MOLDINO
The Edge To Innovation

EPOCH GLOBAL SERIES

Epoch G End Mill series

MOLDINO Tool Engineering, Ltd.

New Product News | No.1080E-9 | 2021-7

Abundant lineup with a total of 118 items covers a broad machining range

Epoch G End Mill series

Line-up

Shape	Item code	Size	No. of items	Coating	Photo	Release date
Ball	Epoch G Ball Panacea HGOB2-PN	φ0.3～φ20	19 items	PN		On sale now
	Epoch G Ball -TH HGOB2-TH	φ0.5～φ20	13 items	TH		On sale now
	Global Forging Ball HGFB2-TH	φ2～φ12	7 items	TH		On sale now
Radius	Epoch G Turbo 2NT -TH HGOF2-TH	φ2～φ12	8 items	TH		On sale now
	Epoch G Turbo 4NT -TH HGOF4-TH	φ2～φ12	8 items	TH		On sale now
	Epoch G Radius 4NT -TH HGOR4-TH	φ6～φ20	15 items	TH		On sale now
Square	Epoch G Square 2NT Panacea HGOS2-PN	φ0.2～φ20	26 items	PN		On sale now
	Epoch G Square 4NT Panacea HGOS4-PN	φ1～φ20	13 items	PN		On sale now
	Epoch G Square 4NT -TH HGOSH4-TH	φ1～φ12	9 items	TH		On sale now

Coating

New PaNacea Coating

- A heat-resistant coating material with excellent adhesion to the tool substrate was achieved by optimizing the Al content.
- Exhibits with good wear resistance due to doping of the AlCr coating layer with Si.
- Exhibits excellent cutting life for cutting materials such as plastic molds, etc. where tool seizure often occurs. Provides the long life in cutting processing of materials starting with HPM-MAGIC and including prehardened steel, carbon steel, alloy steel, SUS, SKD61, SKD11, etc.
- By improving heat resistance, long life are possible for both wet cutting and dry cutting.

Note) This product obtains less electric conductivity. Therefore, Please caution of using electric

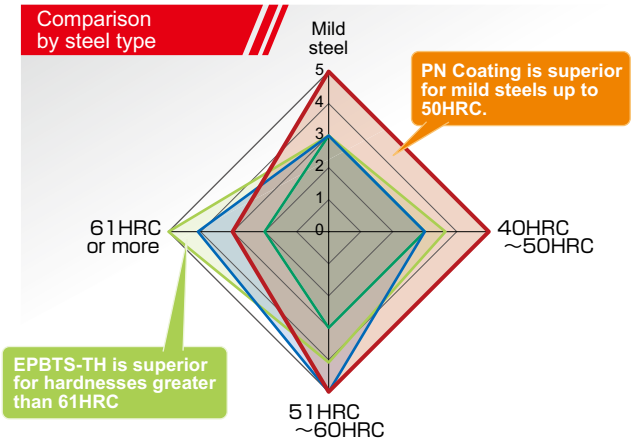
Advanced TH Coating

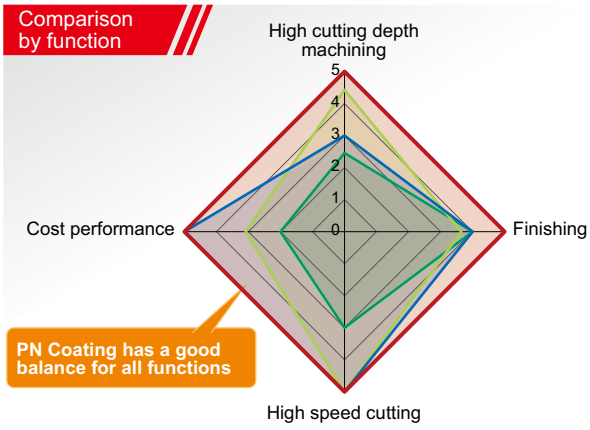
- Hardness and oxidation resistance of TH Coating is further improved. Enables longer life and higher efficient when cutting high-hardness materials.(Si nano composite coating with finer crystal particles)
- Exhibits amazing performance when cutting high-hardness materials. (55HRC or higher)
- Long life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

Concept

●Ball End Mill

HGOB-PN High-efficiency machining at high cutting depths. Stable even for finishing.
HGOB-TH Ideal for high-efficiency machining of high-hardness materials.

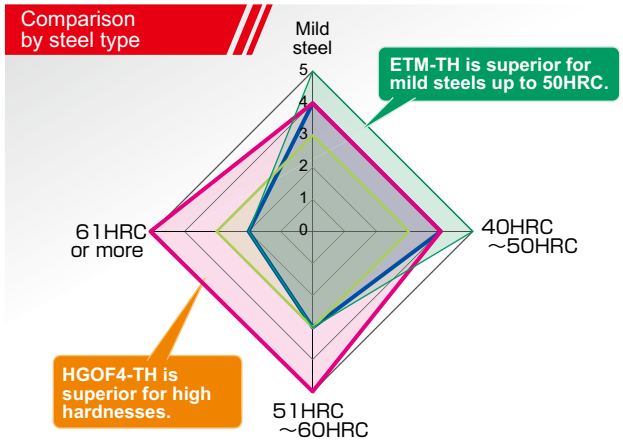


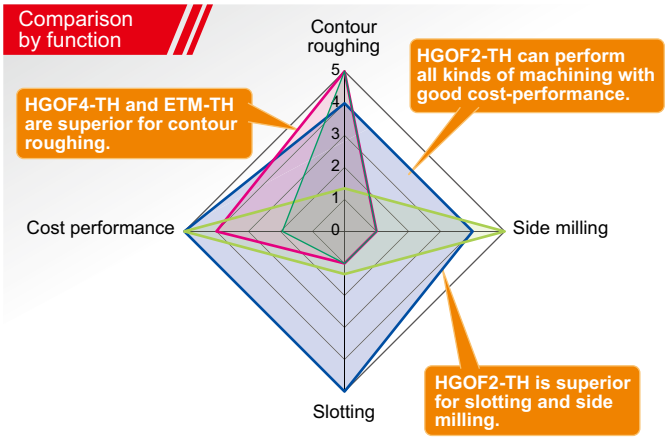


HGOB-TH HGOB-PN EPBTS-TH Conventional general end mill

●Radius End Mill

HGOF-TH Ultra-high-efficiency contour machining can be performed. (HGOF2-TH can also perform slotting or side milling.)
HGOR-TH For general-purpose machining region with focus on side milling.





HGOF2-TH HGOF4-TH HGOR4-TH ETM-TH

Cutting area

Newly developed PN Coating and the TH Coating with its excellent results enable high-efficiency machining for wide-ranging applications from roughing to finishing on a broad range of cutting materials.

■ Table of suitability of each coating for various cutting materials

Coating	Low-carbon steel	Alloy steels	Pre-hardened steels	Hardened steels		Stainless steels	Cast iron, Ductile cast iron	Non-ferric Aluminum alloy; Copper
				~50HRC	51~60HRC			
PN	◎	◎	◎	◎	○	◎	◎	◎
TH		◎	◎	◎	◎			

Can handle machining of plastic molds, diecast molds, press dies, or various parts.

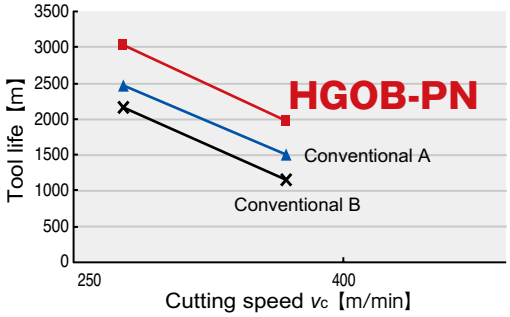
Field data

Performance of HGOB-PN and HGOS-PN

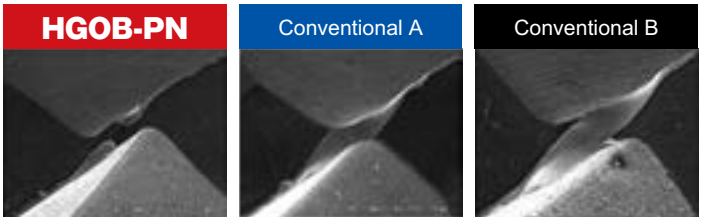
01 Life comparison when cutting HPM-MAGIC high-performance plastic mold material

Tool: Ball End Mill (*R*3×2NT)

Cutting conditions *n*=15,000、20,000min^{-1}、*vf*=6,000、8,000mm/min、 *ap*×*ae*=0.4mm×0.2mm、 Dry, Air-blow
Work material = HPM-MAGIC（40HRC）



Cutting condition *n*=20,000min^{-1}、*vf*=8,000mm/min
ap×*ae*=0.4mm×0.2mm Cutting distance L=4,000m

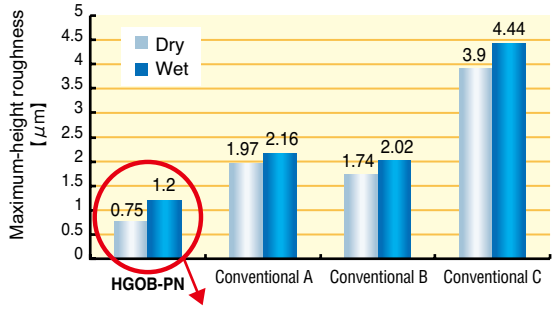


Provides stable machining in all rotation regions.

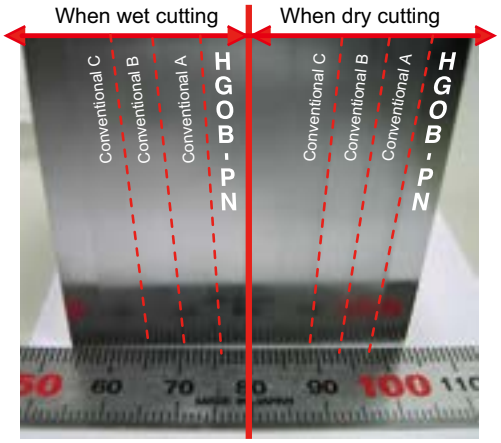
02 Comparison of machined surface grade when cutting carbon steel S50CⒶ

Tool: Ball End Mill (*R*1×2NT)

Cutting conditions *n*=24,000min^{-1} *vf*=3,170mm/min
ap×*ae*=0.1mm×0.1mm
Work material =S50CⒶ(200HB)
Coolant：Dry、Wet



HGOB-PN is good for both dry and wet cutting

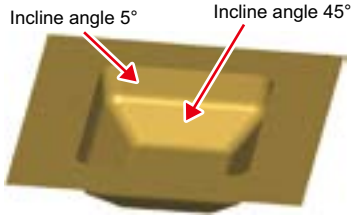


Comparison of machined surface gloss condition

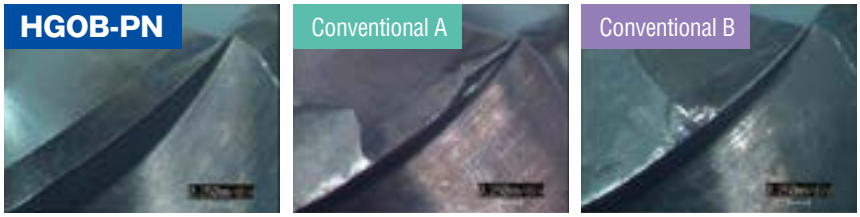
03 Comparison of chipping damage when cutting hardened steel HPM38Ⓗ

Tool: Ball End Mill (*R*3×2NT)

Cutting conditions *n*=19,200min^{-1}、*vf*=3,690mm/min *ap*×*ae*=0.72×2.16mm Work material =HPM38Ⓗ
Coolant：Wet Cutting distance：1 pocketing（Cutting distance10m）



Upper : 35mmx40mm
Bottom : 22mmx17mm
Depth : Incline 5°（0～8mm）
Incline 45°（8～14mm）

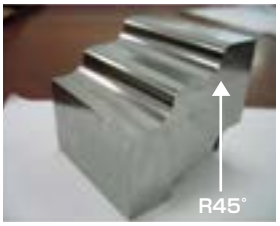


HGOB-PN is the best for high-performance cutting.

