Opening the future of small diameter milling
with ϕ3mm shank tools.

Value Series
ϕ3 mm Shank End Mills Vol.2

New
Add 4
Ball End Mills

Square End Mills

Radius End Mills

UNION TOOL CO.

Recommended for improved milling quality and cost reduction!

New ϕ3 mm shank

Union Tool's new standard: Value series

ϕ3 mm Shank (h4 tolerance) × Overall length 38 mm

Fixed size of ϕ3 Shank x Overall Length 38 mm
ϕ3 shank is used to save valuable carbide material. h4 tolerance is compatible for both shrink fit and collet holders. More series to follow in the future.

Cost effective

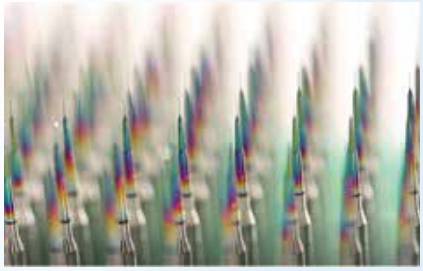
PCB drills mass production technology is applied to end mills.
To attain affordable prices, we applied our existing and proven automatic mass production technology for blank rods, flute grinding, coating and inspection to these new end mills.

High Quality

Small diameter V series are high-precision as a result of using the latest in-house technologies.
We developed new grinding machines specialized for small diameter end mills for high-precision milling that will innovate manufacturing technology for high-precision, high-efficiency milling.

Our in-house developed production facility for PCB tools

PCB: Printed Circuit Board



Over 5million coated PCB tools manufactured every month

Carefully crafted in Mitsuke of Niigata prefecture

How to find the best coating for your material applications

UNION TOOL offers various coating to match your needs.

POINT

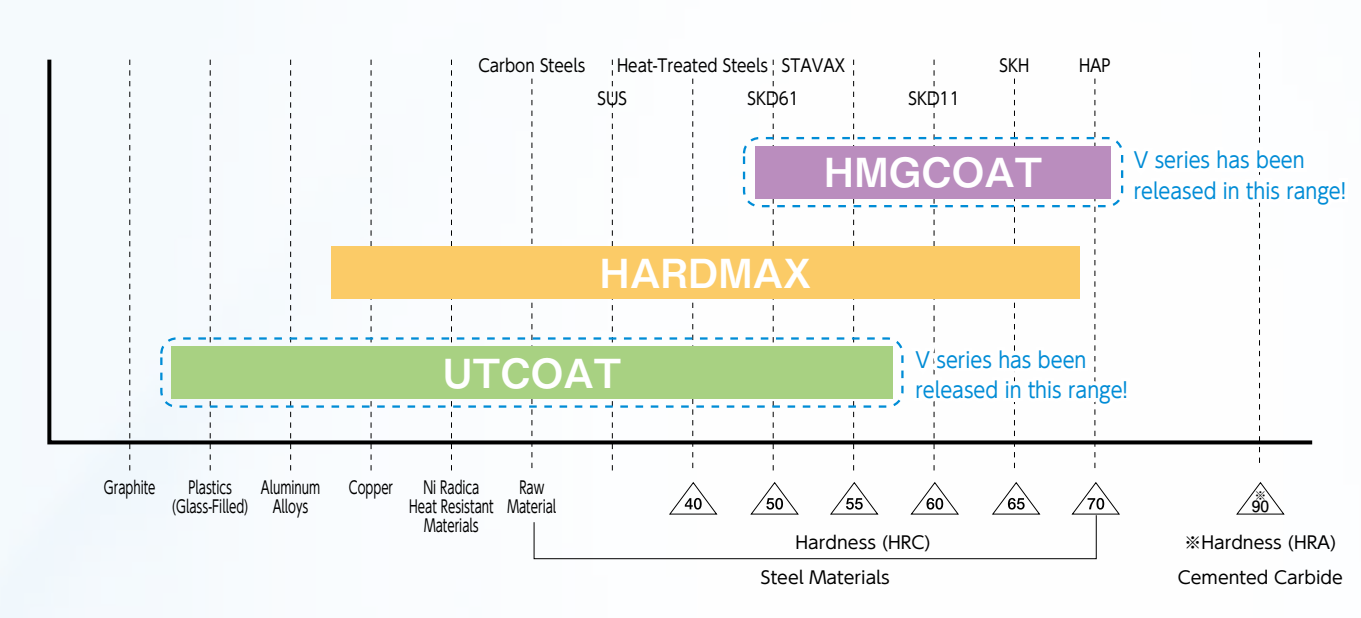
HMGCOAT HMGCOAT offers higher wear resistance as compared to the HARDMAX coating, and is more suited for hardened steels and high speed steels over 60HRC.

HARDMAX HARDMAX offers higher hardness and heat resistance, and is more suited for hard materials over 40HRC.

UTCOAT UTCOAT offers higher toughness and lubricity, and is more suited for a wider range of applications, from copper/raw materials up to 55HRC.

New Release

Additional coating HMGCOAT and UTCOAT expands the application range of work materials!



Features of Coating

☆Highly Recommended ◎Recommended ○Suggested △Satisfactory

Type	Color	Hardness (HV)	Heat Resistance	Toughness	Lubricant Efficiency	Recommended Use
HMG COAT	Purple-Black	3700～4200	☆	○	◎	for Steels
HARD MAX	Yellow-Gold	3500～4000	☆	○	◎	
UT COAT	Purple-Black	3000～3500	◎	◎	☆	

VHGLB

Value Series HMGCOAT Longneck Ball

HMGCOAT
2 Flutes Short Shank Long Neck Ball End Mills

NEW

Super MG

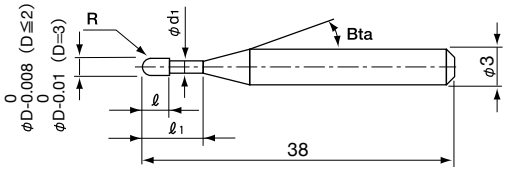
HMG COAT

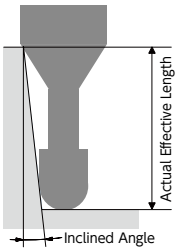
Shank Dia 0/-0.003

30°

Back Taper Geometry

Except for R0.05~R0.4





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.

Radius of Ball Nose	Diameter Tolerance	Ball Radius Accuracy
R0.05 ~ R0.075	0/-0.008	± 0.002
R0.1 ~ R1		± 0.003
R1.5	0/-0.01	

Material Applications (☆ Highly Recommended ◎ Recommended ○ Suggested)

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

Total 31 models

Unit(mm)

Model Number	Radius of Ball Nose R	Effective Length ℓ1	Length of Cut ℓ	Neck Diameter φd1	Shank Taper Angle Bta	Effective Length by Inclined Angles 30′	1°	1°30′	2°	3°	Series
VHGLB 2001-003	R0.05	0.3	0.08	0.093	16°	0.34	0.36	0.38	0.40	0.44	VHGLB
VHGLB 20015-003	R0.075	0.3	0.12	0.14	16°	0.36	0.38	0.40	0.41	0.45	VHGLB
VHGLB 2002-005	R0.1	0.5	0.16	0.18	16°	0.63	0.66	0.68	0.71	0.76	VHGLB
VHGLB 2002-010	R0.1	1	0.16	0.18	16°	1.15	1.20	1.24	1.28	1.37	VHGLB
VHGLB 2003-010	R0.15	1	0.24	0.28	16°	1.15	1.19	1.23	1.27	1.36	VHGLB
VHGLB 2003-015	R0.15	1.5	0.24	0.28	16°	1.67	1.73	1.78	1.84	1.97	VHGLB
VHGLB 2004-010	R0.2	1	0.32	0.38	16°	1.15	1.19	1.23	1.27	1.35	VHGLB
VHGLB 2004-020	R0.2	2	0.32	0.38	16°	2.19	2.25	2.33	2.40	2.57	VHGLB
VHGLB 2004-030	R0.2	3	0.32	0.38	16°	3.22	3.32	3.43	3.54	3.79	VHGLB
VHGLB 2005-015	R0.25	1.5	0.4	0.48	16°	1.67	1.72	1.77	1.83	1.95	VHGLB
VHGLB 2005-020	R0.25	2	0.4	0.48	16°	2.19	2.25	2.32	2.40	2.56	VHGLB
VHGLB 2005-025	R0.25	2.5	0.4	0.48	16°	2.71	2.79	2.87	2.97	3.18	VHGLB
VHGLB 2006-010	R0.3	1	0.48	0.58	16°	1.15	1.19	1.22	1.26	1.33	VHGLB
VHGLB 2006-015	R0.3	1.5	0.48	0.58	16°	1.67	1.72	1.77	1.82	1.94	VHGLB
VHGLB 2006-020	R0.3	2	0.48	0.58	16°	2.19	2.25	2.32	2.39	2.55	VHGLB
VHGLB 2006-030	R0.3	3	0.48	0.58	16°	3.22	3.32	3.42	3.53	3.78	VHGLB
VHGLB 2006-040	R0.3	4	0.48	0.58	16°	4.25	4.38	4.52	4.67	5.00	VHGLB
VHGLB 2008-020	R0.4	2	0.64	0.78	16°	2.18	2.25	2.31	2.38	2.53	VHGLB
VHGLB 2008-040	R0.4	4	0.64	0.78	16°	4.25	4.37	4.51	4.66	4.98	VHGLB
VHGLB 2010-020	R0.5	2	0.8	0.97	16°	2.20	2.26	2.32	2.38	2.53	VHGLB
VHGLB 2010-025	R0.5	2.5	0.8	0.97	16°	2.72	2.79	2.87	2.95	3.14	VHGLB
VHGLB 2010-030	R0.5	3	0.8	0.97	16°	3.23	3.32	3.42	3.52	3.75	VHGLB
VHGLB 2010-040	R0.5	4	0.8	0.97	16°	4.26	4.39	4.52	4.66	4.98	VHGLB
VHGLB 2010-060	R0.5	6	0.8	0.97	16°	6.33	6.52	6.72	6.94	7.43	VHGLB
VHGLB 2015-030	R0.75	3	1.2	1.46	16°	3.11	3.19	3.28	3.37	3.57	VHGLB
VHGLB 2015-040	R0.75	4	1.2	1.46	16°	4.15	4.26	4.38	4.51	4.79	VHGLB
VHGLB 2015-060	R0.75	6	1.2	1.46	16°	6.21	6.39	6.58	6.78	7.24	VHGLB
VHGLB 2020-030	R1	3	1.6	1.96	16°	3.11	3.18	3.25	3.33	3.52	VHGLB
VHGLB 2020-040	R1	4	1.6	1.96	16°	4.14	4.24	4.35	4.47	4.74	VHGLB
VHGLB 2020-060	R1	6	1.6	1.96	16°	6.20	6.37	6.55	6.75	7.19	VHGLB
VHGLB 2030-060	R1.5	6	2.4	2.93	–	No Interference	No Interference	No Interference	No Interference	No Interference	VHGLB

