NS TOOL

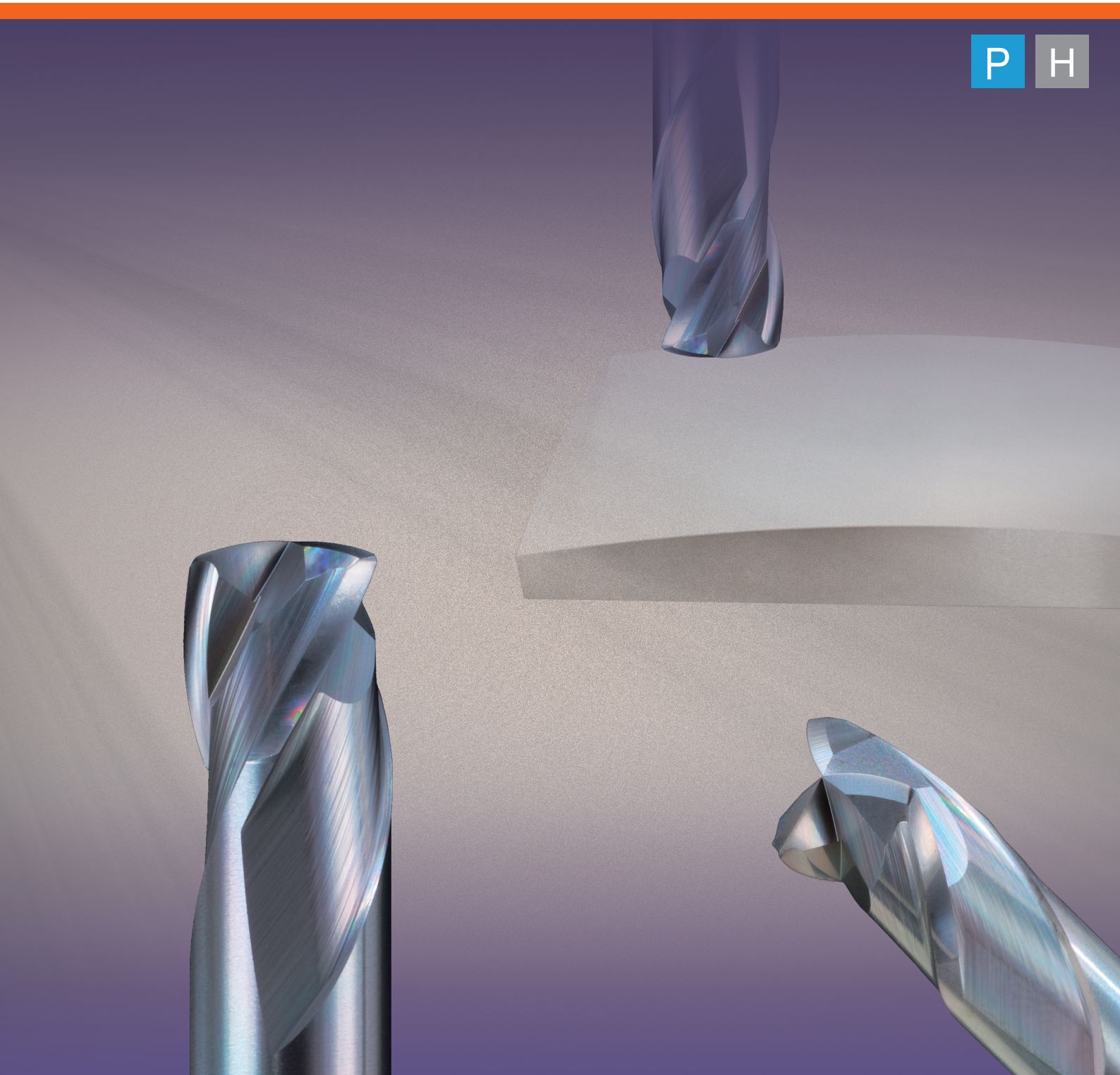
For Crafting Tomorrow

MUGEN COATING PREMIUM
High Efficiency Lens Form 3-Flute End Mill

MLFH330

Total 7 sizes

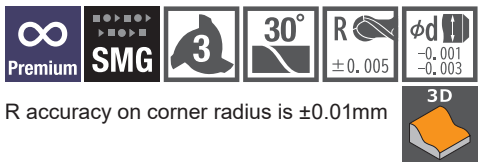
P H



Realizes large pick feed even with small size diameter
Specialized lens form 3-Flute end mill improves productivity compared to ball end mills

MUGEN COATING PREMIUM
High Efficiency Lens Form 3-Flute End Mill

MLFH330



R accuracy on corner radius is ±0.01mm

φ1 ×R1 ～ φ6 × R8　　Total 7 sizes

Features

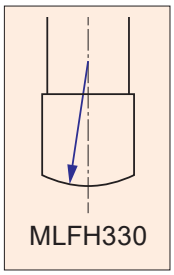
Feature 1 | Coating | Performance of MUGEN COATING PREMIUM

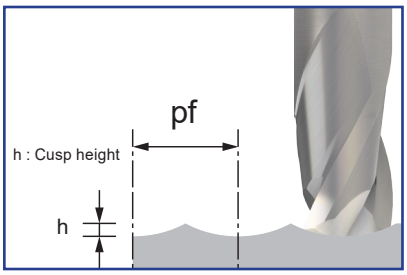
Most optimize for work materials from 40HRC to 65HRC.
MUGEN COATING PREMIUM has further improved than the conventional MUGEN COATING that achieves longer tool life.