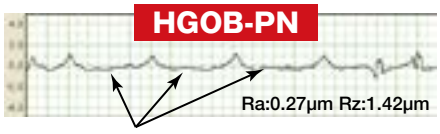
04 Comparison of machined surface when cutting general-purpose plastic mold material SCM440Ⓗ

Tool: Ball End Mill (*R*3×2NT)　　Work material：SCM440Ⓗ (30HRC)

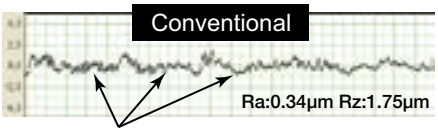
Process	Tool	Tool dia.	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut a_p×a_e (mm)	Coolant
Contour roughing	HGOB2060-PN	*R*3	8,000	1,920	0.5×1.2	Air-blow
Contour finishing	HGOB2060-PN	*R*3	12,200	2,800	0.2×0.2	Water base
Contour finishing (high-grade)	HGOB2060-PN	*R*3	12,200	2,800	0.15×0.15	Water base
	Conventional					



Comparison of machined surface roughness of R45° section in pick direction



Good machined surface without vibrations

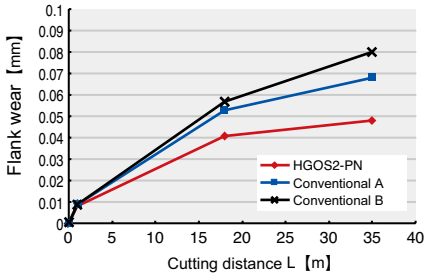


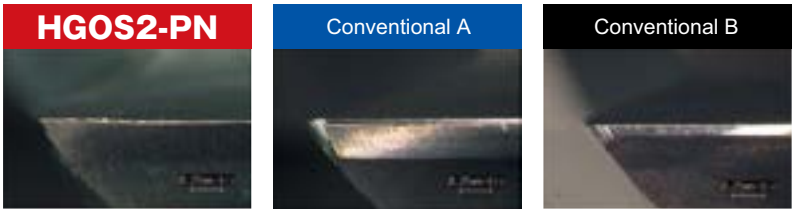
Vibrations occur within pitch

05 Side cutting surface comparison data on carbon steel S50CⒶ

Tool: Square End Mill (φ6×2NT)

Cutting conditions Work material =S50C (200HB)　　Cutting distance：35m
n=4,700min^{-1}　v_f=280mm/min,　a_p×a_e=9mm×0.6mm　　Coolant：Wet

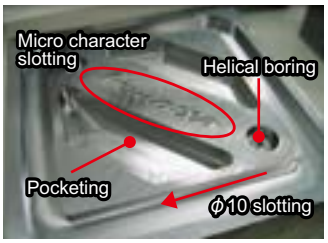




With HGOS2-PN, wear progress was the slowest and most stable.

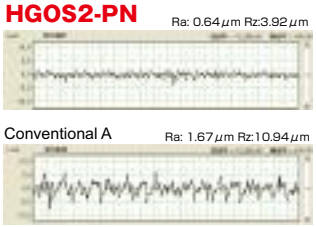
06 Part machining data on carbon steel S50CⒶ

Process	Machined shape	Tool	Tool dia.	Revolution (min^{-1})	Feed rate (mm/min)	Depth of cut a_p×a_e (mm)	Coolant	Cutting distance (mm)
Contour roughing	Helical boring	HGOS2060-PN	φ6	10,000	300	6.5×2	Air-blow	723
Contour roughing	Pocketing	HGOS2060-PN	φ6	11,000	650	6.5×0.6	Air-blow	2,837
Edge cutting	Character slotting	HGOS2010-PN	φ1	22,300	223	0.5×1	Air-blow	326
Edge cutting	Slotting	HGOS2100-PN	φ10	1,250	175	4×10	Air-blow	653

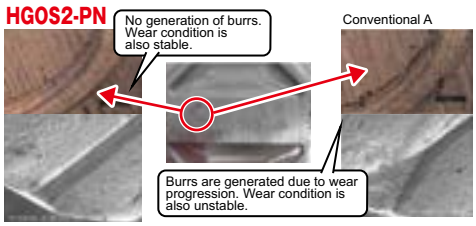


In addition to side surface and grooving, it can also be used in a variety of other ways.

Comparison of bottom surface roughness for slotting



Character slotting



Field data

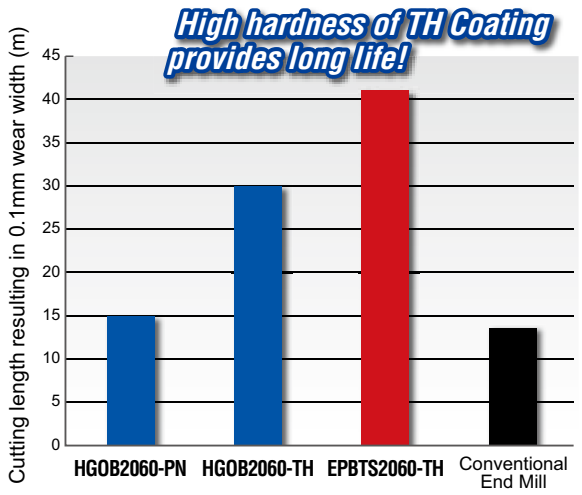
Performance of HGOB-TH

01 Direct-carving machining of cold-forged die material

Work material : SKD11Ⓗ(60HRC), Tool : *R*3×2NT

Cutting conditions n=10,000min^{-1} (v_c=188m/min)、v_f=3,000mm/min (f_z=0.15mm/t)、$a_p \times a_e$=0.36mm×1.08mm、Air-blow

Comparison of tool life

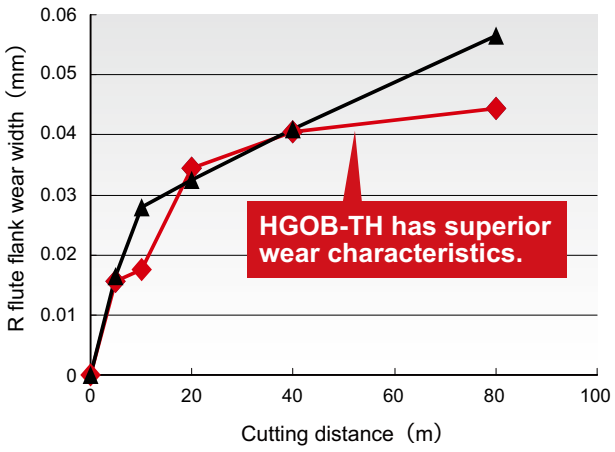


Photograph of wear after cutting 20m

02 Direct-carving machining of hot-forged die material

Work material : SKD61Ⓗ(45HRC), Tool : *R*1×2NT

Cutting conditions n=30,000min^{-1} (v_c=188m/min)、v_f=1,700mm/min (f_z=0.028mm/t)、$a_p \times a_e$=0.2mm×0.6mm、Air-blow、Cutting distance 80m

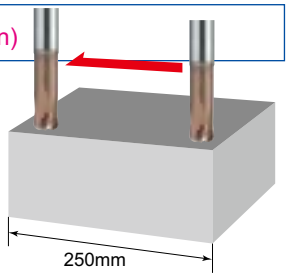


Performance of HGOF4-TH

01 Bottom machining of high-hardness materials (Feed limit evaluation)

Work material : SKD11Ⓗ (60HRC), Tool : ϕ10×r2 HGOF4100-20-TH

Cutting conditions n=1,600min^{-1} (v_c=50m/min)、v_f = under table a_p×a_e=0.3mm×3mm、Air-blow



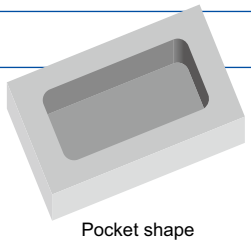
V_f (mm/min)	1,000	1,200	1,400	1,600	1,800
f_z (mm/t)	f_z=0.16	f_z=0.19	f_z=0.22	f_z=0.25	f_z=0.28
HGOF4-TH	○	○	○	○	○
Conventional radius end mill	×				

Epoch G Turbo with low cutting resistance is particularly superior for high-efficiency machining of high-hardness materials.

02 High-efficiency pocket machining (Life evaluation)

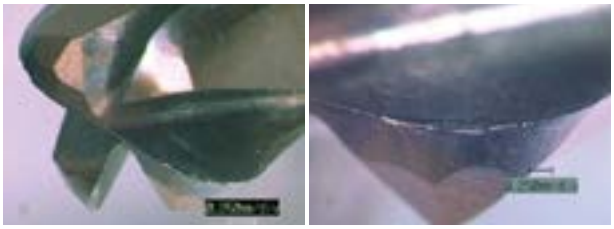
Work material : DACⒽ (50HRC), Tool : ϕ6×r1.5 HGOF4060-15-TH

Cutting conditions n=4,200min^{-1} (v_c=79m/min)、v_f=5,040mm/min (f_z=0.3mm/t)、a_p×a_e=0.3mm×3mm、 Air-blow、 Cutting time：30min.

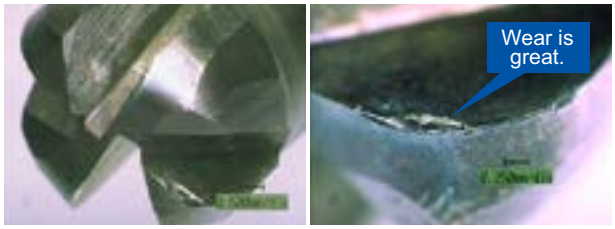


Pocket shape
Incline angle 5°
43(W)×90(L)×25(D)mm

HGOF4-TH



Conventional end mill



Wear is small even for high-efficiency machining.

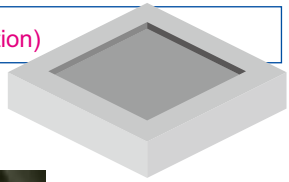
03 High-efficiency roughing of powder metallurgy HSS (Life evaluation)

Work material : HAP40 (67HRC), Tool : ϕ4×r 1, HGOF4040-10-TH

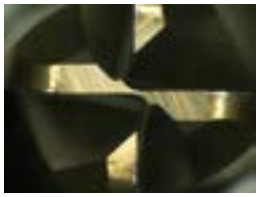
Cutting conditions

n=4,800min^{-1} (v_c=60m/min)、v_f=1,150mm/min (f_z=0.06mm/t)、a_p×a_e=0.15mm×1.7mm、 Mist-blow、

High-efficiency roughing of powder metallurgy HSS. Machining time: Approx. 18 min.



Pocket shape
80mm×80mm×0.6mm



Wear width: 0.05mm
Cutting length: 20m

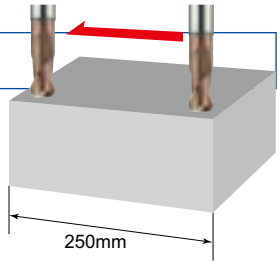
Field data

Performance of HGOF2-TH

01 Bottom cutting (Feed limit evaluation)

Work material : Equivalent to SUS420J2 (52HRC), Tool : φ6×r1.5 HGOF2060-15-TH

Cutting conditions n=2,700min^{-1} (v_c=50m/min)、 v_f=under table
OH=24mm (4D)、a_p×a_e=0.3mm×1.5mm、 Air-blow



Vf (mm/min) / fz (mm/t)	500 fz=0.09	1,000 fz=0.18	1,500 fz=0.27	2,000 fz=0.036	2,500 fz=0.46	3,000 fz=0.56	3,500 fz=0.65
HGOF2060-15-TH	○	○	○	○	○	○	○
Conventional general 2flutes radius end mill	○	Chipping					

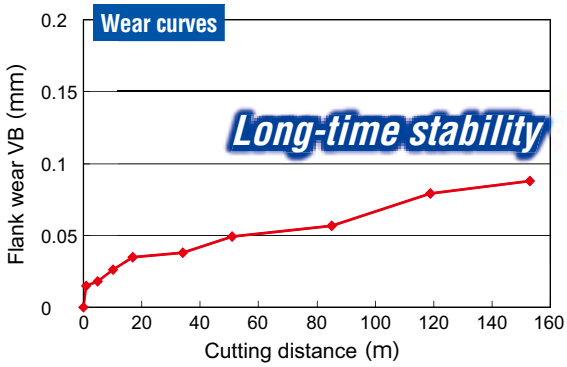
More than 7 times the machining efficiency.

Epoch G Turbo enables machining at far higher feed rates.

