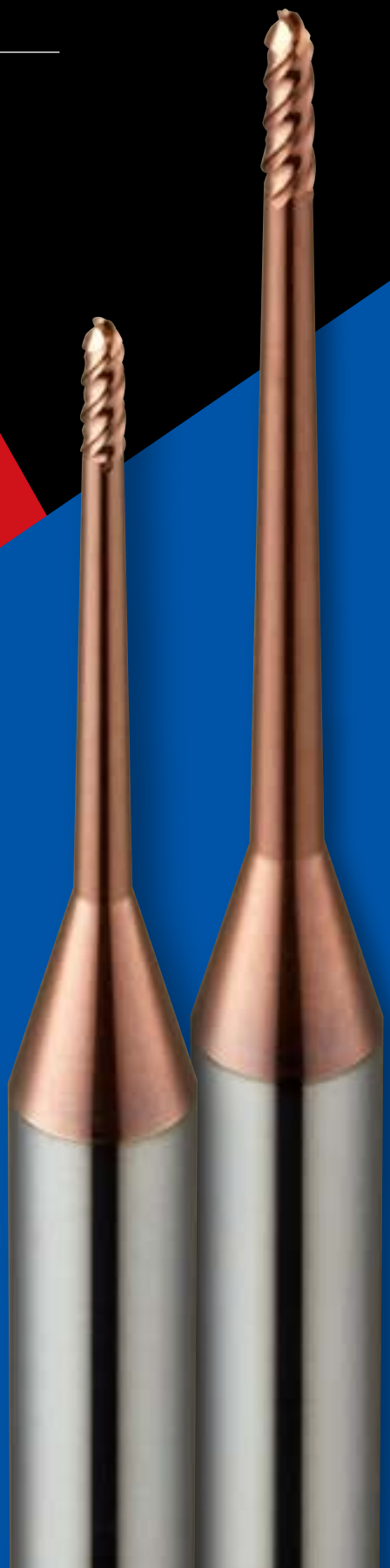
MOLDINO
The Edge To Innovation

Taper Ball End Mill for High Accuracy Rib Slotting

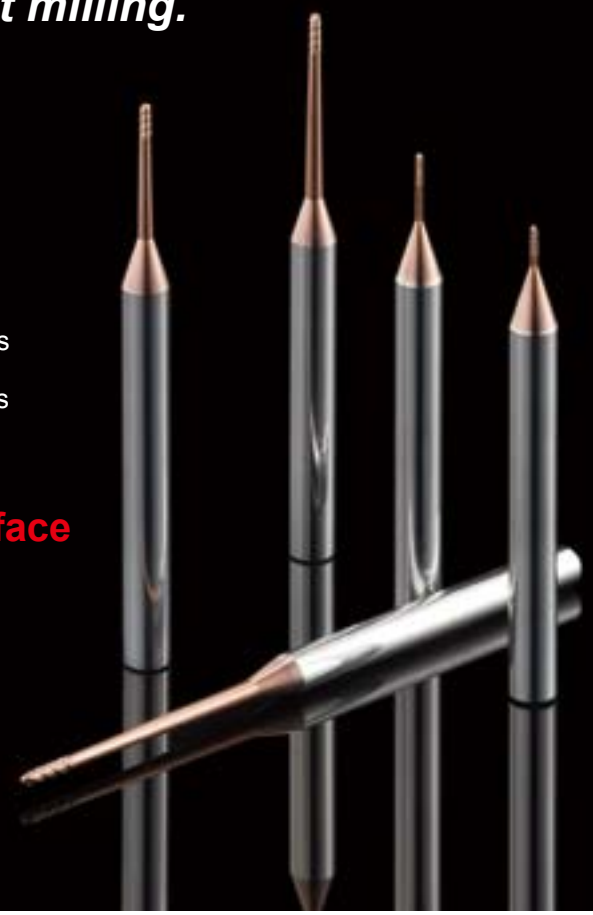
EB4HR-ATH



MOLDINO Tool Engineering, Ltd.

New Product News | No.1804E-2 | 2020-4

New rib slotting method by contouring with taper end mill. Reduce the polishing time with direct milling.



Features of EB4HR-ATH

01 Reduces machining steps occurring at tool change

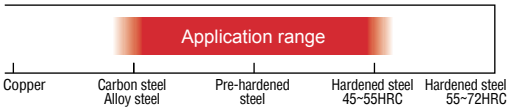
Tapered peripheral edge shape reduces the machining steps occurring at tool change.
Furthermore, when used from roughing, the cutting remain is reduced and high accuracy finishing is realized.

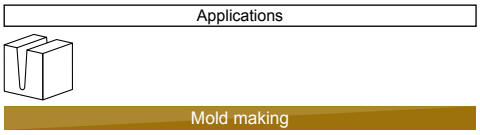
02 Achieves high quality machined surface

A good machined surface can be obtained with double flank shape and high-helix edge shape.
Reduces the polishing time of the next process.

03 Adopts ATH Coating

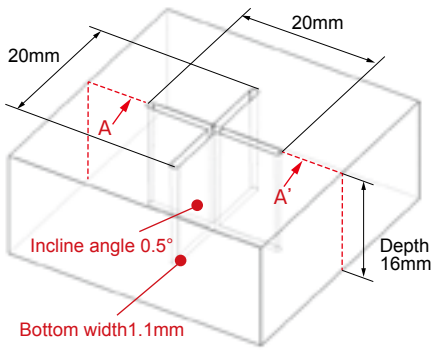
Shows excellent performance for high hardness steels cutting such as cold die steels, high speed steels, pre-hardened steels etc.

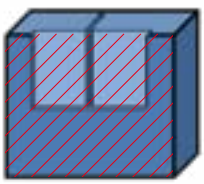




EB4HR-ATH
R0.3～R0.6 [108 Items]

Technology





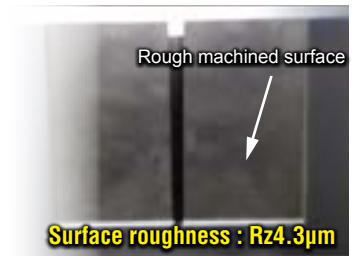
Cross-section observation

Rib slot model

Cutting by conventional tools

Difficult to remove steps by polishing

EDM



Takes time to polish rough machined surface

EB4HR-ATH

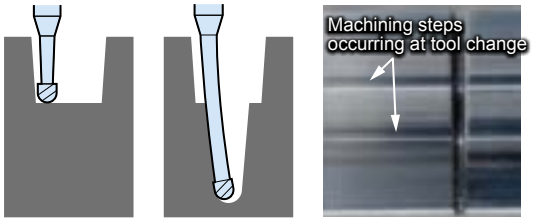
Good machined surface and reduces polishing time

Reduces the total machining time including polishing by suppressing the machining steps caused by tool change.