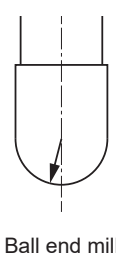
Premium MUGEN COATING PREMIUM		
Prehardened Steel P	Hardened Steel H	
	40～60HRC	～65HRC
◎	◎	○

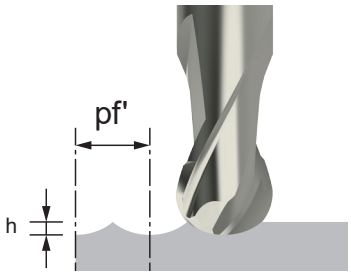
Feature 2 | Improved productivity | Lens Form 3-Flute

2-1 Realize large pick feed than conventional ball end mills that achieve high efficiency machining.



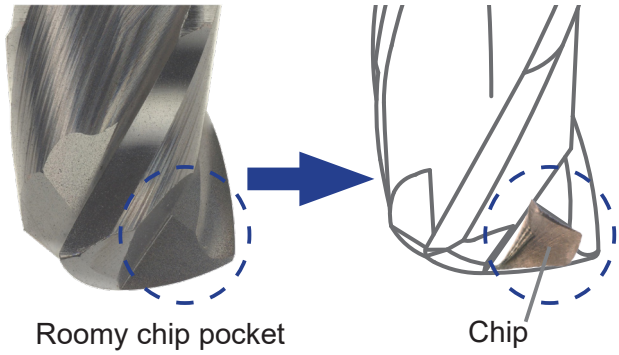






2-2

Large enough chip pockets prevent unexpected chipping of cutting edge or chip jamming due to the size of the chips by large pick feed.



■ Comparison of machining efficiency with conventional products

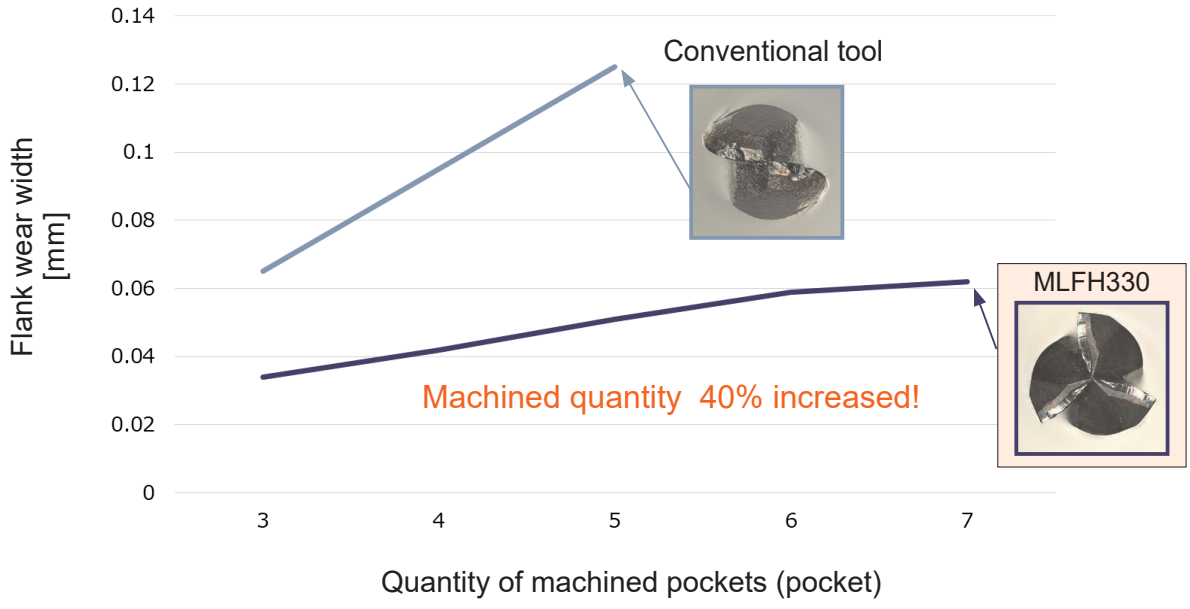
Work material : STAVAX (52HRC)
Coolant : Oil mist
Machining size : 14.5 × 30.8 × 3 mm

Achieves high efficiency with both productivity and cost performance through shortening machining time and increasing tool life.