02 Bottom cutting (Life evaluation)

Work material : Equivalent to SUS420J2(52HRC), Tool : HGOF2060-15-TH

Cutting conditions n=2,700min^{-1} (v_c=50m/min)、 v_f=1,620mm/min (f_z=0.3mm/t)、OH=24mm (4D)
a_p×a_e=0.3mm×1.5mm Cutting time：94min. Air-blow



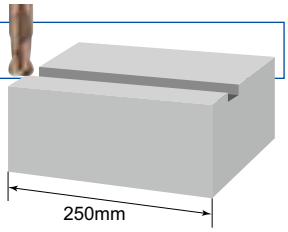
After cutting distance of 155m

Interrupted cutting possible

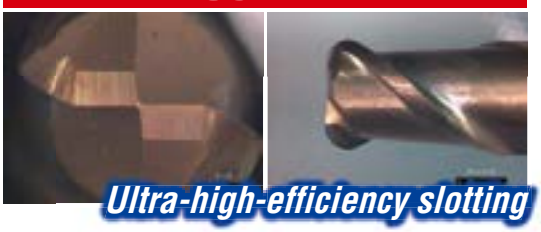
03 Slotting (High-efficiency slotting)

Work material : Equivalent to SUS420J2(52HRC), Tool : φ6×r1.5 HGOF2060-15-TH

Cutting conditions n=3,200min^{-1} (v_c=60m/min)、 v_f=250mm/min (f_z=0.04mm/t)、
OH=24mm (4D) a_p×a_e=6mm×6mm Air-blow



HGOF2-TH



After 1 slotting

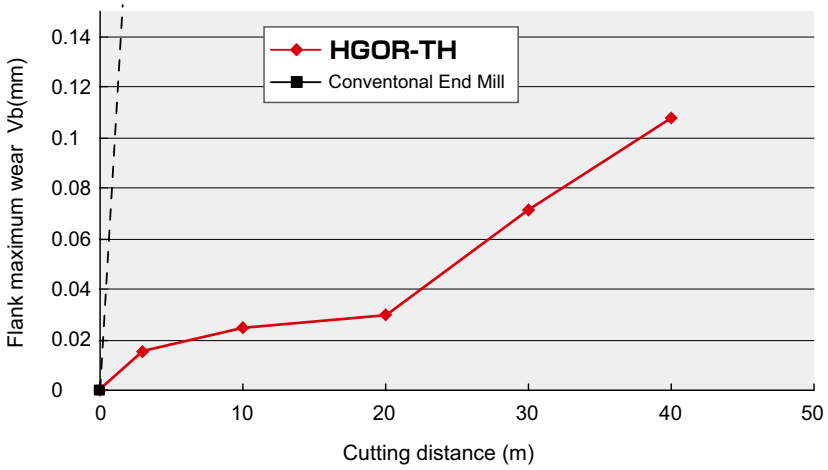
Comventional end mill

Performance of HGOR-TH

01 Comparison data for side milling of pre-hardened steel material for plastic molds

Work material : Pre-hardened steel (40HRC), Tool : ϕ6×4NT

Cutting conditions n=4,250min^{-1} (v_c=80m/min)、v_f=510mm/min (f_z=0.03mm/t)、a_p×a_e=6mm×0.6mm、 Air-blow



Conventonal End Mill

Chipping at 0.25m

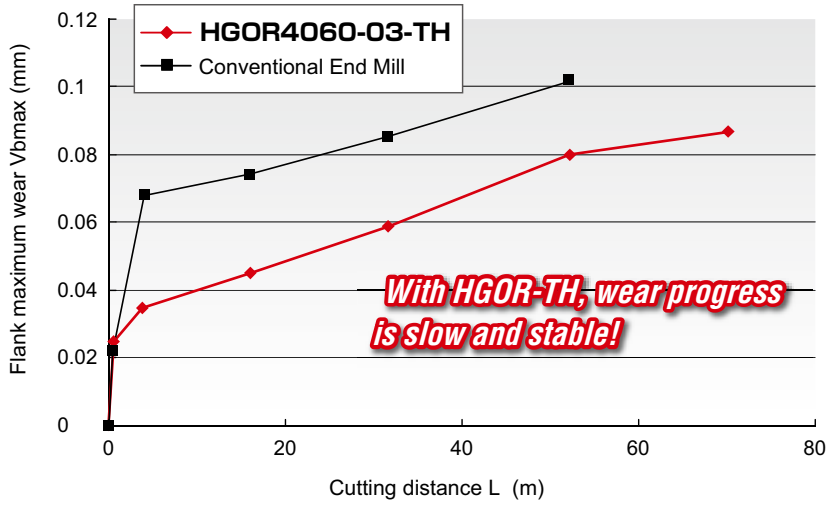
HGOR-TH

Stable wear even after cutting 20m

02 Comparison data for side milling of FC250 cast-iron material

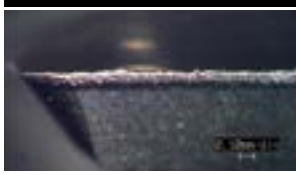
Work material : FC250, Tool : ϕ6×4NT

Cutting conditions n=9,550min^{-1} (v_c=187m/min)、v_f=2,290mm/min (f_z=0.06mm/t)、a_p×a_e=3mm×5mm、 Air-blow



Photograph of wear after cutting 30m

Conventional End Mill



HGOR-TH

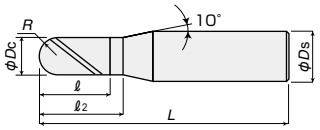
Epoch G Ball

HGOB-PN Panacea

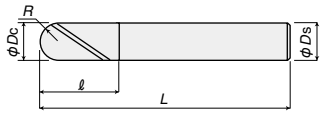
R accuracy : Right table

Tolerance on shank : h5

A type



B type



(mm)

R	*R* accuracy
0.15~6	±0.005
8~10	±0.01

HGOB2○○○(-○)-PN

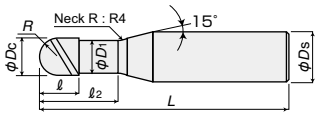
Item code	Stock	Size (mm) Ball radius *R*	Tool dia. *Dc*	Flute length *ℓ*	Under neck length *ℓ2*	Neck dia.	Overall length *L*	Shank dia. *Ds*	No. of flutes	Type	Coating
HGOB2003-PN	●	0.15	0.3	0.6	0.9	—	50	4	2	A	PN
HGOB2004-PN	●	0.2	0.4	0.8	1.1	—	50	4	2	A	PN
HGOB2005-PN	●	0.25	0.5	1	1.3	—	50	4	2	A	PN
HGOB2006-PN	●	0.3	0.6	1.2	1.5	—	50	4	2	A	PN
HGOB2008-PN	●	0.4	0.8	1.6	1.9	—	50	4	2	A	PN
HGOB2010-PN	●	0.5	1	2.5	3.5	—	50	4	2	A	PN
HGOB2015-PN	●	0.75	1.5	4	5	—	50	4	2	A	PN
HGOB2020-PN	●	1	2	5	6	—	50	6	2	A	PN
HGOB2025-PN	●	1.25	2.5	7	8	—	50	6	2	A	PN
HGOB2030-PN	●	1.5	3	8	9	—	70	6	2	A	PN
HGOB2040-4-PN	●	2	4	8	—	—	70	4	2	B	PN
HGOB2040-PN	●	2	4	8	9	—	70	6	2	A	PN
HGOB2050-PN	●	2.5	5	10	11	—	80	6	2	A	PN
HGOB2060-PN	●	3	6	12	—	—	90	6	2	B	PN
HGOB2080-PN	●	4	8	14	—	—	100	8	2	B	PN
HGOB2100-PN	●	5	10	18	—	—	100	10	2	B	PN
HGOB2120-PN	●	6	12	22	—	—	110	12	2	B	PN
HGOB2160-PN	●	8	16	30	—	—	140	16	2	B	PN
HGOB2200-PN	●	10	20	38	—	—	160	20	2	B	PN

HGOB-TH

R accuracy : Right table

Tolerance on shank :h5

A type



B type

*R*8 and *R*10 don't have *ℓ*2 and *D*1

(mm)

R	*R* accuracy
0.15~6	±0.005
8~10	±0.01

HGOB2○○○-TH

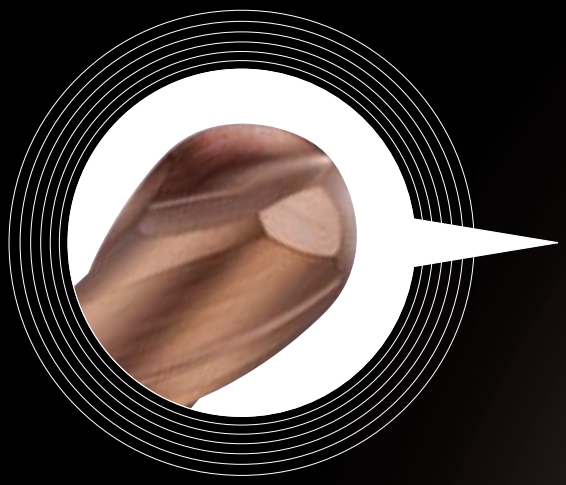
Item code	Stock	Size (mm) Ball radius *R*	Tool dia. *Dc*	Flute length *ℓ*	Under neck length *ℓ2*	Neck dia. *D1*	Overall length *L*	Shank dia. *Ds*	No. of flutes	Type	Coating
HGOB2005-TH	●	0.25	0.5	0.5	1.25	0.47	40	4	2	A	TH
HGOB2010-TH	●	0.5	1	1	2.5	0.95	40	4	2	A	TH
HGOB2015-TH	●	0.75	1.5	1.5	3.75	1.45	40	4	2	A	TH
HGOB2020-TH	●	1	2	2	5	1.95	40	6	2	A	TH
HGOB2030-TH	●	1.5	3	3	7.5	2.9	45	6	2	A	TH
HGOB2040-TH	●	2	4	4	10	3.9	45	6	2	A	TH
HGOB2050-TH	●	2.5	5	5	12.5	4.9	50	6	2	A	TH
HGOB2060-TH	●	3	6	6	15	5.9	50	6	2	B	TH
HGOB2080-TH	●	4	8	8	20	7.9	60	8	2	B	TH
HGOB2100-TH	●	5	10	10	25	9.9	65	10	2	B	TH
HGOB2120-TH	●	6	12	12	30	11.9	75	12	2	B	TH
HGOB2160-TH	●	8	16	16	—	—	140	16	2	B	TH
HGOB2200-TH	●	10	20	20	—	—	160	20	2	B	TH

● : Stoked Items.

Special strong geometry
provides both rigidity and good cutting performance.

Features of HGFB-TH

Enables high-efficient machining with increased cutting depth and feed rate.
Ideal for high-efficient machining from roughing to finishing
of 35HRC or higher materials.



High Heat Resistance
High Cost Performance
High Rigidity Geometry

TH Coating

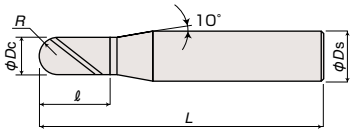
- Enables longer life and higher efficient when cutting high-hardness materials.
- Exhibits amazing performance when cutting high-hardness materials (35HRC or higher). Double the tool life and more than double the machining efficiency. Cold-worked die steel, HSS, tool steel, composite materials, carbide alloys, etc.
- Long life for both dry cutting and wet cutting.

Global Forging Ball

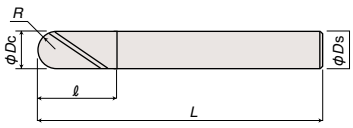
HGFB-TH

R accuracy : ±0.01 Helix angle : 30°

Tolerance on shank :h5



A type



B type

HGFB2○○○-TH

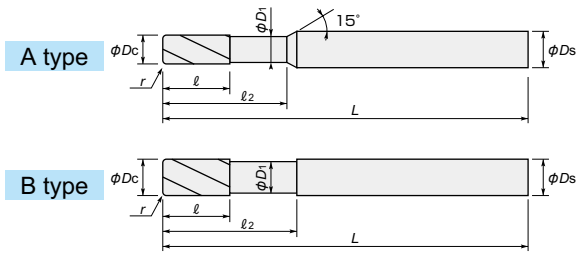
Item Code	Stock	Size (mm)					No. of flutes	Type	Coating
		R	Tool dia. *Dc*	Flute length *ℓ*	Overall length *L*	Shank dia. *Ds*			
HGFB2020-TH	●	**1**	**2**	**3**	50	6	2	A	TH
HGFB2030-TH	●	**1.5**	**3**	**4.5**	70	6	2	A	TH
HGFB2040-TH	●	**2**	**4**	**6**	70	6	2	A	TH
HGFB2060-TH	●	**3**	**6**	**9**	90	6	2	B	TH
HGFB2080-TH	●	**4**	**8**	**12**	100	8	2	B	TH
HGFB2100-TH	●	**5**	**10**	**15**	100	10	2	B	TH
HGFB2120-TH	●	**6**	**12**	**18**	110	12	2	B	TH

● : Stocked Items.