Features 01 Reduces machining steps occurring at tool change

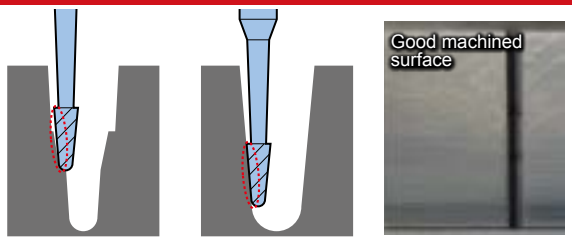
Issue in general contour roughing

Since deflection amount is different according to the tool neck length, the machining steps occur at tool change.



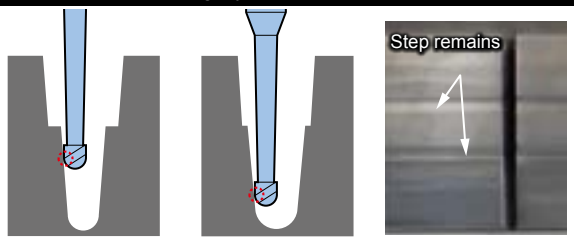
Contour finishing

EB4HR-ATH



Since the peripheral edge of EB4HR-ATH works repeatedly, easy to remove the steps.

Cutting by conventional tools

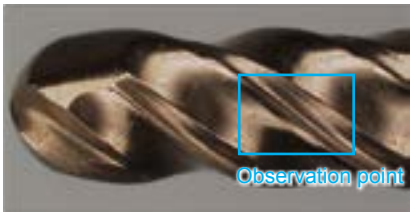


Since ball edge works at a point, steps can not be removed sufficiently.

The peripheral cutting edge effectively removes the steps occurring at tool change.

Features 02 Achieve high quality machined surface

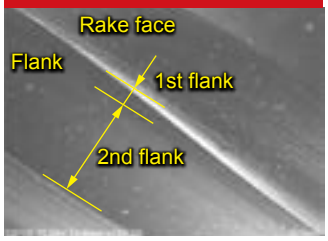
Special peripheral cutting edge shape



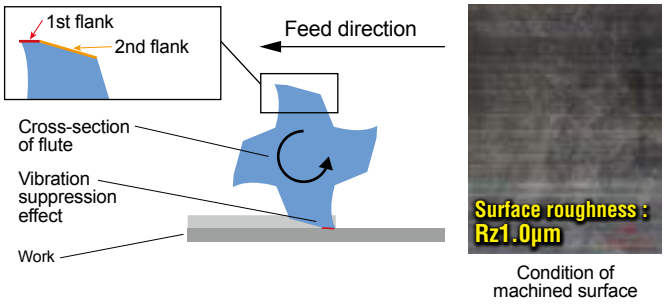
Double flank shape

40° high helix edge shape excellent in sharpness

Double flank shape

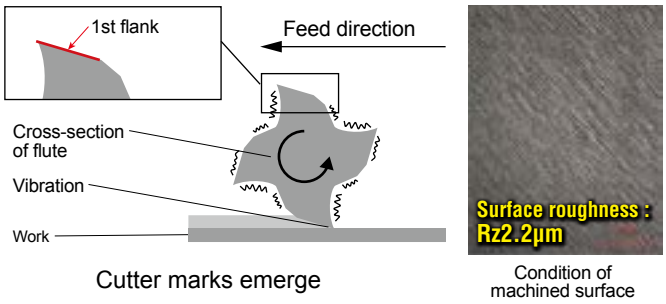


Double flank shape



Condition of machined surface

Conventional shape



Cutter marks emerge

Condition of machined surface

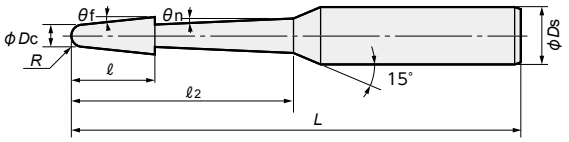
Special peripheral cutting edge shape gives better machined surface and reduces polishing time

Features 03 Adopts ATH Coating

- Hardness and oxidation resistance of TH coatings 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

Line Up

Tip : 2 flutes
Periphery : 4 flutes



EB4HR○○○○TN-○○-○○-ATH

Carbide | ATH Coated | Helix 40° | h5

(mm)

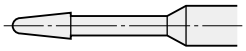
Ball radius R	Tolerance on R
R0.3~R0.6	±0.02