Process	Conventional 2-flute ball end mill	MLFH330
Tool size	R0.5 × 3	ϕ 1×R1 × 3
Spindle speed [min^{-1}]	40,000	27,500
Feed [mm/min]	2,500	3,750
Depth of cut ap × ae [mm]	0.1 × 0.3	0.1 × 0.425
Feed per tooth [mm/tooth]	0.031	0.045
Machining time (1 pocket)	25 min	15 min

Machining time reduced by 40%

Comparison between machined pocket quantity and flank wear width

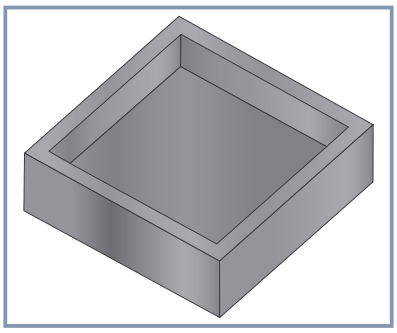


Realizes large pick feed even with small size diameter
Specialized lens form 3-Flute end mill improves productivity compared to ball end mills

■ Machining efficiency and cost comparison with 2-flute ball end mills（ϕ6・R3）

◆ Comparison of machining efficiency

Work material : STAVAX（52HRC）
Coolant : Oil mist
Machining size : 94 × 95.5 × 20 mm

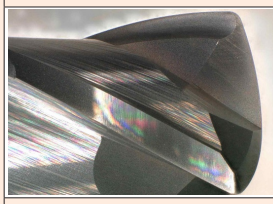
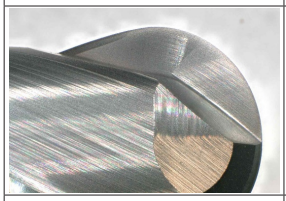
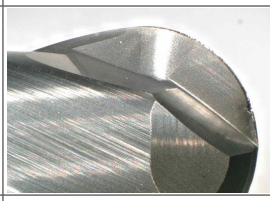
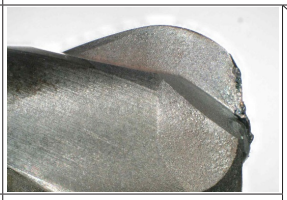


Machining example

Tool	**MLFH330 (3-flute)**	2-flute ball end mill
Tool size	**ϕ 6×R8 × 20**	R3 × 20
Spindle speed [min^{-1}]	**9,650**	16,000
Feed [mm/min]	**4,500**	3,000
Depth of cut ap × ae [mm]	**0.3 × 3.265**	0.3 × 2
Feed per tooth [mm/tooth]	**0.155**	0.094
Machining time/ pocket	**55 min**	2 hr

Actual machining efficiency 2.2 times higher!

Comparison of tool wear conditions [Rake face]

Tool	Before machining	After machining 1pc	After machining 3pcs	After machining 5.5pcs
MLFH330 ϕ6 × R8 × 20		Machining time : 55 min	Machining time : 2 hr 45 min	Machining time : 5 hr
				
		R retreat amount : **0.006 mm**	R retreat amount : **0.022 mm**	R retreat amount : **0.069 mm**
2-flute ball end mill R3 × 20		Machining time : 2 hr	After machining 2.5 pockets in 5 hours, 2-flute ball end mill reached to its tool life	
				
		R retreat amount : 0.041 mm	R retreat amount : unmeasurable	

MLFH330 realizes high efficiency machining with **5.5 pockets** in 5 hours, which is **2.2 times** higher comparing to 2-flute ball end mill that reached to its tool life after machining 2.5 pockets in 5 hours.

◆ Cost comparison

Comparison of cost for five pockets of the same shape and machining efficiency

Tool	**MLFH330 (3-flute)**	2-flute ball end mill
Tool size	**ϕ 6×R8 × 20**	R3 × 20
Tool Q'ty [pcs]	**1**	2
Tool cost	**¥ 11,000 (¥ 11,000/pc)**	¥ 14,400 (¥ 7,200/pc)
Machining time [min]	**275**	600
Machine charge fee※	**¥ 22,900**	¥ 50,000
Machining cost	**¥ 33,900**	¥ 64,400

47% cost reduction compare with 2-flute ball end mills

※Machine charge fee: JPY 5,000/hr

Improvements in machining efficiency help significantly reduce costs by shortening machine operating time and reducing the number of tools used.