Epoch G Turbo

HGOF-TH

Tolerance on dia. : $^{0}_{-0.03}$mm



HGOF2○○○-○○-TH

Item code	Stock	Size (mm)							No. of flutes	Type	Coating
		Tool dia. *Dc*	Corner radius *r*	Flute length *ℓ*	Under neck length *ℓ2*	Neck dia. *D1*	Overall length *L*	Shank dia. *Ds*			
HGOF2020-05-TH	●	2	0.5	3	6	1.9	60	6	2	A	TH
HGOF2030-08-TH	●	3	0.8	4.5	9	2.9	60	6	2	A	TH
HGOF2040-10-TH	●	4	1	6	12	3.8	60	6	2	A	TH
HGOF2050-12-TH	●	5	1.2	7.5	15	4.7	60	6	2	A	TH
HGOF2060-15-TH	●	6	1.5	9	18	5.7	60	6	2	B	TH
HGOF2080-20-TH	●	8	2	12	24	7.6	75	8	2	B	TH
HGOF2100-20-TH	●	10	2	15	30	9.5	80	10	2	B	TH
HGOF2120-20-TH	●	12	2	18	36	11.5	100	12	2	B	TH

HGOF4○○○-○○-TH

Item code	Stock	Size (mm)							No. of flutes	Type	Coating
		Tool dia. *Dc*	Corner radius *r*	Flute length *ℓ*	Under neck length *ℓ2*	Neck dia. *D1*	Overall length *L*	Shank dia. *Ds*			
HGOF4020-05-TH	●	2	0.5	1	6	1.9	60	6	4	A	TH
HGOF4030-08-TH	●	3	0.8	1.5	9	2.9	60	6	4	A	TH
HGOF4040-10-TH	●	4	1	2	12	3.8	60	6	4	A	TH
HGOF4050-12-TH	●	5	1.2	2.5	15	4.7	60	6	4	A	TH
HGOF4060-15-TH	●	6	1.5	3	18	5.7	60	6	4	B	TH
HGOF4080-20-TH	●	8	2	4	24	7.6	75	8	4	B	TH
HGOF4100-20-TH	●	10	2	5	30	9.5	80	10	4	B	TH
HGOF4120-20-TH	●	12	2	6	36	11.5	100	12	4	B	TH

Epoch G Radius

HGOR-TH

Tolerance on dia. : $^{0}_{-0.03}$mm

HGOR4○○○-○○-TH

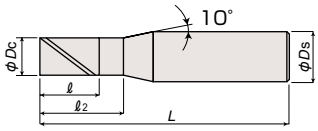
Item code	Stock	Size (mm)							No. of flutes	Coating
		Tool dia.	Corner radius	Flute length	Under neck length	Neck dia.	Overall length	Shank dia.		
HGOR4060-03-TH	●	6	0.3	9	18	5.7	50	6	4	TH
HGOR4060-05-TH	●	6	0.5	9	18	5.7	50	6	4	TH
HGOR4060-10-TH	●	6	1	9	18	5.7	50	6	4	TH
HGOR4080-03-TH	●	8	0.3	12	24	7.6	55	8	4	TH
HGOR4080-05-TH	●	8	0.5	12	24	7.6	55	8	4	TH
HGOR4080-10-TH	●	8	1	12	24	7.6	55	8	4	TH
HGOR4100-03-TH	●	10	0.3	15	30	9.5	70	10	4	TH
HGOR4100-05-TH	●	10	0.5	15	30	9.5	70	10	4	TH
HGOR4100-10-TH	●	10	1	15	30	9.5	70	10	4	TH
HGOR4120-03-TH	●	12	0.3	18	36	11.5	75	12	4	TH
HGOR4120-10-TH	●	12	1	18	36	11.5	75	12	4	TH
HGOR4160-05-TH	●	16	0.5	24	48	15	90	16	4	TH
HGOR4160-20-TH	●	16	2	24	48	15	90	16	4	TH
HGOR4200-05-TH	●	20	0.5	30	60	19	100	20	4	TH
HGOR4200-20-TH	●	20	2	30	60	19	100	20	4	TH

● : Stoked Items.

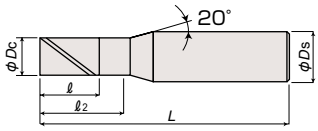
Epoch G Square

HGOS2-PN Panacea

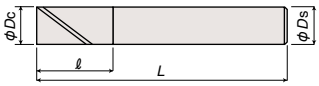
Tolerance on dia. : Right table　　Tolerance on shank : h5



A type



B type



C type

(mm)

Tool dia.	Dia. tolerance
0.2～0.9	0～−0.015
1～20	0～−0.02

HGOS2○○○-PN

Item code	Stock	Size (mm) Tool dia. Dc	Flute length ℓ	Under neck length ℓ2	Overall length L	Shank dia. Ds	No. of flutes	Type	Coating
HGOS2002-PN	●	0.2	0.4	0.6	40	4	2	A	PN
HGOS2003-PN	●	0.3	0.6	0.9	40	4	2	A	PN
HGOS2004-PN	●	0.4	0.8	1.1	40	4	2	A	PN
HGOS2005-PN	●	0.5	1	1.3	40	4	2	A	PN
HGOS2006-PN	●	0.6	1.2	1.5	40	4	2	A	PN
HGOS2007-PN	●	0.7	1.4	1.7	40	4	2	A	PN
HGOS2008-PN	●	0.8	1.6	1.9	40	4	2	A	PN
HGOS2009-PN	●	0.9	1.8	2.1	40	4	2	A	PN
HGOS2010-PN	●	1	2	2.5	40	4	2	A	PN
HGOS2015-PN	●	1.5	3	3.5	40	4	2	A	PN
HGOS2020-PN	●	2	6	7	40	4	2	A	PN
HGOS2025-PN	●	2.5	8	9	40	4	2	A	PN
HGOS2030-PN	●	3	8	9	45	6	2	A	PN
HGOS2035-PN	●	3.5	10	11	45	6	2	A	PN
HGOS2040-PN	●	4	11	12	45	6	2	B	PN
HGOS2045-PN	●	4.5	11	12	45	6	2	B	PN
HGOS2050-PN	●	5	13	14	60	6	2	B	PN
HGOS2055-PN	●	5.5	13	14	60	6	2	B	PN
HGOS2060-PN	●	6	13	—	60	6	2	C	PN
HGOS2070-PN	●	7	16	17	70	8	2	B	PN
HGOS2080-PN	●	8	19	—	75	8	2	C	PN
HGOS2090-PN	●	9	19	20	80	10	2	B	PN
HGOS2100-PN	●	10	22	—	80	10	2	C	PN
HGOS2120-PN	●	12	26	—	100	12	2	C	PN
HGOS2160-PN	●	16	35	—	110	16	2	C	PN
HGOS2200-PN	●	20	40	—	125	20	2	C	PN

● : Stoked Items.

HGOS4-PN Panacea

Tolerance on dia. : Right table　　Tolerance on shank : h5

(mm)

Tool dia.	Dia. tolerance
1～20	0～−0.02

HGOS4○○○-PN

Item code	Stock	Size (mm) Tool dia. Dc	Flute length ℓ	Under neck length ℓ2	Overall length L	Shank dia. Ds	No. of flutes	Type	Coating
HGOS4010-PN	●	1	2.5	3	40	4	4	A	PN
HGOS4015-PN	●	1.5	4	4.5	40	4	4	A	PN
HGOS4020-PN	●	2	6	7	40	4	4	A	PN
HGOS4025-PN	●	2.5	8	9	40	4	4	A	PN
HGOS4030-PN	●	3	10	11	45	6	4	A	PN
HGOS4040-PN	●	4	12	13	45	6	4	B	PN
HGOS4050-PN	●	5	15	16	60	6	4	B	PN
HGOS4060-PN	●	6	15	—	60	6	4	C	PN
HGOS4080-PN	●	8	20	—	75	8	4	C	PN
HGOS4100-PN	●	10	25	—	80	10	4	C	PN
HGOS4120-PN	●	12	30	—	100	12	4	C	PN
HGOS4160-PN	●	16	35	—	110	16	4	C	PN
HGOS4200-PN	●	20	40	—	125	20	4	C	PN

● : Stoked Items.

High-rigidity flute shape and TH Coating enables high-speed finishing of high-hardness steels.

Flute shape designed with consideration given to chip removal enables high-accuracy finishing of pre-hardened steel and hardened steel.

Features of HGOSH-TH

01 Enables high-speed finishing of pre-hardened steel and hardened steel with hardnesses of 35 to 55 HRC.

02 Use of TH Coating with excellent layer hardness and heat-resistance offers long tool life when cutting high-hardness steels.

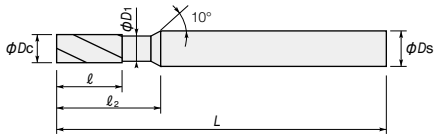
03 Under neck specifications enable processing depths of up to 3D.

Epoch G Square

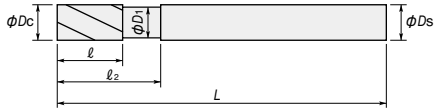
HGOSH-TH

Tolerance on dia. : Right table　　Tolerance on shank : h5

A type



B type



(mm)

Tool dia.	Tolerance on dia.
1~6	$^{0}_{-0.015}$
8~12	$^{0}_{-0.02}$

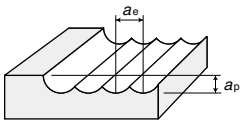
HGOSH4○○○-TH

Item Code	Stock	Size (mm)						No. of flutes	Type	Coating
		Tool dia. *Dc*	Flute length *ℓ*	Under neck length *ℓ2*	Neck dia. *D1*	Overall length *L*	Shank dia. *Ds*			
HGOSH4010-TH	●	1	2	3	0.96	50	6	4	A	TH
HGOSH4015-TH	●	1.5	3	4.5	1.44	50	6	4	A	TH
HGOSH4020-TH	●	2	4	6	1.92	50	6	4	A	TH
HGOSH4030-TH	●	3	6	9	2.88	60	6	4	A	TH
HGOSH4040-TH	●	4	8	12	3.85	60	6	4	A	TH
HGOSH4060-TH	●	6	12	18	5.85	60	6	4	B	TH
HGOSH4080-TH	●	8	16	24	7.8	75	8	4	B	TH
HGOSH4100-TH	●	10	20	30	9.8	80	10	4	B	TH
HGOSH4120-TH	●	12	24	36	11.8	100	12	4	B	TH

● : Stocked Items.