Item Code	Stock	Size (mm)							Neck Shape	Neck Angle θn (°)
		Ball Radius R	Tool Dia. Dc	Taper angle on side θf	Under Neck Length ℓ2	Flute Length ℓ	Overall Length L	Shank Dia. Ds		
EB4HR0060TN-4-05-ATH	●	0.3	0.6	0.5	4	3.2	50	4	A	-
EB4HR0060TN-5-05-ATH	●	0.3	0.6	0.5	5	3.2	50	4	A	-
EB4HR0060TN-6-05-ATH	●	0.3	0.6	0.5	6	3.2	50	4	A	-
EB4HR0060TN-7-05-ATH	●	0.3	0.6	0.5	7	3.2	50	4	B	0.5
EB4HR0060TN-8-05-ATH	●	0.3	0.6	0.5	8	3.2	50	4	B	0.5
EB4HR0060TN-9-05-ATH	●	0.3	0.6	0.5	9	3.2	50	4	B	0.5
EB4HR0060TN-10-05-ATH	●	0.3	0.6	0.5	10	3.2	50	4	B	0.5
EB4HR0060TN-4-10-ATH	●	0.3	0.6	1	4	3.2	50	4	A	-
EB4HR0060TN-5-10-ATH	●	0.3	0.6	1	5	3.2	50	4	A	-
EB4HR0060TN-6-10-ATH	●	0.3	0.6	1	6	3.2	50	4	A	-
EB4HR0060TN-7-10-ATH	●	0.3	0.6	1	7	3.2	50	4	B	1
EB4HR0060TN-8-10-ATH	●	0.3	0.6	1	8	3.2	50	4	B	1
EB4HR0060TN-9-10-ATH	●	0.3	0.6	1	9	3.2	50	4	B	1
EB4HR0060TN-10-10-ATH	●	0.3	0.6	1	10	3.2	50	4	B	1
EB4HR0070TN-4-05-ATH	●	0.35	0.7	0.5	4	3.2	50	4	A	-
EB4HR0070TN-5-05-ATH	●	0.35	0.7	0.5	5	3.2	50	4	A	-
EB4HR0070TN-6-05-ATH	●	0.35	0.7	0.5	6	3.2	50	4	A	-
EB4HR0070TN-7-05-ATH	●	0.35	0.7	0.5	7	3.2	50	4	B	0.5
EB4HR0070TN-8-05-ATH	●	0.35	0.7	0.5	8	3.2	50	4	B	0.5
EB4HR0070TN-9-05-ATH	●	0.35	0.7	0.5	9	3.2	50	4	B	0.5
EB4HR0070TN-10-05-ATH	●	0.35	0.7	0.5	10	3.2	50	4	B	0.5
EB4HR0070TN-4-10-ATH	●	0.35	0.7	1	4	3.2	50	4	A	-
EB4HR0070TN-5-10-ATH	●	0.35	0.7	1	5	3.2	50	4	A	-
EB4HR0070TN-6-10-ATH	●	0.35	0.7	1	6	3.2	50	4	A	-
EB4HR0070TN-7-10-ATH	●	0.35	0.7	1	7	3.2	50	4	B	1
EB4HR0070TN-8-10-ATH	●	0.35	0.7	1	8	3.2	50	4	B	1
EB4HR0070TN-9-10-ATH	●	0.35	0.7	1	9	3.2	50	4	B	1
EB4HR0070TN-10-10-ATH	●	0.35	0.7	1	10	3.2	50	4	B	1
EB4HR0080TN-4-05-ATH	●	0.4	0.8	0.5	4	3.2	50	4	A	-
EB4HR0080TN-6-05-ATH	●	0.4	0.8	0.5	6	3.2	50	4	A	-
EB4HR0080TN-8-05-ATH	●	0.4	0.8	0.5	8	3.2	50	4	B	0.5
EB4HR0080TN-10-05-ATH	●	0.4	0.8	0.5	10	3.2	50	4	B	0.5
EB4HR0080TN-12-05-ATH	●	0.4	0.8	0.5	12	3.2	55	4	B	0.5
EB4HR0080TN-14-05-ATH	●	0.4	0.8	0.5	14	3.2	55	4	B	0.5
EB4HR0080TN-4-10-ATH	●	0.4	0.8	1	4	3.2	50	4	A	-
EB4HR0080TN-6-10-ATH	●	0.4	0.8	1	6	3.2	50	4	A	-
EB4HR0080TN-8-10-ATH	●	0.4	0.8	1	8	3.2	50	4	B	1
EB4HR0080TN-10-10-ATH	●	0.4	0.8	1	10	3.2	50	4	B	1
EB4HR0080TN-12-10-ATH	●	0.4	0.8	1	12	3.2	55	4	B	1
EB4HR0080TN-14-10-ATH	●	0.4	0.8	1	14	3.2	55	4	B	1
EB4HR0090TN-4-05-ATH	●	0.45	0.9	0.5	4	3.2	50	4	A	-
EB4HR0090TN-6-05-ATH	●	0.45	0.9	0.5	6	3.2	50	4	A	-
EB4HR0090TN-8-05-ATH	●	0.45	0.9	0.5	8	3.2	50	4	B	0.5
EB4HR0090TN-10-05-ATH	●	0.45	0.9	0.5	10	3.2	50	4	B	0.5
EB4HR0090TN-12-05-ATH	●	0.45	0.9	0.5	12	3.2	55	4	B	0.5
EB4HR0090TN-14-05-ATH	●	0.45	0.9	0.5	14	3.2	55	4	B	0.5
EB4HR0090TN-4-10-ATH	●	0.45	0.9	1	4	3.2	50	4	A	-
EB4HR0090TN-6-10-ATH	●	0.45	0.9	1	6	3.2	50	4	A	-
EB4HR0090TN-8-10-ATH	●	0.45	0.9	1	8	3.2	50	4	B	1
EB4HR0090TN-10-10-ATH	●	0.45	0.9	1	10	3.2	50	4	B	1
EB4HR0090TN-12-10-ATH	●	0.45	0.9	1	12	3.2	55	4	B	1
EB4HR0090TN-14-10-ATH	●	0.45	0.9	1	14	3.2	55	4	B	1

● : Stocked items.