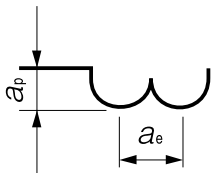
VHGLB Milling Conditions

WORK MATERIAL			PREHARDENED STEELS / HARDENED STEELS NAK / STAVAX (~55HRC)				HARDENED STEELS SKD11 (55~62HRC)				HARDENED STEELS HAP10 (62~66HRC)			
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	48,000	200	0.005	0.01	48,000	200	0.005	0.01	48,000	150	0.003	0.006
20015-003	R0.075	0.3	48,000	230	0.007	0.014	48,000	230	0.007	0.014	48,000	170	0.005	0.01
2002-005	R0.1	0.5	44,000	250	0.01	0.03	42,000	250	0.01	0.03	40,000	200	0.008	0.024
2002-010	R0.1	1	44,000	250	0.01	0.03	42,000	250	0.01	0.03	40,000	200	0.008	0.024
2003-010	R0.15	1	44,000	400	0.01	0.03	42,000	350	0.01	0.03	40,000	300	0.01	0.03
2003-015	R0.15	1.5	44,000	400	0.01	0.03	42,000	350	0.01	0.03	40,000	300	0.01	0.03
2004-010	R0.2	1	44,000	600	0.015	0.045	42,000	550	0.015	0.045	40,000	500	0.013	0.036
2004-020	R0.2	2	44,000	600	0.015	0.045	42,000	550	0.015	0.045	40,000	500	0.013	0.036
2004-030	R0.2	3	35,200	330	0.008	0.024	33,600	310	0.008	0.024	32,000	280	0.008	0.022
2005-015	R0.25	1.5	44,000	900	0.02	0.065	40,000	800	0.015	0.05	36,000	600	0.015	0.05
2005-020	R0.25	2	44,000	900	0.02	0.065	40,000	800	0.015	0.05	36,000	600	0.015	0.05
2005-025	R0.25	2.5	44,000	900	0.02	0.065	40,000	800	0.015	0.05	36,000	600	0.015	0.05
2006-010	R0.3	1	40,000	1,400	0.045	0.15	36,000	1,500	0.03	0.13	32,000	1,000	0.02	0.1
2006-015	R0.3	1.5	40,000	1,400	0.03	0.13	36,000	1,300	0.03	0.13	32,000	1,000	0.02	0.1
2006-020	R0.3	2	40,000	1,400	0.03	0.13	36,000	1,300	0.03	0.13	32,000	1,000	0.02	0.1
2006-030	R0.3	3	40,000	1,200	0.025	0.1	36,000	1,100	0.025	0.1	32,000	900	0.02	0.1
2006-040	R0.3	4	40,000	1,000	0.02	0.08	32,000	800	0.02	0.08	32,000	700	0.015	0.07
2008-020	R0.4	2	35,000	1,600	0.06	0.21	30,000	1,600	0.04	0.17	26,000	1,350	0.04	0.15
2008-040	R0.4	4	35,000	1,600	0.06	0.21	30,000	1,600	0.04	0.17	26,000	1,350	0.04	0.15
2010-020	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
2010-025	R0.5	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
2010-030	R0.5	3	30,000	1,750	0.1	0.3	24,000	2,000	0.1	0.2	21,000	1,750	0.03	0.17
2010-040	R0.5	4	30,000	1,750	0.1	0.3	24,000	2,000	0.1	0.2	21,000	1,750	0.03	0.17
2010-060	R0.5	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
2015-030	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
2015-040	R0.75	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
2015-060	R0.75	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
2020-030	R1	3	28,000	2,900	0.3	0.7	14,000	2,100	0.15	0.5	14,700	2,100	0.15	0.35
2020-040	R1	4	28,000	2,900	0.3	0.7	14,000	2,100	0.15	0.5	14,700	2,100	0.15	0.35
2020-060	R1	6	28,000	2,900	0.2	0.6	14,000	2,100	0.1	0.4	14,700	2,100	0.15	0.3
2030-060	R1.5	6	21,000	3,000	0.4	1	13,250	2,500	0.24	0.55	11,040	2,280	0.24	0.55

VHGLB Milling Conditions

WORK MATERIAL			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)
2001-003	R0.05	0.3	40,000	120	0.002	0.004
20015-003	R0.075	0.3	40,000	135	0.003	0.006
2002-005	R0.1	0.5	36,000	150	0.006	0.018
2002-010	R0.1	1	36,000	150	0.006	0.018
2003-010	R0.15	1	36,000	250	0.008	0.024
2003-015	R0.15	1.5	36,000	250	0.008	0.024
2004-010	R0.2	1	36,000	350	0.01	0.027
2004-020	R0.2	2	36,000	350	0.01	0.027
2004-030	R0.2	3	28,000	200	0.006	0.016
2005-015	R0.25	1.5	30,000	400	0.015	0.03
2005-020	R0.25	2	30,000	400	0.015	0.03
2005-025	R0.25	2.5	30,000	400	0.015	0.03
2006-010	R0.3	1	25,000	600	0.02	0.1
2006-015	R0.3	1.5	25,000	600	0.02	0.1
2006-020	R0.3	2	25,000	600	0.02	0.1
2006-030	R0.3	3	25,000	500	0.02	0.1
2006-040	R0.3	4	25,000	400	0.01	0.075
2008-020	R0.4	2	20,000	700	0.02	0.12
2008-040	R0.4	4	20,000	700	0.02	0.12
2010-020	R0.5	2	16,000	875	0.05	0.2
2010-025	R0.5	2.5	16,000	875	0.05	0.2
2010-030	R0.5	3	16,000	875	0.03	0.17
2010-040	R0.5	4	16,000	875	0.03	0.17
2010-060	R0.5	6	14,500	525	0.025	0.15
2015-030	R0.75	3	11,250	875	0.06	0.29
2015-040	R0.75	4	11,250	875	0.06	0.29
2015-060	R0.75	6	11,250	875	0.04	0.24
2020-030	R1	3	12,250	1,800	0.08	0.35
2020-040	R1	4	12,250	1,800	0.08	0.35
2020-060	R1	6	12,250	1,800	0.06	0.3
2030-060	R1.5	6	9,200	1,900	0.12	0.55

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 the tool is chattering and heats up to a red color.
- Every coolant offers stable milling.



VHSLB

Value Series HARDMAX Longneck Ball

HARDMAX
2 Flutes Short Shank Long Neck Ball End Mills

Additional 4 models

Super MG

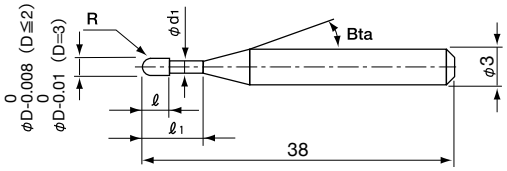
HARD MAX

Shank Dia 0/-0.003

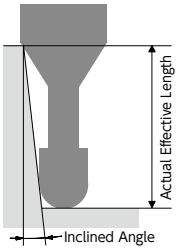
0° — R0.05

30° — R0.1～R1.5

Back Taper Geometry — Except for R0.05～R0.4



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.



Radius of Ball Nose	Diameter Tolerance	Ball Radius Accuracy	Helix Angle
R0.05	0/-0.008	± 0.002	0°
R0.1 ～ R0.75		± 0.003	30°
R1		± 0.004	
R1.5	0/-0.01	± 0.005	

Material Applications（☆ Highly Recommended ◎ Recommended ○ Suggested）

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
○	○	◎	◎	◎	◎	○			○			○	○		

Total 53 models

Unit(mm)

Model Number	Radius of Ball Nose R	Effective Length ℓ_1	Length of Cut ℓ	Neck Diameter ϕd_1	Shank Taper Angle Bta	Effective Length by Inclined Angles 30′	1°	1°30′	2°	3°	Series
VHSLB 2001-003	R0.05	0.3	0.08	0.093	11°	0.34	0.37	0.39	0.41	0.46	VHSLB
VHSLB 2002-003	R0.1	0.3	0.16	0.18	16°	0.43	0.45	0.46	0.48	0.52	VHSLB
VHSLB 2002-005	R0.1	0.5	0.16	0.18	16°	0.64	0.66	0.69	0.71	0.76	VHSLB
VHSLB 2002-0075	R0.1	0.75	0.16	0.18	16°	0.90	0.93	0.97	1.00	1.07	VHSLB
VHSLB 2002-010	R0.1	1	0.16	0.18	16°	1.16	1.20	1.24	1.28	1.38	VHSLB
VHSLB 2003-005	R0.15	0.5	0.24	0.28	16°	0.63	0.66	0.68	0.71	0.75	VHSLB
VHSLB 2003-0075	R0.15	0.75	0.24	0.28	16°	0.90	0.93	0.96	0.99	1.06	VHSLB
VHSLB 2003-010	R0.15	1	0.24	0.28	16°	1.16	1.20	1.24	1.28	1.37	VHSLB
VHSLB 2003-015	R0.15	1.5	0.24	0.28	16°	1.67	1.73	1.78	1.84	1.97	VHSLB
VHSLB 2003-020	R0.15	2	0.24	0.28	16°	2.19	2.26	2.33	2.41	2.59	VHSLB
VHSLB 2003-030	R0.15	3	0.24	0.28	16°	3.22	3.33	3.43	3.55	3.81	VHSLB
VHSLB 2004-005	R0.2	0.5	0.32	0.38	16°	0.63	0.65	0.68	0.70	0.74	VHSLB
VHSLB 2004-010	R0.2	1	0.32	0.38	16°	1.15	1.19	1.23	1.27	1.35	VHSLB
VHSLB 2004-015	R0.2	1.5	0.32	0.38	16°	1.67	1.73	1.78	1.84	1.96	VHSLB
VHSLB 2004-020	R0.2	2	0.32	0.38	16°	2.19	2.26	2.33	2.41	2.57	VHSLB
VHSLB 2004-030	R0.2	3	0.32	0.38	16°	3.22	3.32	3.43	3.54	3.80	VHSLB
VHSLB 2004-040	R0.2	4	0.32	0.38	16°	4.25	4.39	4.53	4.68	5.02	VHSLB
VHSLB 2005-010	R0.25	1	0.4	0.48	16°	1.15	1.19	1.23	1.26	1.34	VHSLB
VHSLB 2005-015	R0.25	1.5	0.4	0.48	16°	1.67	1.72	1.77	1.83	1.95	VHSLB
VHSLB 2005-020	R0.25	2	0.4	0.48	16°	2.19	2.25	2.32	2.40	2.56	VHSLB
VHSLB 2005-025	R0.25	2.5	0.4	0.48	16°	2.71	2.79	2.87	2.97	3.18	VHSLB
VHSLB 2005-030	R0.25	3	0.4	0.48	16°	3.22	3.32	3.42	3.54	3.79	VHSLB
VHSLB 2005-040	R0.25	4	0.4	0.48	16°	4.25	4.38	4.53	4.68	5.01	VHSLB