Recommended Cutting Conditions

HGOB-PN



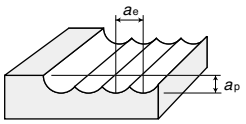
Types of finishing	Ball radius R (mm)	Tool dia. Dc (mm)	Flute length ℓ (mm)	Copper alloys, Aluminium alloys				Cast irons, Carbon steels (150～200HB) FC250,S50C,S55C				Stainless steels (25～35HRC) SUS304,SUS316			
				Revolution min^{-1}	Feed rate mm/min	ap mm	ae mm	Revolution min^{-1}	Feed rate mm/min	ap mm	ae mm	Revolution min^{-1}	Feed rate mm/min	ap mm	ae mm
Roughing	0.15	0.3	0.6	35,032	2,102	0.039	0.117	31,847	1,911	0.039	0.117	28,662	1,720	0.038	0.112
	0.2	0.4	0.8	35,032	2,102	0.052	0.156	31,847	1,911	0.052	0.156	28,662	1,720	0.050	0.150
	0.25	0.5	1	35,032	2,102	0.065	0.195	31,847	1,911	0.065	0.195	28,662	1,720	0.063	0.187
	0.3	0.6	1.2	29,193	2,335	0.078	0.234	26,539	2,123	0.078	0.234	23,885	1,911	0.075	0.225
	0.4	0.8	1.6	26,274	2,102	0.104	0.312	23,885	1,911	0.104	0.312	21,497	1,720	0.100	0.300
	0.5	1	2.5	28,025	2,803	0.130	0.390	25,478	2,548	0.130	0.390	22,930	2,293	0.125	0.375
	0.75	1.5	4	25,690	3,083	0.195	0.585	23,355	2,803	0.195	0.585	21,019	2,522	0.188	0.562
	1	2	5	24,522	3,433	0.260	0.780	22,293	3,121	0.260	0.780	20,064	2,809	0.250	0.750
	1.25	2.5	7	22,420	3,587	0.325	0.975	20,382	3,261	0.325	0.975	18,344	2,935	0.313	0.937
	1.5	3	8	21,019	3,783	0.390	1.170	19,108	3,439	0.390	1.170	17,197	3,096	0.375	1.125
	2	4	8	20,143	4,029	0.520	1.560	18,312	3,662	0.520	1.560	16,481	3,296	0.500	1.500
			8	20,143	4,834	0.520	1.560	18,312	4,395	0.520	1.560	16,481	3,955	0.500	1.500
	2.5	5	10	18,217	5,101	0.650	1.950	16,561	4,637	0.650	1.950	14,904	4,173	0.625	1.875
	3	6	12	15,764	5,045	0.780	2.340	14,331	4,586	0.780	2.340	12,898	4,127	0.750	2.250
	4	8	14	12,699	4,572	1.040	3.120	11,545	4,156	1.040	3.120	10,390	3,740	1.000	3.000
	5	10	18	10,860	4,344	1.300	3.900	9,873	3,949	1.300	3.900	8,885	3,554	1.250	3.750
	6	12	22	9,634	4,239	1.560	4.680	8,758	3,854	1.560	4.680	7,882	3,468	1.500	4.500
	8	16	30	7,444	3,573	2.080	6.240	6,768	3,248	2.080	6.240	6,091	2,924	2.000	6.000
	10	20	38	5,955	3,097	2.600	7.800	5,414	2,815	2.600	7.800	4,873	2,534	2.500	7.500
Finishing	0.15	0.3	0.6	44,586	1,783	0.015	0.015	37,155	1,486	0.015	0.015	33,439	1,204	0.015	0.015
	0.2	0.4	0.8	42,994	1,720	0.020	0.020	35,828	1,433	0.020	0.020	32,245	1,161	0.020	0.020
	0.25	0.5	1	42,038	1,682	0.025	0.025	35,032	1,401	0.025	0.025	31,529	1,135	0.025	0.025
	0.3	0.6	1.2	35,032	2,102	0.030	0.030	29,193	1,752	0.030	0.030	26,274	1,419	0.030	0.030
	0.4	0.8	1.6	31,051	1,863	0.040	0.040	25,876	1,553	0.040	0.040	23,288	1,258	0.040	0.040
	0.5	1	2.5	30,573	1,834	0.050	0.050	25,478	1,529	0.050	0.050	22,930	1,238	0.050	0.050
	0.75	1.5	4	29,299	1,758	0.075	0.075	24,416	1,465	0.075	0.075	21,975	1,187	0.075	0.075
	1	2	5	29,618	2,369	0.100	0.100	24,682	1,975	0.100	0.100	22,213	1,599	0.100	0.100
	1.25	2.5	7	28,280	2,262	0.125	0.125	23,567	1,885	0.125	0.125	21,210	1,527	0.125	0.125
	1.5	3	8	26,115	2,089	0.150	0.150	21,762	1,741	0.150	0.150	19,586	1,410	0.150	0.150
	2	4	8	24,363	1,949	0.200	0.200	20,303	1,624	0.200	0.200	18,272	1,316	0.200	0.200
			8	24,363	2,436	0.200	0.200	20,303	2,030	0.200	0.200	18,272	1,645	0.200	0.200
	2.5	5	10	22,548	2,255	0.250	0.250	18,790	1,879	0.250	0.250	16,911	1,522	0.250	0.250
	3	6	12	19,427	2,331	0.300	0.300	16,189	1,943	0.300	0.300	14,570	1,574	0.300	0.300
	4	8	14	16,003	1,920	0.400	0.400	13,336	1,600	0.400	0.400	12,002	1,296	0.400	0.400
	5	10	18	14,713	2,060	0.500	0.500	12,261	1,717	0.500	0.500	11,035	1,390	0.500	0.500
	6	12	22	13,535	2,436	0.600	0.600	11,279	2,030	0.600	0.600	10,151	1,645	0.600	0.600
	8	16	30	10,868	2,174	0.800	0.800	9,057	1,811	0.800	0.800	8,151	1,467	0.800	0.800
	10	20	38	7,739	1,548	1.000	1.000	6,449	1,290	1.000	1.000	5,804	1,045	1.000	1.000

【Note】

① PN Coating is less electro conductive. Therefore, electric transmitted measuring systems may not work.
② Use the appropriate coolant for the work material and machining shape.
③ Use a highly rigid and accurate machine as possible.
④ The pick feed in the table is a general condition; please select the ae according to the cusp height requested.
⑤ These conditions are for general guidance; in actual machining conditions adjust the parameters according to your actual machine and work-piece conditions.
⑥ If the rpm available is lower than that recommended please reduce the feed rate to the same ratio.

Recommended Cutting Conditions

HGOB-PN



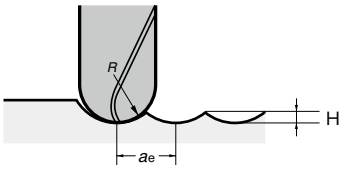
Types of finishing	Ball radius R (mm)	Tool dia. Dc (mm)	Flute length ℓ (mm)	Alloy steels (25～35HRC) HPM7,SKD61Ⓐ,SKT4				Pre-hardened steels (35～45HRC) HPM-MAGIC,CENA1,NAK80				Hardened steels (45～52HRC) SKD61Ⓗ,HPM38,DAC-MAGIC			
				Revolution min^{-1}	Feed rate mm/min	ap mm	ae mm	Revolution min^{-1}	Feed rate mm/min	ap mm	ae mm	Revolution min^{-1}	Feed rate mm/min	ap mm	ae mm
Roughing	0.15	0.3	0.6	28,662	1,634	0.036	0.108	25,796	1,393	0.035	0.103	22,930	1,176	0.033	0.099
	0.2	0.4	0.8	28,662	1,634	0.048	0.144	25,796	1,393	0.046	0.138	22,930	1,176	0.044	0.132
	0.25	0.5	1	28,662	1,634	0.060	0.180	25,796	1,393	0.058	0.172	22,930	1,176	0.055	0.165
	0.3	0.6	1.2	23,885	1,815	0.072	0.216	21,497	1,548	0.069	0.207	19,108	1,307	0.066	0.198
	0.4	0.8	1.6	21,497	1,634	0.096	0.288	19,347	1,393	0.092	0.276	17,197	1,176	0.088	0.264
	0.5	1	2.5	22,930	2,178	0.120	0.360	20,637	1,857	0.115	0.345	18,344	1,568	0.110	0.330
	0.75	1.5	4	21,019	2,396	0.180	0.540	18,917	2,043	0.173	0.517	16,815	1,725	0.165	0.495
	1	2	5	20,064	2,668	0.240	0.720	18,057	2,275	0.230	0.690	16,051	1,921	0.220	0.660
	1.25	2.5	7	18,344	2,788	0.300	0.900	16,510	2,377	0.288	0.862	14,675	2,008	0.275	0.825
	1.5	3	8	17,197	2,941	0.360	1.080	15,478	2,507	0.345	1.035	13,758	2,117	0.330	0.990
	2	4	8	16,481	3,131	0.480	1.440	14,833	2,670	0.460	1.380	13,185	2,255	0.440	1.320
			8	16,481	3,758	0.480	1.440	14,833	3,204	0.460	1.380	13,185	2,706	0.440	1.320
	2.5	5	10	14,904	3,965	0.600	1.800	13,414	3,380	0.575	1.725	11,924	2,855	0.550	1.650
	3	6	12	12,898	3,921	0.720	2.160	11,608	3,343	0.690	2.070	10,318	2,823	0.660	1.980
	4	8	14	10,390	3,553	0.960	2.880	9,351	3,030	0.920	2.760	8,312	2,558	0.880	2.640
	5	10	18	8,885	3,376	1.200	3.600	7,997	2,879	1.150	3.450	7,108	2,431	1.100	3.300
	6	12	22	7,882	3,295	1.440	4.320	7,094	2,809	1.380	4.140	6,306	2,372	1.320	3.960
	8	16	30	6,091	2,777	1.920	5.760	5,482	2,368	1.840	5.520	4,873	2,000	1.760	5.280
	10	20	38	4,873	2,407	2.400	7.200	4,385	2,052	2.300	6.900	3,898	1,733	2.200	6.600
Finishing	0.15	0.3	0.6	33,439	1,204	0.012	0.012	30,096	975	0.009	0.009	26,752	770	0.009	0.009
	0.2	0.4	0.8	32,245	1,161	0.016	0.016	29,021	940	0.012	0.012	25,796	743	0.012	0.012
	0.25	0.5	1	31,529	1,135	0.020	0.020	28,376	919	0.015	0.015	25,223	726	0.015	0.015
	0.3	0.6	1.2	26,274	1,419	0.024	0.024	23,646	1,149	0.018	0.018	21,019	908	0.018	0.018
	0.4	0.8	1.6	23,288	1,258	0.032	0.032	20,959	1,019	0.024	0.024	18,631	805	0.024	0.024
	0.5	1	2.5	22,930	1,238	0.040	0.040	20,637	1,003	0.030	0.030	18,344	792	0.030	0.030
	0.75	1.5	4	21,975	1,187	0.060	0.060	19,777	961	0.045	0.045	17,580	759	0.045	0.045
	1	2	5	22,213	1,599	0.080	0.080	19,992	1,295	0.060	0.060	17,771	1,024	0.060	0.060
	1.25	2.5	7	21,210	1,527	0.100	0.100	19,089	1,237	0.075	0.075	16,968	977	0.075	0.075
	1.5	3	8	19,586	1,410	0.120	0.120	17,627	1,142	0.090	0.090	15,669	903	0.090	0.090
	2	4	8	18,272	1,316	0.160	0.160	16,445	1,066	0.120	0.120	14,618	842	0.120	0.120
			8	18,272	1,645	0.160	0.160	16,445	1,332	0.120	0.120	14,618	1,052	0.120	0.120
	2.5	5	10	16,911	1,522	0.200	0.200	15,220	1,233	0.150	0.150	13,529	974	0.150	0.150
	3	6	12	14,570	1,574	0.240	0.240	13,113	1,275	0.180	0.180	11,656	1,007	0.180	0.180
	4	8	14	12,002	1,296	0.320	0.320	10,802	1,050	0.240	0.240	9,602	830	0.240	0.240
	5	10	18	11,035	1,390	0.400	0.400	9,932	1,126	0.300	0.300	8,828	890	0.300	0.300
	6	12	22	10,151	1,645	0.480	0.480	9,136	1,332	0.360	0.360	8,121	1,052	0.360	0.360
	8	16	30	8,151	1,467	0.640	0.640	7,336	1,188	0.480	0.480	6,521	939	0.480	0.480
	10	20	38	5,804	1,045	0.800	0.800	5,224	846	0.600	0.600	4,643	669	0.600	0.600

Ball end mill pick feed and theoretical cusp height table (μm)

Ball Radius R (mm)	Pick Feed : ae (mm) 0.02	0.03	0.04	0.05	0.075	0.1	0.15	0.2	0.3	0.4	0.5
0.1	0.50	1.13	2.02	3.18	–	–	–	–	–	–	–
0.3	0.17	0.38	0.67	1.04	2.35	4.20	9.53	–	–	–	–
0.5	0.10	0.23	0.40	0.63	1.41	2.51	5.66	10.10	23.03	41.74	66.99
1	0.05	0.11	0.20	0.31	0.70	1.25	2.82	5.01	11.31	20.20	31.75
1.5	0.03	0.08	0.13	0.21	0.47	0.83	1.88	3.34	7.52	13.39	20.98
2	0.03	0.06	0.10	0.16	0.35	0.63	1.41	2.50	5.63	10.03	15.69
2.5	0.02	0.05	0.08	0.13	0.28	0.50	1.13	2.00	4.50	8.01	12.53
3	0.017	0.04	0.07	0.10	0.23	0.42	0.94	1.67	3.75	6.67	10.43
4	0.013	0.03	0.05	0.08	0.18	0.31	0.70	1.25	2.81	5.00	7.82
5	0.010	0.02	0.04	0.06	0.14	0.25	0.56	1.00	2.25	4.00	6.25
6	0.008	0.02	0.03	0.05	0.12	0.21	0.47	0.83	1.88	3.33	5.21

Pick feed and Cusp height

$$H=R-\sqrt{R^2-ae^2/4} \fallingdotseq ae^2/8R$$



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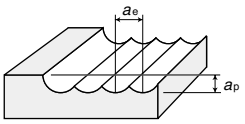
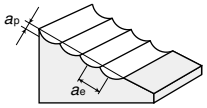