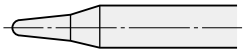
■ Detail of neck shape

Neck shape A
Straight neck



Neck shape B
Taper neck

Neck shape C
Without neck



EB4HR○○○○TN-○○-○○-ATH

Item Code	Stock	Size (mm)							Neck Shape	Neck Angle θn (°)
		Ball Radius *R*	Tool Dia. *Dc*	Taper angle on side θf	Under Neck Length ℓ2	Flute Length ℓ	Overall Length *L*	Shank Dia. *Ds*		
EB4HR0100TN-4-05-ATH	●	0.5	1	0.5	4	4	50	4	C	-
EB4HR0100TN-6-05-ATH	●	0.5	1	0.5	6	4	50	4	A	-
EB4HR0100TN-8-05-ATH	●	0.5	1	0.5	8	4	50	4	B	0.5
EB4HR0100TN-10-05-ATH	●	0.5	1	0.5	10	4	50	4	B	0.5
EB4HR0100TN-12-05-ATH	●	0.5	1	0.5	12	4	55	4	B	0.5
EB4HR0100TN-14-05-ATH	●	0.5	1	0.5	14	4	55	4	B	0.5
EB4HR0100TN-16-05-ATH	●	0.5	1	0.5	16	4	55	4	B	0.5
EB4HR0100TN-18-05-ATH	●	0.5	1	0.5	18	4	60	4	B	0.5
EB4HR0100TN-20-05-ATH	●	0.5	1	0.5	20	4	60	4	B	0.5
EB4HR0100TN-4-10-ATH	●	0.5	1	1	4	4	50	4	C	-
EB4HR0100TN-6-10-ATH	●	0.5	1	1	6	4	50	4	A	-
EB4HR0100TN-8-10-ATH	●	0.5	1	1	8	4	50	4	B	1
EB4HR0100TN-10-10-ATH	●	0.5	1	1	10	4	50	4	B	1
EB4HR0100TN-12-10-ATH	●	0.5	1	1	12	4	55	4	B	1
EB4HR0100TN-14-10-ATH	●	0.5	1	1	14	4	55	4	B	1
EB4HR0100TN-16-10-ATH	●	0.5	1	1	16	4	55	4	B	1
EB4HR0100TN-18-10-ATH	●	0.5	1	1	18	4	60	4	B	1
EB4HR0100TN-20-10-ATH	●	0.5	1	1	20	4	60	4	B	1
EB4HR0110TN-4-05-ATH	●	0.55	1.1	0.5	4	4	50	4	C	-
EB4HR0110TN-6-05-ATH	●	0.55	1.1	0.5	6	4	50	4	A	-
EB4HR0110TN-8-05-ATH	●	0.55	1.1	0.5	8	4	50	4	B	0.5
EB4HR0110TN-10-05-ATH	●	0.55	1.1	0.5	10	4	50	4	B	0.5
EB4HR0110TN-12-05-ATH	●	0.55	1.1	0.5	12	4	55	4	B	0.5
EB4HR0110TN-14-05-ATH	●	0.55	1.1	0.5	14	4	55	4	B	0.5
EB4HR0110TN-16-05-ATH	●	0.55	1.1	0.5	16	4	55	4	B	0.5
EB4HR0110TN-18-05-ATH	●	0.55	1.1	0.5	18	4	60	4	B	0.5
EB4HR0110TN-20-05-ATH	●	0.55	1.1	0.5	20	4	60	4	B	0.5
EB4HR0110TN-4-10-ATH	●	0.55	1.1	1	4	4	50	4	C	-
EB4HR0110TN-6-10-ATH	●	0.55	1.1	1	6	4	50	4	A	-
EB4HR0110TN-8-10-ATH	●	0.55	1.1	1	8	4	50	4	B	1
EB4HR0110TN-10-10-ATH	●	0.55	1.1	1	10	4	50	4	B	1
EB4HR0110TN-12-10-ATH	●	0.55	1.1	1	12	4	55	4	B	1
EB4HR0110TN-14-10-ATH	●	0.55	1.1	1	14	4	55	4	B	1
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EB4HR0110TN-18-10-ATH	●	0.55	1.1	1	18	4	60	4	B	1
EB4HR0110TN-20-10-ATH	●	0.55	1.1	1	20	4	60	4	B	1
EB4HR0120TN-6-05-ATH	●	0.6	1.2	0.5	6	4.8	50	4	A	-
EB4HR0120TN-8-05-ATH	●	0.6	1.2	0.5	8	4.8	50	4	B	0.5
EB4HR0120TN-10-05-ATH	●	0.6	1.2	0.5	10	4.8	50	4	B	0.5
EB4HR0120TN-12-05-ATH	●	0.6	1.2	0.5	12	4.8	55	4	B	0.5
EB4HR0120TN-14-05-ATH	●	0.6	1.2	0.5	14	4.8	55	4	B	0.5
EB4HR0120TN-16-05-ATH	●	0.6	1.2	0.5	16	4.8	55	4	B	0.5
EB4HR0120TN-18-05-ATH	●	0.6	1.2	0.5	18	4.8	60	4	B	0.5
EB4HR0120TN-20-05-ATH	●	0.6	1.2	0.5	20	4.8	60	4	B	0.5
EB4HR0120TN-22-05-ATH	●	0.6	1.2	0.5	22	4.8	60	4	B	0.5
EB4HR0120TN-24-05-ATH	●	0.6	1.2	0.5	24	4.8	60	4	B	0.5
EB4HR0120TN-6-10-ATH	●	0.6	1.2	1	6	4.8	50	4	A	-
EB4HR0120TN-8-10-ATH	●	0.6	1.2	1	8	4.8	50	4	B	1
EB4HR0120TN-10-10-ATH	●	0.6	1.2	1	10	4.8	50	4	B	1
EB4HR0120TN-12-10-ATH	●	0.6	1.2	1	12	4.8	55	4	B	1
EB4HR0120TN-14-10-ATH	●	0.6	1.2	1	14	4.8	55	4	B	1
EB4HR0120TN-16-10-ATH	●	0.6	1.2	1	16	4.8	55	4	B	1
EB4HR0120TN-18-10-ATH	●	0.6	1.2	1	18	4.8	60	4	B	1
EB4HR0120TN-20-10-ATH	●	0.6	1.2	1	20	4.8	60	4	B	1
EB4HR0120TN-22-10-ATH	●	0.6	1.2	1	22	4.8	60	4	B	1
EB4HR0120TN-24-10-ATH	●	0.6	1.2	1	24	4.8	60	4	B	1