■ Comparison of chip removal volume with 2-flute ball end mill

MLFH330
(3-flute)

Work Material			Hardened Steels SKD11・PD613(～62HRC)					Comparison of chip removal volume with 2-flute ball end mill
Dia.	End Tooth Bottom Radius	Under Neck Length	Spindle Speed	Feed	Depth of Cut		Material removal rate	
			min^{-1}	mm/min	a_p mm	a_e mm	mm^3/min	
1	1	3	21,000	2,400	0.1	0.28	67.2	**1.7** times higher
2	2	6	12,000	2,400	0.2	0.5	240	**2.0** times higher
3	3	9	10,000	3,000	0.2	0.85	510	**3.2** times higher
4	4	12	9,000	3,000	0.2	1.2	720	**1.8** times higher
5	5	15	8,200	3,000	0.2	1.6	960	**1.6** times higher
6	6	20	7,000	3,000	0.3	1.8	1,620	**1.8** times higher
6	8	20	6,500	3,000	0.3	2	1,800	**2.0** times higher

2-flute ball end mill

Work Material		Hardened Steels SKD11・PD613(～62HRC)				
Radius	Under Neck Length	Spindle Speed	Feed	Depth of Cut		Material removal rate
		min^{-1}	mm/min	a_p mm	a_e mm	mm^3/min
R0.5	3	30,000	2,000	0.1	0.2	40
R1	6	25,000	2,000	0.2	0.3	120
R1.5	10	18,000	2,000	0.2	0.4	160
R2	12	16,000	2,500	0.2	0.8	400
R2.5	15	12,000	2,500	0.2	1.2	600
R3	20	8,000	2,500	0.3	1.2	900

The MLFH330 enables for a large pick feed and the 3-flutes improve machining efficiency!

Realizes large pick feed even with small size diameter
Specialized lens form 3-Flute end mill improves productivity compared to ball end mills

■ Points of using MLFH330

CAM software can define the tool shape of MLFH330 (Lens shape)

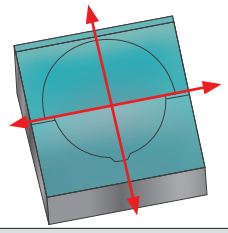
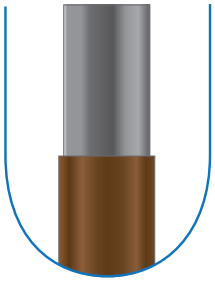
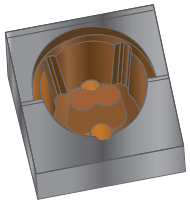
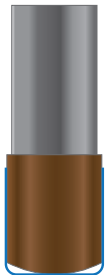
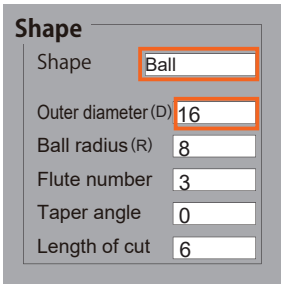
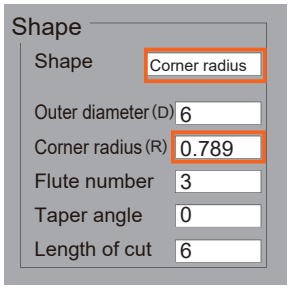
Yes

STEP and DXF files are distributed on our website. Please use them to check interference and create tool paths. Please give it a try!

No

If CAM software cannot define the tool shape of MLFH330, please use it with a simple adjustment of the parameters! Please see the tool settings below.

● Tool setting

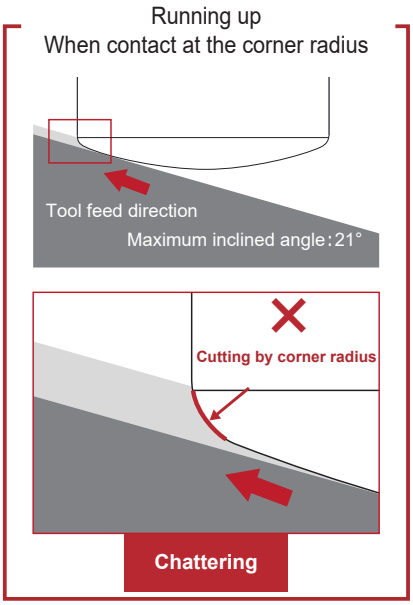
Pattern 1: No wall shape		Pattern 2: Pocket shape	
Define the tool shape as “Ball end mill”		Define the tool shape as “Corner radius end mill”	
Applicable shape	MLFH330 definition image	Applicable shape	MLFH330 definition image
No wall shape 		Pocket shape 	
Way to set up CAM		Way to set up CAM	
① Define the tool shape as “**ball end mill**” ② Enter **twice the end tooth bottom radius (R) of MLFH330** as the tool diameter Tool : MLFH330 ϕ6×R8×20 		① Define the tool shape as “**Corner radius end mill**” ② Enter the **theoretical corner radius of MLFH330** as the tool corner radius ※For approximate R, please refer the specifications table on page 8 Tool : MLFH330 ϕ6×R8×20 	