Roughing

Work material (Hardness)	Condition range	Depth of cut (mm)	Cutting condition	Ball radius R × Tool dia. Dc (mm)									
				R0.5×1	R1×2	R1.5×3	R2×4	R3×6	R4×8	R5×10	R6×12	R8×16	R10×20
Tool steels (25～35HRC) SKD	High Speed	ap=0.1Dc	Revolution (min^{-1})	50,000	48,000	32,000	24,000	16,000	12,000	10,000	8,000	6,000	4,800
		ae=0.3Dc	Feed rate (mm/min)	1,800	3,170	3,260	3,360	3,360	3,600	3,600	3,100	2,580	2,060
	General	ap=0.1Dc	Revolution (min^{-1})	20,000	20,000	16,000	12,000	8,000	6,000	4,800	4,000	3,000	2,400
		ae=0.3Dc	Feed rate (mm/min)	720	1,320	1,630	1,680	1,680	1,800	1,730	1,550	1,290	1,030
Pre-hardened steels (35～45HRC) CENA1, NAK80	High Speed	ap=0.1Dc	Revolution (min^{-1})	50,000	48,000	32,000	24,000	16,000	12,000	10,000	8,000	6,000	4,800
		ae=0.3Dc	Feed rate (mm/min)	1,600	2,780	2,880	2,930	2,940	3,020	3,120	2,690	2,220	1,780
	General	ap=0.1Dc	Revolution (min^{-1})	20,000	20,000	16,000	12,000	8,000	6,000	4,800	4,000	3,000	2,400
		ae=0.3Dc	Feed rate (mm/min)	640	1,160	1,440	1,460	1,470	1,510	1,500	1,340	1,110	890
Hardened steels (45～55HRC) SKD61, SKT4	High Speed	ap=0.08Dc	Revolution (min^{-1})	50,000	38,000	25,000	19,000	13,000	10,000	7,600	6,400	4,800	3,800
		ae=0.24Dc	Feed rate (mm/min)	1,500	1,980	2,100	2,170	2,240	2,320	2,170	1,970	1,630	1,290
	General	ap=0.1Dc	Revolution (min^{-1})	20,000	16,000	11,000	8,000	5,300	4,000	3,200	2,700	2,000	1,600
		ae=0.3Dc	Feed rate (mm/min)	540	750	830	820	820	840	820	750	610	490
Hardened steels (55～65HRC) SKD11, SKH51	High Speed	ap=0.05Dc	Revolution (min^{-1})	50,000	29,000	19,000	14,000	9,600	7,200	5,700	4,800	3,600	2,900
		ae=0.15Dc	Feed rate (mm/min)	1,300	1,390	1,440	1,460	1,500	1,510	1,480	1,340	1,110	890
	General	ap=0.07Dc	Revolution (min^{-1})	20,000	13,000	8,500	6,400	4,200	3,200	2,500	2,100	1,600	1,300
		ae=0.21Dc	Feed rate (mm/min)	470	560	580	600	590	600	590	530	440	360
Hardened steels (65～70HRC) SKH, HAP	High Speed	ap=0.05Dc	Revolution (min^{-1})	38,000	19,000	13,000	10,000	6,400	4,800	3,800	3,200	2,400	1,900
		ae=0.15Dc	Feed rate (mm/min)	990	910	990	1,040	1,000	1,010	990	900	740	590
	General	ap=0.07Dc	Revolution (min^{-1})	16,000	8,000	5,300	4,000	2,700	2,000	1,600	1,300	1,000	800
		ae=0.21Dc	Feed rate (mm/min)	370	350	360	370	380	380	370	330	280	220



Finishing

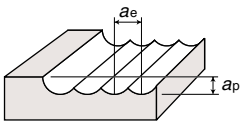
Work material (Hardness)	Condition range	ap:Finishing cut amount ae：Pick feed (mm)	Cutting condition	Ball radius R × Tool dia. Dc (mm)									
				R0.5×1	R1×2	R1.5×3	R2×4	R3×6	R4×8	R5×10	R6×12	R8×16	R10×20
Tool steels (25～35HRC) SKD	High Speed	ap=0.05～0.1	Revolution (min^{-1})	50,000	32,000	25,000	22,000	16,000	12,000	10,000	8,000	6,000	4,800
		ae=0.02Dc	Feed rate (mm/min)	5,000	3,840	3,500	3,740	3,520	2,880	2,600	2,160	1,680	1,340
	General	ap=0.05～0.1	Revolution (min^{-1})	20,000	20,000	17,000	13,000	8,500	6,400	5,100	4,200	3,200	2,500
		ae=0.02Dc	Feed rate (mm/min)	2,000	2,400	2,380	2,210	1,870	1,540	1,330	1,130	900	700
Pre-hardened steels (35～45HRC) CENA1, NAK80	High Speed	ap=0.05～0.1	Revolution (min^{-1})	50,000	32,000	25,000	22,000	16,000	12,000	10,000	8,000	6,000	4,800
		ae=0.02Dc	Feed rate (mm/min)	5,000	3,840	3,500	3,740	3,520	2,880	2,600	2,160	1,680	1,340
	General	ap=0.05～0.1	Revolution (min^{-1})	20,000	20,000	17,000	13,000	8,500	6,400	5,100	4,200	3,200	2,500
		ae=0.02Dc	Feed rate (mm/min)	2,000	2,400	2,380	2,210	1,870	1,540	1,330	1,130	900	700
Hardened steels (45～55HRC) SKD61, SKT4	High Speed	ap=0.05～0.1	Revolution (min^{-1})	50,000	32,000	24,000	20,000	13,000	10,000	8,000	6,600	5,000	4,000
		ae=0.02Dc	Feed rate (mm/min)	4,000	3,200	2,880	3,200	2,730	2,300	2,000	1,720	1,350	1,080
	General	ap=0.05～0.1	Revolution (min^{-1})	20,000	20,000	14,000	10,000	6,900	5,200	4,100	3,500	2,600	2,100
		ae=0.02Dc	Feed rate (mm/min)	1,600	2,000	1,680	1,600	1,450	1,200	1,030	910	700	570
Hardened steels (55～65HRC) SKD11, SKH51	High Speed	ap=0.05～0.1	Revolution (min^{-1})	50,000	32,000	21,000	16,000	11,000	8,000	6,400	5,300	4,000	3,200
		ae=0.02Dc	Feed rate (mm/min)	2,500	2,880	2,520	2,400	2,200	1,760	1,540	1,330	1,040	830
	General	ap=0.05～0.1	Revolution (min^{-1})	15,000	15,000	13,000	9,600	6,400	4,800	3,800	3,200	2,400	1,900
		ae=0.02Dc	Feed rate (mm/min)	750	1,350	1,560	1,440	1,280	1,060	910	800	620	490
Hardened steels (65～70HRC) SKH, HAP	High Speed	ap=0.05～0.1	Revolution (min^{-1})	48,000	24,000	16,000	12,000	8,000	6,000	4,800	4,000	3,000	2,400
		ae=0.02Dc	Feed rate (mm/min)	2,400	2,160	1,920	1,800	1,600	1,320	1,150	1,000	780	620
	General	ap=0.05～0.1	Revolution (min^{-1})	15,000	14,000	10,000	7,200	4,800	3,600	2,900	2,400	1,800	1,400
		ae=0.02Dc	Feed rate (mm/min)	750	1,260	1,200	1,080	960	790	700	600	470	360

【Note】
① Use a highly rigid and accurate machine as possible.
② The pick feed in the table is a general condition; please select the *ae* according to the cusp height requested.
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

HGFB-TH

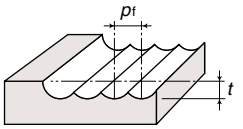
Applied for from heavy roughing to finishing of over 35HRC up to 70HRC.
Recommended for Forging die and die casting die cutting.



Roughing

Work material (Hardness)	Cutting range	Depth of cut (mm)	Cutting conditions	Tool dia. (mm)						
				R1.5×3	R2×4	R2.5×5	R3×6	R4×8	R5×10	R6×12
Pre-hardened steels (35～45HRC) CENA1,NAK80	High Speed	a_p=0.12Dc a_e=0.36Dc	n (min^{-1})	37,700	28,300	22,800	19,200	14,700	11,800	9,800
			Vf (mm/min)	3,620	3,620	3,650	3,690	3,760	3,780	3,650
	General	a_p=0.12Dc a_e=0.36Dc	n (min^{-1})	17,300	13,000	10,500	8,800	6,800	5,400	4,500
			Vf (mm/min)	1,560	1,560	1,580	1,580	1,630	1,620	1,570
Hardened steels (45～55HRC) SKD61,SKT4	High Speed	a_p=0.1Dc a_e=0.3Dc	n (min^{-1})	27,500	20,600	16,700	14,000	10,700	8,600	7,200
			Vf (mm/min)	2,810	2,800	2,840	2,860	2,910	2,920	2,850
	General	a_p=0.1Dc a_e=0.3Dc	n (min^{-1})	14,300	10,700	8,600	7,300	5,600	4,500	3,700
			Vf (mm/min)	1,030	1,030	1,030	1,050	1,080	1,080	1,030
Hardened steels (55～65HRC) SKD11,SKH51	High Speed	a_p=0.06Dc a_e=0.18Dc	n (min^{-1})	22,400	16,800	13,600	11,400	8,800	7,000	5,800
			Vf (mm/min)	2,280	2,280	2,310	2,330	2,390	2,380	2,300
	General	a_p=0.08Dc a_e=0.24Dc	n (min^{-1})	12,200	9,200	7,400	6,200	4,800	3,800	3,200
			Vf (mm/min)	730	740	740	740	770	760	740
Hardened steels (65～72HRC) SKH,HAP	High Speed	a_p=0.05Dc a_e=0.15Dc	n (min^{-1})	13,200	9,900	8,000	6,800	5,200	4,100	3,400
			Vf (mm/min)	1,110	1,110	1,120	1,140	1,160	1,150	1,110
	General	a_p=0.07Dc a_e=0.21Dc	n (min^{-1})	7,100	5,300	4,300	3,600	2,800	2,200	1,900
			Vf (mm/min)	340	340	340	350	360	350	350

Finishing

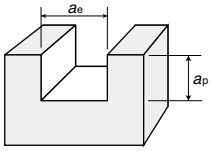


t: Finishing cut amount
p_f: Pick feed

Work material (Hardness)	Cutting range	Depth of cut (mm)	Cutting conditions	Tool dia. (mm)						
				R1.5×3	R2×4	R2.5×5	R3×6	R4×8	R5×10	R6×12
Pre-hardened steels (35～45HRC) CENA1,NAK80	High Speed	t=0.05～0.1 p_f=0.02Dc	n (min^{-1})	27,500	24,200	20,900	17,600	13,200	11,000	8,800
			Vf (mm/min)	3,890	4,150	4,020	3,910	3,200	2,890	2,400
	General	t=0.05～0.1 p_f=0.02Dc	n (min^{-1})	17,000	13,000	10,500	8,500	6,400	5,100	4,200
			Vf (mm/min)	2,620	2,430	2,260	2,060	1,690	1,460	1,240
Hardened steels (45～55HRC) SKD61,SKT4	High Speed	t=0.05～0.1 p_f=0.02Dc	n (min^{-1})	26,400	22,000	18,150	14,300	11,000	8,800	7,260
			Vf (mm/min)	3,200	3,550	3,310	3,030	2,550	2,220	1,910
	General	t=0.05～0.1 p_f=0.02Dc	n (min^{-1})	15,400	11,000	9,130	7,590	5,720	4,510	3,850
			Vf (mm/min)	1,850	1,760	1,670	1,600	1,320	1,130	1,000
Hardened steels (55～65HRC) SKD11,SKH51	High Speed	t=0.05～0.1 p_f=0.02Dc	n (min^{-1})	23,100	17,600	14,850	12,100	8,800	7,040	5,830
			Vf (mm/min)	2,800	2,660	2,550	2,440	1,680	1,640	1,490
	General	t=0.05～0.1 p_f=0.02Dc	n (min^{-1})	14,300	10,560	7,040	5,280	4,180	3,520	2,640
			Vf (mm/min)	1,720	1,580	1,440	1,410	1,170	1,000	880
Hardened steels (65～72HRC) SKH,HAP	High Speed	t=0.05～0.1 p_f=0.02Dc	n (min^{-1})	17,600	13,200	11,000	8,800	6,600	5,280	4,400
			Vf (mm/min)	2,130	2,000	1,910	1,780	1,470	1,280	1,110
	General	t=0.05～0.1 p_f=0.02Dc	n (min^{-1})	11,000	7,920	6,490	5,280	3,960	3,190	2,640
			Vf (mm/min)	1,320	1,190	1,100	1,060	870	770	660

HGOF2-TH

Slotting



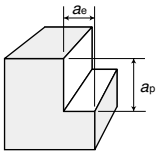
Work material (Hardness)	Depth of cut Dc:Tool dia. (mm)	Cutting condition	Tool dia.× Corner radius (mm)							
			ϕ2	ϕ3	ϕ4	ϕ5	ϕ6	ϕ8	ϕ10	ϕ12
Cast irons, Carbon steels, Alloy steels (200～250HB) FC,S50C	a_p≦1Dc	Revolution (min^{-1})	9,550	6,400	4,800	3,800	3,200	2,400	1,900	1,600
	a_e=1Dc	Feed rate (mm/min)	168	196	220	232	244	260	232	216
Alloy steels (25～35HRC) SKD,SCM	a_p≦0.5Dc	Revolution (min^{-1})	9,550	6,400	4,800	3,800	3,200	2,400	1,900	1,600
	a_e=1Dc	Feed rate (mm/min)	136	176	200	212	220	236	208	192
Stainless steels (25～35HRC) SUS304	a_p≦0.5Dc	Revolution (min^{-1})	6,685	4,480	3,360	2,660	2,240	1,680	1,330	1,120
	a_e=1Dc	Feed rate (mm/min)	90	115	130	138	145	155	135	125
Pre-hardened steels (35～45HRC) CENA1, NAK80	a_p≦0.5Dc	Revolution (min^{-1})	8,750	5,800	4,400	3,500	2,900	2,200	1,800	1,500
	a_e=1Dc	Feed rate (mm/min)	112	144	164	172	180	192	176	160
Hardened steels (45～55HRC) SKD61,SKT4	a_p≦0.2Dc	Revolution (min^{-1})	8,000	5,300	4,000	3,200	2,700	2,000	1,600	1,300
	a_e=1Dc	Feed rate (mm/min)	76	96	112	116	124	132	116	104

【Note】

① Use a highly rigid and accurate machine as possible.
② These conditions are for general guidance; in actual machining conditions adjust the parameters according to your actual machine and work-piece conditions.
③ If the rpm available is lower than that recommended please reduce the feed rate to the same ratio.
④ To increase efficiency even further, increase the rotation speed and the feed rate by the same ratio.

