6 Flutes Ball End Mill for High-efficiency Finishing

**EPHB-PN**

**1. Cautions regarding handling**
- 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. Cautions regarding mounting**
- Before use, check the outside appearance of the tool for scratches, cracks, etc. and that it is firmly mounted in the collet chuck, etc.
- If abnormal chattering, etc. occurs during use, stop the machine immediately and remove the cause of the chattering.

**3. Cautions during use**
- Before use, confirm the dimensions and direction of rotation of the tool and milling work material.
  - 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.
  - 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.
  - 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.
  - Do not use the tool for any purpose other than that for which it is intended.

Specifications for the products listed in this catalog are subject to change without notice due to replacement or modification.

Printed in JAPAN
Printed using vegetable oil ink.
Features of EPHB-PN

01 6 flutes specification enables finishing at feed rate of 20m/min.

High-efficiency machining is possible than conventional ball end mills. Use of outer side cutting edge maximizes the tool performance.

More effective machining is possible by using 5-axis MC.

02 High accuracy and long tool life

Employed original cutting edge geometry which tuned 6 edges finely. High accuracy machining with long tool life is possible since each edge work uniformly even with micro cutting depth.

03 High rigidity design

Tool rigidity increased as much as possible in order to suppress the deflection of the tool occurred during cutting.

High precision machining is realized with cutting edge design suitable for finishing.

Furthermore, abrasion is suppressed by applying PN coating and it improves tool life.

PN Coating

- Copper
- Carbon steel
- Alloy steel
- Stainless steel
- Pre-hardened steel
- Hardened steel 45-50HRC
- Hardened steel 55-65HRC

Applications

- Mold making
- Parts processing

EPHB-PN

R3~R6 [ 4 Items ]

Features 01 6 flutes specification enables finishing at feed rate of 20m/min.

High feed (21m/min) 5-axis finishing

6Flutes Ball End Mill
EPHB6080-PN (R4)
Work material : S50C
n=15,000min⁻¹ (vc=377m/min)
v=21,000mm/min (fz=0.23mm/t)
Stock material=0.1mm
Pick feed : 0.15mm
Dry(Air Blow)
5-axis MC.
Features **01** High accuracy and long tool life

Comparison of cutting resistance during 45° inclined surface finishing

6 Flutes Ball End Mill  EPHB6100-PN (R5)  Work material: S50C  45° inclined surface  

<table>
<thead>
<tr>
<th>Condition</th>
<th>Feed per rev.</th>
<th>Surface roughness</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPHB6100-PN</td>
<td>3.00μm</td>
<td>Ra:0.50μm Rz:3.22μm</td>
</tr>
<tr>
<td>Conventional 6 flutes ball end mil</td>
<td>3.00μm</td>
<td>Ra:0.99μm Rz:4.40μm</td>
</tr>
</tbody>
</table>

Surface roughness

Because the runout variation for each edges are as small as possible, cutting force will be small. Also, from the damage of each edges are uniformity, high-accuracy machining can be done for a long time.

**Features 02**

High accuracy and long tool life

- 6 flutes specification enables finishing at feed rate of 20m/min.
- High accuracy and long tool life
- High rigidity design

**Features 03**

High rigidity design

- It employed a positive cutting edge geometry which is more rigid than general ball end mills and suitable for finishing.
- Applying PN coating and realizes longer tool life.

**PN 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. (2x the cutting life compared to conventional products.)
- 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 transmitted measuring systems.

**Characteristics**

- **Adhesion of PN coating**
  - Conventional coating: Coating is peeling.
  - PN coating: No peeling, Superior adhesion

- **Cross-sectional structure and characteristics of PN coating membrane**
  - Membrane structure with improved lubrication characteristics
  - Microstructure increases heat resistance
  - Improved adhesion strength
### Line Up

6 flutes

**EPHB6000-PN**

<table>
<thead>
<tr>
<th>Item code</th>
<th>Stock</th>
<th>Size (mm)</th>
<th>No. of flutes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ball Radius $R$</td>
<td>Tool dia. $D_c$</td>
</tr>
<tr>
<td>EPHB6060-PN</td>
<td>●</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>EPHB6080-PN</td>
<td>●</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>EPHB6100-PN</td>
<td>●</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>EPHB6120-PN</td>
<td>●</td>
<td>6</td>
<td>12</td>
</tr>
</tbody>
</table>

### 6 flutes usable range by ball radius

It is usable with 3-axis MC since tool center has cutting edges even 2 flutes. EPHB-PN could perform at its true potential by using the following 6 flutes range with 5-axis machine, etc.

- **R3 EPHB6060-PN**
- **R4 EPHB6080-PN**
- **R5 EPHB6100-PN**
- **R6 EPHB6120-PN**

※ Angle represents non-6 flutes part. When machining with spindle tilted, please set the angle of spindle considering $ap$ etc.