HARDMAX 2 Flutes Short Shank Long Neck Ball End Mills

	Model Number	Radius of Ball Nose R	Effective Length ℓ_1	Length of Cut ℓ	Neck Diameter ϕd_1	Shank Taper Angle Bta	Effective Length by Inclined Angles					Series
							30′	1°	1°30′	2°	3°	
	VHSLB 2006-010	R0.3	1	0.48	0.58	16°	1.15	1.19	1.22	1.26	1.33	VHSLB
	VHSLB 2006-015	R0.3	1.5	0.48	0.58	16°	1.67	1.72	1.77	1.82	1.94	VHSLB
	VHSLB 2006-020	R0.3	2	0.48	0.58	16°	2.19	2.25	2.32	2.39	2.55	VHSLB
	VHSLB 2006-025	R0.3	2.5	0.48	0.58	16°	2.70	2.78	2.87	2.96	3.16	VHSLB
	VHSLB 2006-030	R0.3	3	0.48	0.58	16°	3.22	3.32	3.42	3.53	3.78	VHSLB
	VHSLB 2006-040	R0.3	4	0.48	0.58	16°	4.25	4.38	4.52	4.67	5.00	VHSLB
	VHSLB 2006-050	R0.3	5	0.48	0.58	16°	5.28	5.45	5.62	5.81	6.22	VHSLB
	VHSLB 2006-060	R0.3	6	0.48	0.58	16°	6.31	6.51	6.72	6.95	7.45	VHSLB
	VHSLB 2008-020	R0.4	2	0.64	0.78	16°	2.18	2.25	2.31	2.38	2.53	VHSLB
	VHSLB 2008-030	R0.4	3	0.64	0.78	16°	3.22	3.31	3.41	3.52	3.75	VHSLB
	VHSLB 2008-040	R0.4	4	0.64	0.78	16°	4.25	4.37	4.51	4.66	4.98	VHSLB
	VHSLB 2008-050	R0.4	5	0.64	0.78	16°	5.28	5.44	5.61	5.79	6.20	VHSLB
	VHSLB 2008-060	R0.4	6	0.64	0.78	16°	6.31	6.50	6.71	6.93	7.43	VHSLB
	VHSLB 2010-020	R0.5	2	0.8	0.97	16°	2.20	2.26	2.32	2.39	2.54	VHSLB
	VHSLB 2010-025	R0.5	2.5	0.8	0.97	16°	2.72	2.79	2.87	2.96	3.15	VHSLB
	VHSLB 2010-030	R0.5	3	0.8	0.97	16°	3.24	3.33	3.42	3.53	3.76	VHSLB
	VHSLB 2010-040	R0.5	4	0.8	0.97	16°	4.27	4.39	4.52	4.67	4.98	VHSLB
	VHSLB 2010-050	R0.5	5	0.8	0.97	16°	5.30	5.46	5.62	5.80	6.21	VHSLB
	VHSLB 2010-060	R0.5	6	0.8	0.97	16°	6.33	6.52	6.72	6.94	7.43	VHSLB
※	VHSLB 2010-080	R0.5	8	0.8	0.97	16°	8.39	8.65	8.93	9.22	9.88	VHSLB
	VHSLB 2015-030	R0.75	3	1.2	1.46	16°	3.12	3.20	3.28	3.37	3.58	VHSLB
	VHSLB 2015-040	R0.75	4	1.2	1.46	16°	4.15	4.26	4.38	4.51	4.80	VHSLB
	VHSLB 2015-060	R0.75	6	1.2	1.46	16°	6.21	6.39	6.58	6.79	7.25	VHSLB
※	VHSLB 2015-080	R0.75	8	1.2	1.46	16°	8.28	8.52	8.78	9.07	9.69	VHSLB
	VHSLB 2020-030	R1	3	1.6	1.96	16°	3.11	3.18	3.26	3.34	3.52	VHSLB
	VHSLB 2020-040	R1	4	1.6	1.96	16°	4.14	4.24	4.36	4.48	4.74	VHSLB
	VHSLB 2020-060	R1	6	1.6	1.96	16°	6.20	6.37	6.56	6.75	7.19	VHSLB
※	VHSLB 2020-080	R1	8	1.6	1.96	16°	8.27	8.50	8.76	9.03	9.64	VHSLB
	VHSLB 2030-060	R1.5	6	2.4	2.93	—	No Interference	No Interference	No Interference	No Interference	No Interference	VHSLB
※	VHSLB 2030-080	R1.5	8	2.4	2.93	—	No Interference	No Interference	No Interference	No Interference	No Interference	VHSLB

※ Additional model

VHSLB Milling Conditions

WORK MATERIAL			COPPER OFC / TPC				CARBON STEELS S45C / S50C (~225HB)				ALLOY STEELS SK / SCM / SUS (225~325HB)			
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	54,000	85	0.004	0.004	54,000	85	0.004	0.004	54,000	85	0.004	0.004
2002-003	R0.1	0.3	54,000	430	0.01	0.01	60,000	350	0.008	0.016	60,000	350	0.008	0.016
2002-005	R0.1	0.5	54,000	430	0.01	0.01	60,000	350	0.008	0.016	60,000	350	0.008	0.016
2002-0075	R0.1	0.75	54,000	380	0.008	0.008	60,000	320	0.007	0.015	60,000	320	0.007	0.015
2002-010	R0.1	1	54,000	380	0.008	0.008	60,000	250	0.005	0.015	60,000	250	0.005	0.015
2003-005	R0.15	0.5	54,000	720	0.015	0.015	43,000	500	0.012	0.024	43,000	500	0.012	0.024
2003-0075	R0.15	0.75	54,000	720	0.015	0.015	43,000	500	0.012	0.024	43,000	500	0.012	0.024
2003-010	R0.15	1	54,000	640	0.014	0.015	43,000	450	0.008	0.024	43,000	450	0.008	0.024
2003-015	R0.15	1.5	54,000	640	0.014	0.015	43,000	400	0.007	0.021	43,000	400	0.007	0.021
2003-020	R0.15	2	49,000	530	0.011	0.011	40,000	300	0.006	0.018	40,000	300	0.006	0.018
2003-030	R0.15	3	43,000	460	0.009	0.01	38,000	200	0.004	0.012	38,000	200	0.004	0.012
2004-005	R0.2	0.5	54,000	870	0.023	0.036	35,000	1,200	0.02	0.04	35,000	1,200	0.02	0.04
2004-010	R0.2	1	54,000	870	0.023	0.036	35,000	1,200	0.02	0.04	35,000	1,200	0.02	0.04
2004-015	R0.2	1.5	54,000	790	0.022	0.036	35,000	900	0.016	0.033	35,000	900	0.016	0.033
2004-020	R0.2	2	54,000	790	0.022	0.036	35,000	600	0.011	0.033	35,000	600	0.011	0.033
2004-030	R0.2	3	50,000	660	0.017	0.018	35,000	400	0.008	0.024	35,000	400	0.008	0.024
2004-040	R0.2	4	50,000	640	0.012	0.018	35,000	300	0.005	0.015	35,000	300	0.005	0.015
2005-010	R0.25	1	57,000	1,380	0.029	0.054	34,000	1,300	0.03	0.06	34,000	1,300	0.03	0.06
2005-015	R0.25	1.5	57,000	1,380	0.029	0.054	34,000	1,000	0.025	0.05	34,000	1,000	0.025	0.05
2005-020	R0.25	2	57,000	1,250	0.028	0.054	34,000	800	0.023	0.046	34,000	800	0.023	0.046
2005-025	R0.25	2.5	57,000	1,250	0.028	0.054	34,000	700	0.015	0.045	34,000	700	0.015	0.045
2005-030	R0.25	3	55,000	1,010	0.021	0.036	32,000	550	0.012	0.036	32,000	550	0.012	0.036
2005-040	R0.25	4	55,000	1,010	0.021	0.036	31,000	450	0.01	0.03	31,000	450	0.01	0.03
2006-010	R0.3	1	57,000	1,670	0.035	0.144	33,000	1,500	0.04	0.08	33,000	1,500	0.04	0.08
2006-015	R0.3	1.5	57,000	1,670	0.035	0.144	33,000	1,500	0.04	0.08	33,000	1,500	0.04	0.08
2006-020	R0.3	2	57,000	1,540	0.034	0.144	33,000	1,400	0.036	0.072	33,000	1,400	0.036	0.072
2006-025	R0.3	2.5	57,000	1,540	0.034	0.144	33,000	1,200	0.033	0.066	33,000	1,200	0.033	0.066
2006-030	R0.3	3	57,000	1,540	0.034	0.144	33,000	900	0.025	0.066	33,000	900	0.025	0.066
2006-040	R0.3	4	54,000	1,130	0.026	0.108	31,000	700	0.02	0.06	31,000	700	0.02	0.06
2006-050	R0.3	5	46,000	960	0.019	0.072	29,000	440	0.015	0.045	29,000	440	0.015	0.045
2006-060	R0.3	6	46,000	960	0.019	0.072	24,000	380	0.012	0.036	24,000	380	0.012	0.036
2008-020	R0.4	2	55,000	2,060	0.063	0.18	30,000	1,800	0.06	0.12	30,000	1,800	0.06	0.12
2008-030	R0.4	3	55,000	1,860	0.063	0.18	30,000	1,600	0.05	0.1	30,000	1,600	0.05	0.1
2008-040	R0.4	4	55,000	1,860	0.063	0.18	30,000	1,300	0.04	0.1	30,000	1,300	0.04	0.1
2008-050	R0.4	5	47,000	1,410	0.038	0.108	30,000	1,100	0.035	0.1	30,000	1,100	0.035	0.1
2008-060	R0.4	6	47,000	1,410	0.038	0.108	27,000	900	0.025	0.075	27,000	900	0.025	0.075
2010-020	R0.5	2	46,000	2,000	0.072	0.36	30,000	1,600	0.08	0.16	30,000	1,600	0.08	0.16
2010-025	R0.5	2.5	46,000	2,000	0.072	0.36	30,000	1,600	0.08	0.16	30,000	1,600	0.08	0.16
2010-030	R0.5	3	46,000	2,000	0.072	0.36	24,000	1,600	0.07	0.14	24,000	1,600	0.07	0.14
2010-040	R0.5	4	46,000	2,000	0.071	0.36	24,000	1,500	0.065	0.13	24,000	1,500	0.065	0.13
2010-050	R0.5	5	46,000	2,000	0.071	0.36	24,000	1,400	0.06	0.12	24,000	1,400	0.06	0.12
2010-060	R0.5	6	39,000	1,500	0.071	0.18	18,000	1,200	0.04	0.12	18,000	1,200	0.04	0.12
2010-080	R0.5	8	39,000	1,500	0.043	0.18	16,500	900	0.027	0.081	16,500	900	0.027	0.081
2015-030	R0.75	3	30,000	2,200	0.171	0.324	30,000	1,600	0.12	0.24	30,000	1,600	0.12	0.24
2015-040	R0.75	4	30,000	2,200	0.171	0.324	30,000	1,500	0.11	0.22	30,000	1,500	0.11	0.22
2015-060	R0.75	6	30,000	1,980	0.147	0.324	23,000	1,300	0.1	0.2	23,000	1,300	0.1	0.2
2015-080	R0.75	8	26,000	1,500	0.106	0.27	18,000	1,100	0.08	0.16	18,000	1,100	0.08	0.16

