MOLDINO
The Edge To Innovation

3 flutes Ball End Mill for High efficient deep cutting

EMBE-ATH/EMBPE-ATH

Epoch Mega Feed Ball Evolution

MOLDINO Tool Engineering, Ltd.

New Product News | No.1406E-12 | 2026-2

Employs a strongly helical ball edge geometry to achieve reduced cutting force and improved chip removal!

Features of EMB(P)E-ATH

01 Newly developed high helix variable pitch ball edge geometry

Newly developed ball edge shape greatly improves cutting performance. Cutting force is reduced, vibrations are suppressed, and chip removal is improved so tool damage is reduced even when performing deep cutting.Provides good cutting capabilities even on high-performance materials (high-toughness materials) that have poor machinability!

02 Improved heat resistance and wear resistance (ATH Coating)

Employs ATH Coating to provide even more improved heat resistance and wear resistance compared to conventional products. Achieves long tool life even in high-efficiency conditions.

03 Broad lineup (Total of 117 items)

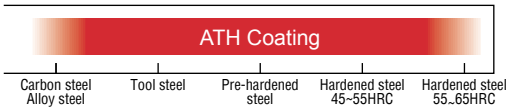
Abundant lineup to respond to customers needs for deep cutting molds.

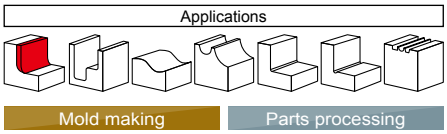
04 Capable of high-accuracy machining (Improved RE accuracy)

RE accuracy is improved compared to conventional 3-flute products. (RE accuracy is ±0.005mm for small diameters of below ϕ4mm.)

05 Capable of high-efficient side milling cutting (high helix peripheral cutting edge)

Smooth connection at joint between ball edge and high helix peripheral cutting edge.Enables high-efficiency side-surface cutting using the outer peripheral cutting edge, making it compatible with new machining methods.





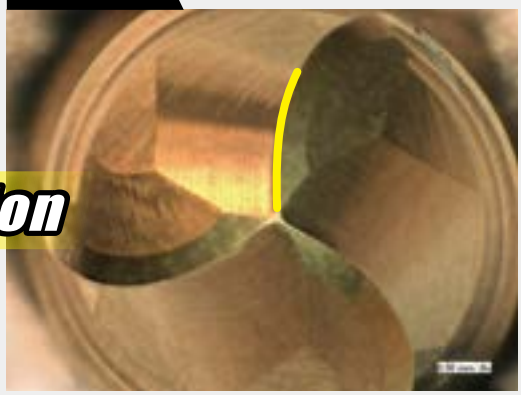
EMBE-ATH
RE0.5～RE10 [21 Items]

EMBPE-ATH
RE0.5～RE6 [96 Items]

Features　High helix edge shape and special pocket shape tip

EMBE-ATH

Conventional

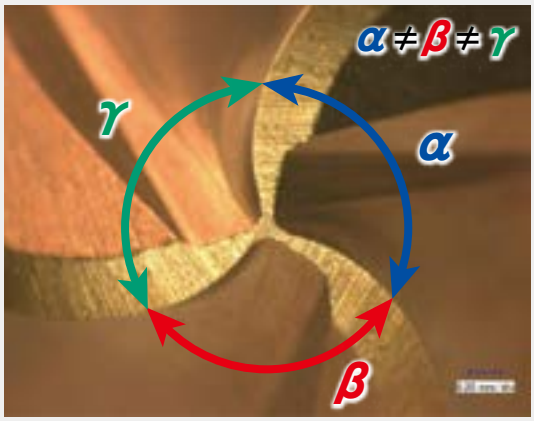


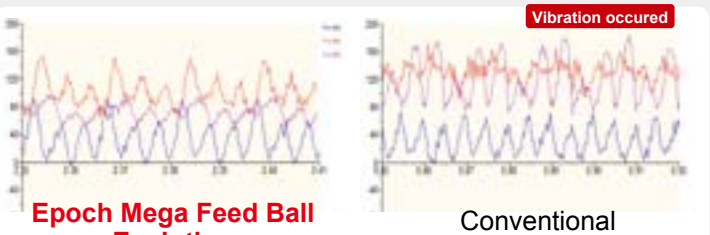
Evolution

High helix edge shape ▶ Reduce cutting force, improve chip removal flow

Optimize chip pocket of cutting edge ▶ Improve chip removal perfoemance

Features　Vibration suppression by variable pitch of end cutting effect





Epoch Mega Feed Ball Evolution

Conventional

<Cutting conditions>

Work material：DAC-MAGIC（45HRC）　Tool dia.：φ6×3flutes
n=4,000min^{-1}（v_c=75m/min）　v_f=1,150㎜/min（f_z=0.096㎜/t）
a_p=0.3㎜　a_e=1㎜　Water base coolant　OH=30mm
Makino V33(HSK-F63)　Bottom slotting

By variable pitch geometry

- **Can reduce chattering vibration when deep cutting or corner part processing.**

Especially effective by speed processing, and can realize highly efficient processing.

Features　Improved heat-resistant coating　ATHcoating

Features and characteristics

- Hardness and oxidation resistance of TH Coating is further improved.
  Enables longer life and higher efficient when cutting high-hardness materials.
  (Si nano composite coating with finer crystal particles)
- Exhibits amazing performance when cutting high-hardness materials (55HRC or higher)
  Cold-worked die steel, HSS, tool steel.
- Long life for both dry cutting and wet cutting

Back Draft Shape

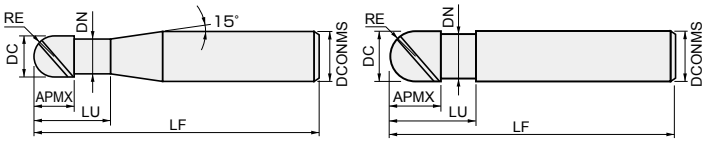
By employing the backdraft shape that has provided good results for Epoch Deep series, chattering vibrations are suppressed even when machining deep areas, so that a good machined surface can be achieved.

Note: Adopted as the pencil neck type of less than 4 millimeters of tool diameter.

Line Up

Straight Type

3Flutes



A type　　B type

(mm)

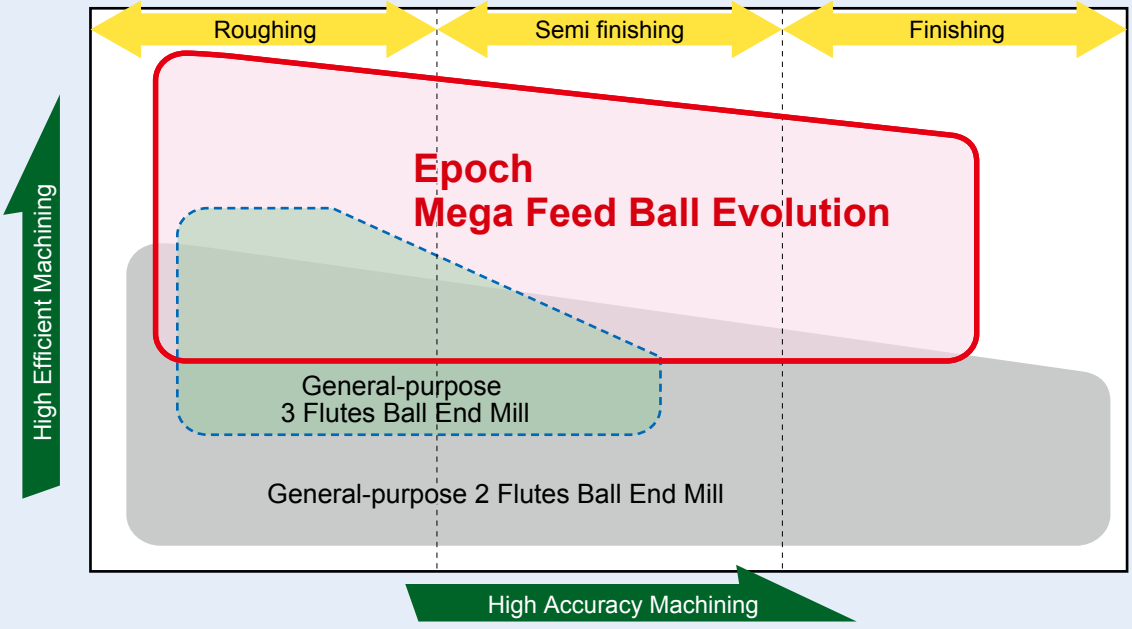
Ball radius RE	Tolerance on RE	Tolerance on dia.
0.5~1.75	±0.005	0~−0.010
2~3	±0.007	0~−0.014
4~6	±0.010	0~−0.020
8~10	±0.015	0~−0.030

EMBE3○○○ (-S○)-ATH

Carbide　ATH　Helix angle 40°　Unequal Pitch　h5

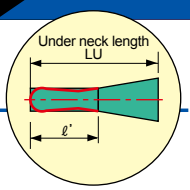
Item code	Stock	Size(mm)							Shape
		Ball radius	Tool dia.	Flute length	Under neck length	Neck dia.	Overall length	Shank dia.	
		RE	DC	APMX	LU	DN	LF	DCONMS	
EMBE3010-S4-ATH	●	0.5	1	1.5	3	0.95	50	4	A
EMBE3010-S6-ATH	●			1.5	3	0.95	50	6	A
EMBE3015-S4-ATH	●	0.75	1.5	2.5	4.5	1.43	50	4	A
EMBE3015-S6-ATH	●			2.5	4.5	1.43	50	6	A
EMBE3020-S4-ATH	●	1	2	3	6	1.9	50	4	A
EMBE3020-S6-ATH	●			3	6	1.9	50	6	A
EMBE3025-S4-ATH	●	1.25	2.5	4	7.5	2.38	50	4	A
EMBE3025-S6-ATH	●			4	7.5	2.38	50	6	A
EMBE3030-S4-ATH	●	1.5	3	4.5	9	2.9	70	4	A
EMBE3030-S6-ATH	●			4.5	9	2.9	70	6	A
EMBE3035-S4-ATH	●	1.75	3.5	5.5	10.5	3.4	70	4	A
EMBE3035-S6-ATH	●			5.5	10.5	3.4	70	6	A
EMBE3040-S4-ATH	●	2	4	6	12	3.9	70	4	B
EMBE3040-S6-ATH	●			6	12	3.9	70	6	A
EMBE3050-ATH	●	2.5	5	7.5	15	4.7	80	6	A
EMBE3060-ATH	●	3	6	9	18	5.7	90	6	B
EMBE3080-ATH	●	4	8	12	24	7.6	100	8	B
EMBE3100-ATH	●	5	10	15	30	9.5	100	10	B
EMBE3120-ATH	●	6	12	18	36	11.5	110	12	B
EMBE3160-ATH	●	8	16	24	48	15	140	16	B
EMBE3200-ATH	●	10	20	30	60	19	160	20	B

Performance and positioning



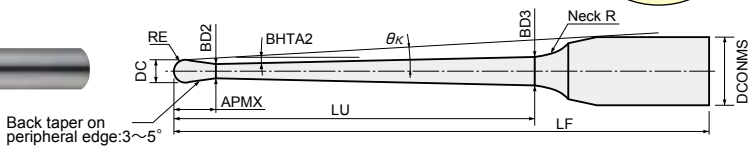
● : Stocked items.

Pencil Neck Type



3Flutes

【Note】※:RE 2mm or higher does not have backdraft shape.



(mm)