HGOF2-TH

Side cutting



Work material (Hardness)	Depth of cut Dc:Tool dia. (mm)	Cutting condition	Tool dia.× Corner radius (mm)							
			ϕ2	ϕ3	ϕ4	ϕ5	ϕ6	ϕ8	ϕ10	ϕ12
Cast irons, Carbon steels, Alloy steels (200～250HB) FC,S50C	a_p≦1.5Dc	Revolution (min^{-1})	14,300	9,600	7,200	5,700	4,800	3,600	2,900	2,400
	a_e=0.15Dc	Feed rate (mm/min)	385	430	460	500	540	575	535	500
Alloy steels (25～35HRC) SKD,SCM	a_p≦1.5Dc	Revolution (min^{-1})	14,300	9,600	7,200	5,700	4,800	3,600	2,900	2,400
	a_e=0.1Dc	Feed rate (mm/min)	345	385	415	450	485	520	480	450
Stainless steels (25～35HRC) SUS304	a_p≦1.5Dc	Revolution (min^{-1})	10,000	6,720	5,040	4,000	3,360	2,520	2,030	1,680
	a_e=0.1Dc	Feed rate (mm/min)	225	250	270	295	315	340	315	295
Pre-hardened steels (35～45HRC) CENA1, NAK80	a_p≦1.5Dc	Revolution (min^{-1})	12,700	8,500	6,400	5,100	4,200	3,200	2,500	2,100
	a_e=0.07Dc	Feed rate (mm/min)	280	305	330	360	375	410	370	350
Hardened steels (45～55HRC) SKD61,SKT4	a_p≦1.5Dc	Revolution (min^{-1})	11,100	7,400	5,600	4,500	3,700	2,800	2,200	1,900
	a_e=0.05Dc	Feed rate (mm/min)	200	230	250	275	290	315	285	275

【Note】

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Recommended Cutting Conditions

HGOF4-TH HGOF2-TH

When using the 2-flute model, set feed rate only to 50% of the value below as a general criteria. Further, it is not recommended to use the 2-flute model for cutting materials with hardness of 55HRC.

Contouring

Work material (Hardness)	Cutting condition	Tool dia.× Corner radius (mm)							
		φ2×r0.5	φ3×r0.8	φ4×r1	φ5×r1.2	φ6×r1.5	φ8×r2	φ10×r2	φ12×r2
Cast Irons, Carbon steels, Alloy steels (150～250HB) FC, S50C, SCM	Revolution (min^{-1})	12,000	8,000	6,000	4,800	4,000	3,000	2,400	2,000
	Feed rate (mm/min)	5,380	6,050	6,380	6,380	6,720	6,720	6,720	6,380
	*a*p mm	0.12	0.19	0.24	0.29	0.36	0.48	0.48	0.48
	*a*e mm	0.5	0.7	1	1.3	1.5	2	3	4
Tool steels (25～35HRC) SUS304, SKD	Revolution (min^{-1})	11,000	7,400	5,600	4,500	3,700	2,800	2,200	1,900
	Feed rate (mm/min)	4,510	5,110	5,450	5,470	5,680	5,730	5,630	5,540
	*a*p mm	0.12	0.19	0.24	0.29	0.36	0.48	0.48	0.48
	*a*e mm	0.5	0.7	1	1.3	1.5	2	3	4
Pre-hardened steels (35～45HRC) NAK80, CENA1	Revolution (min^{-1})	10,000	6,900	5,200	4,100	3,400	2,600	2,100	1,700
	Feed rate (mm/min)	3,200	3,730	3,950	3,900	4,080	4,160	4,200	3,880
	*a*p mm	0.12	0.19	0.24	0.29	0.36	0.48	0.48	0.48
	*a*e mm	0.5	0.7	1	1.3	1.5	2	3	4
Hardened steels (45～55HRC) SKD61, SKT4	Revolution (min^{-1})	8,000	5,300	4,000	3,200	2,700	2,000	1,600	1,300
	Feed rate (mm/min)	2,560	2,860	3,040	3,040	3,240	3,200	3,200	2,960
	*a*p mm	0.08	0.13	0.17	0.20	0.25	0.34	0.34	0.34
	*a*e mm	0.5	0.7	1	1.3	1.5	2	3	4
Hardened steels (55～60HRC) SKD11, SKH51	Revolution (min^{-1})	8,000	5,300	4,000	3,200	2,700	2,000	1,600	1,300
	Feed rate (mm/min)	1,275	1,425	1,525	1,525	1,625	1,600	1,600	1,488
	*a*p mm	0.06	0.10	0.12	0.14	0.18	0.24	0.24	0.24
	*a*e mm	0.5	0.7	1	1.3	1.5	2	3	4

【Note】

① Use a highly rigid and accurate machine as possible.
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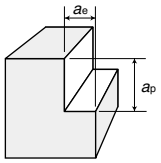
HGOR-TH



Side cutting

Work material (Hardness)	Depth of cut *Dc*:Tool dia. (mm)	Cutting condition	Tool dia. *Dc* (mm)					
			φ6	φ8	φ10	φ12	φ16	φ20
Cast Irons, Carbon steels, Alloy steels (200～250HB) FC, S50C	*a*p≦1.5*Dc*	Revolution (min^{-1})	5,836	4,377	3,501	2,918	2,188	1,751
	*a*e=0.1*Dc*	Feed rate (mm/min)	934	875	840	817	788	770
Alloy steels (25～35HRC) SCM440	*a*p≦1.5*Dc*	Revolution (min^{-1})	4,775	3,581	2,865	2,387	1,790	1,432
	*a*e=0.1*Dc*	Feed rate (mm/min)	668	645	630	621	609	573
Pre-hardened steels (35～45HRC) CENA1, NAK80	*a*p≦1*Dc*	Revolution (min^{-1})	4,244	3,183	2,546	2,122	1,592	1,273
	*a*e=0.07*Dc*	Feed rate (mm/min)	509	509	509	509	509	458
Hardened steels (45～55HRC) SKD61,SKT4	*a*p≦1*Dc*	Revolution (min^{-1})	3,714	2,785	2,228	1,857	1,393	1,114
	*a*e=0.05*Dc*	Feed rate (mm/min)	223	223	223	223	223	201

【Note】

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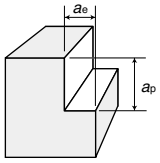
④ To increase efficiency even further, increase the rotation speed and the feed rate by the same ratio.

HGOS2-PN HGOS4-PN



Side cutting

Tool dia. Dc	Flute length ℓ	Copper alloys, Aluminium alloys				Cast irons, Carbon steels (150～200HB) FC250,S50C,S55C				Stainless steels (25～35HRC) SUS304,SUS316			
		Revolution min-1	Feed rate mm/min	ap mm	ae mm	Revolution min-1	Feed rate mm/min	ap mm	ae mm	Revolution min-1	Feed rate mm/min	ap mm	ae mm
0.2	0.4	66,879	669	0.300	0.010	55,732	557	0.300	0.010	33,439	301	0.300	0.008
0.3	0.6	44,586	446	0.450	0.015	37,155	372	0.450	0.015	22,293	201	0.450	0.012
0.4	0.8	38,217	382	0.600	0.020	27,866	279	0.600	0.020	16,720	150	0.600	0.016
0.5	1	38,217	382	0.750	0.025	25,478	255	0.750	0.025	15,287	138	0.750	0.020
0.6	1.2	41,401	662	0.900	0.030	26,539	425	0.900	0.030	15,924	229	0.900	0.024
0.7	1.4	35,487	568	1.050	0.035	29,572	473	1.050	0.035	17,743	256	1.050	0.028
0.8	1.6	33,439	535	1.200	0.040	25,876	414	1.200	0.040	15,525	224	1.200	0.032
0.9	1.8	33,970	544	1.350	0.045	24,770	396	1.350	0.045	14,862	214	1.350	0.036
1	2	38,217	764	1.500	0.050	25,478	510	1.500	0.050	15,287	275	1.500	0.040
1.5	3	28,025	561	2.250	0.150	21,231	425	2.250	0.150	12,739	229	2.250	0.135
2	6	21,019	631	3.000	0.200	17,516	525	3.000	0.200	10,510	284	3.000	0.180
2.5	8	16,815	504	3.750	0.250	14,013	420	3.750	0.250	8,408	227	3.750	0.225
3	8	15,287	611	4.500	0.300	11,677	467	4.500	0.300	7,006	252	4.500	0.270
3.5	10	13,103	524	5.250	0.350	10,919	437	5.250	0.350	6,551	236	5.250	0.315
4	11	11,465	573	6.000	0.400	9,554	478	6.000	0.400	5,732	258	6.000	0.360
4.5	11	10,191	510	6.750	0.450	8,493	425	6.750	0.450	5,096	229	6.750	0.405
5	13	9,172	550	7.500	0.500	7,643	459	7.500	0.500	4,586	248	7.500	0.450
5.5	13	8,338	500	8.250	0.550	6,948	417	8.250	0.550	4,169	225	8.250	0.495
6	13	7,643	459	9.000	0.600	6,369	382	9.000	0.600	3,822	206	9.000	0.540
7	16	6,551	459	10.500	0.700	5,460	382	10.500	0.700	3,276	206	10.500	0.630
8	19	5,732	401	12.000	0.800	4,777	334	12.000	0.800	2,866	181	12.000	0.720
9	19	5,096	408	13.500	0.900	4,246	340	13.500	0.900	2,548	183	13.500	0.810
10	22	4,586	459	15.000	1.000	3,822	382	15.000	1.000	2,293	206	15.000	0.900
12	26	3,822	459	18.000	1.200	3,185	382	18.000	1.200	1,911	206	18.000	1.080
16	35	2,866	401	24.000	1.600	2,389	334	24.000	1.600	1,433	181	24.000	1.440
20	40	2,293	367	30.000	2.000	1,911	306	30.000	2.000	1,146	165	30.000	1.800

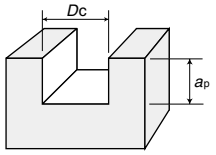
Tool dia. Dc	Flute length ℓ	Alloy steels (25～35HRC) HPM7,SKD61Ⓐ,SKT4				Pre-hardened steels (35～45HRC) HPM-MAGIC,CENA1,NAK80				Hardened steels (45～52HRC) SKD61Ⓗ,HPM38,DAC-MAGIC			
		Revolution min-1	Feed rate mm/min	ap mm	ae mm	Revolution min-1	Feed rate mm/min	ap mm	ae mm	Revolution min-1	Feed rate mm/min	ap mm	ae mm
0.2	0.4	33,439	301	0.300	0.008	26,752	217	0.300	0.006	16,720	105	0.300	0.006
0.3	0.6	22,293	201	0.450	0.012	17,834	144	0.450	0.009	11,146	70	0.450	0.009
0.4	0.8	16,720	150	0.600	0.016	13,376	108	0.600	0.012	8,360	53	0.600	0.012
0.5	1	15,287	138	0.750	0.020	12,229	99	0.750	0.015	7,643	48	0.750	0.015
0.6	1.2	15,924	229	0.900	0.024	12,739	165	0.900	0.018	7,962	80	0.900	0.018
0.7	1.4	17,743	256	1.050	0.028	14,195	184	1.050	0.021	8,872	89	1.050	0.021
0.8	1.6	15,525	224	1.200	0.032	12,420	161	1.200	0.024	7,763	78	1.200	0.024
0.9	1.8	14,862	214	1.350	0.036	11,890	154	1.350	0.027	7,431	75	1.350	0.027
1	2	15,287	275	1.500	0.040	12,229	198	1.500	0.030	7,643	96	1.500	0.030
1.5	3	12,739	229	2.250	0.135	10,191	165	2.250	0.120	6,369	80	2.250	0.045
2	6	10,510	284	3.000	0.180	6,115	149	3.000	0.160	5,732	108	3.000	0.060
2.5	8	8,408	227	3.750	0.225	5,707	139	3.750	0.200	5,350	101	3.750	0.075
3	8	7,006	252	4.500	0.270	5,096	165	4.500	0.240	4,777	120	4.500	0.090
3.5	10	6,551	236	5.250	0.315	4,659	151	5.250	0.280	4,368	110	5.250	0.105
4	11	5,732	258	6.000	0.360	4,331	175	6.000	0.320	4,061	128	6.000	0.120
4.5	11	5,096	229	6.750	0.405	4,076	165	6.750	0.360	3,822	120	6.750	0.135
5	13	4,586	248	7.500	0.450	3,873	188	7.500	0.400	3,631	137	7.500	0.150
5.5	13	4,169	225	8.250	0.495	3,706	180	8.250	0.440	3,474	131	8.250	0.165
6	13	3,822	206	9.000	0.540	3,397	165	9.000	0.480	3,185	120	9.000	0.180
7	16	3,276	206	10.500	0.630	2,912	165	10.500	0.560	2,730	120	10.500	0.210
8	19	2,866	181	12.000	0.720	2,548	144	12.000	0.640	2,389	105	12.000	0.240
9	19	2,548	183	13.500	0.810	2,265	147	13.500	0.720	2,123	107	13.500	0.270
10	22	2,293	206	15.000	0.900	2,038	165	15.000	0.800	1,911	120	15.000	0.300
12	26	1,911	206	18.000	1.080	1,699	165	18.000	0.960	1,592	120	18.000	0.360
16	35	1,433	181	24.000	1.440	1,274	144	24.000	1.280	1,194	105	24.000	0.480
20	40	1,146	165	30.000	1.800	1,019	132	30.000	1.600	955	96	30.000	0.600