VHSLB Milling Conditions

WORK MATERIAL			PREHARDENED STEELS / HARDENED STEELS NAK / STAVAX (~55HRC)				HARDENED STEELS SKD11 (55~62HRC)				HARDENED STEELS HAP10 (62~66HRC)			
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	48,000	55	0.002	0.002	48,000	45	0.002	0.002	48,000	45	0.002	0.002
2002-003	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
2002-005	R0.1	0.5	60,000	200	0.003	0.005	60,000	200	0.002	0.003	60,000	130	0.002	0.003
2002-0075	R0.1	0.75	60,000	200	0.003	0.005	60,000	200	0.002	0.003	60,000	130	0.002	0.003
2002-010	R0.1	1	60,000	200	0.003	0.005	60,000	200	0.002	0.003	60,000	130	0.002	0.003
2003-005	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
2003-0075	R0.15	0.75	60,000	350	0.006	0.008	45,000	310	0.004	0.007	43,500	180	0.003	0.005
2003-010	R0.15	1	60,000	350	0.006	0.008	45,000	310	0.004	0.007	43,500	180	0.003	0.005
2003-015	R0.15	1.5	60,000	350	0.006	0.008	45,000	310	0.004	0.007	43,500	180	0.003	0.005
2003-020	R0.15	2	60,000	210	0.004	0.007	45,000	190	0.003	0.005	43,500	110	0.002	0.004
2003-030	R0.15	3	42,500	140	0.002	0.004	32,000	80	0.002	0.004	32,000	65	0.001	0.002
2004-005	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
2004-010	R0.2	1	50,000	500	0.01	0.02	37,500	420	0.007	0.012	35,000	240	0.005	0.008
2004-015	R0.2	1.5	50,000	500	0.01	0.02	37,500	420	0.007	0.012	35,000	240	0.005	0.008
2004-020	R0.2	2	50,000	500	0.01	0.02	37,500	420	0.007	0.012	35,000	240	0.005	0.008
2004-030	R0.2	3	40,000	250	0.005	0.008	31,900	210	0.004	0.008	30,500	160	0.003	0.005
2004-040	R0.2	4	32,000	180	0.003	0.005	25,500	150	0.002	0.004	24,300	120	0.002	0.004
2005-010	R0.25	1	44,000	650	0.015	0.04	33,000	530	0.01	0.02	30,000	300	0.007	0.01
2005-015	R0.25	1.5	44,000	650	0.015	0.04	33,000	530	0.01	0.02	30,000	300	0.007	0.01
2005-020	R0.25	2	44,000	650	0.015	0.04	33,000	530	0.01	0.02	30,000	300	0.007	0.01
2005-025	R0.25	2.5	44,000	650	0.015	0.04	33,000	530	0.01	0.02	30,000	300	0.007	0.01
2005-030	R0.25	3	40,000	500	0.01	0.02	31,000	400	0.007	0.01	28,550	230	0.005	0.008
2005-040	R0.25	4	32,700	180	0.005	0.015	27,150	150	0.003	0.008	25,650	100	0.002	0.005
2006-010	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
2006-015	R0.3	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
2006-020	R0.3	2	40,000	1,100	0.03	0.13	30,000	1,200	0.02	0.1	26,500	800	0.01	0.075
2006-025	R0.3	2.5	40,000	800	0.02	0.1	30,000	800	0.015	0.09	26,500	520	0.008	0.065
2006-030	R0.3	3	40,000	800	0.02	0.1	30,000	800	0.015	0.09	26,500	520	0.008	0.065
2006-040	R0.3	4	40,000	500	0.015	0.09	30,000	500	0.01	0.075	26,500	340	0.006	0.05
2006-050	R0.3	5	32,000	400	0.01	0.075	25,000	390	0.007	0.05	23,000	260	0.005	0.04
2006-060	R0.3	6	24,000	300	0.007	0.06	21,000	320	0.005	0.04	19,500	210	0.004	0.03
2008-020	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
2008-030	R0.4	3	35,000	1,400	0.05	0.19	27,000	1,400	0.03	0.15	23,500	900	0.015	0.1
2008-040	R0.4	4	35,000	1,200	0.04	0.17	27,000	1,200	0.025	0.135	23,500	600	0.012	0.095
2008-050	R0.4	5	31,500	900	0.03	0.15	25,000	900	0.02	0.12	22,000	500	0.01	0.085
2008-060	R0.4	6	28,000	600	0.02	0.12	23,000	600	0.012	0.095	20,500	400	0.006	0.065
2010-020	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
2010-025	R0.5	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
2010-030	R0.5	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
2010-040	R0.5	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
2010-050	R0.5	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
2010-060	R0.5	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
2010-080	R0.5	8	24,000	800	0.025	0.155	18,500	580	0.015	0.12	18,400	480	0.015	0.12
2015-030	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
2015-040	R0.75	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
2015-060	R0.75	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
2015-080	R0.75	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

VHSLB Milling Conditions

WORK MATERIAL			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)
2001-003	R0.05	0.3	36,000	22	0.002	0.002
2002-003	R0.1	0.3	45,000	65	0.002	0.003
2002-005	R0.1	0.5	45,000	65	0.002	0.003
2002-0075	R0.1	0.75	45,000	65	0.002	0.003
2002-010	R0.1	1	45,000	65	0.002	0.003
2003-005	R0.15	0.5	32,500	90	0.003	0.005
2003-0075	R0.15	0.75	32,500	90	0.003	0.005
2003-010	R0.15	1	32,500	90	0.003	0.005
2003-015	R0.15	1.5	32,500	90	0.003	0.005
2003-020	R0.15	2	32,500	55	0.002	0.004
2003-030	R0.15	3	24,000	30	0.001	0.002
2004-005	R0.2	0.5	26,250	120	0.005	0.008
2004-010	R0.2	1	26,250	120	0.005	0.008
2004-015	R0.2	1.5	26,250	120	0.005	0.008
2004-020	R0.2	2	26,250	120	0.005	0.008
2004-030	R0.2	3	22,800	80	0.003	0.005
2004-040	R0.2	4	18,200	60	0.002	0.004
2005-010	R0.25	1	22,500	150	0.007	0.01
2005-015	R0.25	1.5	22,500	150	0.007	0.01
2005-020	R0.25	2	22,500	150	0.007	0.01
2005-025	R0.25	2.5	22,500	150	0.007	0.01
2005-030	R0.25	3	21,400	115	0.005	0.008
2005-040	R0.25	4	19,900	50	0.002	0.005
2006-010	R0.3	1	20,000	500	0.015	0.09
2006-015	R0.3	1.5	20,000	400	0.01	0.075
2006-020	R0.3	2	20,000	400	0.01	0.075
2006-025	R0.3	2.5	20,000	260	0.008	0.065
2006-030	R0.3	3	20,000	260	0.008	0.065
2006-040	R0.3	4	20,000	170	0.006	0.05
2006-050	R0.3	5	18,000	130	0.005	0.04
2006-060	R0.3	6	15,000	105	0.004	0.03
2008-020	R0.4	2	17,500	500	0.02	0.12
2008-030	R0.4	3	17,500	450	0.015	0.1
2008-040	R0.4	4	17,500	300	0.012	0.095
2008-050	R0.4	5	16,500	250	0.01	0.085
2008-060	R0.4	6	15,500	200	0.006	0.065
2010-020	R0.5	2	16,000	875	0.05	0.2
2010-025	R0.5	2.5	16,000	875	0.05	0.2
2010-030	R0.5	3	16,000	875	0.03	0.17
2010-040	R0.5	4	16,000	875	0.03	0.17
2010-050	R0.5	5	16,000	875	0.03	0.17
2010-060	R0.5	6	14,500	525	0.025	0.15
2010-080	R0.5	8	13,800	240	0.015	0.12
2015-030	R0.75	3	11,250	875	0.06	0.29
2015-040	R0.75	4	11,250	875	0.06	0.29
2015-060	R0.75	6	11,250	875	0.04	0.24
2015-080	R0.75	8	10,500	525	0.03	0.21

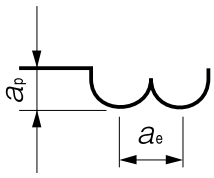
VHSLB Milling Conditions

WORK MATERIAL			COPPER OFC / TPC				CARBON STEELS S45C / S50C (~225HB)				ALLOY STEELS SK / SCM / SUS (225~325HB)			
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)
2020-030	R1	3	22,000	2,140	0.232	0.54	30,000	2,000	0.21	0.42	30,000	2,000	0.21	0.42
2020-040	R1	4	22,000	2,140	0.232	0.54	30,000	2,000	0.21	0.42	30,000	2,000	0.21	0.42
2020-060	R1	6	22,000	2,140	0.232	0.54	30,000	2,000	0.21	0.42	30,000	2,000	0.21	0.42
2020-080	R1	8	22,000	1,920	0.185	0.36	30,000	2,000	0.18	0.36	30,000	2,000	0.18	0.36
2030-060	R1.5	6	15,000	2,890	0.278	0.54	24,000	2,500	0.32	0.9	24,000	2,500	0.32	0.9
2030-080	R1.5	8	15,000	2,890	0.278	0.54	24,000	2,500	0.32	0.9	24,000	2,500	0.32	0.9

WORK MATERIAL			PREHARDENED STEELS / HARDENED STEELS NAK / STAVAX (~55HRC)				HARDENED STEELS SKD11 (55~62HRC)				HARDENED STEELS HAP10 (62~66HRC)			
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)
2020-030	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
2020-040	R1	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
2020-060	R1	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
2020-080	R1	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
2030-060	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
2030-080	R1.5	8	21,000	3,000	0.4	1	10,500	2,200	0.2	0.7	9,200	1,900	0.12	0.55

WORK MATERIAL			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)
2020-030	R1	3	9,200	900	0.08	0.35
2020-040	R1	4	9,200	900	0.08	0.35
2020-060	R1	6	9,200	900	0.06	0.3
2020-080	R1	8	9,200	900	0.06	0.3
2030-060	R1.5	6	6,900	950	0.12	0.55
2030-080	R1.5	8	6,900	950	0.12	0.55

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 the tool is chattering and heats up to a red color.
- Every coolant offers stable milling.
- Recommend wet coolant for Copper.