Ball radius RE	Tolerance on RE
0.5~1.75	±0.005
2~3	±0.007
4~6	±0.010

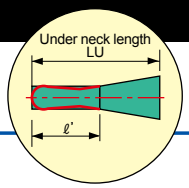
EMBPE3○○○-○○○-○○-ATH

Carbide | ATH | Helix angle 40° | Unequal Pitch | h5

Item code	Stock	Size(mm)												The effective under-neck length for the various draft angles.				
		Ball radius	Tool dia.	Neck angle	Under neck length	Flute length	Neck dia.	Under neck dia.	Overall length	Shank dia.	Neck shape	Approx neck length	Interference angle					
		RE	DC	BHTA2	LU	APMX	BD2	BD3	LF	DCONMS		ℓ'	θK	0.75°	1°	1.5°	2°	3°
EMBPE3010-6-09-ATH	●	0.5	1	0.9	6	0.8	0.94	1.103	50	6	A	2.70	8.36	6.45	6.66	6.96	7.19	7.56
EMBPE3010-8-09-ATH	●			0.9	8	0.8	0.94	1.166	55	6	A	2.70	7.55	8.4	8.68	9.05	9.32	9.93
EMBPE3010-10-09-ATH	●			0.9	10	0.8	0.94	1.229	55	6	A	2.70	6.88	10.33	10.71	11.13	11.43	12.39
EMBPE3010-12-09-ATH	●			0.9	12	0.8	0.94	1.291	60	6	A	2.70	6.32	12.25	12.73	13.2	13.54	14.85
EMBPE3010-14-09-ATH	●			0.9	14	0.8	0.94	1.354	60	6	A	2.70	5.85	13.77	14.75	15.27	15.65	17.31
EMBPE3010-16-09-ATH	●			0.9	16	0.8	0.94	1.417	60	6	A	2.70	5.44	13.77	16.77	17.34	17.87	19.77
EMBPE3010-18-09-ATH	●			0.9	18	0.8	0.94	1.480	65	6	A	2.70	5.08	13.77	18.79	19.4	20.08	22.23
EMBPE3010-20-09-ATH	●			0.9	20	0.8	0.94	1.543	65	6	A	2.70	4.77	13.77	20.81	21.46	22.3	24.68
EMBPE3010-22-09-ATH	●			0.9	22	0.8	0.94	1.606	70	6	A	2.70	4.5	13.77	22.82	23.51	24.52	27.14
EMBPE3010-24-09-ATH	●			0.9	24	0.8	0.94	1.668	70	6	A	2.70	4.25	13.77	24.84	25.57	26.73	29.6
EMBPE3010-26-09-ATH	●			0.9	26	0.8	0.94	1.731	70	6	A	2.70	4.03	13.77	26.86	27.62	28.95	32.06
EMBPE3010-28-09-ATH	●			0.9	28	0.8	0.94	1.794	75	6	A	2.70	3.83	13.77	28.88	29.73	31.17	34.52
EMBPE3010-30-09-ATH	●			0.9	30	0.8	0.94	1.857	75	6	A	2.70	3.65	13.77	30.89	31.84	33.38	36.98
EMBPE3010-32-09-ATH	●			0.9	32	0.8	0.94	1.920	80	6	A	2.70	3.49	13.77	32.91	33.95	35.6	39.43
EMBPE3010-34-09-ATH	●			0.9	34	0.8	0.94	1.983	80	6	A	2.70	3.34	13.77	34.92	36.07	37.82	41.89
EMBPE3010-36-09-ATH	●			0.9	36	0.8	0.94	2.045	80	6	A	2.70	3.2	13.77	36.94	38.18	40.03	44.35
EMBPE3015-8-09-ATH	●	0.75	1.5	0.9	8	1.35	1.42	1.628	55	6	A	3.89	7.32	8.54	8.77	9.1	9.35	9.97
EMBPE3015-10-09-ATH	●			0.9	10	1.35	1.42	1.691	55	6	A	3.89	6.63	10.5	10.79	11.17	11.46	12.43
EMBPE3015-14-09-ATH	●			0.9	14	1.35	1.42	1.817	60	6	A	3.89	5.57	14.39	14.83	15.31	15.71	17.35
EMBPE3015-16-09-ATH	●			0.9	16	1.35	1.42	1.880	60	6	A	3.89	5.16	16.33	16.84	17.37	17.93	19.8
EMBPE3015-18-09-ATH	●			0.9	18	1.35	1.42	1.943	65	6	A	3.89	4.81	18.24	18.86	19.43	20.14	22.26
EMBPE3015-20-09-ATH	●			0.9	20	1.35	1.42	2.005	65	6	A	3.89	4.5	19.64	20.88	21.49	22.36	24.72
EMBPE3015-22-09-ATH	●			0.9	22	1.35	1.42	2.068	70	6	A	3.89	4.22	19.64	22.89	23.55	24.57	27.18
EMBPE3015-24-09-ATH	●			0.9	24	1.35	1.42	2.131	70	6	A	3.89	3.98	19.64	24.91	25.6	26.79	29.64
EMBPE3015-26-09-ATH	●			0.9	26	1.35	1.42	2.194	70	6	A	3.89	3.77	19.64	26.93	27.68	29.01	32.1
EMBPE3015-28-09-ATH	●			0.9	28	1.35	1.42	2.257	75	6	A	3.89	3.58	19.64	28.94	29.79	31.22	34.55
EMBPE3015-30-09-ATH	●			0.9	30	1.35	1.42	2.320	75	6	A	3.89	3.4	19.64	30.96	31.91	33.44	37.01
EMBPE3015-32-09-ATH	●			0.9	32	1.35	1.42	2.382	80	6	A	3.89	3.24	19.64	32.97	34.02	35.66	39.47
EMBPE3015-34-09-ATH	●			0.9	34	1.35	1.42	2.445	80	6	A	3.89	3.1	19.64	34.99	36.13	37.87	41.93
EMBPE3015-36-09-ATH	●			0.9	36	1.35	1.42	2.508	80	6	A	3.89	2.97	19.64	37	38.24	40.09	No interference
EMBPE3015-38-09-ATH	●			0.9	38	1.35	1.42	2.571	85	6	A	3.89	2.85	19.64	39.02	40.36	42.3	No interference
EMBPE3015-40-09-ATH	●			0.9	40	1.35	1.42	2.634	85	6	A	3.89	2.74	19.64	41.03	42.47	44.52	No interference
EMBPE3020-10-09-ATH	●	1	2	0.9	10	1.7	1.92	2.180	55	6	A	4.24	6.35	10.52	10.8	11.17	11.45	12.38
EMBPE3020-16-09-ATH	●			0.9	16	1.7	1.92	2.369	60	6	A	4.24	4.86	16.36	16.85	17.37	17.91	19.76
EMBPE3020-20-09-ATH	●			0.9	20	1.7	1.92	2.494	65	6	A	4.24	4.2	20.16	20.88	21.49	22.34	24.68
EMBPE3020-24-09-ATH	●			0.9	24	1.7	1.92	2.620	65	6	A	4.24	3.7	20.5	24.92	25.6	26.77	29.59
EMBPE3020-30-09-ATH	●			0.9	30	1.7	1.92	2.809	70	6	A	4.24	3.14	20.5	30.96	31.9	33.42	36.97
EMBPE3020-36-09-ATH	●			0.9	36	1.7	1.92	2.997	80	6	A	4.24	2.73	20.5	37.01	38.24	40.07	No interference
EMBPE3020-40-09-ATH	●			0.9	40	1.7	1.92	3.123	80	6	A	4.24	2.51	20.5	41.03	42.46	44.5	No interference
EMBPE3020-46-09-ATH	●			0.9	46	1.7	1.92	3.311	90	6	A	4.24	2.24	20.5	47.08	48.8	51.15	No interference
EMBPE3020-60-09-ATH	●			0.9	60	1.7	1.92	3.751	100	6	A	4.24	1.79	20.5	61.16	63.59	No interference	No interference
EMBPE3025-16-09-ATH	●	1.25	2.5	0.9	16	2	2.4	2.839	60	6	A	5.18	4.52	16.48	16.9	17.4	17.94	19.77
EMBPE3025-24-09-ATH	●			0.9	24	2	2.4	3.091	65	6	A	5.18	3.39	24.19	24.96	25.62	26.81	29.6
EMBPE3025-30-09-ATH	●			0.9	30	2	2.4	3.279	70	6	A	5.18	2.86	24.88	31.01	31.94	33.46	No interference
EMBPE3025-40-09-ATH	●			0.9	40	2	2.4	3.593	80	6	A	5.18	2.26	24.88	41.07	42.51	44.54	No interference
EMBPE3025-50-09-ATH	●			0.9	50	2	2.4	3.908	90	6	A	5.18	1.87	24.88	51.14	53.07	No interference	No interference
EMBPE3030-16-09-ATH	●	1.5	3	0.9	16	2.5	2.86	3.284	55	6	A	6.95	4.11	16.67	17	17.46	18.05	19.87
EMBPE3030-20-09-ATH	●			0.9	20	2.5	2.86	3.409	60	6	A	6.95	3.5	20.59	21.03	21.57	22.48	24.78
EMBPE3030-24-09-ATH	●			0.9	24	2.5	2.86	3.535	65	6	A	6.95	3.04	24.51	25.06	25.72	26.92	29.7
EMBPE3030-30-09-ATH	●			0.9	30	2.5	2.86	3.724	70	6	A	6.95	2.54	30.35	31.1	32.06	33.56	No interference
EMBPE3030-40-09-ATH	●			0.9	40	2.5	2.86	4.038	80	6	A	6.95	2	34.28	41.16	42.62	No interference	No interference
EMBPE3030-50-09-ATH	●			0.9	50	2.5	2.86	4.352	90	6	A	6.95	1.65	34.28	51.22	53.18	No interference	No interference
EMBPE3030-60-09-ATH	●			0.9	60	2.5	2.86	4.666	100	6	A	6.95	1.4	34.28	61.28	No interference	No interference	No interference

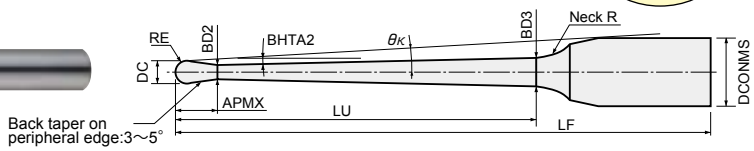
Line Up

Pencil Neck Type



3Flutes

【Note】※:RE 2mm or higher does not have backdraft shape.



(mm)

Ball radius RE	Tolerance on RE
0.5~1.75	±0.005
2~3	±0.007
4~6	±0.010

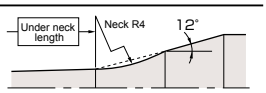
EMBPE3○○○-○○○-○○-ATH

Carbide | ATH | Helix angle 40° | Unequal Pitch | h5

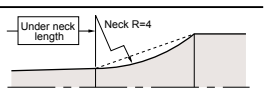
Item code	Stock	Size(mm)												The effective under-neck length for the various draft angles.				
		Ball radius	Tool dia.	Neck angle	Under neck length	Flute length	Neck dia.	Under neck dia.	Overall length	Shank dia.	Neck shape	Approx neck length	Interference angle					
		RE	DC	BHTA2	LU	APMX	BD2	BD3	LF	DCONMS		ℓ'	θK	0.75°	1°	1.5°	2°	3°
EMBPE3035-20-09-ATH	●	1.75	3.5	0.9	20	2.75	3.36	3.901	60	6	A	7.20	3.09	20.6	21.03	21.56	22.46	24.73
EMBPE3035-30-09-ATH	●			0.9	30	2.75	3.36	4.216	70	6	A	7.20	2.21	30.36	31.1	32.05	33.54	No interference
EMBPE3035-40-09-ATH	●			0.9	40	2.75	3.36	4.530	80	6	A	7.20	1.72	34.53	41.16	42.61	No interference	No interference
EMBPE3035-50-09-ATH	●			0.9	50	2.75	3.36	4.844	90	6	A	7.20	1.41	34.53	51.22	No interference	No interference	No interference
EMBPE3035-60-09-ATH	●			0.9	60	2.75	3.36	5.158	100	6	B	7.20	1.19	34.53	61.27	No interference	No interference	No interference
EMBPE3040-20-09-ATH	●	2	4	0.9	20	6	3.9	4.339	70	6	A	–	2.62	20.77	21.13	21.62	22.58	No interference
EMBPE3040-30-09-ATH	●			0.9	30	6	3.9	4.654	80	6	A	–	1.84	30.61	31.19	32.18	No interference	No interference
EMBPE3040-40-09-ATH	●			0.9	40	6	3.9	4.968	90	6	B	–	1.42	40.38	41.25	No interference	No interference	No interference
EMBPE3040-50-09-ATH	●			0.9	50	6	3.9	5.282	100	6	B	–	1.16	45.15	51.3	No interference	No interference	No interference
EMBPE3040-60-09-ATH	●			0.9	60	6	3.9	5.596	110	6	B	–	0.97	45.15	No interference	No interference	No interference	No interference
EMBPE3040-70-09-ATH	●			0.9	70	6	3.9	5.910	120	8	A	–	1.58	45.15	71.4	74.43	No interference	No interference
EMBPE3040-80-09-ATH	●			0.9	80	6	3.9	6.224	130	8	A	–	1.4	45.15	81.45	No interference	No interference	No interference
EMBPE3050-30-09-ATH	●	2.5	5	0.9	30	7.5	4.9	5.606	80	8	A	–	2.6	30.72	31.24	32.24	33.7	No interference
EMBPE3050-40-09-ATH	●			0.9	40	7.5	4.9	5.921	90	8	A	–	2.03	40.54	41.29	42.8	44.78	No interference
EMBPE3050-50-09-ATH	●			0.9	50	7.5	4.9	6.235	100	8	A	–	1.67	50.24	51.35	53.36	No interference	No interference
EMBPE3050-60-09-ATH	●			0.9	60	7.5	4.9	6.549	110	8	A	–	1.42	51.67	61.4	No interference	No interference	No interference
EMBPE3050-70-09-ATH	●			0.9	70	7.5	4.9	6.863	120	8	A	–	1.23	51.67	71.45	No interference	No interference	No interference
EMBPE3050-80-09-ATH	●			0.9	80	7.5	4.9	7.177	130	8	B	–	1.09	51.67	81.49	No interference	No interference	No interference
EMBPE3060-30-09-ATH	●	3	6	0.9	30	9	5.9	6.559	80	8	A	–	1.89	30.81	31.29	32.29	No interference	No interference
EMBPE3060-40-09-ATH	●			0.9	40	9	5.9	6.873	90	8	B	–	1.45	40.66	41.34	No interference	No interference	No interference
EMBPE3060-50-09-ATH	●			0.9	50	9	5.9	7.188	100	8	B	–	1.18	50.46	51.39	No interference	No interference	No interference
EMBPE3060-60-09-ATH	●			0.9	60	9	5.9	7.502	110	8	B	–	0.99	58.18	No interference	No interference	No interference	No interference
EMBPE3060-70-09-ATH	●			0.9	70	9	5.9	7.816	120	10	A	–	1.59	58.18	71.48	74.54	No interference	No interference
EMBPE3060-80-09-ATH	●			0.9	80	9	5.9	8.130	130	10	A	–	1.41	58.18	81.53	No interference	No interference	No interference
EMBPE3060-100-09-ATH	●			0.9	100	9	5.9	8.759	150	10	A	–	1.15	58.18	101.61	No interference	No interference	No interference
EMBPE3060-120-09-ATH	●			0.9	120	9	5.9	9.387	200	10	B	–	0.97	58.18	No interference	No interference	No interference	No interference
EMBPE3080-40-09-ATH	●	4	8	0.9	40	12	7.9	8.779	100	10	A	–	1.48	40.85	41.42	No interference	No interference	No interference
EMBPE3080-50-09-ATH	●			0.9	50	12	7.9	9.093	110	10	B	–	1.2	50.71	51.47	No interference	No interference	No interference
EMBPE3080-60-09-ATH	●			0.9	60	12	7.9	9.408	120	10	B	–	1	60.53	No interference	No interference	No interference	No interference
EMBPE3080-70-09-ATH	●			0.9	70	12	7.9	9.722	130	10	B	–	0.86	70.22	No interference	No interference	No interference	No interference
EMBPE3080-80-09-ATH	●			0.9	80	12	7.9	10.036	140	12	A	–	1.43	71.21	81.6	No interference	No interference	No interference
EMBPE3080-100-09-ATH	●			0.9	100	12	7.9	10.664	160	12	A	–	1.16	71.21	101.76	No interference	No interference	No interference
EMBPE3080-120-09-ATH	●			0.9	120	12	7.9	11.293	200	12	B	–	0.98	71.21	No interference	No interference	No interference	No interference
EMBPE3100-50-09-ATH	●	5	10	0.9	50	15	9.9	10.999	120	12	B	–	1.21	50.89	51.55	No interference	No interference	No interference
EMBPE3100-60-09-ATH	●			0.9	60	15	9.9	11.313	130	12	B	–	1.02	60.76	61.59	No interference	No interference	No interference
EMBPE3100-75-09-ATH	●			0.9	75	15	9.9	11.785	140	12	B	–	0.81	75.49	No interference	No interference	No interference	No interference
EMBPE3100-81-09-ATH	●			0.9	81	15	9.9	12.000	150	12	C	–	0.76	81.04	No interference	No interference	No interference	No interference
EMBPE3100-100-09-ATH	●			0.9	100	15	9.9	12.570	170	16	D	–	1.73	84.25	101.07	103.56	No interference	No interference
EMBPE3100-120-09-ATH	●			0.9	120	15	9.9	13.198	200	16	D	–	1.45	84.25	121.17	No interference	No interference	No interference
EMBPE3120-60-09-ATH	●	6	12	0.9	60	18	11.9	13.219	140	16	D	–	1.99	60.27	60.96	62.38	No interference	No interference
EMBPE3120-80-09-ATH	●			0.9	80	18	11.9	13.847	160	16	D	–	1.49	80.12	81.06	No interference	No interference	No interference
EMBPE3120-100-09-ATH	●			0.9	100	18	11.9	14.476	180	16	D	–	1.2	97.28	101.16	No interference	No interference	No interference
EMBPE3120-120-09-ATH	●			0.9	120	18	11.9	15.104	200	16	D	–	1	97.28	No interference	No interference	No interference	No interference