Recommended Cutting Conditions

Roughing conditions

Work material				1		2		3		4	
				Carbon steels, Alloy steels (180～250HB)		Tool steels (25～35HRC)		Pre-hardened steels (35～45HRC)		Hardened Steels (45～55HRC)	
Ratio to standard depth of cut				100%		90%		80%		65%	
Ball Radius R (mm)	Tool dia. Dc (mm)	Under neck length ℓ_2 (mm)	a_p (mm)	Revolution n min^{-1}	Feed rate v_f mm/min	Revolution n min^{-1}	Feed rate v_f mm/min	Revolution n min^{-1}	Feed rate v_f mm/min	Revolution n min^{-1}	Feed rate v_f mm/min
0.3	0.6	4	0.024	36,000	1,030	32,400	920	30,600	760	27,000	610
	0.6	5	0.020	36,000	970	32,400	880	30,600	720	27,000	580
	0.6	6	0.015	36,000	970	32,400	880	30,600	720	27,000	580
	0.6	7	0.008	32,000	820	28,800	730	27,200	600	24,000	490
	0.6	8	0.008	32,000	820	28,800	730	27,200	600	24,000	490
	0.6	9	0.006	32,000	820	28,800	730	27,200	600	24,000	490
	0.6	10	0.005	28,000	710	25,200	640	23,800	530	21,000	430
0.35	0.7	4	0.034	36,000	1,130	32,400	1,020	30,600	840	27,000	690
	0.7	5	0.030	36,000	1,130	32,400	1,020	30,600	840	27,000	690
	0.7	6	0.027	36,000	1,070	32,400	960	30,600	800	27,000	650
	0.7	7	0.020	32,000	840	28,800	760	27,200	630	24,000	520
	0.7	8	0.010	32,000	840	28,800	760	27,200	630	24,000	520
	0.7	9	0.008	32,000	840	28,800	760	27,200	630	24,000	520
	0.7	10	0.005	28,000	740	25,200	670	23,800	550	21,000	460
0.4	0.8	4	0.035	40,000	1,440	36,000	1,300	34,000	1,090	30,000	900
	0.8	6	0.032	36,000	1,170	32,400	1,050	30,600	880	27,000	730
	0.8	8	0.020	32,000	1,040	28,800	930	27,200	780	24,000	650
	0.8	10	0.010	32,000	980	28,800	880	27,200	740	24,000	610
	0.8	12	0.008	32,000	980	28,800	880	27,200	740	24,000	610
	0.8	14	0.005	28,000	860	25,200	770	23,816	650	21,000	530
0.45	0.9	4	0.045	38,000	1,620	34,200	1,460	32,300	1,200	28,500	1,000
	0.9	6	0.042	34,200	1,310	30,800	1,180	29,100	980	25,700	810
	0.9	8	0.030	30,400	1,170	27,400	1,050	25,800	880	22,800	720
	0.9	10	0.020	30,400	1,170	27,400	1,050	25,800	880	22,800	720
	0.9	12	0.010	30,400	1,170	27,400	1,050	25,800	880	22,800	720
	0.9	14	0.008	26,000	1,000	23,500	900	22,100	750	19,500	620
0.5	1	4	0.040	32,400	1,460	29,200	1,310	27,500	1,120	24,300	920
	1	6	0.040	32,400	1,460	29,200	1,310	27,500	1,120	24,300	920
	1	8	0.040	32,400	1,460	29,200	1,310	27,500	1,120	24,300	920
	1	10	0.025	32,400	1,460	29,200	1,310	27,500	1,120	24,300	920
	1	12	0.013	28,800	1,220	25,900	1,100	24,500	940	21,600	770
	1	14	0.010	28,800	1,220	25,900	1,100	24,500	940	21,600	770
	1	16	0.008	28,800	1,220	25,900	1,100	24,500	940	21,600	770
	1	18	0.006	25,200	1,010	22,700	910	21,400	770	18,900	640
	1	20	0.005	21,600	860	19,400	780	18,400	660	16,200	540
0.55	1.1	4	0.040	30,600	1,480	27,500	1,330	26,000	1,090	23,000	920
	1.1	6	0.040	30,600	1,480	27,500	1,330	26,000	1,090	23,000	920
	1.1	8	0.040	30,600	1,480	27,500	1,330	26,000	1,090	23,000	920
	1.1	10	0.025	30,600	1,480	27,500	1,330	26,000	1,090	23,000	920
	1.1	12	0.020	27,200	1,240	24,500	1,110	23,100	920	20,400	770
	1.1	14	0.015	27,200	1,240	24,500	1,110	23,100	920	20,400	770
	1.1	16	0.010	27,200	1,240	24,500	1,110	23,100	920	20,400	770
	1.1	18	0.008	23,800	1,020	21,400	910	20,200	750	17,800	630
	1.1	20	0.005	20,400	870	18,300	780	17,300	640	15,200	540
0.6	1.2	6	0.060	28,800	1,500	25,900	1,350	24,500	1,100	21,600	950
	1.2	8	0.040	28,800	1,500	25,900	1,350	24,500	1,100	21,600	950
	1.2	10	0.035	28,800	1,420	25,900	1,210	24,500	1,100	21,600	860
	1.2	12	0.030	28,800	1,350	25,900	1,210	24,500	1,100	21,600	860
	1.2	14	0.025	24,600	1,150	22,200	1,040	21,000	940	18,500	730
	1.2	16	0.020	24,600	1,150	22,200	1,040	21,000	940	18,500	730
	1.2	18	0.015	24,600	1,150	22,200	1,040	21,000	940	18,500	730
	1.2	20	0.010	21,000	990	19,000	890	18,000	810	15,900	630
	1.2	22	0.010	21,000	990	19,000	890	18,000	810	15,900	630
	1.2	24	0.008	21,000	990	19,000	890	18,000	810	15,900	630