Long neck ball end mill R0.5 x Effective length 6mm

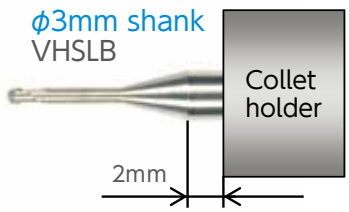
The comparison example of different shank diameter between ϕ3mm & ϕ4mm

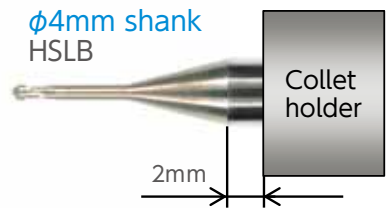
Comparison of tool wearing and Dimensional accuracy

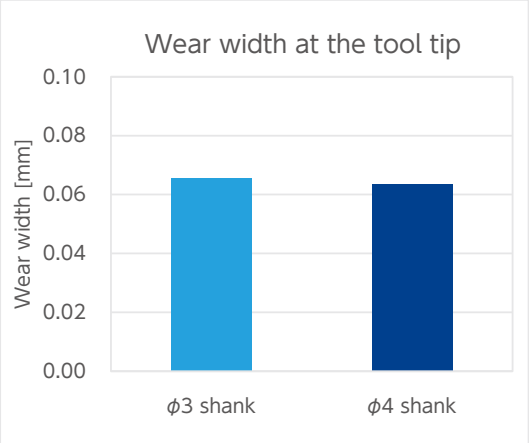
<Condition>

Work material : SKD11(60HRC) (DIN :1.2379, AISI : D2)
Coolant : Air blow
Tool holder : Collet holder
Milling shape : Pocket (□8mm x 8mm x depth 3mm)
Cycle time : about 35 min.

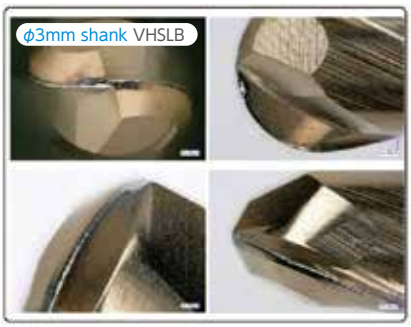
n : 21,500 min^{-1}
V_f : 1,250 mm/min
a_p : 0.03 mm
a_e : 0.17 mm

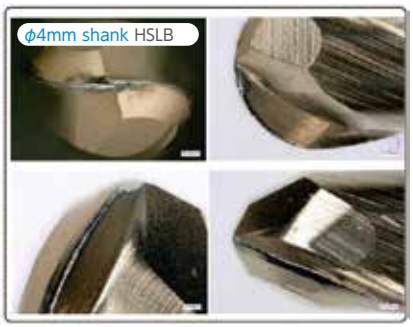


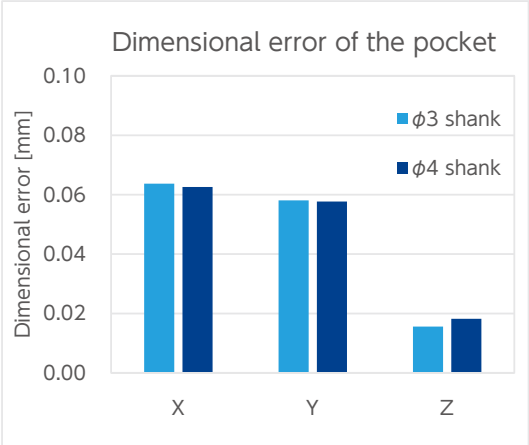




<Tool damage>







If the overhang is shortened, the performance equivalent to that of a ϕ4mm shank can be obtained.

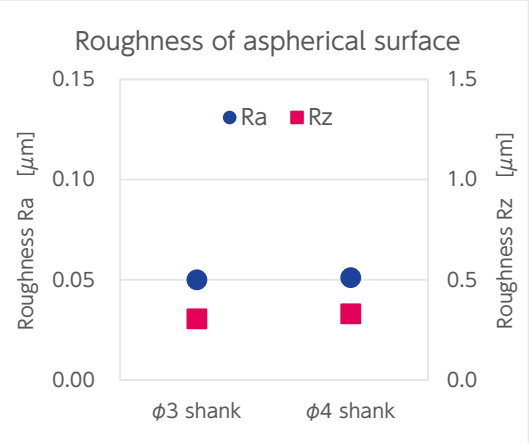
Comparison of roughness and reflection of the aspherical surface (Finishing process).

The upper surface of the square prism was processed aspherically, and the surface roughness and reflection were compared.
We obtained the same results as the ϕ4mm shank in terms of surface roughness and reflection.

<Condition>

Work material : HAP10(64HRC)
Coolant : Air blow
Tool holder : Hydraulic chuck
(Overhang : 2mm of the shank part)
Milling shape : Aspherical surface (□5mm x 5mm) R25
Cycle time : about 26 min.

n : 29,600 min^{-1}
V_f : 500 mm/min
a_p : 0.015 mm
a_e : 0.006 mm



<Aspherical shape photos>

ϕ3mm shank VHSLB

ϕ4mm shank HSLB

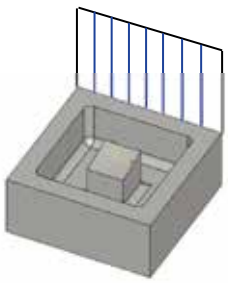


Image of the time of shooting

* These photos were taken as shown in the image on the right so that the blue line printed on the paper would reflected.

VCSELB

Value Series UTCOAT Longneck Ball

UTCOAT
2 Flutes Short Shank Long Neck Ball End Mills

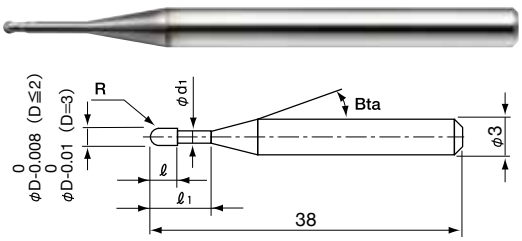
NEW

Super MG | UT COAT | Shank Dia 0/-0.003

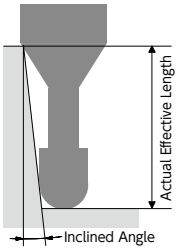
0° — R0.05~R0.075

30° — R0.1~R1.5

Back Taper Geometry — Except for R0.05~R0.15



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.



Radius of Ball Nose	Diameter Tolerance	Ball Radius Accuracy	Helix Angle
R0.05 ~ R0.075	0/-0.008	± 0.002	0°
R0.1 ~ R0.75		± 0.003	30°
R1		± 0.004	
R1.5	0/-0.01	± 0.005	

Material Applications (☆ Highly Recommended ◎ Recommended ○ Suggested)

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

Total 30 models

Unit(mm)

Model Number	Radius of Ball Nose R	Effective Length ℓ1	Length of Cut ℓ	Neck Diameter φd1	Shank Taper Angle Bta	Effective Length by Inclined Angles 30′	1°	1°30′	2°	3°	Series
VCSELB 2001-003	R0.05	0.3	0.08	0.094	11°	0.34	0.36	0.38	0.41	0.46	VCSELB
VCSELB 20015-003	R0.075	0.3	0.12	0.14	11°	0.37	0.39	0.41	0.43	0.48	VCSELB
VCSELB 2002-005	R0.1	0.5	0.16	0.18	11°	0.64	0.67	0.70	0.73	0.82	VCSELB
VCSELB 2002-010	R0.1	1	0.16	0.18	11°	1.16	1.21	1.28	1.34	1.50	VCSELB
VCSELB 2003-010	R0.15	1	0.24	0.28	11°	1.16	1.21	1.27	1.33	1.49	VCSELB
VCSELB 2003-020	R0.15	2	0.24	0.28	11°	2.20	2.30	2.42	2.55	2.85	VCSELB
VCSELB 2003-030	R0.15	3	0.24	0.28	11°	3.25	3.40	3.58	3.77	4.22	VCSELB
VCSELB 2004-010	R0.2	1	0.32	0.38	11°	1.16	1.21	1.26	1.32	1.47	VCSELB
VCSELB 2004-020	R0.2	2	0.32	0.38	11°	2.20	2.30	2.41	2.54	2.83	VCSELB
VCSELB 2004-030	R0.2	3	0.32	0.38	11°	3.24	3.40	3.57	3.76	4.20	VCSELB
VCSELB 2004-040	R0.2	4	0.32	0.38	11°	4.29	4.50	4.72	4.97	5.57	VCSELB
VCSELB 2005-020	R0.25	2	0.4	0.48	11°	2.19	2.29	2.40	2.52	2.81	VCSELB
VCSELB 2005-030	R0.25	3	0.4	0.48	11°	3.24	3.39	3.56	3.74	4.18	VCSELB
VCSELB 2005-040	R0.25	4	0.4	0.48	11°	4.29	4.49	4.71	4.96	5.55	VCSELB
VCSELB 2006-020	R0.3	2	0.48	0.58	11°	2.19	2.29	2.39	2.51	2.79	VCSELB
VCSELB 2006-030	R0.3	3	0.48	0.58	11°	3.24	3.39	3.55	3.73	4.16	VCSELB
VCSELB 2006-040	R0.3	4	0.48	0.58	11°	4.28	4.48	4.70	4.95	5.53	VCSELB
VCSELB 2006-060	R0.3	6	0.48	0.58	11°	6.38	6.68	7.02	7.39	8.27	VCSELB
VCSELB 2008-020	R0.4	2	0.64	0.78	11°	2.19	2.28	2.38	2.49	2.76	VCSELB
VCSELB 2008-040	R0.4	4	0.64	0.78	11°	4.28	4.47	4.69	4.93	5.50	VCSELB
VCSELB 2008-060	R0.4	6	0.64	0.78	11°	6.37	6.67	7.00	7.37	8.23	VCSELB

UTCOAT 2 Flutes Short Shank Long Neck Ball End Mills

Model Number	Radius of Ball Nose R	Effective Length ℓ_1	Length of Cut ℓ	Neck Diameter ϕd_1	Shank Taper Angle Bta	Effective Length by Inclined Angles					Series
						30′	1°	1°30′	2°	3°	
VCSELB 2010-030	R0.5	3	0.8	0.97	11°	3.26	3.40	3.55	3.73	4.13	VCSELB
VCSELB 2010-040	R0.5	4	0.8	0.97	11°	4.31	4.50	4.71	4.94	5.50	VCSELB
VCSELB 2010-050	R0.5	5	0.8	0.97	11°	5.35	5.60	5.87	6.16	6.87	VCSELB
VCSELB 2010-060	R0.5	6	0.8	0.97	11°	6.40	6.70	7.02	7.38	8.24	VCSELB
VCSELB 2015-040	R0.75	4	1.2	1.46	11°	4.25	4.42	4.62	4.84	5.35	VCSELB
VCSELB 2015-060	R0.75	6	1.2	1.46	11°	6.34	6.62	6.93	7.27	8.09	VCSELB
VCSELB 2020-040	R1	4	1.6	1.96	11°	4.24	4.40	4.58	4.78	5.26	VCSELB
VCSELB 2020-060	R1	6	1.6	1.96	11°	6.33	6.60	6.89	7.22	8.00	VCSELB
VCSELB 2030-060	R1.5	6	2.4	2.93	—	No Interference	No Interference	No Interference	No Interference	No Interference	VCSELB