■ Detail of neck shape

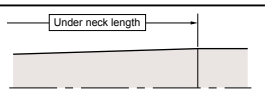
Neck shape A
Compound neck shape



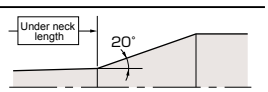
Neck shape B
Without taper

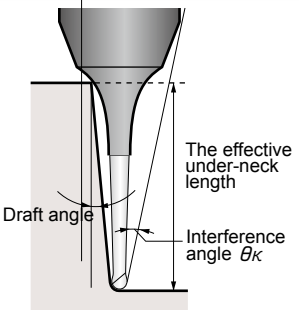


Neck shape C



Neck shape D
Taper 20°





● : Stocked items.

Re-grinding, Recommended Cutting Conditions

Re-grinding compatibility range table

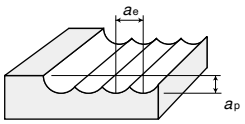
Item code	Product name	Line up tool dia. (mm)	Shape	Re-grinding compatibility range(mm)	
				Outer dia.	End
EMBE-ATH	Epoch Mega Feed Ball Evolution -Straight type	1～20		6～20	4～20
EMBPE-ATH	Epoch Mega Feed Ball Evolution -Pencil type	1～12		N/A	4～12

For regrinding of this tool, please ask our company. We will reproduce the special tip section shape.

【Note】EMBPE-ATH has a special flute shape.
Because of this, regrinding is not possible for tools with a under neck length of more than 10DC

Recommended cutting conditions

EMBE-ATH Straight type



〈Roughing〉

Work material		Carbon steels, Alloy steels (180～250HB) S50C, S55C				Tool steels (25～40HRC) HPM7, SCM440, SKD61, SKT4				Pre-hardened steels, Hardened steels (40～50HRC)							
										Free-cutting materials SKD61, CENA1, HPM-MAGIC, NAK80				High-toughness materials DAC-MAGIC, DAC55, DH31			
Ball radius RE (mm)	Tool dia. DC (mm)	Revolution n min^{-1}	Feed rate v_f mm/min	a_p mm	a_e mm	Revolution n min^{-1}	Feed rate v_f mm/min	a_p mm	a_e mm	Revolution n min^{-1}	Feed rate v_f mm/min	a_p mm	a_e mm	Revolution n min^{-1}	Feed rate v_f mm/min	a_p mm	a_e mm
0.5	**1**	50,000	2,360	0.100	0.300	50,000	2,360	0.100	0.300	50,000	2,230	0.100	0.300	28,700	1,160	0.060	0.180
0.75	**1.5**	46,700	3,530	0.150	0.450	42,500	3,210	0.150	0.450	38,200	2,720	0.150	0.450	19,100	1,240	0.090	0.270
1	**2**	35,000	3,750	0.200	0.600	31,800	3,410	0.200	0.600	28,700	2,900	0.200	0.600	14,300	1,310	0.120	0.360
1.25	**2.5**	28,000	3,810	0.250	0.750	25,500	3,470	0.250	0.750	22,900	2,940	0.250	0.750	11,500	1,340	0.150	0.450
1.5	**3**	23,400	3,890	0.300	0.900	21,200	3,530	0.300	0.900	19,100	3,000	0.300	0.900	9,600	1,370	0.180	0.540
1.75	**3.5**	20,000	4,010	0.350	1.050	18,200	3,650	0.350	1.050	16,400	3,100	0.350	1.050	8,200	1,410	0.210	0.630
2	**4**	17,500	4,100	0.400	1.200	15,900	3,730	0.400	1.200	14,300	3,160	0.400	1.200	7,200	1,450	0.240	0.720
2.5	**5**	14,000	4,280	0.500	1.500	12,700	3,880	0.500	1.500	11,500	3,310	0.500	1.500	5,700	1,490	0.300	0.900
3	**6**	11,700	4,420	0.600	1.800	10,600	4,010	0.600	1.800	9,600	3,420	0.600	1.800	4,800	1,560	0.360	1.080
4	**8**	8,800	4,660	0.800	2.400	8,000	4,230	0.800	2.400	7,200	3,590	0.800	2.400	3,600	1,630	0.480	1.440
5	**10**	7,000	4,850	1.000	3.000	6,400	4,440	1.000	3.000	5,700	3,720	1.000	3.000	2,900	1,720	0.600	1.800
6	**12**	5,800	4,600	1.200	3.600	5,300	4,210	1.200	3.600	4,800	3,590	1.200	3.600	2,400	1,630	0.720	2.160
8	**16**	4,400	4,440	1.600	4.800	4,000	4,030	1.600	4.800	3,600	3,420	1.600	4.800	1,800	1,560	0.960	2.880
10	**20**	3,500	3,880	2.000	6.000	3,200	3,550	2.000	6.000	2,900	3,030	2.000	6.000	1,400	1,330	1.200	3.600

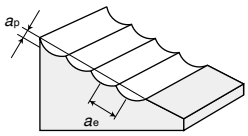
Work material		Hardened steels (50～55HRC) HPM38, SKD61				Hardened steels (55～65HRC) SKD11, YXR3, YXR33			
Ball radius RE (mm)	Tool dia. DC (mm)	Revolution n min^{-1}	Feed rate v_f mm/min	a_p mm	a_e mm	Revolution n min^{-1}	Feed rate v_f mm/min	a_p mm	a_e mm
0.5	**1**	50,000	1,870	0.070	0.210	44,600	1,250	0.050	0.150
0.75	**1.5**	34,000	2,030	0.105	0.315	29,700	1,340	0.075	0.225
1	**2**	25,500	2,160	0.140	0.420	22,300	1,420	0.100	0.300
1.25	**2.5**	20,400	2,200	0.175	0.525	17,800	1,440	0.125	0.375
1.5	**3**	17,000	2,240	0.210	0.630	14,900	1,480	0.150	0.450
1.75	**3.5**	14,600	2,320	0.245	0.735	12,700	1,520	0.175	0.525
2	**4**	12,700	2,350	0.280	0.840	11,100	1,550	0.200	0.600
2.5	**5**	10,200	2,460	0.350	1.050	8,900	1,620	0.250	0.750
3	**6**	8,500	2,540	0.420	1.260	7,400	1,670	0.300	0.900
4	**8**	6,400	2,680	0.560	1.680	5,600	1,760	0.400	1.200
5	**10**	5,100	2,790	0.700	2.100	4,500	1,860	0.500	1.500
6	**12**	4,200	2,640	0.840	2.520	3,700	1,750	0.600	1.800
8	**16**	3,200	2,550	1.120	3.360	2,800	1,680	0.800	2.400
10	**20**	2,500	2,190	1.400	4.200	2,200	1,450	1.000	3.000

【Note】

① Use the appropriate coolant for the work material and machining shape.
② Use as highly rigid and accurate machine as possible.
③ These conditions are for general guidance; in actual machining conditions adjust the parameters according to your actual machine and work-piece conditions.
④ If the rpm available is lower than that recommended please reduce the feed rate to the same ratio.

Recommended Cutting Conditions

EMBE-ATH Straight type

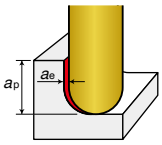


〈Finishing〉

Work material		Carbon steels, Alloy steels (180～250HB) S50C, S55C				Tool steels (25～40HRC) HPM7, SCM440, SKD61, SKT4				Pre-hardened steels, Hardened steels (40～50HRC) SKD61, CENA1, HPM-MAGIC, NAK80 DAC-MAGIC, DAC55, DH31			
Ball radius RE (mm)	Tool dia. DC (mm)	Revolution n min^{-1}	Feed rate v_f mm/min	a_p mm	a_e mm	Revolution n min^{-1}	Feed rate v_f mm/min	a_p mm	a_e mm	Revolution n min^{-1}	Feed rate v_f mm/min	a_p mm	a_e mm
0.5	1	50,000	1,640	0.02～0.05	0.02	50,000	1,640	0.02～0.05	0.02	50,000	1,550	0.02～0.05	0.02
0.75	1.5	50,000	2,630	0.02～0.07	0.03	50,000	2,630	0.02～0.07	0.03	50,000	2,480	0.02～0.07	0.03
1	2	47,800	3,560	0.02～0.10	0.04	44,600	3,320	0.02～0.10	0.04	41,400	2,910	0.02～0.10	0.04
1.25	2.5	38,200	3,680	0.05～0.12	0.05	35,700	3,440	0.05～0.12	0.05	33,100	3,010	0.05～0.12	0.05
1.5	3	31,800	3,840	0.05～0.15	0.06	29,700	3,590	0.05～0.15	0.06	27,600	3,150	0.05～0.15	0.06
1.75	3.5	27,300	3,890	0.05～0.15	0.07	25,500	3,640	0.05～0.15	0.07	23,700	3,190	0.05～0.15	0.07
2	4	23,900	3,940	0.05～0.20	0.08	22,300	3,670	0.05～0.20	0.08	20,700	3,220	0.05～0.20	0.08
2.5	5	19,100	4,060	0.05～0.25	0.1	17,800	3,780	0.05～0.25	0.1	16,600	3,330	0.05～0.25	0.1
3	6	15,900	4,180	0.05～0.3	0.12	14,900	3,920	0.05～0.3	0.12	13,800	3,430	0.05～0.3	0.12
4	8	11,900	4,380	0.05～0.4	0.16	11,100	4,080	0.05～0.4	0.16	10,400	3,620	0.05～0.4	0.16
5	10	9,600	4,330	0.05～0.5	0.2	8,900	4,020	0.05～0.5	0.2	8,300	3,540	0.05～0.5	0.2
6	12	8,000	4,290	0.05～0.6	0.24	7,400	3,970	0.05～0.6	0.24	6,900	3,500	0.05～0.6	0.24
8	16	6,000	3,990	0.05～0.8	0.32	5,600	3,730	0.05～0.8	0.32	5,200	3,270	0.05～0.8	0.32
10	20	4,800	3,700	0.05～1.0	0.4	4,500	3,470	0.05～1.0	0.4	4,100	2,990	0.05～1.0	0.4

Work material		Hardened steels (50～55HRC) HPM38, SKD61				Hardened steels (55～65HRC) SKD11, YXR3, YXR33			
Ball radius RE (mm)	Tool dia. DC (mm)	Revolution n min^{-1}	Feed rate v_f mm/min	a_p mm	a_e mm	Revolution n min^{-1}	Feed rate v_f mm/min	a_p mm	a_e mm
0.5	1	50,000	1,320	0.02～0.05	0.02	50,000	990	0.02～0.05	0.02
0.75	1.5	44,600	1,880	0.02～0.07	0.03	38,200	1,210	0.02～0.07	0.03
1	2	33,400	1,990	0.02～0.10	0.04	28,700	1,290	0.02～0.10	0.04
1.25	2.5	26,800	2,070	0.05～0.12	0.05	22,900	1,330	0.05～0.12	0.05
1.5	3	22,300	2,160	0.05～0.15	0.06	19,100	1,390	0.05～0.15	0.06
1.75	3.5	19,100	2,180	0.05～0.15	0.07	16,400	1,410	0.05～0.15	0.07
2	4	16,700	2,200	0.05～0.20	0.08	14,300	1,420	0.05～0.20	0.08
2.5	5	13,400	2,280	0.05～0.25	0.1	11,500	1,470	0.05～0.25	0.1
3	6	11,100	2,340	0.05～0.3	0.12	9,600	1,520	0.05～0.3	0.12
4	8	8,400	2,480	0.05～0.4	0.16	7,200	1,600	0.05～0.4	0.16
5	10	6,700	2,420	0.05～0.5	0.2	5,700	1,550	0.05～0.5	0.2
6	12	5,600	2,410	0.05～0.6	0.24	4,800	1,550	0.05～0.6	0.24
8	16	4,200	2,240	0.05～0.8	0.32	3,600	1,440	0.05～0.8	0.32
10	20	3,300	2,040	0.05～1.0	0.4	2,900	1,350	0.05～1.0	0.4

【Note】
① Use the appropriate coolant for the work material and machining shape.
② Use as highly rigid and accurate machine as possible.
③ These conditions are for general guidance; in actual machining conditions adjust the parameters according to your actual machine and work-piece conditions.
④ If the rpm available is lower than that recommended please reduce the feed rate to the same ratio.