Finishing conditions

Work material				1		2		3		4	
				Carbon steels, Alloy steels (180～250HB)		Tool steels (25～35HRC)		Pre-hardened steels (35～45HRC)		Hardened Steels (45～55HRC)	
Ratio to standard depth of cut				100%		90%		80%		65%	
Ball Radius R (mm)	Tool dia. Dc (mm)	Under neck length ℓ_2 (mm)	a_p (mm)	Revolution n min^{-1}	Feed rate v_f mm/min	Revolution n min^{-1}	Feed rate v_f mm/min	Revolution n min^{-1}	Feed rate v_f mm/min	Revolution n min^{-1}	Feed rate v_f mm/min
0.3	0.6	4	0.023	18,000	1,030	16,200	920	15,300	760	13,500	620
	0.6	5	0.023	18,000	970	16,200	880	15,300	720	13,500	580
	0.6	6	0.020	18,000	970	16,200	880	15,300	720	13,500	580
	0.6	7	0.020	16,000	820	14,400	730	13,600	600	12,000	490
	0.6	8	0.020	16,000	820	14,400	730	13,600	600	12,000	490
	0.6	9	0.020	16,000	820	14,400	730	13,600	600	12,000	490
	0.6	10	0.020	14,000	710	12,600	640	11,900	530	10,500	430
0.35	0.7	4	0.023	18,000	1,130	16,200	1,020	15,300	840	13,500	690
	0.7	5	0.023	18,000	1,130	16,200	1,020	15,300	840	13,500	690
	0.7	6	0.020	18,000	1,070	16,200	960	15,300	790	13,500	650
	0.7	7	0.020	16,000	840	14,400	760	13,600	630	12,000	520
	0.7	8	0.020	16,000	840	14,400	760	13,600	630	12,000	520
	0.7	9	0.020	16,000	840	14,400	760	13,600	630	12,000	520
	0.7	10	0.020	14,000	740	12,600	670	11,900	550	10,500	460
0.4	0.8	4	0.028	20,000	1,440	18,000	1,300	17,000	1,090	15,000	900
	0.8	6	0.028	18,000	1,170	16,200	1,050	15,300	880	13,500	730
	0.8	8	0.025	16,000	1,040	14,400	930	13,600	780	12,000	650
	0.8	10	0.025	16,000	980	14,400	880	13,600	740	12,000	610
	0.8	12	0.025	16,000	980	14,400	880	13,600	740	12,000	610
	0.8	14	0.025	14,000	860	12,600	770	11,900	650	10,500	530
0.45	0.9	4	0.028	19,000	1,620	17,100	1,460	16,200	1,220	14,300	1,000
	0.9	6	0.028	17,100	1,310	15,400	1,180	14,600	980	12,900	810
	0.9	8	0.025	15,200	1,170	13,700	1,050	12,900	880	11,400	720
	0.9	10	0.025	15,200	1,170	13,700	1,050	12,900	880	11,400	720
	0.9	12	0.025	15,200	1,170	13,700	1,050	12,900	880	11,400	720
	0.9	14	0.025	13,000	1,000	11,800	900	11,100	750	9,800	620
0.5	1	4	0.035	16,200	1,460	14,600	1,310	13,800	1,120	12,200	920
	1	6	0.035	16,200	1,460	14,600	1,310	13,800	1,120	12,200	920
	1	8	0.035	16,200	1,460	14,600	1,310	13,800	1,120	12,200	920
	1	10	0.032	16,200	1,460	14,600	1,310	13,800	1,120	12,200	920
	1	12	0.032	14,400	1,220	13,000	1,100	12,300	940	10,800	770
	1	14	0.032	14,400	1,220	13,000	1,100	12,300	940	10,800	770
	1	16	0.032	14,400	1,220	13,000	1,100	12,300	940	10,800	770
	1	18	0.030	12,600	1,010	11,400	900	10,700	770	9,500	640
	1	20	0.030	10,800	860	9,700	780	9,200	660	8,100	540
0.55	1.1	4	0.035	15,300	1,480	13,800	1,330	13,000	1,090	11,500	920
	1.1	6	0.035	15,300	1,480	13,800	1,330	13,000	1,090	11,500	920
	1.1	8	0.035	15,300	1,480	13,800	1,330	13,000	1,090	11,500	920
	1.1	10	0.032	15,300	1,480	13,800	1,330	13,000	1,090	11,500	920
	1.1	12	0.032	13,600	1,240	12,300	1,110	11,600	920	10,200	770
	1.1	14	0.032	13,600	1,240	12,300	1,110	11,600	920	10,200	770
	1.1	16	0.032	13,600	1,240	12,300	1,110	11,600	920	10,200	770
	1.1	18	0.030	11,900	1,020	10,700	910	10,100	750	8,900	630
	1.1	20	0.030	10,200	870	9,200	780	8,700	640	7,600	540
0.6	1.2	6	0.043	14,400	1,500	13,000	1,350	12,300	1,100	10,800	950
	1.2	8	0.043	14,400	1,500	13,000	1,350	12,300	1,100	10,800	950
	1.2	10	0.043	14,400	1,400	13,000	1,210	12,300	1,100	10,800	860
	1.2	12	0.040	14,400	1,350	13,000	1,210	12,300	1,100	10,800	860
	1.2	14	0.040	12,300	1,150	11,100	1,040	10,500	940	9,300	730
	1.2	16	0.040	12,300	1,150	11,100	1,040	10,500	940	9,300	730
	1.2	18	0.040	12,300	1,150	11,100	1,040	10,500	940	9,300	730
	1.2	20	0.037	10,500	990	9,500	890	9,000	810	8,000	630
	1.2	22	0.037	10,500	990	9,500	890	9,000	810	8,000	630
	1.2	24	0.037	10,500	990	9,500	890	9,000	810	8,000	630

【Note】 ①a_p is shown as the criteria for Group 1 workpieces. For other groups, adjust the cutting depth according to the cutting depth factors in the above table.
②Adjust by setting a_e to (3 to 5)×(a_p)×(cutting depth ratio). When performing finishing processing, calculate the theoretical cusp height and set accordingly.

Cutting depth setting example : When finishing in pre-hardened steel with EB4HR0100TN-10-05-ATH.
Cutting depth = 0.032(a_p)×0.8(Cutting depth factor for group 3 pre-hardened steel) = 0.0256mm

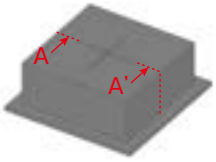
③Use the water or oil based coolant for the work material and machining shape.
④These Recommended Cutting Conditions indicate only the rule of a thumb for the cutting conditions. In actual machining, the condition should be adjusted according to the machining shape, purpose and the machine type.
⑤If the rpm available is lower than that recommended please reduce the feed rate to the same ratio.

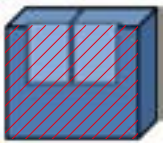
Field data

Comparison with conventional tools

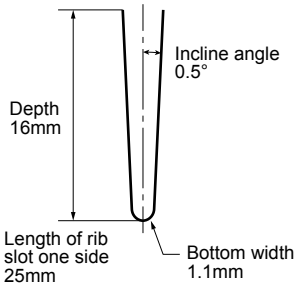
Machine : Vertical M/C
Coolant : Water base
Work material : NAK80 (40HRC)
L/D=16