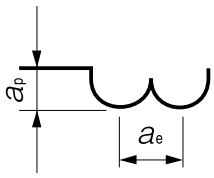
VCSELB Milling Conditions

WORK MATERIAL			COPPER / ALUMINUM ALLOYS				CARBON STEELS / ALLOY STEELS S45C / S50C / SK / SCM (~325HB)				PREHARDENED STEELS NAK80 / STAVAX / HPM38 (30~45HRC)			
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	54,000	85	0.004	0.004	54,000	85	0.004	0.004	48,000	55	0.002	0.002
20015-003	R0.075	0.3	54,000	160	0.007	0.009	54,000	160	0.007	0.009	48,000	90	0.004	0.004
2002-005	R0.1	0.5	60,000	350	0.008	0.024	60,000	350	0.008	0.016	60,000	300	0.008	0.024
2002-010	R0.1	1	60,000	250	0.006	0.018	60,000	250	0.005	0.015	60,000	250	0.006	0.018
2003-010	R0.15	1	43,000	450	0.01	0.03	43,000	450	0.008	0.024	54,000	400	0.01	0.03
2003-020	R0.15	2	40,000	300	0.006	0.018	40,000	300	0.006	0.018	50,000	300	0.007	0.021
2003-030	R0.15	3	38,000	200	0.004	0.012	38,000	200	0.004	0.012	42,000	200	0.004	0.012
2004-010	R0.2	1	35,000	1,200	0.03	0.09	35,000	1,200	0.02	0.04	50,000	650	0.025	0.075
2004-020	R0.2	2	35,000	600	0.015	0.045	35,000	600	0.011	0.033	50,000	500	0.015	0.045
2004-030	R0.2	3	35,000	400	0.01	0.03	35,000	400	0.008	0.024	42,000	400	0.01	0.03
2004-040	R0.2	4	35,000	300	0.005	0.015	35,000	300	0.005	0.015	35,000	300	0.005	0.015
2005-020	R0.25	2	34,000	800	0.025	0.075	34,000	800	0.023	0.046	45,000	700	0.022	0.066
2005-030	R0.25	3	32,000	550	0.016	0.048	32,000	550	0.012	0.036	41,000	550	0.014	0.042
2005-040	R0.25	4	31,000	450	0.012	0.036	31,000	450	0.01	0.03	35,000	450	0.01	0.03
2006-020	R0.3	2	33,000	1,400	0.045	0.135	33,000	1,400	0.036	0.072	40,000	1,200	0.045	0.09
2006-030	R0.3	3	33,000	900	0.035	0.105	33,000	900	0.025	0.066	40,000	800	0.03	0.075
2006-040	R0.3	4	31,000	700	0.027	0.081	31,000	700	0.02	0.06	35,000	560	0.022	0.066
2006-060	R0.3	6	24,000	380	0.012	0.036	24,000	380	0.012	0.036	24,000	380	0.01	0.03
2008-020	R0.4	2	30,000	2,200	0.1	0.3	30,000	1,800	0.06	0.12	35,000	1,800	0.07	0.14
2008-040	R0.4	4	30,000	1,400	0.07	0.21	30,000	1,300	0.04	0.1	35,000	1,300	0.05	0.12
2008-060	R0.4	6	27,000	900	0.04	0.12	27,000	900	0.025	0.075	27,000	800	0.03	0.09
2010-030	R0.5	3	30,000	1,800	0.11	0.33	24,000	1,600	0.07	0.14	30,000	1,500	0.08	0.16
2010-040	R0.5	4	30,000	1,700	0.09	0.27	24,000	1,500	0.065	0.13	30,000	1,300	0.075	0.15
2010-050	R0.5	5	30,000	1,600	0.08	0.24	24,000	1,400	0.06	0.12	30,000	1,200	0.07	0.14
2010-060	R0.5	6	30,000	1,400	0.06	0.18	18,000	1,200	0.04	0.12	30,000	1,100	0.06	0.12
2015-040	R0.75	4	30,000	1,800	0.14	0.42	30,000	1,500	0.11	0.22	30,000	1,600	0.11	0.22
2015-060	R0.75	6	30,000	1,800	0.12	0.36	23,000	1,300	0.1	0.2	30,000	1,400	0.1	0.2
2020-040	R1	4	30,000	2,000	0.2	0.6	30,000	2,000	0.21	0.42	30,000	2,000	0.2	0.6
2020-060	R1	6	30,000	2,000	0.2	0.6	30,000	2,000	0.21	0.42	30,000	2,000	0.2	0.6
2030-060	R1.5	6	24,000	2,500	0.32	0.9	24,000	2,500	0.32	0.9	24,000	2,500	0.3	0.9

VCSELB Milling Conditions

WORK MATERIAL			HARDENED STEELS STAVAX / HPM38 / SKD61 (45~55HRC)			
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	48,000	55	0.002	0.002
20015-003	R0.075	0.3	48,000	90	0.004	0.004
2002-005	R0.1	0.5	60,000	300	0.006	0.018
2002-010	R0.1	1	60,000	220	0.005	0.015
2003-010	R0.15	1	43,000	400	0.007	0.021
2003-020	R0.15	2	40,000	300	0.005	0.015
2003-030	R0.15	3	38,000	200	0.004	0.008
2004-010	R0.2	1	35,000	650	0.015	0.045
2004-020	R0.2	2	35,000	400	0.01	0.03
2004-030	R0.2	3	35,000	330	0.007	0.021
2004-040	R0.2	4	35,000	250	0.005	0.015
2005-020	R0.25	2	32,000	700	0.016	0.048
2005-030	R0.25	3	31,000	500	0.012	0.036
2005-040	R0.25	4	30,000	390	0.01	0.03
2006-020	R0.3	2	30,000	1,200	0.036	0.054
2006-030	R0.3	3	30,000	900	0.026	0.052
2006-040	R0.3	4	28,000	600	0.018	0.054
2006-060	R0.3	6	24,000	380	0.008	0.024
2008-020	R0.4	2	25,000	1,700	0.07	0.1
2008-040	R0.4	4	25,000	1,200	0.045	0.09
2008-060	R0.4	6	23,000	800	0.023	0.069
2010-030	R0.5	3	21,500	1,400	0.08	0.12
2010-040	R0.5	4	21,500	1,300	0.075	0.1
2010-050	R0.5	5	21,500	1,200	0.06	0.09
2010-060	R0.5	6	21,500	1,100	0.05	0.1
2015-040	R0.75	4	18,000	1,400	0.11	0.17
2015-060	R0.75	6	15,000	1,200	0.1	0.16
2020-040	R1	4	16,000	1,300	0.17	0.5
2020-060	R1	6	14,000	1,100	0.15	0.4
2030-060	R1.5	6	14,000	1,400	0.25	0.76

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 the tool is chattering and heats up to a red color.
- Recommend oil coolant for Stainless Steels and Heat Resistant Alloys.
- Recommend wet coolant for Copper.



VHLS

Value Series HARDMAX Longneck Square

HARDMAX
2 Flutes Short Shank Long Neck Square End Mills

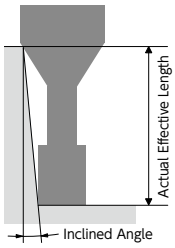
Super MG

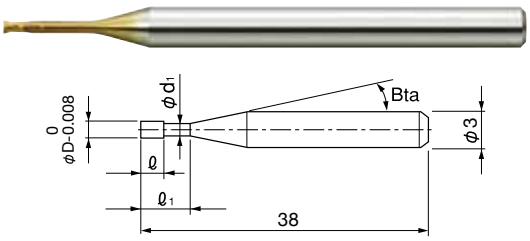
HARD MAX

30°

Shank Dia 0/-0.003

Flatland





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.

Material Applications (☆ Highly Recommended ◎ Recommended ○ Suggested)

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
○	○	◎	◎	○		○			○			○	○		

Total 30 models

Unit(mm)

Model Number	Outside Diameter φ	Effective Length ℓ1	Length of Cut ℓ	Neck Diameter φd1	Shank Taper Angle Bta	Effective Length by Inclined Angles 30′	1°	1°30′	2°	3°	Series
VHLS 2001-003	0.1	0.3	0.1	0.093	11°	0.35	0.37	0.39	0.42	0.48	VHLS
VHLS 2002-005	0.2	0.5	0.3	0.18	16°	0.68	0.72	0.76	0.80	0.87	VHLS
VHLS 2002-010	0.2	1	0.3	0.18	16°	1.21	1.27	1.32	1.37	1.48	VHLS
VHLS 2003-010	0.3	1	0.4	0.28	16°	1.25	1.32	1.39	1.45	1.56	VHLS
VHLS 2003-015	0.3	1.5	0.4	0.28	16°	1.77	1.86	1.94	2.02	2.17	VHLS
VHLS 2003-020	0.3	2	0.4	0.28	16°	2.30	2.41	2.50	2.59	2.78	VHLS
VHLS 2004-015	0.4	1.5	0.6	0.38	16°	1.85	1.97	2.07	2.17	2.34	VHLS
VHLS 2004-020	0.4	2	0.6	0.38	16°	2.38	2.52	2.64	2.75	2.96	VHLS
VHLS 2004-030	0.4	3	0.6	0.38	16°	3.44	3.61	3.75	3.88	4.18	VHLS
VHLS 2004-040	0.4	4	0.6	0.38	16°	4.49	4.69	4.85	5.02	5.40	VHLS
VHLS 2005-015	0.5	1.5	0.7	0.49	16°	1.92	2.06	2.19	2.30	2.51	VHLS
VHLS 2005-020	0.5	2	0.7	0.49	16°	2.46	2.62	2.76	2.89	3.13	VHLS
VHLS 2005-025	0.5	2.5	0.7	0.49	16°	2.99	3.18	3.33	3.47	3.74	VHLS
VHLS 2005-030	0.5	3	0.7	0.49	16°	3.52	3.73	3.89	4.04	4.35	VHLS
VHLS 2005-040	0.5	4	0.7	0.49	16°	4.58	4.82	5.01	5.18	5.57	VHLS
VHLS 2005-060	0.5	6	0.7	0.49	16°	6.69	6.97	7.21	7.46	8.02	VHLS
VHLS 2006-020	0.6	2	0.9	0.59	16°	2.52	2.71	2.88	3.03	3.30	VHLS
VHLS 2006-030	0.6	3	0.9	0.59	16°	3.60	3.83	4.02	4.20	4.52	VHLS
VHLS 2006-040	0.6	4	0.9	0.59	16°	4.67	4.93	5.15	5.34	5.75	VHLS
VHLS 2006-060	0.6	6	0.9	0.59	16°	6.78	7.10	7.36	7.62	8.19	VHLS
VHLS 2008-030	0.8	3	1.2	0.79	16°	3.60	3.83	4.02	4.20	4.52	VHLS
VHLS 2008-040	0.8	4	1.2	0.79	16°	4.67	4.93	5.15	5.34	5.75	VHLS
VHLS 2008-060	0.8	6	1.2	0.79	16°	6.78	7.10	7.36	7.62	8.19	VHLS
VHLS 2010-030	1	3	1.5	0.96	16°	3.71	3.92	4.10	4.26	4.59	VHLS
VHLS 2010-040	1	4	1.5	0.96	16°	4.77	5.01	5.22	5.40	5.81	VHLS
VHLS 2010-050	1	5	1.5	0.96	16°	5.82	6.09	6.32	6.54	7.03	VHLS
VHLS 2010-060	1	6	1.5	0.96	16°	6.87	7.17	7.42	7.68	8.26	VHLS
VHLS 2015-040	1.5	4	2.3	1.46	16°	4.17	4.31	4.46	4.61	4.96	VHLS
VHLS 2015-060	1.5	6	2.3	1.46	16°	6.24	6.44	6.66	6.89	7.41	VHLS
VHLS 2020-060	2	6	3	1.93	16°	6.29	6.49	6.71	6.95	7.47	VHLS