〈Side cutting〉

Work material		Carbon steels, Alloy steels (180～250HB) S50C, S55C				Tool steels (25～40HRC) HPM7, SCM440, SKD61, SKT4				Pre-hardened steels, Hardened steels (40～50HRC)							
										Free-cutting materials SKD61, CENA1, HPM-MAGIC, NAK80				High-toughness materials DAC-MAGIC, DAC55, DH31			
Ball radius RE (mm)	Tool dia. DC (mm)	Revolution n min^{-1}	Feed rate v_f mm/min	a_p mm	a_e mm	Revolution n min^{-1}	Feed rate v_f mm/min	a_p mm	a_e mm	Revolution n min^{-1}	Feed rate v_f mm/min	a_p mm	a_e mm	Revolution n min^{-1}	Feed rate v_f mm/min	a_p mm	a_e mm
0.5	**1**	50,000	2,700	1.0	0.100	50,000	2,480	1.0	0.075	50,000	2,230	1.0	0.050	28,700	1,160	1.0	0.050
0.75	**1.5**	38,200	3,300	1.5	0.150	38,200	3,030	1.5	0.113	38,200	2,720	1.5	0.075	19,100	1,240	1.5	0.075
1	**2**	28,700	3,510	2.0	0.200	28,700	3,220	2.0	0.150	28,700	2,900	2.0	0.100	14,300	1,310	2.0	0.100
1.25	**2.5**	22,900	3,570	2.5	0.250	22,900	3,270	2.5	0.188	22,900	2,940	2.5	0.125	11,500	1,340	2.5	0.125
1.5	**3**	19,100	3,630	3.0	0.300	19,100	3,330	3.0	0.225	19,100	3,000	3.0	0.150	9,600	1,370	3.0	0.150
1.75	**3.5**	16,400	3,760	3.5	0.350	16,400	3,450	3.5	0.263	16,400	3,100	3.5	0.175	8,200	1,410	3.5	0.175
2	**4**	14,300	3,830	4.0	0.400	14,300	3,510	4.0	0.300	14,300	3,160	4.0	0.200	7,200	1,450	4.0	0.200
2.5	**5**	11,500	4,020	5.0	0.500	11,500	3,680	5.0	0.375	11,500	3,310	5.0	0.250	5,700	1,490	5.0	0.250
3	**6**	9,600	4,150	6.0	0.600	9,600	3,800	6.0	0.450	9,600	3,420	6.0	0.300	4,800	1,560	6.0	0.300
4	**8**	7,200	4,350	8.0	0.800	7,200	3,990	8.0	0.600	7,200	3,590	8.0	0.400	3,600	1,630	8.0	0.400
5	**10**	5,700	4,510	10.0	1.000	5,700	4,140	10.0	0.750	5,700	3,720	10.0	0.500	2,900	1,720	10.0	0.500
6	**12**	4,800	4,350	12.0	1.200	4,800	3,990	12.0	0.900	4,800	3,590	12.0	0.600	2,400	1,630	12.0	0.600
8	**16**	3,600	4,150	16.0	1.600	3,600	3,800	16.0	1.200	3,600	3,420	16.0	0.800	1,800	1,560	16.0	0.800
10	**20**	2,900	3,670	20.0	2.000	2,900	3,370	20.0	1.500	2,900	3,030	20.0	1.000	1,400	1,330	20.0	1.000

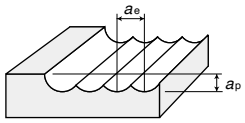
Work material		Hardened steels (50～55HRC) HPM38, SKD61				Hardened steels (55～65HRC) SKD11, YXR3, YXR33			
Ball radius RE (mm)	Tool dia. DC (mm)	Revolution n min^{-1}	Feed rate v_f mm/min	a_p mm	a_e mm	Revolution n min^{-1}	Feed rate v_f mm/min	a_p mm	a_e mm
0.5	**1**	50,000	1,870	1.0	0.050	44,600	1,210	1.0	0.02
0.75	**1.5**	34,000	2,030	1.5	0.075	29,700	1,290	1.5	0.03
1	**2**	25,500	2,160	2.0	0.100	22,300	1,380	2.0	0.04
1.25	**2.5**	20,400	2,200	2.5	0.125	17,800	1,400	2.5	0.05
1.5	**3**	17,000	2,240	3.0	0.150	14,900	1,430	3.0	0.06
1.75	**3.5**	14,600	2,320	3.5	0.175	12,700	1,470	3.5	0.07
2	**4**	12,700	2,350	4.0	0.200	11,100	1,500	4.0	0.08
2.5	**5**	10,200	2,460	5.0	0.250	8,900	1,570	5.0	0.10
3	**6**	8,500	2,540	6.0	0.300	7,400	1,610	6.0	0.12
4	**8**	6,400	2,680	8.0	0.400	5,600	1,710	8.0	0.16
5	**10**	5,100	2,790	10.0	0.500	4,500	1,800	10.0	0.20
6	**12**	4,200	2,640	12.0	0.600	3,700	1,690	12.0	0.24
8	**16**	3,200	2,550	16.0	0.800	2,800	1,630	16.0	0.32
10	**20**	2,500	2,190	20.0	1.000	2,200	1,410	20.0	0.40

	～62HRC	62～65HRC
Slant angle for helical boring	**1°**	**0.5°**
Feed rate for helical boring	70% of side cutting conditions	

※Set the hole diameter for helical boring to between 1.6 and 2.0 times the tool diameter.
※Set the maximum depth for helical boring to the tool diameter or smaller (≤ 1DC).

Recommended Cutting Conditions

EMBPE-ATH Pencil type



〈Roughing〉

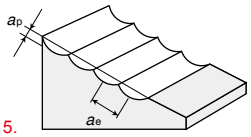
Work material			Carbon steels Alloy steels (180～250HB) S50C, S55C				Tool steels (25～40HRC) HPM7, SCM440 SKD61, SKT4				Pre-hardened steels, Hardened steels (40～50HRC)								Hardened steels (50～55HRC) HPM38, SKD61				Hardened steels (55～65HRC) SKD11, YXR3 YXR33			
											Free-cutting materials SKD61, CENA1 HPM-MAGIC, NAK80				High-toughness materials DAC-MAGIC DAC55, DH31											
Ball radius RE (mm)	Tool dia. DC (mm)	Under neck length LU (mm)	Revolution n min-1	Feed rate Vf mm/min	ap mm	ae mm	Revolution n min-1	Feed rate Vf mm/min	ap mm	ae mm	Revolution n min-1	Feed rate Vf mm/min	ap mm	ae mm	Revolution n min-1	Feed rate Vf mm/min	ap mm	ae mm	Revolution n min-1	Feed rate Vf mm/min	ap mm	ae mm	Revolution n min-1	Feed rate Vf mm/min	ap mm	ae mm
0.5	1	6	50,000	2,160	0.090	0.270	50,000	2,160	0.090	0.270	48,000	1,940	0.090	0.270	26,700	1,080	0.081	0.243	42,600	1,380	0.063	0.189	37,300	910	0.045	0.135
		8	50,000	2,160	0.090	0.270	50,000	2,160	0.090	0.270	48,000	1,940	0.090	0.270	26,700	1,080	0.081	0.243	42,600	1,380	0.063	0.189	37,300	910	0.045	0.135
		10	50,000	2,160	0.080	0.240	48,700	2,100	0.080	0.240	43,900	1,780	0.080	0.240	24,400	990	0.072	0.216	39,000	1,260	0.056	0.168	34,100	830	0.040	0.120
		12	49,700	1,910	0.070	0.210	44,700	1,720	0.070	0.210	40,200	1,450	0.070	0.210	22,400	810	0.063	0.189	35,800	1,030	0.049	0.147	31,300	680	0.035	0.105
		14	44,600	1,710	0.060	0.180	40,100	1,540	0.060	0.180	36,100	1,300	0.060	0.180	20,100	720	0.054	0.162	32,100	920	0.042	0.126	28,100	610	0.030	0.090
		16	44,600	1,710	0.060	0.180	40,100	1,540	0.060	0.180	36,100	1,300	0.060	0.180	20,100	720	0.054	0.162	32,100	920	0.042	0.126	28,100	610	0.030	0.090
		18	40,100	1,540	0.050	0.150	36,100	1,390	0.050	0.150	32,500	1,170	0.050	0.150	18,100	650	0.045	0.135	28,900	830	0.035	0.105	25,300	550	0.025	0.075
		20	40,100	1,540	0.050	0.150	36,100	1,390	0.050	0.150	32,500	1,170	0.050	0.150	18,100	650	0.045	0.135	28,900	830	0.035	0.105	25,300	550	0.025	0.075
		22	35,000	1,340	0.040	0.120	31,500	1,210	0.040	0.120	28,400	1,020	0.040	0.120	15,800	570	0.036	0.108	25,200	730	0.028	0.084	22,100	480	0.020	0.060
		24	30,600	1,180	0.030	0.090	27,500	1,060	0.030	0.090	24,800	890	0.030	0.090	13,800	500	0.027	0.081	22,000	630	0.021	0.063	19,300	420	0.015	0.045
		26	30,600	1,180	0.030	0.090	27,500	1,060	0.030	0.090	24,800	890	0.030	0.090	13,800	500	0.027	0.081	22,000	630	0.021	0.063	19,300	420	0.015	0.045
		28	25,500	860	0.020	0.060	22,900	770	0.020	0.060	20,600	650	0.020	0.060	11,500	360	0.018	0.054	18,300	460	0.014	0.042	16,100	300	0.010	0.030
		30	25,500	860	0.020	0.060	22,900	770	0.020	0.060	20,600	650	0.020	0.060	11,500	360	0.018	0.054	18,300	460	0.014	0.042	16,100	300	0.010	0.030
		32	21,000	710	0.010	0.030	18,900	640	0.010	0.030	17,000	540	0.010	0.030	9,500	300	0.009	0.027	15,100	380	0.007	0.021	13,200	250	0.005	0.015
		34	15,900	530	0.005	0.015	14,300	480	0.005	0.015	12,900	410	0.005	0.015	7,200	230	0.005	0.014	11,500	290	0.004	0.011	10,000	190	0.003	0.008
		36	15,900	530	0.005	0.015	14,300	480	0.005	0.015	12,900	410	0.005	0.015	7,200	230	0.005	0.014	11,500	290	0.004	0.011	10,000	190	0.003	0.008
0.75	1.5	8	39,500	2,670	0.135	0.405	35,500	2,400	0.135	0.405	32,000	2,070	0.135	0.405	17,800	1,150	0.122	0.365	28,400	1,530	0.095	0.284	24,900	1,010	0.068	0.203
		10	39,500	2,670	0.135	0.405	35,500	2,400	0.135	0.405	32,000	2,070	0.135	0.405	17,800	1,150	0.122	0.365	28,400	1,530	0.095	0.284	24,900	1,010	0.068	0.203
		14	36,100	2,440	0.120	0.360	32,500	2,190	0.120	0.360	29,200	1,890	0.120	0.360	16,200	1,050	0.108	0.324	26,000	1,400	0.084	0.252	22,700	920	0.060	0.180
		16	33,100	1,990	0.105	0.315	29,800	1,790	0.105	0.315	26,800	1,540	0.105	0.315	14,900	860	0.095	0.284	23,800	1,140	0.074	0.221	20,900	750	0.053	0.158
		18	33,100	1,990	0.105	0.315	29,800	1,790	0.105	0.315	26,800	1,540	0.105	0.315	14,900	860	0.095	0.284	23,800	1,140	0.074	0.221	20,900	750	0.053	0.158
		20	29,700	1,780	0.090	0.270	26,800	1,610	0.090	0.270	24,100	1,390	0.090	0.270	13,400	770	0.081	0.243	21,400	1,030	0.063	0.189	18,700	670	0.045	0.135
		22	29,700	1,780	0.090	0.270	26,800	1,610	0.090	0.270	24,100	1,390	0.090	0.270	13,400	770	0.081	0.243	21,400	1,030	0.063	0.189	18,700	670	0.045	0.135
		24	29,700	1,780	0.090	0.270	26,800	1,610	0.090	0.270	24,100	1,390	0.090	0.270	13,400	770	0.081	0.243	21,400	1,030	0.063	0.189	18,700	670	0.045	0.135
		26	26,800	1,610	0.075	0.225	24,100	1,450	0.075	0.225	21,700	1,250	0.075	0.225	12,000	690	0.068	0.203	19,300	930	0.053	0.158	16,900	610	0.038	0.113
		28	26,800	1,610	0.075	0.225	24,100	1,450	0.075	0.225	21,700	1,250	0.075	0.225	12,000	690	0.068	0.203	19,300	930	0.053	0.158	16,900	610	0.038	0.113
		30	26,800	1,610	0.075	0.225	24,100	1,450	0.075	0.225	21,700	1,250	0.075	0.225	12,000	690	0.068	0.203	19,300	930	0.053	0.158	16,900	610	0.038	0.113
		32	23,400	1,400	0.060	0.180	21,000	1,260	0.060	0.180	18,900	1,090	0.060	0.180	10,500	600	0.054	0.162	16,800	810	0.042	0.126	14,700	530	0.030	0.090
		34	23,400	1,400	0.060	0.180	21,000	1,260	0.060	0.180	18,900	1,090	0.060	0.180	10,500	600	0.054	0.162	16,800	810	0.042	0.126	14,700	530	0.030	0.090
		36	20,400	1,220	0.045	0.135	18,300	1,100	0.045	0.135	16,500	950	0.045	0.135	9,200	530	0.041	0.122	14,700	710	0.032	0.095	12,800	460	0.023	0.068
		38	20,400	1,220	0.045	0.135	18,300	1,100	0.045	0.135	16,500	950	0.045	0.135	9,200	530	0.041	0.122	14,700	710	0.032	0.095	12,800	460	0.023	0.068
		40	17,000	890	0.030	0.090	15,300	800	0.030	0.090	13,800	700	0.030	0.090	7,600	380	0.027	0.081	12,200	510	0.021	0.063	10,700	340	0.015	0.045
1	2	10	31,800	3,430	0.200	0.600	28,700	3,100	0.200	0.600	25,800	2,630	0.200	0.600	14,300	1,460	0.180	0.540	22,900	1,920	0.140	0.420	20,100	1,270	0.100	0.300
		16	29,600	2,880	0.180	0.540	26,700	2,600	0.180	0.540	24,000	2,200	0.180	0.540	13,300	1,220	0.162	0.486	21,300	1,610	0.126	0.378	18,700	1,060	0.090	0.270
		20	27,100	2,630	0.120	0.360	24,400	2,370	0.120	0.360	21,900	2,010	0.120	0.360	12,200	1,120	0.108	0.324	19,500	1,470	0.084	0.252	17,100	970	0.060	0.180
		24	24,800	2,140	0.110	0.330	22,400	1,940	0.110	0.330	20,100	1,640	0.110	0.330	11,200	910	0.099	0.297	17,900	1,200	0.077	0.231	15,600	790	0.055	0.165
		30	22,300	1,930	0.100	0.300	20,100	1,740	0.100	0.300	18,100	1,480	0.100	0.300	10,000	820	0.090	0.270	16,100	1,080	0.070	0.210	14,000	710	0.050	0.150
		36	20,100	1,740	0.080	0.240	18,100	1,560	0.080	0.240	16,300	1,330	0.080	0.240	9,000	730	0.072	0.216	14,400	970	0.056	0.168	12,600	640	0.040	0.120
		40	20,100	1,740	0.080	0.240	18,100	1,560	0.080	0.240	16,300	1,330	0.080	0.240	9,000	730	0.072	0.216	14,400	970	0.056	0.168	12,600	640	0.040	0.120
		46	17,500	1,510	0.060	0.180	15,800	1,370	0.060	0.180	14,200	1,160	0.060	0.180	7,900	640	0.054	0.162	12,600	850	0.042	0.126	11,000	550	0.030	0.090
		60	12,700	960	0.044	0.132	11,500	870	0.044	0.132	10,300	740	0.044	0.132	5,700	410	0.040	0.119	9,200	540	0.031	0.092	8,000	350	0.022	0.066
1.25	2.5	16	23,700	2,880	0.225	0.675	21,300	2,590	0.225	0.675	19,200	2,230	0.225	0.675	10,700	1,240	0.203	0.608	17,100	1,660	0.158	0.473	14,900	1,090	0.113	0.338
		24	21,700	2,640	0.150	0.450	19,500	2,370	0.150	0.450	17,500	2,030	0.150	0.450	9,700	1,130	0.135	0.405	15,600	1,520	0.105	0.315	13,600	990	0.075	0.225
		30	19,900	2,150	0.138	0.413	17,900	1,930	0.138	0.413	16,100	1,660	0.138	0.413	8,900	920	0.124	0.371	14,300	1,240	0.096	0.289	12,500	810	0.069	0.206
		40	17,800	1,920	0.125	0.375	16,100	1,740	0.125	0.375	14,400	1,490	0.125	0.375	8,000	830	0.113	0.338	12,800	1,110	0.088	0.263	11,200	730	0.063	0.188
		50	16,100	1,740	0.100	0.300	14,400	1,560	0.100	0.300	13,000	1,340	0.100	0.300	7,200	740	0.090	0.270	11,600	1,000	0.070	0.210	10,100	650	0.050	0.150
1.5	3	16	19,700	2,930	0.270	0.810	17,800	2,640	0.270	0.810	16,000	2,250	0.270	0.810	8,900	1,250	0.243	0.729	14,200	1,690	0.189	0.567	12,400	1,100	0.135	0.405
		20	19,700	2,930	0.270	0.810	17,800	2,640	0.270	0.810	16,000	2,250	0.270	0.810	8,900	1,250	0.243	0.729	14,200	1,690	0.189	0.567	12,400	1,100	0.135	0.405
		24	19,700	2,930	0.270	0.810	17,800	2,640	0.270	0.810	16,000	2,250	0.270	0.810	8,900	1,250	0.243	0.729	14,200	1,690	0.189	0.567	12,400	1,100	0.135	0.405
		30	18,000	2,670	0.180	0.540	16,200	2,410	0.180	0.540	14,600	2,050	0.180	0.540	8,100	1,140	0.162	0.486	13,000	1,540	0.126	0.378	11,400	1,020	0.090	0.270
		40	14,900	1,970	0.150	0.450	13,400	1,770	0.150	0.450	12,000	1,500	0.150	0.450	6,700	840	0.135	0.405	10,700	1,130	0.105	0.315	9,400	740	0.075	0.225
		50	13,400	1,770	0.120	0.360	12,000	1,580	0.120	0.360	10,800	1,350	0.120	0.360	6,000	750	0.108	0.324	9,600	1,010	0.084	0.252	8,400	670	0.060	0.180
		60	13,400	1,770	0.120	0.360	12,000	1,580	0.120	0.360	10,800	1,350	0.120	0.360	6,000	750	0.108	0.324	9,600	1,010	0.084	0.252	8,400	670	0.060	0.180

