



## MRBSH330

MUGEN COATING PREMIUM Plus  
High efficient 3-Flute Small-Diameter  
Long Neck Ball End Mill for Hardened Steel



## MSBH345

MUGEN COATING PREMIUM  
3-Flute Ball End Mill for Hardened Steel



## MSB345

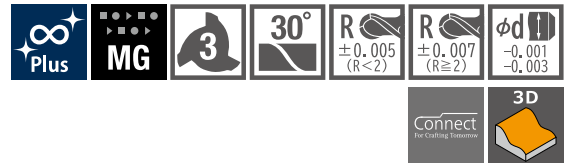
MUGEN COATING  
3-Flute Ball End Mill



# High-efficiency high-precision die machining with improved cutting edge rigidity and chip evacuation

MUGEN COATING PREMIUM Plus  
 High Efficient 3-Flute Small-Diameter  
 Long Neck Ball End Mill for Hardened Steel

## MRBSH330



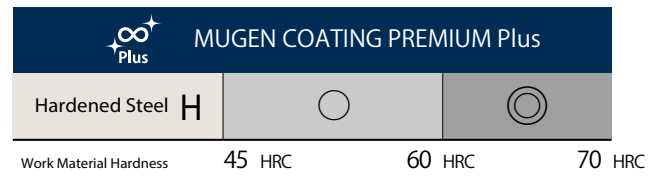
R0.1 ~ R3 Total 31 sizes



### Features

|                     |                       |                                    |
|---------------------|-----------------------|------------------------------------|
| Feature<br><b>1</b> | <b>Long tool life</b> | Coating MUGEN COATING PREMIUM Plus |
|---------------------|-----------------------|------------------------------------|

MUGEN COATING PREMIUM Plus is suitable for machining above 60HRC  
 Demonstrates same performance with MUGEN COATING PREMIUM even on machining 45 ~ 60HRC



Comparison with other tool brand on roughing process

- Tool size : R1
- Work Material : HAP40 (64HRC)
- Spindle speed : 20,000 min<sup>-1</sup>
- Feed : 2,400 mm/min

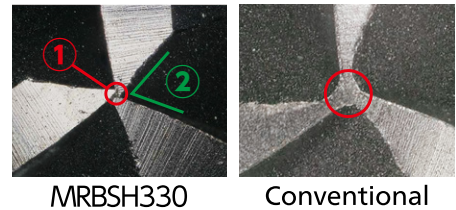
Realize long tool life during high speed machining even comparing with other tool brands

Comparison under the same rate of depth of cut  
 ap 0.23 x ae 0.3 mm

|   | Before use | After 60min | After 90min | After 120min |
|---|------------|-------------|-------------|--------------|
| <b>MRBSH330</b><br>R1 x 6                         |            |             |             |              |
| Other tool brand A<br>4-flute ball end mill<br>R1 |            |             |             |              |
| Other tool brand B<br>4-flute ball end mill<br>R1 |            |             |             |              |

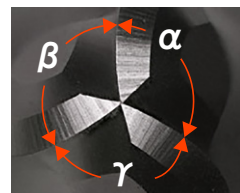
**Feature 2 High efficiency** Cutting edge shape · Unequal flute spacing · 3-Flute · Chip evacuation

**2-1**  
Optimized center ball shape reduces cutting load to enable high depth of cut



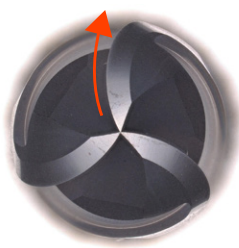
**2-2**  
Optimized chip pocket design realizes smooth chip removal

**2-3**  
Unequal flute prevent chattering



$\alpha \neq \beta \neq \gamma$

**2-4**  
Adopting strong spiral gash for the large diameters to reduce cutting load, break up the chips to improve the chip removal ability and unequal flute prevents chattering (R□1.5)