VHLS Milling Conditions

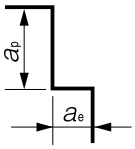
WORK MATERIAL			COPPER OFC / TPC				CARBON STEELS S45C / S50C (~225HB)				ALLOY STEELS SK / SCM / SUS (225~325HB)			
Model Number	Outside Diameter (mm)	Effective Length (mm)	Spindle Speed (min^{-1})	Feed Rate (mm/min)	a_p Axial Depth (mm)	a_e Radial Depth (mm)	Spindle Speed (min^{-1})	Feed Rate (mm/min)	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	0.1	0.3	50,000	170	0.018	0.035	50,000	170	0.005	0.035	50,000	160	0.005	0.035
2002-005	0.2	0.5	50,000	340	0.027	0.13	50,000	340	0.009	0.13	50,000	310	0.008	0.13
2002-010	0.2	1	50,000	290	0.018	0.035	50,000	290	0.007	0.035	50,000	260	0.006	0.035
2003-010	0.3	1	50,000	560	0.045	0.101	50,000	560	0.015	0.101	50,000	500	0.013	0.101
2003-015	0.3	1.5	50,000	460	0.041	0.05	50,000	460	0.013	0.05	50,000	410	0.011	0.05
2003-020	0.3	2	41,500	350	0.032	00.023	41,500	350	0.01	0.023	41,500	320	0.009	0.023
2004-015	0.4	1.5	50,000	660	0.054	0.095	50,000	660	0.016	0.095	50,000	640	0.015	0.095
2004-020	0.4	2	50,000	610	0.045	0.052	50,000	610	0.014	0.052	50,000	580	0.013	0.052
2004-030	0.4	3	44,500	510	0.027	0.018	44,500	510	0.009	0.018	43,600	450	0.008	0.018
2004-040	0.4	4	41,000	440	0.018	0.008	41,000	440	0.006	0.008	38,000	360	0.005	0.008
2005-015	0.5	1.5	50,000	1,020	0.09	0.139	50,000	1,020	0.029	0.139	50,000	870	0.027	0.139
2005-020	0.5	2	50,000	900	0.081	0.098	50,000	900	0.025	0.098	50,000	760	0.023	0.098
2005-025	0.5	2.5	50,000	780	0.072	0.057	50,000	780	0.021	0.057	47,000	650	0.019	0.057
2005-030	0.5	3	44,200	660	0.05	0.037	44,200	660	0.016	0.037	39,900	530	0.015	0.037
2005-040	0.5	4	40,600	580	0.041	0.016	40,600	580	0.013	0.016	36,100	460	0.012	0.016
2005-060	0.5	6	33,400	420	0.023	0.005	33,400	420	0.007	0.005	28,500	320	0.006	0.005
2006-020	0.6	2	50,000	1,240	0.117	0.18	50,000	1,240	0.038	0.18	50,000	930	0.034	0.18
2006-030	0.6	3	50,000	990	0.09	0.075	50,000	990	0.03	0.075	44,000	740	0.026	0.075
2006-040	0.6	4	41,300	740	0.063	0.03	41,300	740	0.021	0.03	34,700	550	0.018	0.03
2006-060	0.6	6	32,100	520	0.036	0.01	32,100	520	0.012	0.01	27,000	390	0.01	0.01
2008-030	0.8	3	41,200	1,050	0.171	0.15	41,200	1,050	0.053	0.15	34,500	790	0.049	0.15
2008-040	0.8	4	37,100	930	0.14	0.08	37,100	930	0.044	0.08	31,100	700	0.04	0.08
2008-060	0.8	6	28,800	680	0.077	0.024	28,800	680	0.025	0.024	24,200	510	0.022	0.024
2010-030	1	3	37,900	1,340	0.257	0.263	37,900	1,340	0.067	0.263	31,500	990	0.072	0.263
2010-040	1	4	34,100	1,170	0.212	0.195	34,100	1,170	0.067	0.195	28,400	870	0.06	0.195
2010-050	1	5	30,300	1,000	0.167	0.127	30,300	1,000	0.053	0.127	25,300	750	0.048	0.127
2010-060	1	6	26,500	850	0.122	0.058	26,500	850	0.039	0.058	22,100	630	0.035	0.058
2015-040	1.5	4	26,600	1,340	0.378	0.462	26,600	1,340	0.12	0.462	22,100	1,000	0.109	0.462
2015-060	1.5	6	22,800	1,120	0.297	0.293	22,800	1,120	0.094	0.293	19,000	840	0.085	0.293
2020-060	2	6	20,300	1,350	0.338	0.926	20,300	1,350	0.107	0.926	17,400	1,030	0.097	0.926

VHLS Milling Conditions

WORK MATERIAL			PREHARDENED STEELS / HARDENED STEELS NAK / SKD (30~45HRC)				HARDENED STEELS SKD / SKT (45~55HRC)				HARDENED STEELS SKD / SKH (55~60HRC)			
Model Number	Outside Diameter (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	0.1	0.3	50,000	140	0.004	0.035	50,000	90	0.002	0.035	30,000	10	0.002	0.08
2002-005	0.2	0.5	50,000	270	0.006	0.13	44,800	180	0.004	0.13	15,000	10	0.002	0.13
2002-010	0.2	1	50,000	230	0.004	0.035	40,800	160	0.002	0.035	15,000	10	0.002	0.035
2003-010	0.3	1	50,000	440	0.01	0.101	50,000	330	0.007	0.101	14,600	14	0.004	0.101
2003-015	0.3	1.5	50,000	360	0.009	0.05	42,700	260	0.006	0.05	14,600	13	0.004	0.05
2003-020	0.3	2	41,500	280	0.007	0.023	33,200	190	0.005	0.023	14,600	12	0.003	0.023
2004-015	0.4	1.5	48,100	470	0.012	0.095	38,500	320	0.008	0.095	14,300	17	0.004	0.095
2004-020	0.4	2	44,600	430	0.01	0.052	35,700	290	0.007	0.052	14,300	17	0.004	0.052
2004-030	0.4	3	37,500	340	0.006	0.018	30,000	230	0.005	0.018	14,300	16	0.003	0.018
2004-040	0.4	4	33,100	280	0.004	0.008	26,500	190	0.003	0.008	14,300	15	0.002	0.008
2005-015	0.5	1.5	46,500	610	0.02	0.139	37,300	410	0.015	0.139	14,000	20	0.008	0.139
2005-020	0.5	2	40,600	510	0.018	0.098	32,500	350	0.013	0.098	14,000	20	0.007	0.098
2005-025	0.5	2.5	34,700	410	0.016	0.057	27,700	290	0.011	0.057	14,000	20	0.006	0.057
2005-030	0.5	3	32,200	370	0.011	0.037	25,700	260	0.009	0.037	14,000	19	0.005	0.037
2005-040	0.5	4	29,700	330	0.009	0.016	23,700	230	0.007	0.016	14,000	18	0.004	0.016
2005-060	0.5	6	24,700	250	0.005	0.005	19,700	170	0.003	0.005	14,000	16	0.002	0.005
2006-020	0.6	2	39,100	600	0.026	0.18	31,300	410	0.019	0.18	12,000	23	0.01	0.18
2006-030	0.6	3	33,500	500	0.02	0.075	26,800	340	0.015	0.075	12,000	22	0.008	0.075
2006-040	0.6	4	27,900	390	0.014	0.03	22,300	270	0.01	0.03	12,000	21	0.005	0.03
2006-060	0.6	6	23,000	290	0.008	0.01	18,400	200	0.006	0.01	12,000	19	0.003	0.01
2008-030	0.8	3	26,200	530	0.038	0.15	21,000	370	0.027	0.15	8,000	21	0.016	0.15
2008-040	0.8	4	24,100	480	0.031	0.08	19,300	330	0.022	0.08	8,000	20	0.013	0.08
2008-060	0.8	6	19,800	370	0.017	0.024	15,800	250	0.012	0.024	8,000	18	0.007	0.024
2010-030	1	3	23,400	650	0.057	0.263	18,700	440	0.039	0.263	6,500	15	0.016	0.263
2010-040	1	4	21,500	580	0.047	0.195	17,200	400	0.033	0.195	6,500	15	0.015	0.195
2010-050	1	5	19,600	510	0.037	0.127	15,700	360	0.027	0.127	6,500	15	0.014	0.127
2010-060	1	6	17,600	440	0.027	0.058	14,100	310	0.02	0.058	6,500	14	0.012	0.058
2015-040	1.5	4	16,300	640	0.084	0.462	13,000	440	0.06	0.462	9,600	95	0.036	0.462
2015-060	1.5	6	14,400	550	0.066	0.293	11,500	380	0.047	0.293	9,600	60	0.028	0.293
2020-060	2	6	12,500	650	0.075	0.926	10,000	450	0.054	0.926	9,600	211	0.032	0.926

Note:
- Recommend using a non-contact measuring device to avoid damaging the precision tip point.
- Decrease both spindle speed and feed rate proportionally when the milling parameters exceed the machine's maximum spindle speed.
- Every coolant offers stable milling.
- Recommend oil coolant for Stainless Steels and Heat Resistant Alloys.
- Recommend wet coolant for Copper.

Side Milling

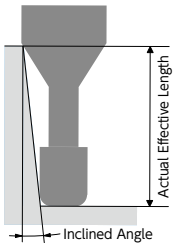


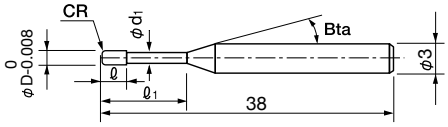
VHLRS

Value Series HARDMAX Longneck Radius

HARDMAX
2 Flutes Short Shank Long Neck Radius End Mills

Super MG | HARD MAX | 30° | R | R ±0.005 | Shank Dia 0/-0.003





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.