Cross rib slot





Cross-section observation

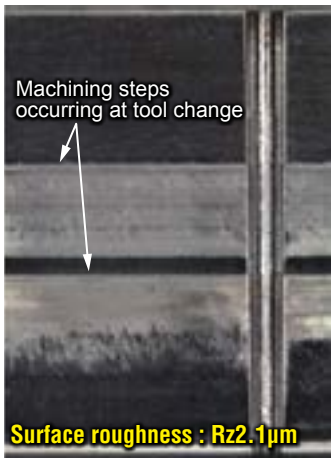


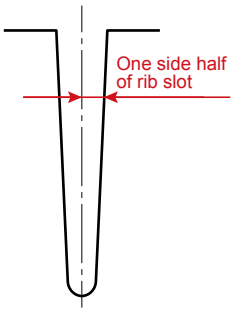
Process	Item code	Tool dia. (mm)	Under neck length (mm)	Revolution (min^{-1})	Feed rate (mm/min)	ap (mm)	Removal stock (mm)	Cutting time (min)
Contour roughing	EB4HR0100TN-6-05-ATH	1	6	24,000	1,000	0.023	0.03	20min
Contour roughing	EB4HR0100TN-10-05-ATH	1	10	21,000	910	0.013	0.03	19min
Contour roughing	EB4HR0100TN-16-05-ATH	1	16	21,000	770	0.008	0.03	56min
Contour finishing	EB4HR0100TN-16-05-ATH	1	16	10,820	424	0.025	0	41min

Total machining time 136min.

Comparison of machined surface

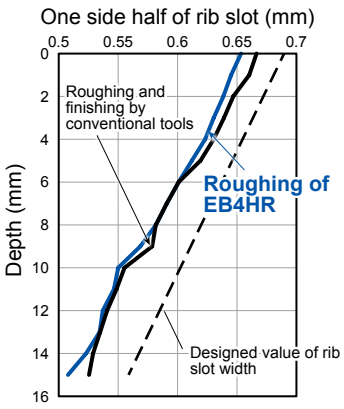
Roughing and finishing by conventional tools





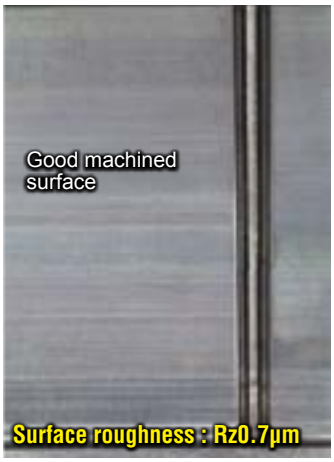
Measurement points of rib slot

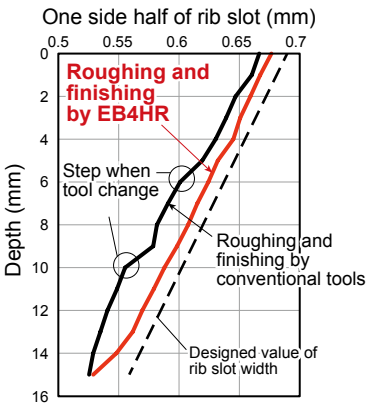
Roughing with EB4HR



Machining accuracy got by roughing with EB4HR is equivalent to that of roughing and finishing with conventional tools

Roughing and finishing of EB4HR





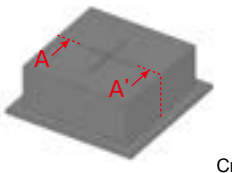
More accurate rib slots can be machined by using EB4HR from roughing to finishing

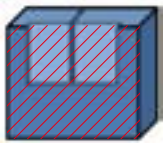
Realizes high precision machining by using EB4HR from roughing to finishing

Comparison between EDM and direct milling for rib slot (L/D=20mm)

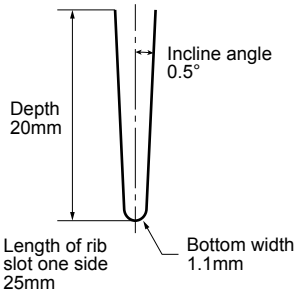
Machine : Vertical M/C
Coolant : Water base
Work material : NAK80 (40HRC)
L/D=20

Cross rib slot





Cross-section observation

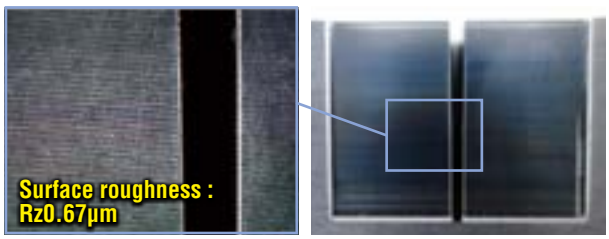


Process	Item code	No. of tools used	Tool dia. (mm)	Under neck length (mm)	Revolution (min^{-1})	Feed rate (mm/min)	ap (mm)	Removal stock (mm)	Cutting time (min)
Contour roughing	EB4HR0100TN-6-05-ATH	1	1	6	24,000	1,000	0.030	0.03	25min
Contour roughing	EB4HR0100TN-12-05-ATH	1	1	12	24,000	900	0.022	0.03	34min
Contour roughing	EB4HR0100TN-16-05-ATH	1	1	16	21,000	700	0.014	0.03	47min
Contour roughing	EB4HR0100TN-20-05-ATH	1	1	20	18,000	660	0.010	0.03	68min
Contour semi-finishing	EB4HR0100TN-20-05-ATH	1	1	20	18,000	660	0.040	0.02	75min
Contour finishing	EB4HR0100TN-20-05-ATH		1	20	12,000	450	0.020	0	209min

Total machining time 458min.

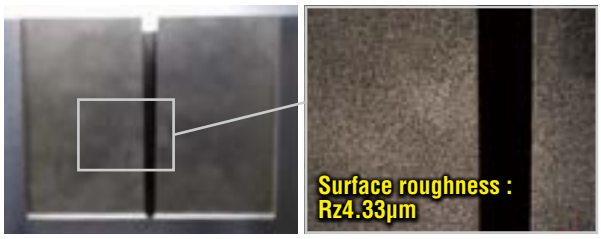
Comparison of machined surface by machining and EDM

EB4HR



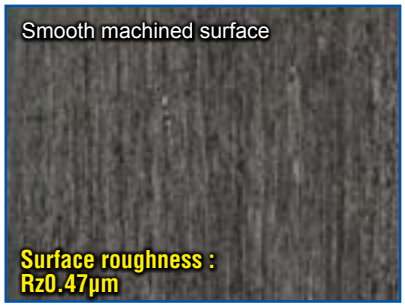
Total cutting time :
About **7 hours 30 min.**