Work material			Carbon steels Alloy steels (180～250HB) S50C, S55C				Tool steels (25～40HRC) HPM7, SCM440 SKD61, SKT4				Pre-hardened steels, Hardened steels (40～50HRC)								Hardened steels (50～55HRC) HPM38, SKD61				Hardened steels (55～65HRC) SKD11, YXR3 YXR33			
											Free-cutting materials SKD61, CENA1 HPM-MAGIC, NAK80				High-toughness materials DAC-MAGIC DAC55, DH31											
Ball radius RE (mm)	Tool dia. DC (mm)	Under neck length LU (mm)	Revolution n min-1	Feed rate Vf mm/min	ap mm	ae mm	Revolution n min-1	Feed rate Vf mm/min	ap mm	ae mm	Revolution n min-1	Feed rate Vf mm/min	ap mm	ae mm	Revolution n min-1	Feed rate Vf mm/min	ap mm	ae mm	Revolution n min-1	Feed rate Vf mm/min	ap mm	ae mm	Revolution n min-1	Feed rate Vf mm/min	ap mm	ae mm
1.75	3.5	20	16,900	3,060	0.315	0.945	15,200	2,750	0.315	0.945	13,700	2,330	0.315	0.945	7,600	1,290	0.284	0.851	12,200	1,750	0.221	0.662	10,700	1,160	0.158	0.473
		30	15,500	2,800	0.210	0.630	13,900	2,510	0.210	0.630	12,500	2,130	0.210	0.630	7,000	1,190	0.189	0.567	11,100	1,590	0.147	0.441	9,700	1,050	0.105	0.315
		40	14,200	2,280	0.193	0.578	12,800	2,060	0.193	0.578	11,500	1,740	0.193	0.578	6,400	970	0.173	0.520	10,200	1,300	0.135	0.404	8,900	850	0.096	0.289
		50	12,700	2,040	0.175	0.525	11,500	1,850	0.175	0.525	10,300	1,560	0.175	0.525	5,700	860	0.158	0.473	9,200	1,170	0.123	0.368	8,000	770	0.088	0.263
		60	11,500	1,850	0.140	0.420	10,300	1,660	0.140	0.420	9,300	1,410	0.140	0.420	5,200	790	0.126	0.378	8,300	1,060	0.098	0.294	7,200	690	0.070	0.210
2	4	20	15,900	3,720	0.400	1.200	14,300	3,350	0.400	1.200	12,900	2,860	0.400	1.200	7,200	1,600	0.360	1.080	11,500	2,140	0.280	0.840	10,000	1,410	0.200	0.600
		30	14,800	3,120	0.300	0.900	13,300	2,800	0.300	0.900	12,000	2,400	0.300	0.900	6,700	1,340	0.270	0.810	10,700	1,790	0.210	0.630	9,300	1,180	0.150	0.450
		40	13,500	2,840	0.260	0.780	12,200	2,570	0.260	0.780	11,000	2,200	0.260	0.780	6,100	1,220	0.234	0.702	9,700	1,620	0.182	0.546	8,500	1,080	0.130	0.390
		50	12,400	2,320	0.180	0.540	11,200	2,100	0.180	0.540	10,100	1,790	0.180	0.540	5,600	990	0.162	0.486	8,900	1,320	0.126	0.378	7,800	880	0.090	0.270
		60	11,100	2,080	0.120	0.360	10,000	1,870	0.120	0.360	9,000	1,600	0.120	0.360	5,000	890	0.108	0.324	8,000	1,190	0.084	0.252	7,000	790	0.060	0.180
		70	10,000	1,870	0.100	0.300	9,000	1,680	0.100	0.300	8,100	1,440	0.100	0.300	4,500	800	0.090	0.270	7,200	1,070	0.070	0.210	6,300	710	0.050	0.150
		80	10,000	1,870	0.100	0.300	9,000	1,680	0.100	0.300	8,100	1,440	0.100	0.300	4,500	800	0.090	0.270	7,200	1,070	0.070	0.210	6,300	710	0.050	0.150
2.5	5	30	11,800	3,250	0.375	1.125	10,700	2,950	0.375	1.125	9,600	2,490	0.375	1.125	5,300	1,370	0.338	1.013	8,500	1,860	0.263	0.788	7,500	1,240	0.188	0.563
		40	11,800	3,250	0.375	1.125	10,700	2,950	0.375	1.125	9,600	2,490	0.375	1.125	5,300	1,370	0.338	1.013	8,500	1,860	0.263	0.788	7,500	1,240	0.188	0.563
		50	10,800	2,970	0.325	0.975	9,700	2,670	0.325	0.975	8,800	2,280	0.325	0.975	4,900	1,270	0.293	0.878	7,800	1,710	0.228	0.683	6,800	1,120	0.163	0.488
		60	9,900	2,420	0.225	0.675	8,900	2,180	0.225	0.675	8,000	1,840	0.225	0.675	4,500	1,040	0.203	0.608	7,200	1,400	0.158	0.473	6,300	920	0.113	0.338
		70	8,900	2,180	0.150	0.450	8,000	1,960	0.150	0.450	7,200	1,660	0.150	0.450	4,000	920	0.135	0.405	6,400	1,240	0.105	0.315	5,600	820	0.075	0.225
		80	8,900	2,180	0.150	0.450	8,000	1,960	0.150	0.450	7,200	1,660	0.150	0.450	4,000	920	0.135	0.405	6,400	1,240	0.105	0.315	5,600	820	0.075	0.225
3	6	30	10,600	4,010	0.600	1.800	9,600	3,630	0.600	1.800	8,600	3,070	0.600	1.800	4,800	1,710	0.540	1.620	7,600	2,280	0.420	1.260	6,700	1,510	0.300	0.900
		40	9,900	3,370	0.420	1.260	8,900	3,030	0.420	1.260	8,000	2,570	0.420	1.260	4,400	1,410	0.378	1.134	7,100	1,920	0.294	0.882	6,200	1,260	0.210	0.630
		50	9,000	3,060	0.300	0.900	8,100	2,760	0.300	0.900	7,300	2,350	0.300	0.900	4,100	1,320	0.270	0.810	6,500	1,760	0.210	0.630	5,700	1,150	0.150	0.450
		60	9,000	3,060	0.300	0.900	8,100	2,760	0.300	0.900	7,300	2,350	0.300	0.900	4,100	1,320	0.270	0.810	6,500	1,760	0.210	0.630	5,700	1,150	0.150	0.450
		70	8,300	2,510	0.240	0.720	7,500	2,270	0.240	0.720	6,700	1,910	0.240	0.720	3,700	1,060	0.216	0.648	6,000	1,440	0.168	0.504	5,200	940	0.120	0.360
		80	7,400	2,240	0.180	0.540	6,700	2,030	0.180	0.540	6,000	1,710	0.180	0.540	3,300	940	0.162	0.486	5,400	1,300	0.126	0.378	4,700	850	0.090	0.270
		100	6,700	2,030	0.120	0.360	6,000	1,810	0.120	0.360	5,400	1,540	0.120	0.360	3,000	860	0.108	0.324	4,800	1,150	0.084	0.252	4,200	760	0.060	0.180
		120	6,700	2,030	0.120	0.360	6,000	1,810	0.120	0.360	5,400	1,540	0.120	0.360	3,000	860	0.108	0.324	4,800	1,150	0.084	0.252	4,200	760	0.060	0.180
4	8	40	8,000	4,220	0.800	2.400	7,200	3,800	0.800	2.400	6,400	3,190	0.800	2.400	3,600	1,790	0.720	2.160	5,700	2,380	0.560	1.680	5,000	1,580	0.400	1.200
		50	7,400	3,520	0.560	1.680	6,700	3,180	0.560	1.680	6,000	2,690	0.560	1.680	3,300	1,480	0.504	1.512	5,300	1,990	0.392	1.176	4,700	1,330	0.280	0.840
		60	7,400	3,520	0.560	1.680	6,700	3,180	0.560	1.680	6,000	2,690	0.560	1.680	3,300	1,480	0.504	1.512	5,300	1,990	0.392	1.176	4,700	1,330	0.280	0.840
		70	6,800	3,230	0.400	1.200	6,100	2,900	0.400	1.200	5,500	2,470	0.400	1.200	3,000	1,340	0.360	1.080	4,900	1,840	0.280	0.840	4,300	1,220	0.200	0.600
		80	6,800	3,230	0.400	1.200	6,100	2,900	0.400	1.200	5,500	2,470	0.400	1.200	3,000	1,340	0.360	1.080	4,900	1,840	0.280	0.840	4,300	1,220	0.200	0.600
		100	6,200	2,620	0.320	0.960	5,600	2,370	0.320	0.960	5,000	1,990	0.320	0.960	2,800	1,120	0.288	0.864	4,500	1,500	0.224	0.672	3,900	980	0.160	0.480
		120	5,600	2,370	0.240	0.720	5,000	2,110	0.240	0.720	4,500	1,790	0.240	0.720	2,500	1,000	0.216	0.648	4,000	1,330	0.168	0.504	3,500	880	0.120	0.360
5	10	50	6,400	4,440	1.000	3.000	5,700	3,950	1.000	3.000	5,200	3,400	1.000	3.000	3,200	2,090	0.900	2.700	4,600	2,530	0.700	2.100	4,000	1,660	0.500	1.500
		60	5,900	3,680	0.700	2.100	5,300	3,310	0.700	2.100	4,800	2,830	0.700	2.100	3,000	1,770	0.630	1.890	4,300	2,120	0.490	1.470	3,700	1,380	0.350	1.050
		75	5,900	3,680	0.700	2.100	5,300	3,310	0.700	2.100	4,800	2,830	0.700	2.100	3,000	1,770	0.630	1.890	4,300	2,120	0.490	1.470	3,700	1,380	0.350	1.050
		80	5,400	3,370	0.500	1.500	4,900	3,060	0.500	1.500	4,400	2,590	0.500	1.500	2,700	1,590	0.450	1.350	3,900	1,930	0.350	1.050	3,400	1,270	0.250	0.750
		100	5,400	3,370	0.500	1.500	4,900	3,060	0.500	1.500	4,400	2,590	0.500	1.500	2,700	1,590	0.450	1.350	3,900	1,930	0.350	1.050	3,400	1,270	0.250	0.750
		120	5,000	2,770	0.400	1.200	4,500	2,490	0.400	1.200	4,000	2,090	0.400	1.200	2,500	1,310	0.360	1.080	3,600	1,580	0.280	0.840	3,100	1,030	0.200	0.600
6	12	60	5,300	4,210	1.200	3.600	4,800	3,820	1.200	3.600	4,300	3,210	1.200	3.600	2,700	2,020	1.080	3.240	3,800	2,380	0.840	2.520	3,300	1,560	0.600	1.800
		80	4,900	3,510	0.840	2.520	4,400	3,150	0.840	2.520	4,000	2,690	0.840	2.520	2,500	1,680	0.756	2.268	3,600	2,030	0.588	1.764	3,100	1,320	0.420	1.260
		100	4,500	3,220	0.600	1.800	4,100	2,930	0.600	1.800	3,700	2,490	0.600	1.800	2,300	1,550	0.540	1.620	3,200	1,810	0.420	1.260	2,800	1,190	0.300	0.900
		120	4,500	3,220	0.600	1.800	4,100	2,930	0.600	1.800	3,700	2,490	0.600	1.800	2,300	1,550	0.540	1.620	3,200	1,810	0.420	1.260	2,800	1,190	0.300	0.900