【Note】

① PN Coating is less electro conductive. Therefore, electric transmitted measuring systems may not work.
② The cutting conditions given above is applied to 2 flutes type end mills. As for 4 flutes type, increase the feed rate by 1.5 times.
③ Use a highly rigid and accurate machine as possible.
④ Use the appropriate coolant for the work material and machining shape.
⑤ These conditions are for general guidance; in actual machining conditions adjust the parameters according to your actual machine and work-piece conditions.
⑥ If the rpm available is lower than that recommended please reduce the feed rate to the same ratio.

Recommended Cutting Conditions

HGOS2-PN



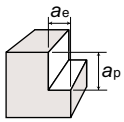
Slotting

Tool dia. Dc	Flute length ℓ	Copper alloys, Aluminium alloys			Cast irons, Carbon steels (150～200HB) FC250,S50C,S55C			Stainless steels (25～35HRC) SUS304,SUS316		
		Revolution min^{-1}	Feed rate mm/min	a_p mm	Revolution min^{-1}	Feed rate mm/min	a_p mm	Revolution min^{-1}	Feed rate mm/min	a_p mm
0.2	0.4	58,678	235	0.01	53,344	213	0.01	37,341	157	0.01
0.3	0.6	39,119	156	0.02	35,563	142	0.02	24,894	120	0.02
0.4	0.8	35,032	140	0.02	26,672	107	0.02	22,293	103	0.02
0.5	1	31,529	126	0.03	25,478	102	0.03	20,064	103	0.03
0.6	1.2	32,113	180	0.03	23,885	191	0.03	20,435	143	0.03
0.7	1.4	30,027	240	0.04	25,023	200	0.04	19,108	161	0.04
0.8	1.6	28,463	228	0.04	23,885	191	0.04	18,113	152	0.04
0.9	1.8	27,247	218	0.05	23,001	184	0.05	17,339	143	0.05
1	2	28,025	215	0.05	22,293	175	0.05	17,834	125	0.05
1.5	3	21,019	210	0.08	16,985	170	0.08	12,739	115	0.08
2	6	15,764	189	0.12	14,331	172	0.12	8,917	96	0.12
2.5	8	12,611	151	0.18	11,465	138	0.18	7,643	83	0.18
3	8	11,677	163	0.30	9,554	134	0.30	6,794	86	0.30
3.5	10	10,009	140	0.35	9,099	127	0.35	6,187	78	0.35
4	11	8,758	140	0.60	7,962	127	0.60	5,732	83	0.60
4.5	11	7,785	125	0.90	7,077	113	0.90	4,034	58	0.90
5	13	7,006	140	1.25	6,369	127	1.25	3,822	69	1.25
5.5	13	6,369	127	1.38	5,790	116	1.38	3,648	66	1.38
6	13	5,839	160	1.80	5,308	150	1.80	3,503	90	1.80
7	16	5,005	200	2.45	4,550	182	2.45	3,139	113	2.45
8	19	4,379	215	3.20	3,981	200	3.20	1,672	125	3.20
9	19	3,892	234	4.05	3,539	212	4.05	1,486	146	4.05
10	22	3,503	210	5.00	3,185	191	5.00	1,338	134	5.00
12	26	2,919	234	6.00	2,654	212	6.00	1,115	103	6.00
16	35	2,189	219	8.00	1,990	199	8.00	975	100	8.00
20	40	1,752	210	10.00	1,592	191	10.00	836	103	10.00

Tool dia. Dc	Flute length ℓ	Alloy steels (25～35HRC) HPM7,SKD61Ⓐ,SKT4			Pre-hardened steels (35～45HRC) HPM-MAGIC,CENA1,NAK80			Hardened steels (45～52HRC) SKD61Ⓗ,HPM38,DAC-MAGIC		
		Revolution min^{-1}	Feed rate mm/min	a_p mm	Revolution min^{-1}	Feed rate mm/min	a_p mm	Revolution min^{-1}	Feed rate mm/min	a_p mm
0.2	0.4	24,005	122	0.01	14,936	56	0.01	8,402	34	0.01
0.3	0.6	16,003	109	0.02	9,958	50	0.01	5,601	30	0.01
0.4	0.8	14,331	103	0.02	8,917	56	0.02	5,016	34	0.02
0.5	1	12,898	93	0.03	8,025	51	0.02	4,514	31	0.02
0.6	1.2	13,137	112	0.03	8,174	51	0.03	4,598	31	0.02
0.7	1.4	12,284	125	0.04	7,643	58	0.03	4,299	35	0.03
0.8	1.6	11,644	119	0.04	7,245	55	0.04	4,075	33	0.03
0.9	1.8	11,146	133	0.05	6,936	61	0.04	3,901	37	0.04
1	2	11,465	125	0.05	7,134	58	0.05	4,013	35	0.04
1.5	3	9,554	114	0.08	5,945	52	0.07	3,344	32	0.06
2	6	7,166	122	0.12	4,459	56	0.11	2,508	34	0.10
2.5	8	5,732	97	0.18	3,567	45	0.16	2,006	27	0.14
3	8	4,777	81	0.30	2,972	37	0.27	1,672	23	0.24
3.5	10	4,095	104	0.35	2,548	48	0.32	1,433	29	0.28
4	11	3,583	91	0.60	2,229	42	0.54	1,254	26	0.49
4.5	11	3,185	92	0.90	1,982	50	0.81	1,115	30	0.73
5	13	2,866	103	1.25	1,783	45	1.13	1,003	27	1.01
5.5	13	2,606	89	1.38	1,621	41	1.24	912	25	1.11
6	13	2,389	105	1.80	1,486	48	1.62	836	30	1.46
7	16	2,047	122	2.45	1,274	56	2.21	717	34	1.98
8	19	1,075	120	3.20	669	54	2.88	376	33	2.59
9	19	955	114	4.05	594	52	3.65	334	32	3.28
10	22	860	117	5.00	535	54	4.50	301	33	4.05
12	26	717	110	6.00	446	51	5.40	251	31	4.86
16	35	627	107	8.00	390	49	7.20	219	30	6.48
20	40	537	100	10.00	334	51	9.00	188	31	8.10

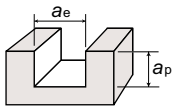
【Note】 The 4 flutes not suitable for slotting.

HGOSH4-TH



Side milling

Work Material (Hardness)	Cutting range	Depth of cut mm	Cutting conditions	Tool dia. *Dc* (mm)								
				φ1	φ1.5	φ2	φ3	φ4	φ6	φ8	φ10	φ12
Carbon steels Alloy Steels (200～250HB) S50C, SCM	High speed	a_p=1.5*Dc*	Revolution min^{-1}	47,800	31,800	23,800	16,000	12,000	8,000	6,000	4,800	4,000
		a_e=0.1*Dc*	Feed rate mm/min	1,500	1,600	1,700	1,800	1,900	2,200	2,400	2,200	2,100
	General	a_p=1.5*Dc*	Revolution min^{-1}	28,600	19,100	14,300	9,600	7,200	4,800	3,600	2,900	2,400
		a_e=0.15*Dc*	Feed rate mm/min	690	760	830	860	920	1,080	1,150	1,070	1,000
Alloy steels SKD, HPM7 P20	High speed	a_p=1.5*Dc*	Revolution min^{-1}	41,400	27,600	20,700	14,000	10,000	6,900	5,200	4,100	3,500
		a_e=0.05*Dc*	Feed rate mm/min	1,160	1,330	1,330	1,400	1,400	1,700	1,900	1,700	1,600
	General	a_p=1.5*Dc*	Revolution min^{-1}	28,600	19,100	14,300	9,600	7,200	4,800	3,600	2,900	2,400
		a_e=0.1*Dc*	Feed rate mm/min	580	690	740	770	830	970	1,040	960	900
Pre-hardened steels (35～45HRC) HPM-MAGIC CENA1	High speed	a_p=1.5*Dc*	Revolution min^{-1}	35,000	23,300	17,500	12,000	8,800	5,800	4,400	3,500	2,900
		a_e=0.05*Dc*	Feed rate mm/min	700	930	980	1,100	1,100	1,300	1,400	1,300	1,200
	General	a_p=1.5*Dc*	Revolution min^{-1}	25,500	17,000	12,700	8,500	6,400	4,200	3,200	2,500	2,100
		a_e=0.07*Dc*	Feed rate mm/min	460	510	560	610	660	750	820	740	700
Hardened steels (45～55HRC) SKD61, HPM38 DAC-MAGIC	High speed	a_p=1.5*Dc*	Revolution min^{-1}	31,800	21,200	15,900	11,000	8,000	5,300	4,000	3,200	2,700
		a_e=0.02*Dc*	Feed rate mm/min	640	760	830	860	900	1,040	1,120	1,030	980
	General	a_p=1.5*Dc*	Revolution min^{-1}	22,300	14,800	1,1100	7,400	5,600	3,700	2,800	2,200	1,900
		a_e=0.05*Dc*	Feed rate mm/min	360	410	440	460	500	580	630	570	550



Slotting

Work Material (Hardness)	Cutting range	Depth of cut mm	Cutting conditions	Tool dia. *Dc* (mm)								
				φ1	φ1.5	φ2	φ3	φ4	φ6	φ8	φ10	φ12
Carbon steels Alloy steels (200～250HB) S50C, SCM	High speed	a_p≦0.5*Dc*	Revolution min^{-1}	25,500	17,000	12,700	8,500	6,400	4,200	3,200	2,500	2,100
		a_e=1*Dc*	Feed rate mm/min	720	750	810	820	920	1,010	1,090	950	880
	General	a_p≦1*Dc*	Revolution min^{-1}	19,100	12,700	9,500	6,400	4,800	3,200	2,400	1,900	1,600
		a_e=1*Dc*	Feed rate mm/min	380	430	450	490	550	610	650	580	540
Alloy steels SKD, HPM7 P20	High speed		Revolution min^{-1}									
			Feed rate mm/min									
	General	a_p≦0.5*Dc*	Revolution min^{-1}	19,100	12,700	9,500	6,400	4,800	3,200	2,400	1,900	1,600
		a_e=0.1*Dc*	Feed rate mm/min	340	380	400	440	500	550	590	520	480
Pre-hardened steels (35～45HRC) HPM-MAGIC CENA1	High speed		Revolution min^{-1}									
			Feed rate mm/min									
	General	a_p≦0.5*Dc*	Revolution min^{-1}	17,500	11,700	8,800	5,800	4,400	2,900	2,200	1,800	1,500
		a_e=1*Dc*	Feed rate mm/min	280	300	330	360	410	450	480	440	400
Hardened steels (45～55HRC) SKD61, HPM38 DAC-MAGIC	High speed		Revolution min^{-1}									
			Feed rate mm/min									
	General	a_p≦0.2*Dc*	Revolution min^{-1}	16,000	10,600	8,000	5,300	4,000	2,700	2,000	1,600	1,300
		a_e=1*Dc*	Feed rate mm/min	190	210	240	240	280	310	330	290	260

【Note】

①Use the high-rigidity and high accuracy machine as possible
②These 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.
③If the rpm available is lower than that recommended please reduce the feed rate to the same ratio.

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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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