Material Applications (☆ Highly Recommended ◎ Recommended ○ Suggested)

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	○			◎			○	○		

Total 24 models

Unit(mm)

Model Number	Outside Diameter φ	Corner Radius CR	Effective Length ℓ1	Length of Cut ℓ	Neck Diameter φd1	Shank Taper Angle Bta	Effective Length by Inclined Angles 30′	1°	1°30′	2°	3°	Series
VHLRS 2002-005-010	0.2	0.05	1	0.2	0.18	16°	1.21	1.26	1.32	1.37	1.47	VHLRS
VHLRS 2003-005-010	0.3	0.05	1	0.3	0.28	16°	1.25	1.32	1.38	1.44	1.55	VHLRS
VHLRS 2004-005-020	0.4	0.05	2	0.4	0.38	16°	2.38	2.52	2.63	2.74	2.94	VHLRS
VHLRS 2004-01-020	0.4	0.1	2	0.4	0.38	16°	2.38	2.51	2.63	2.73	2.93	VHLRS
VHLRS 2005-005-020	0.5	0.05	2	0.5	0.49	16°	2.45	2.62	2.76	2.88	3.12	VHLRS
VHLRS 2005-01-020	0.5	0.1	2	0.5	0.49	16°	2.45	2.61	2.75	2.88	3.11	VHLRS
VHLRS 2006-005-020	0.6	0.05	2	0.6	0.59	16°	2.52	2.71	2.87	3.02	3.29	VHLRS
VHLRS 2006-005-030	0.6	0.05	3	0.6	0.59	16°	3.59	3.82	4.02	4.19	4.51	VHLRS
VHLRS 2006-005-040	0.6	0.05	4	0.6	0.59	16°	4.66	4.93	5.14	5.34	5.74	VHLRS
VHLRS 2006-01-020	0.6	0.1	2	0.6	0.59	16°	2.51	2.70	2.86	3.01	3.28	VHLRS
VHLRS 2006-01-030	0.6	0.1	3	0.6	0.59	16°	3.59	3.82	4.01	4.18	4.50	VHLRS
VHLRS 2006-01-040	0.6	0.1	4	0.6	0.59	16°	4.66	4.92	5.14	5.33	5.72	VHLRS
VHLRS 2008-005-040	0.8	0.05	4	0.8	0.79	16°	4.66	4.93	5.14	5.34	5.74	VHLRS
VHLRS 2008-01-040	0.8	0.1	4	0.8	0.79	16°	4.66	4.92	5.14	5.33	5.72	VHLRS
VHLRS 2008-02-040	0.8	0.2	4	0.8	0.79	16°	4.65	4.91	5.13	5.32	5.70	VHLRS
VHLRS 2010-01-020	1	0.1	2	1	0.96	16°	2.64	2.80	2.95	3.09	3.34	VHLRS
VHLRS 2010-01-040	1	0.1	4	1	0.96	16°	4.76	5.00	5.20	5.39	5.79	VHLRS
VHLRS 2010-01-060	1	0.1	6	1	0.96	16°	6.87	7.16	7.41	7.67	8.24	VHLRS
VHLRS 2010-02-020	1	0.2	2	1	0.96	16°	2.63	2.79	2.94	3.07	3.32	VHLRS
VHLRS 2010-02-040	1	0.2	4	1	0.96	16°	4.76	4.99	5.19	5.38	5.77	VHLRS
VHLRS 2010-02-060	1	0.2	6	1	0.96	16°	6.86	7.15	7.40	7.65	8.21	VHLRS
VHLRS 2015-02-060	1.5	0.2	6	1.5	1.46	16°	6.23	6.43	6.64	6.86	7.36	VHLRS
VHLRS 2020-01-060	2	0.1	6	2	1.93	16°	6.28	6.49	6.70	6.93	7.45	VHLRS
VHLRS 2020-02-060	2	0.2	6	2	1.93	16°	6.28	6.48	6.69	6.92	7.43	VHLRS

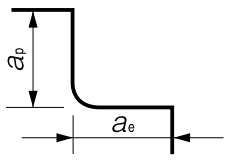
VHLRS Milling Conditions

WORK MATERIAL			COPPER OFC / TPC				CARBON STEELS S45C / S50C (~225HB)				ALLOY STEELS SK / SCM / SUS (225~325HB)			
Model Number	Outside Diameter (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)
2002-005-010	0.2	1	55,000	200	0.027	0.02	55,000	200	0.009	0.02	55,000	200	0.009	0.02
2003-005-010	0.3	1	60,000	500	0.03	0.02	60,000	500	0.011	0.02	60,000	500	0.011	0.02
2004-005-020	0.4	2	40,400	540	0.042	0.054	40,400	450	0.017	0.045	40,400	450	0.017	0.045
2004-01-020	0.4	2	40,400	540	0.042	0.054	40,400	450	0.017	0.045	40,400	450	0.017	0.045
2005-005-020	0.5	2	39,900	1,000	0.075	0.108	39,900	830	0.044	0.117	39,900	830	0.044	0.117
2005-01-020	0.5	2	39,900	1,000	0.075	0.108	39,900	830	0.044	0.117	39,900	830	0.044	0.117
2006-005-020	0.6	2	28,600	610	0.114	0.162	28,600	510	0.015	0.219	28,600	510	0.015	0.219
2006-005-030	0.6	3	23,800	480	0.09	0.135	23,800	400	0.012	0.108	23,800	400	0.012	0.108
2006-005-040	0.6	4	20,400	400	0.063	0.108	20,400	330	0.008	0.104	20,400	330	0.008	0.104
2006-01-020	0.6	2	28,600	610	0.114	0.162	28,600	510	0.015	0.219	28,600	510	0.015	0.219
2006-01-030	0.6	3	23,800	480	0.09	0.135	23,800	400	0.012	0.108	23,800	400	0.012	0.108
2006-01-040	0.6	4	20,400	400	0.063	0.108	20,400	330	0.008	0.104	20,400	330	0.008	0.104
2008-005-040	0.8	4	17,500	540	0.132	0.198	17,500	450	0.021	0.117	17,500	450	0.021	0.117
2008-01-040	0.8	4	17,500	540	0.132	0.198	17,500	450	0.021	0.117	17,500	450	0.021	0.117
2008-02-040	0.8	4	17,500	540	0.132	0.198	17,500	450	0.021	0.117	17,500	450	0.021	0.117
2010-01-020	1	2	17,600	1,100	0.21	0.45	17,600	920	0.053	0.27	17,600	920	0.053	0.27
2010-01-040	1	4	13,800	980	0.201	0.405	13,800	820	0.045	0.27	13,800	820	0.045	0.27
2010-01-060	1	6	11,300	790	0.117	0.387	11,300	650	0.032	0.216	11,300	650	0.032	0.216
2010-02-020	1	2	17,600	1,100	0.21	0.45	17,600	920	0.053	0.27	17,600	920	0.053	0.27
2010-02-040	1	4	13,800	980	0.201	0.405	13,800	820	0.045	0.27	13,800	820	0.045	0.27
2010-02-060	1	6	11,300	790	0.117	0.387	11,300	650	0.032	0.216	11,300	650	0.032	0.216
2015-02-060	1.5	6	10,600	1,240	0.282	0.63	10,600	1,030	0.062	0.405	10,600	1,030	0.062	0.405
2020-01-060	2	6	12,800	1,220	0.321	0.855	12,800	1,020	0.065	0.81	12,800	1,020	0.065	0.81
2020-02-060	2	6	12,800	1,220	0.321	0.855	12,800	1,020	0.065	0.81	12,800	1,020	0.065	0.81

VHLRS Milling Conditions

WORK MATERIAL			PREHARDENED STEELS / HARDENED STEELS NAK / SKD (30~45HRC)				HARDENED STEELS SKD / SKT (45~55HRC)				HARDENED STEELS SKD / SKH (55~65HRC)			
Model Number	Outside Diameter (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)
2002-005-010	0.2	1	55,000	200	0.006	0.02	35,000	150	0.004	0.02	15,000	25	0.002	0.015
2003-005-010	0.3	1	60,000	500	0.007	0.02	35,000	350	0.005	0.02	22,000	35	0.004	0.015
2004-005-020	0.4	2	40,400	450	0.011	0.045	32,300	330	0.009	0.045	19,200	35	0.004	0.045
2004-01-020	0.4	2	40,400	450	0.011	0.045	32,300	330	0.009	0.045	19,200	35	0.004	0.045
2005-005-020	0.5	2	39,900	830	0.029	0.117	32,500	630	0.026	0.117	20,100	68	0.011	0.117
2005-01-020	0.5	2	39,900	830	0.029	0.117	32,500	630	0.026	0.117	20,100	68	0.011	0.117
2006-005-020	0.6	2	28,600	510	0.01	0.219	23,700	390	0.01	0.219	15,200	43	0.004	0.219
2006-005-030	0.6	3	23,800	400	0.008	0.108	19,700	300	0.007	0.108	12,600	33	0.003	0.108
2006-005-040	0.6	4	20,400	330	0.005	0.104	16,800	250	0.005	0.104	10,800	28	0.002	0.104
2006-01-020	0.6	2	28,600	510	0.01	0.219	23,700	390	0.01	0.219	15,200	43	0.004	0.219
2006-01-030	0.6	3	23,800	400	0.008	0.108	19,700	300	0.007	0.108	12,600	33	0.003	0.108
2006-01-040	0.6	4	20,400	330	0.005	0.104	16,800	250	0.005	0.104	10,800	28	0.002	0.104
2008-005-040	0.8	4	17,500	450	0.014	0.117	15,000	360	0.015	0.117	10,200	41	0.007	0.117
2008-01-040	0.8	4	17,500	450	0.014	0.117	15,000	360	0.015	0.117	10,200	41	0.007	0.117
2008-02-040	0.8	4	17,500	450	0.014	0.117	15,000	360	0.015	0.117	10,200	41	0.007	0.117
2010-01-020	1	2	17,600	920	0.035	0.27	15,300	750	0.04	0.27	10,900	89	0.02	0.27
2010-01-040	1	4	13,800	820	0.03	0.27	12,000	670	0.035	0.27	8,500	80	0.017	0.27
2010-01-060	1	6	11,300	650	0.021	0.216	9,800	540	0.024	0.216	7,000	64	0.012	0.216
2010-02-020	1	2	17,600	920	0.035	0.27	15,300	750	0.04	0.27	10,900	89	0.02	0.27
2010-02-040	1	4	13,800	820	0.03	0.27	12,000	670	0.035	0.27	8,500	80	0.017	0.27
2010-02-060	1	6	11,300	650	0.021	0.216	9,800	540	0.024	0.216	7,000	64	0.012	0.216
2015-02-060	1.5	6	10,600	1,030	0.041	0.405	9,700	900	0.055	0.405	7,400	117	0.03	0.405
2020-01-060	2	6	12,800	1,020	0.043	0.81	12,000	930	0.06	0.81	9,700	133	0.036	0.81
2020-02-060	2	6	12,800	1,020	0.043	0.81	12,000	930	0.06	0.81	9,700	133	0.036	0.81

Note:
- Decrease both spindle speed and feed rate proportionally when the milling parameters exceed the machine's maximum spindle speed.
- Every coolant offers stable milling.
- Recommend oil coolant for Stainless Steels and Heat Resistant Alloys.
- Recommend wet coolant for Copper.



Advisory for Safe Use of UNIMAX Tungsten Carbide 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.
- Do not use flammable cutting oils.

Advisory for regrinding UNIMAX Tungsten Carbide 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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