【Note】
① Use the appropriate coolant for the work material and machining shape.
② Use as highly rigid and accurate machine as possible.
③ These conditions are for general guidance; in actual machining conditions adjust the parameters according to your actual machine and work-piece conditions.
④ If the rpm available is lower than that recommended please reduce the feed rate to the same ratio.

Recommended Cutting Conditions

EMBPE-ATH Pencil type



〈Finishing〉

※The condition of "ap" and "ae" assumes finishing process. In actual machining conditions please adjust "ap" and "ae". Please set up the condition of "ap" and "ae" for roughing process, in case of processing over L/D=15.

Work material			Carbon steels Alloy steels (180～250HB) S50C, S55C				Tool steels (25～40HRC) HPM7, SCM440, SKD61, SKT4				Pre-hardened steels Hardened steels (40～50HRC) SKD61, CENA1, HPM-MAGIC, NAK80, DAC-MAGIC, DAC55, DH31				Hardened steels (50～55HRC) HPM38, SKD61				Hardened steels (55～65HRC) SKD11, YXR3 YXR33			
Ball radius RE (mm)	Tool dia. DC (mm)	Under neck length LU (mm)	Revolution n min-1	Feed rate vf mm/min	ap mm	ae mm	Revolution n min-1	Feed rate vf mm/min	ap mm	ae mm	Revolution n min-1	Feed rate vf mm/min	ap mm	ae mm	Revolution n min-1	Feed rate vf mm/min	ap mm	ae mm	Revolution n min-1	Feed rate vf mm/min	ap mm	ae mm
0.5	1	6	50,000	1,760	0.02~0.05	0.02	50,000	1,760	0.02~0.05	0.02	50,000	1,620	0.02~0.05	0.02	47,400	1,280	0.02~0.05	0.02	41,500	810	0.02~0.05	0.02
		8	50,000	1,760	0.02~0.05	0.02	50,000	1,760	0.02~0.05	0.02	50,000	1,620	0.02~0.05	0.02	47,400	1,280	0.02~0.05	0.02	41,500	810	0.02~0.05	0.02
		10	50,000	1,760	0.02~0.05	0.02	50,000	1,760	0.02~0.05	0.02	48,700	1,580	0.02~0.05	0.02	43,300	1,170	0.02~0.05	0.02	37,900	740	0.02~0.05	0.02
		12	50,000	1,560	0.02~0.05	0.02	49,700	1,550	0.02~0.05	0.02	44,700	1,290	0.02~0.05	0.02	39,700	950	0.02~0.05	0.02	34,800	600	0.02~0.05	0.02
		14	49,000	1,530	0.02~0.05	0.02	44,600	1,390	0.02~0.05	0.02	40,100	1,150	0.02~0.05	0.02	35,700	860	0.02~0.05	0.02	31,200	540	0.02~0.05	0.02
		16	49,000	1,530	0.02~0.05	0.02	44,600	1,390	0.02~0.05	0.02	40,100	1,150	0.02~0.05	0.02	35,700	860	0.02~0.05	0.02	31,200	540	0.02~0.05	0.02
		18	44,100	1,380	0.02~0.05	0.02	40,100	1,250	0.02~0.05	0.02	36,100	1,040	0.02~0.05	0.02	32,100	770	0.02~0.05	0.02	28,100	490	0.02~0.05	0.02
		20	44,100	1,380	0.02~0.05	0.02	40,100	1,250	0.02~0.05	0.02	36,100	1,040	0.02~0.05	0.02	32,100	770	0.02~0.05	0.02	28,100	490	0.02~0.05	0.02
		22	38,500	1,200	0.02~0.05	0.02	35,000	1,090	0.02~0.05	0.02	31,500	910	0.02~0.05	0.02	28,000	670	0.02~0.05	0.02	24,500	420	0.02~0.05	0.02
		24	33,600	1,050	0.02~0.05	0.02	30,600	950	0.02~0.05	0.02	27,500	790	0.02~0.05	0.02	24,500	590	0.02~0.05	0.02	21,400	370	0.02~0.05	0.02
		26	33,600	1,050	0.02~0.05	0.02	30,600	950	0.02~0.05	0.02	27,500	790	0.02~0.05	0.02	24,500	590	0.02~0.05	0.02	21,400	370	0.02~0.05	0.02
		28	28,000	760	0.02~0.05	0.02	25,500	700	0.02~0.05	0.02	22,900	580	0.02~0.05	0.02	20,400	430	0.02~0.05	0.02	17,800	270	0.02~0.05	0.02
		30	28,000	760	0.02~0.05	0.02	25,500	700	0.02~0.05	0.02	22,900	580	0.02~0.05	0.02	20,400	430	0.02~0.05	0.02	17,800	270	0.02~0.05	0.02
		32	23,100	630	0.02~0.05	0.02	21,000	570	0.02~0.05	0.02	18,900	480	0.02~0.05	0.02	16,800	350	0.02~0.05	0.02	14,700	220	0.02~0.05	0.02
		34	17,500	480	0.02~0.05	0.02	15,900	430	0.02~0.05	0.02	14,300	360	0.02~0.05	0.02	12,700	270	0.02~0.05	0.02	11,100	170	0.02~0.05	0.02
		36	17,500	480	0.02~0.05	0.02	15,900	430	0.02~0.05	0.02	14,300	360	0.02~0.05	0.02	12,700	270	0.02~0.05	0.02	11,100	170	0.02~0.05	0.02
0.75	1.5	8	43,400	2,340	0.02~0.07	0.03	39,500	2,130	0.02~0.07	0.03	35,500	1,820	0.02~0.07	0.03	31,600	1,370	0.02~0.07	0.03	27,600	890	0.02~0.07	0.03
		10	43,400	2,340	0.02~0.07	0.03	39,500	2,130	0.02~0.07	0.03	35,500	1,820	0.02~0.07	0.03	31,600	1,370	0.02~0.07	0.03	27,600	890	0.02~0.07	0.03
		14	39,700	2,140	0.02~0.07	0.03	36,100	1,950	0.02~0.07	0.03	32,500	1,670	0.02~0.07	0.03	28,900	1,250	0.02~0.07	0.03	25,300	820	0.02~0.07	0.03
		16	36,400	1,750	0.02~0.07	0.03	33,100	1,590	0.02~0.07	0.03	29,800	1,360	0.02~0.07	0.03	26,500	1,020	0.02~0.07	0.03	23,200	670	0.02~0.07	0.03
		18	36,400	1,750	0.02~0.07	0.03	33,100	1,590	0.02~0.07	0.03	29,800	1,360	0.02~0.07	0.03	26,500	1,020	0.02~0.07	0.03	23,200	670	0.02~0.07	0.03
		20	32,700	1,570	0.02~0.07	0.03	29,700	1,430	0.02~0.07	0.03	26,800	1,220	0.02~0.07	0.03	23,800	910	0.02~0.07	0.03	20,800	600	0.02~0.07	0.03
		22	32,700	1,570	0.02~0.07	0.03	29,700	1,430	0.02~0.07	0.03	26,800	1,220	0.02~0.07	0.03	23,800	910	0.02~0.07	0.03	20,800	600	0.02~0.07	0.03
		24	32,700	1,570	0.02~0.07	0.03	29,700	1,430	0.02~0.07	0.03	26,800	1,220	0.02~0.07	0.03	23,800	910	0.02~0.07	0.03	20,800	600	0.02~0.07	0.03
		26	29,400	1,410	0.02~0.07	0.03	26,800	1,290	0.02~0.07	0.03	24,100	1,100	0.02~0.07	0.03	21,400	820	0.02~0.07	0.03	18,700	540	0.02~0.07	0.03
		28	29,400	1,410	0.02~0.07	0.03	26,800	1,290	0.02~0.07	0.03	24,100	1,100	0.02~0.07	0.03	21,400	820	0.02~0.07	0.03	18,700	540	0.02~0.07	0.03
		30	29,400	1,410	0.02~0.07	0.03	26,800	1,290	0.02~0.07	0.03	24,100	1,100	0.02~0.07	0.03	21,400	820	0.02~0.07	0.03	18,700	540	0.02~0.07	0.03
		32	25,700	1,230	0.02~0.07	0.03	23,400	1,120	0.02~0.07	0.03	21,000	960	0.02~0.07	0.03	18,700	720	0.02~0.07	0.03	16,300	470	0.02~0.07	0.03
		34	25,700	1,230	0.02~0.07	0.03	23,400	1,120	0.02~0.07	0.03	21,000	960	0.02~0.07	0.03	18,700	720	0.02~0.07	0.03	16,300	470	0.02~0.07	0.03
		36	22,400	1,080	0.02~0.07	0.03	20,400	980	0.02~0.07	0.03	18,300	830	0.02~0.07	0.03	16,300	630	0.02~0.07	0.03	14,300	410	0.02~0.07	0.03
		38	22,400	1,080	0.02~0.07	0.03	20,400	980	0.02~0.07	0.03	18,300	830	0.02~0.07	0.03	16,300	630	0.02~0.07	0.03	14,300	410	0.02~0.07	0.03
		40	18,700	790	0.02~0.07	0.03	17,000	710	0.02~0.07	0.03	15,300	610	0.02~0.07	0.03	13,600	460	0.02~0.07	0.03	11,900	300	0.02~0.07	0.03
1	2	10	35,000	3,050	0.02~0.10	0.04	31,800	2,770	0.02~0.10	0.04	28,700	2,320	0.02~0.10	0.04	25,500	1,680	0.02~0.10	0.04	22,300	1,140	0.02~0.10	0.04
		16	32,600	2,550	0.02~0.10	0.04	29,600	2,320	0.02~0.10	0.04	26,700	1,950	0.02~0.10	0.04	23,700	1,410	0.02~0.10	0.04	20,700	950	0.02~0.10	0.04
		20	29,800	2,330	0.02~0.10	0.04	27,100	2,120	0.02~0.10	0.04	24,400	1,780	0.02~0.10	0.04	21,700	1,290	0.02~0.10	0.04	18,900	870	0.02~0.10	0.04
		24	27,300	1,900	0.02~0.10	0.04	24,800	1,730	0.02~0.10	0.04	22,400	1,450	0.02~0.10	0.04	19,900	1,050	0.02~0.10	0.04	17,400	710	0.02~0.10	0.04
		30	24,500	1,710	0.02~0.10	0.04	22,300	1,550	0.02~0.10	0.04	20,100	1,300	0.02~0.10	0.04	17,800	940	0.02~0.10	0.04	15,600	640	0.02~0.10	0.04
		36	22,100	1,540	0.02~0.10	0.04	20,100	1,400	0.02~0.10	0.04	18,100	1,170	0.02~0.10	0.04	16,100	850	0.02~0.10	0.04	14,000	570	0.02~0.10	0.04
		40	22,100	1,540	0.02~0.10	0.04	20,100	1,400	0.02~0.10	0.04	18,100	1,170	0.02~0.10	0.04	16,100	850	0.02~0.10	0.04	14,000	570	0.02~0.10	0.04
		46	19,300	1,340	0.02~0.10	0.04	17,500	1,220	0.02~0.10	0.04	15,800	1,020	0.02~0.10	0.04	14,000	740	0.02~0.10	0.04	12,300	500	0.02~0.10	0.04
		60	14,000	850	0.02~0.10	0.04	12,700	770	0.02~0.10	0.04	11,500	650	0.02~0.10	0.04	10,200	470	0.02~0.10	0.04	8,900	320	0.02~0.10	0.04
1.25	2.5	16	26,100	2,540	0.05~0.12	0.05	23,700	2,300	0.05~0.12	0.05	21,300	1,960	0.05~0.12	0.05	19,000	1,490	0.05~0.12	0.05	16,600	990	0.05~0.12	0.05
		24	23,800	2,310	0.05~0.12	0.05	21,700	2,110	0.05~0.12	0.05	19,500	1,790	0.05~0.12	0.05	17,300	1,350	0.05~0.12	0.05	15,200	900	0.05~0.12	0.05
		30	21,900	1,890	0.05~0.12	0.05	19,900	1,720	0.05~0.12	0.05	17,900	1,460	0.05~0.12	0.05	15,900	1,110	0.05~0.12	0.05	13,900	730	0.05~0.12	0.05
		40	19,600	1,690	0.05~0.12	0.05	17,800	1,540	0.05~0.12	0.05	16,100	1,310	0.05~0.12	0.05	14,300	1,000	0.05~0.12	0.05	12,500	660	0.05~0.12	0.05
		50	17,700	1,530	0.05~0.12	0.05	16,100	1,390	0.05~0.12	0.05	14,400	1,180	0.05~0.12	0.05	12,800	890	0.05~0.12	0.05	11,200	590	0.05~0.12	0.05
1.5	3	16	21,700	2,580	0.05~0.15	0.06	19,700	2,340	0.05~0.15	0.06	17,800	2,020	0.05~0.15	0.06	15,800	1,490	0.05~0.15	0.06	13,800	970	0.05~0.15	0.06
		20	21,700	2,580	0.05~0.15	0.06	19,700	2,340	0.05~0.15	0.06	17,800	2,020	0.05~0.15	0.06	15,800	1,490	0.05~0.15	0.06	13,800	970	0.05~0.15	0.06
		24	21,700	2,580	0.05~0.15	0.06	19,700	2,340	0.05~0.15	0.06	17,800	2,020	0.05~0.15	0.06	15,800	1,490	0.05~0.15	0.06	13,800	970	0.05~0.15	0.06
		30	19,900	2,360	0.05~0.15	0.06	18,000	2,140	0.05~0.15	0.06	16,200	1,840	0.05~0.15	0.06	14,400	1,360	0.05~0.15	0.06	12,600	880	0.05~0.15	0.06
		40	16,300	1,720	0.05~0.15	0.06	14,900	1,570	0.05~0.15	0.06	13,400	1,350	0.05~0.15	0.06	11,900	1,000	0.05~0.15	0.06	10,400	650	0.05~0.15	0.06
		50	14,700	1,550	0.05~0.15	0.06	13,400	1,420	0.05~0.15	0.06	12,000	1,210	0.05~0.15	0.06	10,700	900	0.05~0.15	0.06	9,400	590	0.05~0.15	0.06
		60	14,700	1,550	0.05~0.15	0.06	13,400	1,420	0.05~0.15	0.06	12,000	1,210	0.05~0.15	0.06	10,700	900	0.05~0.15	0.06	9,400	590	0.05~0.15	0.06

