		10	9,000	800	0.01	0.02	9,000	600	0.01	0.01	9,000	490	0.005	0.005
2012-024	R0.6	2.4	30,000	3,000	0.05	0.05	29,500	2,550	0.035	0.04	29,000	2,100	0.02	0.03
2012-030		3	30,000	2,750	0.05	0.05	29,000	2,350	0.035	0.035	28,000	2,000	0.02	0.025
2012-060		6	23,500	2,000	0.03	0.03	23,500	1,650	0.025	0.025	23,500	1,300	0.02	0.02

CBN-LBF Milling Conditions

WORK MATERIAL			HEAT-TREATED STEELS / HARDENED STEELS STAVAX (~52HRC)				HARDENED STEELS SKD11 (~62HRC)				HARDENED STEELS HAP10 / HAP72 (~68HRC)			
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)
2015-030	R0.75	3	30,000	3,000	0.07	0.07	28,500	2,550	0.045	0.05	27,000	2,100	0.02	0.03
2015-040		4	28,500	2,750	0.06	0.06	27,250	2,300	0.04	0.04	26,000	1,900	0.02	0.025
2015-060		6	26,000	2,200	0.04	0.045	25,500	1,900	0.03	0.03	25,000	1,650	0.02	0.02
2015-080		8	24,000	2,000	0.025	0.03	24,000	1,700	0.02	0.025	24,000	1,400	0.015	0.02
2015-100		10	16,000	1,300	0.02	0.02	16,000	1,100	0.015	0.018	16,000	900	0.01	0.015
2015-120		12	12,000	1,000	0.016	0.018	12,000	880	0.012	0.016	12,000	730	0.008	0.012
2015-150		15	6,000	600	0.01	0.015	6,000	550	0.008	0.012	6,000	490	0.005	0.008
2020-040	R1	4	30,000	3,000	0.1	0.1	27,000	2,550	0.06	0.065	24,000	2,100	0.02	0.03
2020-050		5	26,000	2,750	0.08	0.08	26,000	2,300	0.05	0.05	24,000	1,900	0.02	0.025
2020-060		6	27,000	2,500	0.05	0.06	25,500	2,050	0.035	0.04	24,000	1,650	0.015	0.025
2020-080		8	25,000	2,200	0.035	0.045	24,500	1,800	0.025	0.03	24,000	1,400	0.015	0.02
2020-100		10	24,000	2,000	0.02	0.03	24,000	1,600	0.015	0.025	24,000	1,200	0.01	0.02
2020-120		12	19,500	1,600	0.017	0.025	19,500	1,300	0.013	0.021	19,500	1,000	0.009	0.017
2020-140		14	15,000	1,250	0.015	0.02	15,000	1,050	0.012	0.018	15,000	850	0.008	0.015
2020-160		16	11,500	990	0.013	0.017	11,500	860	0.011	0.015	11,500	730	0.007	0.013
2020-180		18	8,000	740	0.012	0.013	8,000	670	0.009	0.013	8,000	610	0.006	0.012
2020-200		20	4,500	490	0.01	0.01	4,500	490	0.008	0.01	4,500	490	0.005	0.01
2030-040	R1.5	4	20,000	2,500	0.1	0.15	18,000	2,200	0.06	0.09	16,000	1,900	0.04	0.06
2030-060		6	20,000	2,500	0.1	0.15	18,000	2,200	0.06	0.09	16,000	1,900	0.04	0.06
2030-080		8	18,000	2,200	0.08	0.12	17,000	2,000	0.05	0.075	16,000	1,650	0.04	0.05
2040-060	R2	6	17,000	2,500	0.12	0.18	15,000	2,200	0.08	0.12	13,000	1,900	0.05	0.08
2040-080		8	17,000	2,500	0.12	0.18	15,000	2,200	0.08	0.12	13,000	1,900	0.05	0.08
2040-100		10	16,000	2,200	0.1	0.15	14,000	2,000	0.06	0.09	13,000	1,650	0.05	0.08

Note:

- Decrease both spindle speed and feed rate proportionally when the milling parameters exceed the machine's maximum spindle speed.
- Recommend oil mist to avoid tool damage.



Advisory for Safe Use of UNIMAX End Mills

Correct application and operation is strongly advised to avoid clogging, abrasion, etc, that could cause serious accidents or i njuries.
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.
*Do not use flammable cutting oils.

Advisory for regrinding UNIMAX End Mills

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

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