EDM



Preparation time of electrode about 4 hours
Processing time of EDM about 9 hours
Total time : About **13 hours**

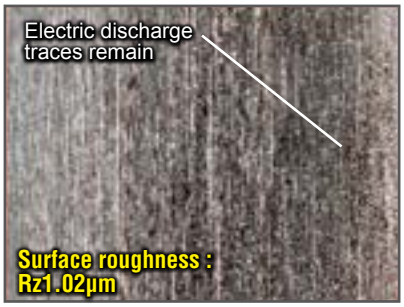
After polishing with 600-grit sandpaper (1h)



Hardness 40HRC

Achieved Rz0.5μm or less
surface roughness

Hardness 47HRC



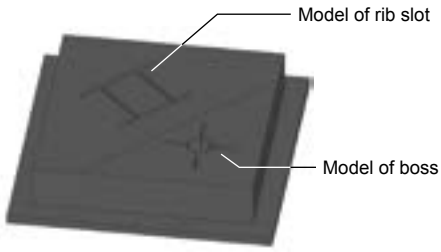
Surface roughness : Rz1.0 μm
Electric discharge traces remain

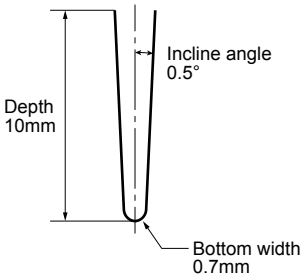
Achieves to reduce polishing time since machined surface is smooth

Field data

Cutting example of high hardness steel

Machine : Vertical M/C
Coolant : Water base
Work material : STAVAX (52HRC)
L/D=16





Model of rib slot

	Process	Item code	No. of tools used	Tool dia. (mm)	Under neck length (mm)	Revolution (min^{-1})	Feed rate (mm/min)	ap (mm)	Removal stock (mm)	Cutting time (min)
	Contouring roughing	EB4HR0060TN-4-05-ATH	3	0.6	4	27,000	610	0.016	0.02	60min
	Contouring roughing	EB4HR0060TN-7-05-ATH	3	0.6	7	24,000	500	0.007	0.02	73min
※1	Contouring roughing	EB4HR0060TN-10-05-ATH	2	0.6	10	21,000	430	0.005	0.02	43min
※2	Contouring semi-finishing	EB4HR0060TN-10-05-ATH	1	0.6	10	10,500	500	0.02	0.02	115min
	Contouring finishing	EB4HR0060TN-10-05-ATH		0.6	10	10,500	500	0.02	0	115min

Total machining time 406min.

Condition of tool wear

EB4HR0060TN-10-05-ATH ※1

EB4HR0060TN-10-05-ATH ※2

Model of boss

Process	Item code	No. of tools used	Tool dia. (mm)	Under neck length (mm)	Revolution (min^{-1})	Feed rate (mm/min)	ap (mm)	Removal stock (mm)	Cutting time (min)
Contouring roughing	EPDBEH2020-8-TH3	1	2	8	7,950	320	0.02	0.02	60min
Contouring roughing	EB4HR0060TN-4-05-ATH	1	0.6	4	23,800	470	0.016	0.02	28min
Contouring finishing	EB4HR0060TN-7-05-ATH	1	0.6	7	10,500	500	0.02	0	19min

Total machining time 107min.

Condition of machined surface

Other form than rib slot can also be machined.

It is possible to machine high hardness steel with high precision for a long time.

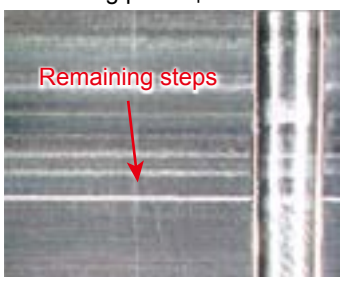
Trouble shooting

In case machining steps that occurred at tool change remained after finishing

Tool：Tool dia.ϕ1 × Under neck length 20mm
EB4HR0100TN-20-05-ATH

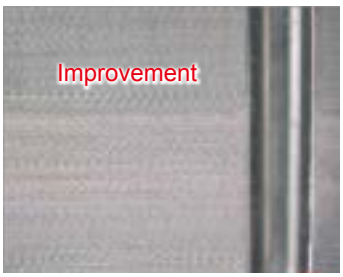
If the finishing pitch is large, the peripheral edge might not work sufficiently and the steps might not be removed.
It is expected to improve by reducing the finishing pitch or do zero cutting

Finishing pitch a_p=0.025mm



Reducing the finishing pitch

Finishing pitch a_p=0.02mm



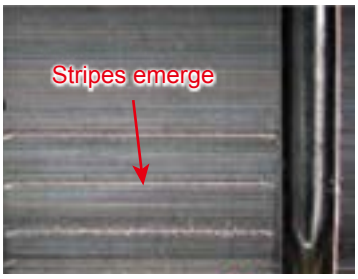
＋Zero-cut a_p=0.025mm

In case horizontal stripes remained at the bottom of rib slot after finishing

Tool：Tool dia.ϕ1×Under neck length 16mm
EB4HR0100TN-16-05-ATH

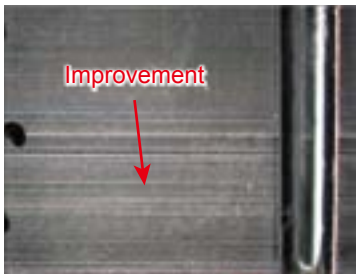
Since the clearance between the bottom of the rib and the tool is small, the horizontal stripes might emerge depending on the cutting conditions. It is expected to improve by reducing the finishing pitch.

Finishing pitch a_p =0.1mm



Reducing the finishing pitch

Finishing pitch a_p =0.02mm



In case the machined surface is rough after finishing

Tool：Tool dia.ϕ1×Under neck length 16mm
EB4HR0100TN-16-05-ATH

If the cutting allowance is set too small, remaining steps or chatter mark might occur.
It is expected to improve by adjusting the cutting allowance.

Cutting allowance 0.01mm

Surface roughness：
Rz1.3μm

Surface roughness：
Rz1.8μm

Adjust the removal stock

Cutting allowance 0.02mm

Surface roughness：
Rz0.9μm

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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 thelocal laws and regulations regarding prevention of hazards due to specified chemical substances.

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