※The condition of "*ap*" and "*ae*" assumes finishing process. In actual machining conditions please adjust "*ap*" and "*ae*". Please set up the condition of "*ap*" and "*ae*" for roughing process, in case of processing over L/D=15.

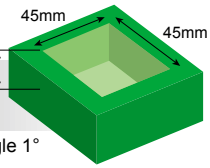
Work material			Carbon steels Alloy steels (180～250HB) S50C, S55C				Tool steels (25～40HRC) HPM7, SCM440, SKD61, SKT4				Pre-hardened steels Hardened steels (40～50HRC) SKD61, CENA1, HPM-MAGIC, NAK80, DAC-MAGIC, DAC55, DH31				Hardened steels (50～55HRC) HPM38, SKD61				Hardened steels (55～65HRC) SKD11, YXR3 YXR33			
Ball radius RE (mm)	Tool dia. DC (mm)	Under neck length LU (mm)	Revolution *n* min^{-1}	Feed rate *vf* mm/min	*ap* mm	*ae* mm	Revolution *n* min^{-1}	Feed rate *vf* mm/min	*ap* mm	*ae* mm	Revolution *n* min^{-1}	Feed rate *vf* mm/min	*ap* mm	*ae* mm	Revolution *n* min^{-1}	Feed rate *vf* mm/min	*ap* mm	*ae* mm	Revolution *n* min^{-1}	Feed rate *vf* mm/min	*ap* mm	*ae* mm
1.75	3.5	20	18,600	2,710	0.05~0.15	0.07	16,900	2,460	0.05~0.15	0.07	15,200	2,050	0.05~0.15	0.07	13,500	1,530	0.05~0.15	0.07	11,800	1,020	0.05~0.15	0.07
		30	17,000	2,480	0.05~0.15	0.07	15,500	2,260	0.05~0.15	0.07	13,900	1,880	0.05~0.15	0.07	12,400	1,410	0.05~0.15	0.07	10,800	930	0.05~0.15	0.07
		40	15,600	2,020	0.05~0.15	0.07	14,200	1,840	0.05~0.15	0.07	12,800	1,540	0.05~0.15	0.07	11,400	1,150	0.05~0.15	0.07	9,900	760	0.05~0.15	0.07
		50	14,000	1,810	0.05~0.15	0.07	12,700	1,650	0.05~0.15	0.07	11,500	1,380	0.05~0.15	0.07	10,200	1,030	0.05~0.15	0.07	8,900	680	0.05~0.15	0.07
		60	12,600	1,630	0.05~0.15	0.07	11,500	1,490	0.05~0.15	0.07	10,300	1,240	0.05~0.15	0.07	9,200	930	0.05~0.15	0.07	8,000	610	0.05~0.15	0.07
2	4	20	17,500	3,260	0.05~0.20	0.08	15,900	2,960	0.05~0.20	0.08	14,300	2,530	0.05~0.20	0.08	12,700	1,910	0.05~0.20	0.08	11,100	1,270	0.05~0.20	0.08
		30	16,300	2,730	0.05~0.20	0.08	14,800	2,480	0.05~0.20	0.08	13,300	2,120	0.05~0.20	0.08	11,800	1,590	0.05~0.20	0.08	10,400	1,070	0.05~0.20	0.08
		40	14,900	2,490	0.05~0.20	0.08	13,500	2,260	0.05~0.20	0.08	12,200	1,940	0.05~0.20	0.08	10,800	1,460	0.05~0.20	0.08	9,500	970	0.05~0.20	0.08
		50	13,700	2,040	0.05~0.20	0.08	12,400	1,850	0.05~0.20	0.08	11,200	1,590	0.05~0.20	0.08	9,900	1,190	0.05~0.20	0.08	8,700	790	0.05~0.20	0.08
		60	12,300	1,830	0.05~0.20	0.08	11,100	1,650	0.05~0.20	0.08	10,000	1,420	0.05~0.20	0.08	8,900	1,070	0.05~0.20	0.08	7,800	710	0.05~0.20	0.08
		70	11,000	1,640	0.05~0.20	0.08	10,000	1,490	0.05~0.20	0.08	9,000	1,270	0.05~0.20	0.08	8,000	960	0.05~0.20	0.08	7,000	640	0.05~0.20	0.08
		80	11,000	1,640	0.05~0.20	0.08	10,000	1,490	0.05~0.20	0.08	9,000	1,270	0.05~0.20	0.08	8,000	960	0.05~0.20	0.08	7,000	640	0.05~0.20	0.08
2.5	5	30	13,000	2,880	0.05~0.25	0.1	11,800	2,610	0.05~0.25	0.1	10,700	2,220	0.05~0.25	0.1	9,500	1,670	0.05~0.25	0.1	8,300	1,100	0.05~0.25	0.1
		40	13,000	2,880	0.05~0.25	0.1	11,800	2,610	0.05~0.25	0.1	10,700	2,220	0.05~0.25	0.1	9,500	1,670	0.05~0.25	0.1	8,300	1,100	0.05~0.25	0.1
		50	11,900	2,630	0.05~0.25	0.1	10,800	2,390	0.05~0.25	0.1	9,700	2,020	0.05~0.25	0.1	8,700	1,530	0.05~0.25	0.1	7,600	1,010	0.05~0.25	0.1
		60	10,900	2,150	0.05~0.25	0.1	9,900	1,950	0.05~0.25	0.1	8,900	1,640	0.05~0.25	0.1	7,900	1,230	0.05~0.25	0.1	7,000	820	0.05~0.25	0.1
		70	9,800	1,930	0.05~0.25	0.1	8,900	1,750	0.05~0.25	0.1	8,000	1,480	0.05~0.25	0.1	7,100	1,110	0.05~0.25	0.1	6,200	730	0.05~0.25	0.1
		80	9,800	1,930	0.05~0.25	0.1	8,900	1,750	0.05~0.25	0.1	8,000	1,480	0.05~0.25	0.1	7,100	1,110	0.05~0.25	0.1	6,200	730	0.05~0.25	0.1
3	6	30	11,700	3,550	0.05~0.3	0.12	10,600	3,210	0.05~0.3	0.12	9,600	2,740	0.05~0.3	0.12	8,500	2,040	0.05~0.3	0.12	7,400	1,330	0.05~0.3	0.12
		40	10,900	2,970	0.05~0.3	0.12	9,900	2,700	0.05~0.3	0.12	8,900	2,280	0.05~0.3	0.12	7,900	1,710	0.05~0.3	0.12	6,900	1,120	0.05~0.3	0.12
		50	9,900	2,700	0.05~0.3	0.12	9,000	2,450	0.05~0.3	0.12	8,100	2,080	0.05~0.3	0.12	7,200	1,560	0.05~0.3	0.12	6,300	1,020	0.05~0.3	0.12
		60	9,900	2,700	0.05~0.3	0.12	9,000	2,450	0.05~0.3	0.12	8,100	2,080	0.05~0.3	0.12	7,200	1,560	0.05~0.3	0.12	6,300	1,020	0.05~0.3	0.12
		70	9,100	2,210	0.05~0.3	0.12	8,300	2,010	0.05~0.3	0.12	7,500	1,710	0.05~0.3	0.12	6,600	1,270	0.05~0.3	0.12	5,800	840	0.05~0.3	0.12
		80	8,200	1,990	0.05~0.3	0.12	7,400	1,790	0.05~0.3	0.12	6,700	1,530	0.05~0.3	0.12	5,900	1,130	0.05~0.3	0.12	5,200	750	0.05~0.3	0.12
		100	7,400	1,790	0.05~0.3	0.12	6,700	1,620	0.05~0.3	0.12	6,000	1,370	0.05~0.3	0.12	5,400	1,040	0.05~0.3	0.12	4,700	680	0.05~0.3	0.12
		120	7,400	1,790	0.05~0.3	0.12	6,700	1,620	0.05~0.3	0.12	6,000	1,370	0.05~0.3	0.12	5,400	1,040	0.05~0.3	0.12	4,700	680	0.05~0.3	0.12
4	8	40	8,800	3,720	0.05~0.4	0.16	8,000	3,380	0.05~0.4	0.16	7,200	2,870	0.05~0.4	0.16	6,400	2,130	0.05~0.4	0.16	5,600	1,410	0.05~0.4	0.16
		50	8,100	3,080	0.05~0.4	0.16	7,400	2,820	0.05~0.4	0.16	6,700	2,410	0.05~0.4	0.16	5,900	1,770	0.05~0.4	0.16	5,200	1,180	0.05~0.4	0.16
		60	8,100	3,080	0.05~0.4	0.16	7,400	2,820	0.05~0.4	0.16	6,700	2,410	0.05~0.4	0.16	5,900	1,770	0.05~0.4	0.16	5,200	1,180	0.05~0.4	0.16
		70	7,400	2,820	0.05~0.4	0.16	6,800	2,590	0.05~0.4	0.16	6,100	2,190	0.05~0.4	0.16	5,400	1,620	0.05~0.4	0.16	4,700	1,070	0.05~0.4	0.16
		80	7,400	2,820	0.05~0.4	0.16	6,800	2,590	0.05~0.4	0.16	6,100	2,190	0.05~0.4	0.16	5,400	1,620	0.05~0.4	0.16	4,700	1,070	0.05~0.4	0.16
		100	6,800	2,300	0.05~0.4	0.16	6,200	2,100	0.05~0.4	0.16	5,600	1,790	0.05~0.4	0.16	5,000	1,330	0.05~0.4	0.16	4,300	870	0.05~0.4	0.16
		120	6,100	2,060	0.05~0.4	0.16	5,600	1,900	0.05~0.4	0.16	5,000	1,600	0.05~0.4	0.16	4,500	1,200	0.05~0.4	0.16	3,900	790	0.05~0.4	0.16
5	10	50	7,000	3,890	0.05~0.5	0.2	6,400	3,550	0.05~0.5	0.2	5,700	2,980	0.05~0.5	0.2	5,100	2,230	0.05~0.5	0.2	4,500	1,490	0.05~0.5	0.2
		60	6,500	3,250	0.05~0.5	0.2	5,900	2,950	0.05~0.5	0.2	5,300	2,490	0.05~0.5	0.2	4,700	1,850	0.05~0.5	0.2	4,100	1,220	0.05~0.5	0.2
		75	6,500	3,250	0.05~0.5	0.2	5,900	2,950	0.05~0.5	0.2	5,300	2,490	0.05~0.5	0.2	4,700	1,850	0.05~0.5	0.2	4,100	1,220	0.05~0.5	0.2
		80	6,000	3,000	0.05~0.5	0.2	5,400	2,700	0.05~0.5	0.2	4,900	2,300	0.05~0.5	0.2	4,300	1,700	0.05~0.5	0.2	3,800	1,130	0.05~0.5	0.2
		100	6,000	3,000	0.05~0.5	0.2	5,400	2,700	0.05~0.5	0.2	4,900	2,300	0.05~0.5	0.2	4,300	1,700	0.05~0.5	0.2	3,800	1,130	0.05~0.5	0.2
		120	5,500	2,440	0.05~0.5	0.2	5,000	2,220	0.05~0.5	0.2	4,500	1,880	0.05~0.5	0.2	4,000	1,400	0.05~0.5	0.2	3,500	920	0.05~0.5	0.2
6	12	60	5,800	3,690	0.05~0.6	0.24	5,300	3,370	0.05~0.6	0.24	4,800	2,870	0.05~0.6	0.24	4,200	2,100	0.05~0.6	0.24	3,700	1,400	0.05~0.6	0.24
		80	5,400	3,090	0.05~0.6	0.24	4,900	2,800	0.05~0.6	0.24	4,400	2,360	0.05~0.6	0.24	3,900	1,760	0.05~0.6	0.24	3,500	1,190	0.05~0.6	0.24
		100	5,000	2,860	0.05~0.6	0.24	4,500	2,580	0.05~0.6	0.24	4,100	2,200	0.05~0.6	0.24	3,600	1,620	0.05~0.6	0.24	3,200	1,090	0.05~0.6	0.24
		120	5,000	2,860	0.05~0.6	0.24	4,500	2,580	0.05~0.6	0.24	4,100	2,200	0.05~0.6	0.24	3,600	1,620	0.05~0.6	0.24	3,200	1,090	0.05~0.6	0.24