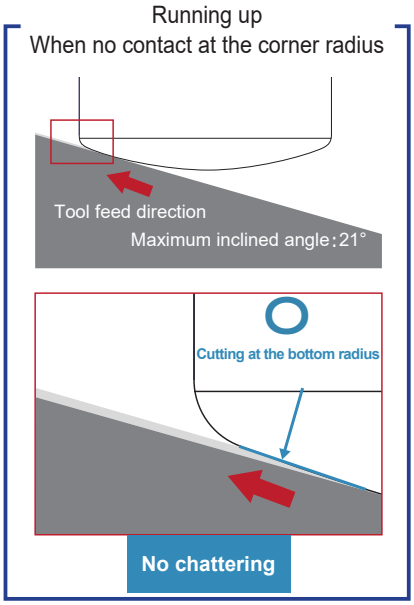
For details, please see the MLFH330 introduction page on our website

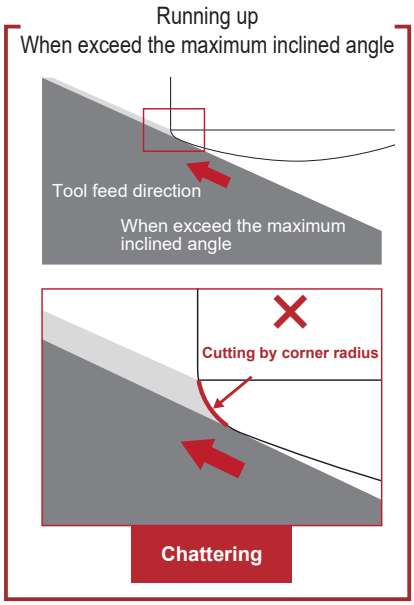
English

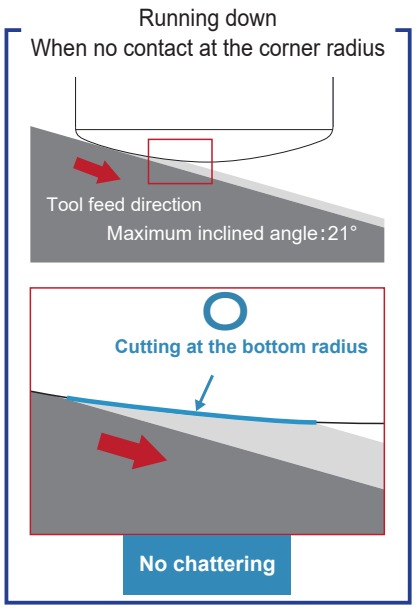
■ Points of creating tool paths

· Please make sure that the inclination angle does not exceed the cutting range at the end cutting edge radius and within the maximum inclination angle.
· Avoid cutting with the corner radius or peripheral cutting edge as this is likely to cause vibration. If cutting is done with the corner radius when ascending on a slope, change the cutting direction so that cutting is done with the corner radius.









MLFH330

Size ϕ1 × R1 ～ ϕ6 × R8

Premium ≦65 HRC

MUGEN COATING PREMIUM High Efficiency Lens Form 3-Flute End Mill

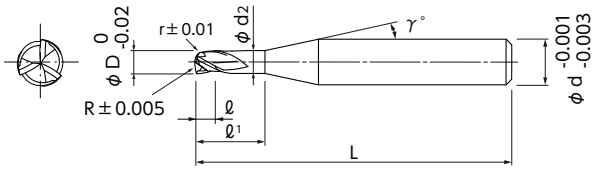
Total 7 Sizes

Realizes large pick feed even with small size diameter
Specialized lens form 3-Flute end mill improves productivity compared to ball end mills

SMG | 3 | 30° | R ±0.005 | ϕd -0.001 -0.003

R accuracy on corner radius is ±0.01mm

3D



- Adopt MUGEN COATING PREMUIM for hardened steel to support machining hardened steel up to 65HRC.
- 3-flute lens form combines larger pick feed than ball end mills improve machining efficiency.
- High productivity can be achieved by using the 5-axis machining to take large pick feeds while keeping the cut point constant.

Work Material

Prehardened Steel	Hardened Steel	
	40～60HRC	～65HRC
◎	◎	○

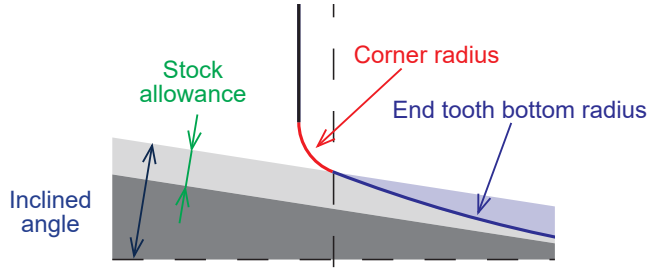
Unit [Size : mm]