### Re-grinding compatibility range table

<table>
<thead>
<tr>
<th>Item Code</th>
<th>Product Name</th>
<th>Line up mill dia. (mm)</th>
<th>Shape</th>
<th>Re-grinding compatibility range (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPHB-PN</td>
<td>6 Flutes Ball End Mill for High-efficiency Finishing</td>
<td>6~12</td>
<td></td>
<td>Outer Dia. 6<del>12 End 6</del>12</td>
</tr>
</tbody>
</table>

● : Stocked Items
Recommended Cutting Conditions

**Standard cutting conditions (Finishing)**

<table>
<thead>
<tr>
<th>Work material</th>
<th>Carbon steels, Alloy steels</th>
<th>Stainless steels, Tool steels</th>
<th>Pre-hardened steels</th>
</tr>
</thead>
<tbody>
<tr>
<td>(180~250HB)</td>
<td>(25~35HRc)</td>
<td>(35~45HRc)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cutting speed (v_c=200)</td>
<td>Cutting speed (v_c=180)</td>
<td>Cutting speed (v_c=160)</td>
</tr>
<tr>
<td></td>
<td>(n_{\text{min}}^{-1})</td>
<td>(n_{\text{min}}^{-1})</td>
<td>(n_{\text{min}}^{-1})</td>
</tr>
<tr>
<td>(R3)</td>
<td>6</td>
<td>5.720 (\leq 0.2)</td>
<td>5.130 (\leq 0.2)</td>
</tr>
<tr>
<td>(R4)</td>
<td>8</td>
<td>5.760 (\leq 0.3)</td>
<td>5.180 (\leq 0.2)</td>
</tr>
<tr>
<td>(R5)</td>
<td>10</td>
<td>5.760 (\leq 0.3)</td>
<td>5.130 (\leq 0.3)</td>
</tr>
<tr>
<td>(R6)</td>
<td>12</td>
<td>5.720 (\leq 0.3)</td>
<td>5.180 (\leq 0.3)</td>
</tr>
</tbody>
</table>

**High speed cutting conditions (Finishing)**

<table>
<thead>
<tr>
<th>Work material</th>
<th>Carbon steels, Alloy steels</th>
<th>Stainless steels, Tool steels</th>
<th>Pre-hardened steels</th>
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<tbody>
<tr>
<td>(180~250HB)</td>
<td>(25~35HRc)</td>
<td>(35~45HRc)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cutting speed (v_c=375)</td>
<td>Cutting speed (v_c=340)</td>
<td>Cutting speed (v_c=300)</td>
</tr>
<tr>
<td></td>
<td>(n_{\text{min}}^{-1})</td>
<td>(n_{\text{min}}^{-1})</td>
<td>(n_{\text{min}}^{-1})</td>
</tr>
<tr>
<td>(R3)</td>
<td>6</td>
<td>21.490 (\leq 0.1)</td>
<td>19.330 (\leq 0.1)</td>
</tr>
<tr>
<td>(R4)</td>
<td>8</td>
<td>21.460 (\leq 0.1)</td>
<td>19.300 (\leq 0.1)</td>
</tr>
<tr>
<td>(R5)</td>
<td>10</td>
<td>21.420 (\leq 0.2)</td>
<td>19.260 (\leq 0.2)</td>
</tr>
<tr>
<td>(R6)</td>
<td>12</td>
<td>21.380 (\leq 0.2)</td>
<td>19.440 (\leq 0.2)</td>
</tr>
</tbody>
</table>

**Note**

1. High speed cutting conditions are applicable as long as projection length of 3D or less and work shape that can be followed by high performance MC.
2. If the rpm available is lower than that recommended please reduce the feed rate to the same ratio.
3. These 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.

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

<table>
<thead>
<tr>
<th>Ball radius (R) (mm)</th>
<th>Pick Feed ( p_{1} ) (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0.104 0.417 1.667 3.752 6.674 10.435 15.038</td>
</tr>
<tr>
<td>4</td>
<td>0.078 0.313 1.250 2.813 5.003 7.820 11.266</td>
</tr>
<tr>
<td>5</td>
<td>0.063 0.250 1.000 2.251 4.002 6.254 9.008</td>
</tr>
<tr>
<td>6</td>
<td>0.052 0.208 0.833 1.875 3.334 5.211 7.505</td>
</tr>
</tbody>
</table>

\[ H = R - \sqrt{R^2 - a^2/4} \approx 2a^2/8R \]
Comparison of finished surface roughness with 2 flutes ball end mill

**2 Flutes Ball End Mill**
- Work material: PX5
- \( n = 12,000 \text{ min}^{-1} (v_c = 301 \text{ m/min}) \)
- \( v_f = 1,440 \text{ mm/min} (f_z = 0.06 \text{ mm/t}) \)
- Pick feed: 0.4mm
- 3-axis MC.
- Dry (Air blow)

**EPHB6080-PN (R4)**
- Work material: PX5
- \( n = 12,000 \text{ min}^{-1} (v_c = 301 \text{ m/min}) \)
- \( v_f = 2,880 \text{ mm/min} (f_z = 0.04 \text{ mm/t}) \)
- Pick feed: 0.2mm
- 3-axis MC.
- Dry (Air blow)

Finished surface roughness was improved since pick feed can be reduced by the increase of feed speed.
Comparison of cutting performance with large diameter indexable tool

**R15 Indexable tool**

- \( n = 6,000 \text{min}^{-1}(v_c=565 \text{m/min}) \)
- \( v_f = 4,000 \text{mm/min} (f_z=0.33 \text{mm/t}) \)
- \( a_e = 0.6 \text{mm} \) (Cutting remain at corner)

**R4 EPHB6080-PN**

- \( n = 14,900 \text{min}^{-1}(v_c=375 \text{m/min}) \)
- \( v_f = 21,460 \text{mm/min} (f_z=0.24 \text{mm/t}) \)
- \( a_e = 0.3 \text{mm} \)

In addition to high-efficiency machining, corners can be finished with a single tool. As there is no step due to tool change, more precise finished surface can be obtained.
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.
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   (4) There is a risk of fire or inflammation due to sparks, heat due to breakage, and cutting chips. Do not use where there is a risk of fire or explosion. Please caution of fire while using oil base coolant, fire prevention is necessary.
   (5) Do not use the tool for any purpose other than that for which it is intended.

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

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