【Note】
① Use the appropriate coolant for the work material and machining shape.
② Use as highly rigid and accurate machine as possible.
③ These conditions are for general guidance; in actual machining conditions adjust the parameters according to your actual machine and work-piece conditions.
④ If the rpm available is lower than that recommended please reduce the feed rate to the same ratio.

Field data

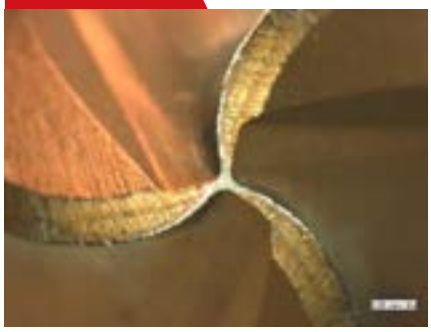
Example of cutting high-toughness material [DH31, 45HRC]

<Model shape>



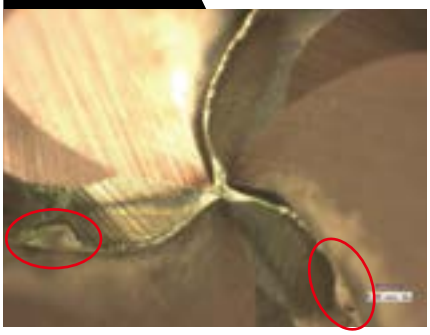
Tool：EMBE3060-ATH　ϕ6 (RE3)
n=4,000min^{-1} (v_c=75m/min)　v_f=1,150mm/min (f_z=0.097mm/t)　a_p=0.36mm　a_e=1mm
Water base coolant　Machine：Vertical MC (HSK-F63)　Over hang：30mm(5DC)
Number of Pocket milling：1pc.　**Process time：75min**

EMBE-ATH



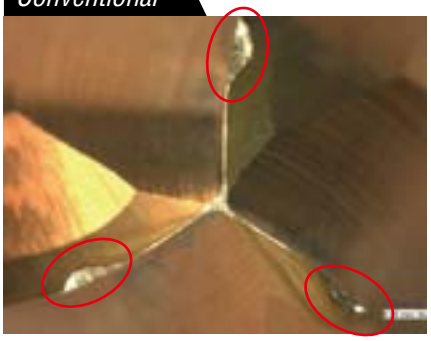
VB=0.05mm
Small wear width
(Continuous cutting is possible.)

Conventional



Tool life is ended due to heavy chipping on 2 edges.

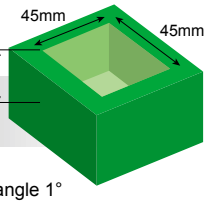
Conventional



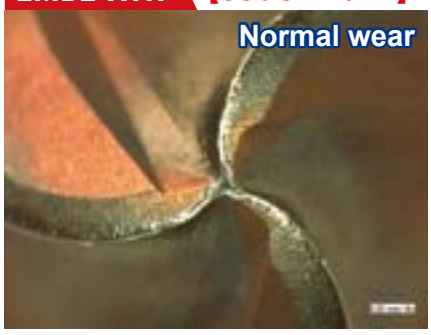
Tool life is ended due to chipping early of use.

Cutting performance of steel grade

<Model shape>



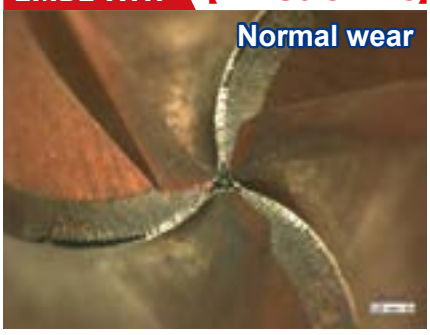
EMBE-ATH 【S50C 220HB】



VB=0.09mm

Tool：EMBE3060-ATH　ϕ6 (RE3)
n=11,700min^{-1} (v_c=220m/min)
v_f=4,390mm/min (f_z=0.125mm/t)
a_p=0.6mm, a_e=1.8mm
Dry air blow
Over hang：30mm(5DC)
Machine：Vertical MC (HSK-F63)
Number of Pocket milling：2 pcs.
Process time：40min

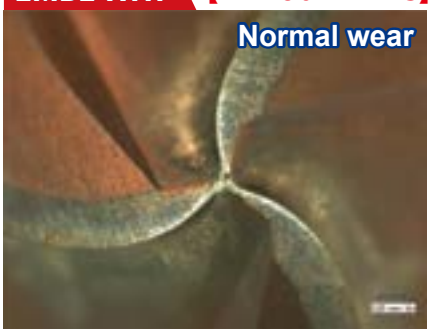
EMBE-ATH 【HPM38 54HRC】



VB=0.06mm

Tool：EMBE3060-ATH　ϕ6 (RE3)
n=8,500min^{-1} (v_c=160m/min)
v_f=2,550mm/min (f_z=0.1mm/t)
a_p=0.42mm, a_e=1.26mm
Dry air blow
Over hang：30mm(5DC)
Machine：Vertical MC (HSK-F63)
Number of Pocket milling：1pc.
Process time：45min

EMBE-ATH 【NAK80 41HRC】

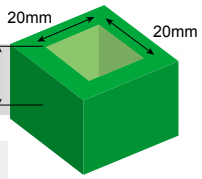


VB=0.04mm

Tool：EMBE3060-ATH　ϕ6 (RE3)
n=9,500min^{-1} (v_c=179m/min)
v_f=3,380mm/min (f_z=0.118mm/t)
a_p=0.6mm, a_e=1.8mm
Dry air blow
Over hang：OH=30mm(5DC)
Machine：Vertical MC (HSK-F63)
Number of Pocket milling：4pcs.
Process time：90min

Achieves high-efficiency on kind of steel grade

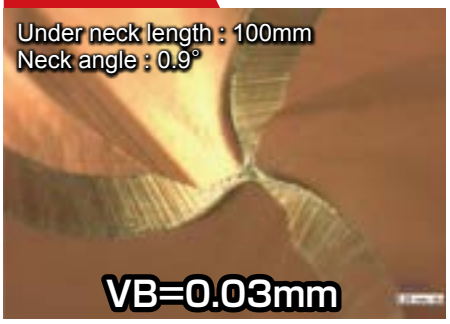
Example of deep cutting (L/D=16) [DH31, 45HRC]



<Model shape>

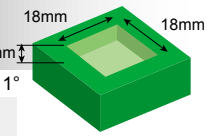
Tool：EMBPE3060-100-09-ATH　ϕ6(RE3) ×Under neck length 100mm × Neck angle 0.9°
n=1,500min^{-1} (v_c=28m/min)　v_f=360mm/min (f_z=0.08mm/t)　a_p=0.21mm　a_e=0.5mm
Water base coolant　　Machine：Vertical MC (HSK-F63)　Over hang：105mm(17.5DC)
Number of Pocket milling：1pc.　**Process time：195min**

EMBPE-ATH



Conventional

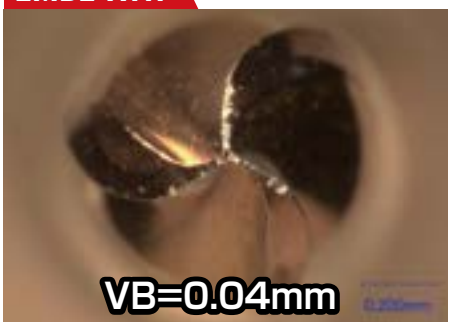
Example of maximum tool dia. φ1 [DH31, 45HRC]



<Model shape>

Tool：EMBE3010-S4-ATH　ϕ1 (RE0.5)
n=18,000min^{-1} (v_c=57m/min)　v_f=900mm/min (f_z=0.025mm/t)　a_p=0.05mm　a_e=0.16mm
Water base coolant　　Machine：Vertical MC (HSK-F63)　Over hang：15mm
Number of Pocket milling：1pc.　**Process time：45min**

EMBE-ATH



Conventional

Recommended line up of ball end mills

4 flutes　**EHHBE-TH3**

Epoch High Hard Ball-TH3

- The performance is shown by direct milling of high hardened materials. (over 55HRC).
- In case of process of the less than 55HRC material which recommends two-flute and three-flute end mill.

More than 55HRC

3 flutes　**EMBE-ATH**

Epoch Mega Feed Ball Evolution

- Possible highly efficient processing for less than 55HRC material.
- Specialized edge shape for sticky material (DH31).
- Lineup with a total of 117 items.

Straight : 21 items
Pencil : 96 items

Less than 55HRC, Deep cutting

2 flutes　**EPBTS-TH**

Epoch TH Hard Ball Strong

- Achieves long tool life by strong edge shape geometry and ATH Coating.
- Even negative cutting edge geometry, high helix edge shape provides low cutting force. Able to the finishing process for high hardened materials.

2 flutes　**HGOB-PN**

Epoch Panacea Ball

- Possible long life processing for less than 52HRC material
- Performance is shown the welding material, for example carbon steel, alloy steel and stainless steel.

MOLDINO

The Edge To Innovation

The diagrams and table data are examples of test results, and are not guaranteed values.

⚠ Attentions on Safety

1. Cautions regarding handling

(1) When removing the tool from its case (packaging), be careful that the tool does not pop out or is dropped. Be particularly careful regarding contact with the tool flutes.
(2) When handling tools with sharp cutting flutes, be careful not to touch the cutting flutes directly with your bare hands.

2. Cautions regarding mounting

(1) Before use, check the outside appearance of the tool for scratches, cracks, etc. and that it is firmly mounted in the collet chuck, etc.
(2) If abnormal chattering, etc. occurs during use, stop the machine immediately and remove the cause of the chattering.

3. Cautions during use

(1) Before use, confirm the dimensions and direction of rotation of the tool and milling work material.
(2) The numerical values in the standard cutting conditions table should be used as criteria when starting new work. The cutting conditions should be adjusted as appropriate when the cutting depth is large, the rigidity of the machine being used is low, or according to the conditions of the work material.
(3) Cutting tools are made of a hard material. During use, they may break and fly off. In addition, cutting chips may also fly off. Since there is a danger of injury to workers, fire, or eye damage from such flying pieces, a safety cover should be attached when work is performed and safety equipment such as safety goggles should be worn to create a safe environment for work.
(4) There is a risk of fire or inflammation due to sparks, heat due to breakage, and cutting chips. Do not use where there is a risk of fire or explosion. **Please caution of fire while using oil base coolant, fire prevention is necessary.**
(5) Do not use the tool for any purpose other than that for which it is intended.

4. Cautions regarding regrinding

(1) If regrinding is not performed at the proper time, there is a risk of the tool breaking. Replace the tool with one in good condition, or perform regrinding.
(2) Grinding dust will be created when regrinding a tool. When regrinding, be sure to attach a safety cover over the work area and wear safety clothes such as safety goggles, etc.
(3) This product contains the specified chemical substance cobalt and its inorganic compounds. When performing regrinding or similar processing, be sure to handle the processing in accordance with the local laws and regulations regarding prevention of hazards due to specified chemical substances.

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