Code No.	Dia. (D)	End Tooth Bottom Radius (R)	Under Neck Length (ℓ1)	Corner Radius (r)	Length of Cut (ℓ)	Neck Dia. (d_2)	Neck Taper Angle (γ)	Shank Dia. (d)	Overall Length (L)
08-00790-10103	1	R1	3	R0.03	1	0.95	12°	6	50
08-00790-20206	2	R2	6	R0.05	2	1.91	12°	6	50
08-00790-30309	3	R3	9	R0.1	3	2.85	12°	6	60
08-00790-40412	4	R4	12	R0.1	4	3.8	12°	6	60
08-00790-50515	5	R5	15	R0.2	5	4.75	12°	6	60
08-00790-60620	6	R6	20	R0.3	6	5.7	-	6	60
08-00790-60820	6	R8	20	R0.3	6	5.7	-	6	60

How to Order When you order, indicate MLFH330 (D)×(R)×(ℓ1). (γ) is reference value.

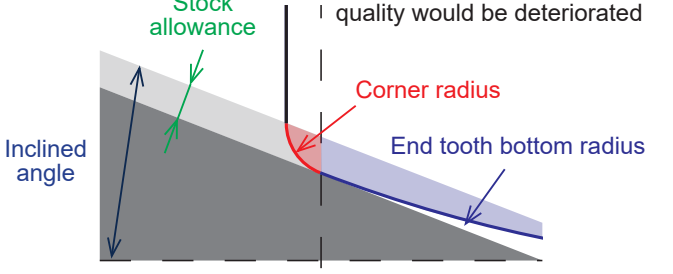
■ Maximum inclined angle means the workpiece that can be machined without problems with the machining allowance shown in the recommended cutting conditions.

Within the maximum inclined angle



Exceed the maximum inclined angle

If the maximum inclined angle is exceeded, machined surface quality would be deteriorated



Roughing

Work Material			Prehadened Steels・Hardened Steels HPM・NAK(～42HRC) HAP38・STAVAX・SKD61(～55HRC)				Hardened Steels SKD11・PD613(～62HRC)				High Speed Steels SKH(～65HRC)			
Dia.	End Tooth Bottom Radius	Under Neck Length	Depth of Cut		Feed	Spindle Speed	Depth of Cut		Feed	Spindle Speed	Depth of Cut		Feed	Spindle Speed
			a_p mm	a_e mm	mm/min	min^{-1}	a_p mm	a_e mm	mm/min	min^{-1}	a_p mm	a_e mm	mm/min	min^{-1}
1	1	3	0.1	0.4	3,500	26,000	0.1	0.28	2,400	21,000	0.08	0.15	1,500	14,000
2	2	6	0.2	0.7	3,500	16,000	0.2	0.5	2,400	12,000	0.15	0.45	1,800	10,000
3	3	9	0.2	1.1	4,200	13,000	0.2	0.85	3,000	10,000	0.2	0.7	2,200	7,600
4	4	12	0.3	2.1	4,200	11,000	0.2	1.2	3,000	9,000	0.2	1	2,200	6,600
5	5	15	0.3	2.4	4,200	10,000	0.2	1.6	3,000	8,200	0.2	1.2	2,200	6,000
6	6	20	0.3	2.8	4,200	9,500	0.3	1.8	3,000	7,000	0.2	1.6	2,200	5,600
6	8	20	0.3	3.2	4,200	9,000	0.3	2	3,000	6,500	0.2	1.8	2,200	5,000

Notes

※1 Depth of Cut: ap=Axial Depth of Cut / ae=Radial Depth of Cut.
※2 Adjust milling condition according to machine rigidity and clamp condition of work material.
※3 In case of chattering etc., please adjust cutting conditions if necessary.
※4 Required careful set up of milling conditions, tool path and etc. at cutting parts, such as corners where will become overloaded.
※5 If machine tool vibration is high during machining, adjust the feed rate as necessary.
※6 Attention to a risk of chipping and breakage when insucient chip flow.
※7 Adjust both spindle speed and feed at the same rate.
※8 Overhang of end mill should be as short as possible form spindle nose.
※9 Oil mist coolant is recommended.
※10 When creating toolpaths in CAM software, tool difinition is recommended by using a lens-shaped end mill.
※11 When measuring tool lengths, download the DXF of the tool geometry from our website and check the tool geometry before measuring.

Finishing

Work Material							Prehadened Steels・Hardened Steels HPM・NAK(～42HRC) HAP38・STAVAX・SKD61(～55HRC)		Hardened Steels SKD11・PD613 (～62HRC)		High Speed Steels SKH (～65HRC)	
Dia.	End Tooth Bottom Radius	Under Neck Length	Maximum Inclined Angle	Cusp Height μm	Depth of Cut		Feed	Spindle Speed	Feed	Spindle Speed	Feed	Spindle Speed
					Stock Allowance mm	Pick Feed mm	mm/min	min^{-1}	mm/min	min^{-1}	mm/min	min^{-1}
1	1	3	17°	0.1	0.02	0.025	2,000	26,000	1,700	21,000	1,100	14,000
2	2	6	20°	0.1	0.02	0.04	1,900	16,000	1,400	12,000	1,100	10,000
3	3	9	20°	0.1	0.03	0.05	1,900	13,000	1,400	10,000	1,100	7,600
4	4	12	21°	0.1	0.03	0.055	1,800	11,000	1,400	9,000	1,100	6,600
5	5	15	21°	0.1	0.04	0.06	1,800	10,000	1,400	8,200	1,100	6,000
6	6	20	21°	0.1	0.04	0.065	1,800	9,500	1,400	7,000	1,100	5,600
6	8	20	14°	0.1	0.04	0.08	2,100	9,000	1,500	6,500	1,200	5,000

Notes

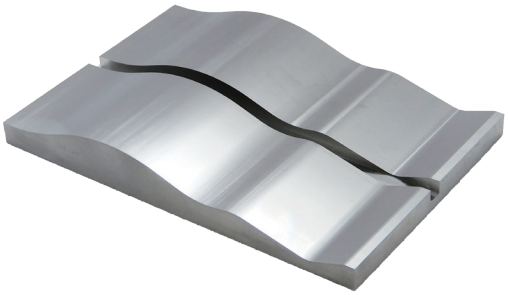
※1 The cutting condition is set that the pick feed achieves a cusp height of 0.1 μm, feed per tooth achieves as same amount as pick feed. Adjust according to machine rigidity and accuracy requirements.
※2 Adjust milling condition according to machine rigidity and clamp condition of work material.
※3 Overhang of end mill should be as short as possible form spindle nose.
※4 Oil mist coolant is recommended.
※5 Adjust both spindle speed and feed at the same rate.
※6 Cutting depth set with care, as the larger the depth of cut, the smaller the maximum inclination angle.
※7 When creating toolpaths in CAM software, tool difinition is recommended by using a lens-shaped end mill.
※8 When measuring tool lengths, download the DXF of the tool geometry from our website and check the tool geometry before measuring.

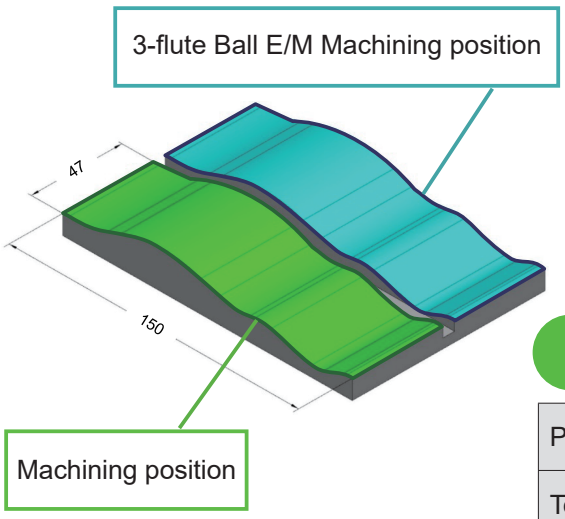
Machining case

Machining Efficiency Comparison Sample　STAVAX (52HRC)

It is possible to set a faster feed rate and a larger pick feed than with a ball end mill, which significantly reduces machining time

Work material : STAVAX (52HRC)
Work size : 150 × 100 mm (Machining depth 15 mm)
Coolant : Oil mist
Total machining time : 2 hr 7 min





MLFH330
Machining condition

Total machining time : 2 hr 7 min

Process	Roughing	Semi-finishing	Finishing
Tool	MLFH330 ϕ 4×R4		MLFH330 ϕ 4×R4
Spindle speed [min^{-1}]	11,000		11,000
Feed [mm/min]	4,200		1,800
Depth of cut ap × ae [mm]	0.3 × 2.1	pf 0.25 (cusp height=2μm)	pf 0.056 (cusp height=0.1μm)
Stock [mm]	0.03		-
Machining time	32 min	9 min	1 hr 26 min

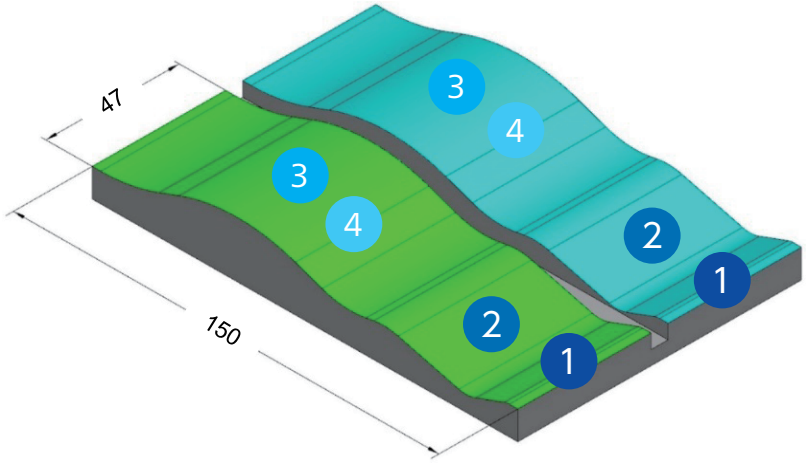
3-flute Ball E/M
Machining condition

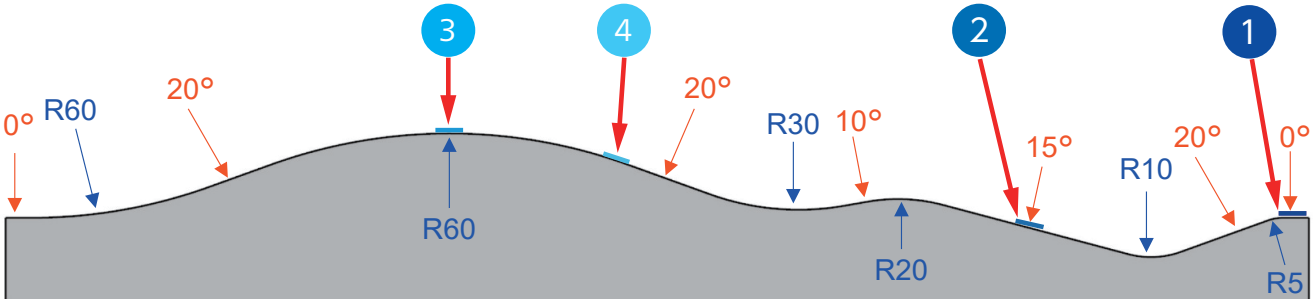
Total machining time : 3 hr 12 min

Process	Roughing	Semi-finishing	Finishing
Tool	3-flute ball end mill R2		3-flute ball end mill R2
Spindle speed [min^{-1}]	20,000		11,000
Feed [mm/min]	3,000		1,800
Depth of cut ap × ae [mm]	0.3 × 1.5	pf 0.18 (cusp height=2μm)	pf 0.04 (cusp height=0.1μm)
Stock [mm]	0.03		-
Machining time	56 min	16 min	2 hr

MLFH330 reduces machining time by approximately **35%** compared to 3-flute ball end mills

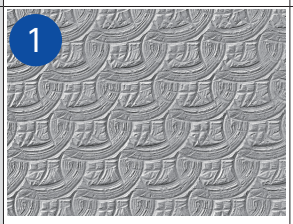
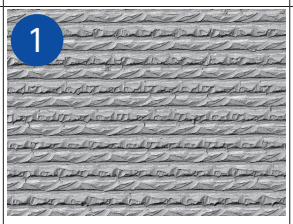
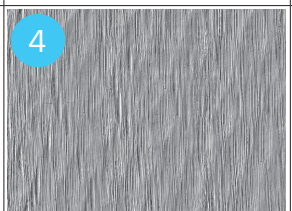
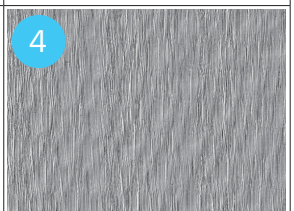
Surface Roughness





Machining shape (Cross section)

Unit [μm]

Tool	MLFH330 ϕ 4×R4		3-flute Ball E/M R2	
Machining position	near 0°	near 15°	near 0°	near 15°
Plane				
	Ra 0.193 Rz 1.163	Ra 0.196 Rz 0.949	Ra 0.813 Rz 3.825	Ra 0.177 Rz 0.937
Curved surface				
	Ra 0.144 Rz 0.944	Ra 0.172 Rz 0.814	Ra 0.824 Rz 3.721	Ra 0.178 Rz 0.882

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CAUTION **Attention on Safety**

1) When removing tools from cases, be careful of getting-out of tools and don't touch directly the cutting edges.
2) Never touch the cutting edges directly with bare hand.
3) Use safety covers and eye protection, as tools may be broken.
4) Use holders, etc. that match the tools and nature of the processing operations. The tool should be firmly attached to the holder to prevent shaking.
5) The work materials clamp firmly.
6) Make sure of dimensions of tools and work pieces before starting operation.
7) It is necessary to adjust conditions according to the dimensions of work materials and the machine.
8) Select a cutting fluid appropriate to the particular usage. Using a non-water cutting fluid could lead to fires due to sparks generated during processing or heat caused by breakage. Ensure that you take proper fire-prevention measures.
9) If abnormal sound, etc. occurs during processing, stop the machine immediately.
10) Don't modify tools.

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■Specifications may change without notice for improvement.
■This print uses environmentally friendly inks.

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