MRBSH330

Conventional

**Machining efficiency comparison with conventional product**

- Work Material : YXR7 (63HRC)
- Coolant : Oil mist
- Work size : 50 × 50 mm



| Process                            | MRBSH330      |                     | Conventional 2-flute ball end mill |                     |
|------------------------------------|---------------|---------------------|------------------------------------|---------------------|
|                                    | Diamond shape | Circle shape pocket | Diamond shape                      | Circle shape pocket |
| Tool size                          | R3 × 20       | R1.5 × 10           | R3 × 20                            | R1.5 × 10           |
| Spindle speed (min <sup>-1</sup> ) | 7,000         | 15,000              | 7,000                              | 15,000              |
| Feed (mm/min)                      | 3,000         | 2,600               | 2,000                              | 1,800               |
| Depth of cut (ap × ae mm)          | 0.25 × 1      | 0.25 × 0.5          | 0.2 × 1                            | 0.15 × 0.3          |
| Machining time                     | 42min 9sec    | 16min 23sec         | 73min 11sec                        | 55min 34sec         |

**Total machining time reduced by 55%**



Introduction of NS Connect  
Scanning the barcode on the back of the case to get various information

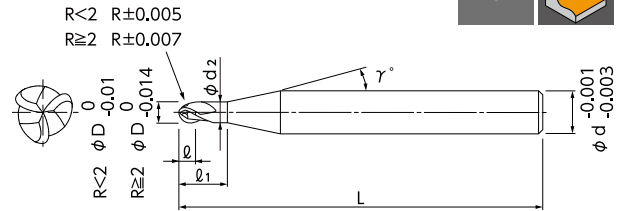
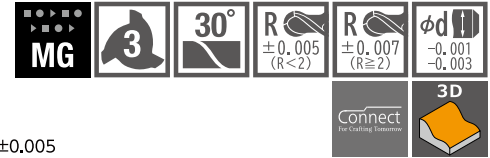


- Features
- Size and Milling conditions
  - Video of machining



Available to check the information anytime, anywhere before use

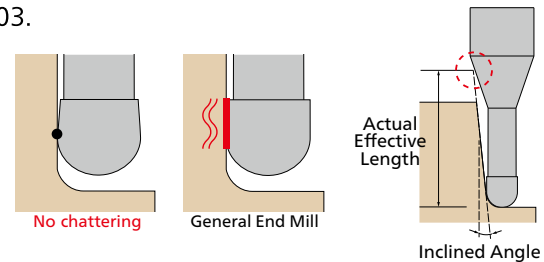
High-efficiency high-precision die machining with improved cutting edge rigidity and chip evacuation



- High-efficiency 3-flute ball end mill optimizes a shape of central edge and enables high depth of cutting.
- Even hardened steel of 45 to 70HRC can be machining with long tool life and high efficiency.
- Shank diameter tolerance, high accuracy type, is - 0.001 ~ - 0.003.

Work Material

|                |
|----------------|
| Hardened Steel |
| 60~70HRC       |
|                |



Unit [Size : mm]

| Code No.         | Radius (R) | Under Neck Length (ℓ1) | Length of Cut (ℓ) | Dia. (D) | Neck Dia. (d2) | Neck Taper Angle (γ) | Shank Dia. (d) | Overall Length (L) | Actual effective length depending on inclined angle of workpiece |       |       |       |       |
|------------------|------------|------------------------|-------------------|----------|----------------|----------------------|----------------|--------------------|--|-------|-------|-------|-------|
|                  |            |                        |                   |          |                |                      |                |                    | 30'  | 1°    | 1°30' | 2°    | 3°    |
| 2.08-00634-01003 | R0.1       | 0.3                    | 0.15              | 0.2      | 0.18           | 12°                  | 4              | 45                 | 0.35   | 0.36  | 0.38  | 0.39  | 0.42  |
| 2.08-00634-01005 |            | 0.5                    | 0.15              | 0.2      | 0.18           | 12°                  | 4              | 45                 | 0.56   | 0.58  | 0.61  | 0.63  | 0.69  |
| 2.08-00634-01505 | R0.15      | 0.5                    | 0.2               | 0.3      | 0.28           | 12°                  | 4              | 45                 | 0.56   | 0.58  | 0.60  | 0.62  | 0.67  |
| 2.08-00634-01506 |            | 0.6                    | 0.2               | 0.3      | 0.28           | 12°                  | 4              | 45                 | 0.66   | 0.69  | 0.71  | 0.74  | 0.81  |
| 2.08-00634-01507 |            | 0.75                   | 0.2               | 0.3      | 0.28           | 12°                  | 4              | 45                 | 0.82   | 0.85  | 0.88  | 0.92  | 1.01  |
| 2.08-00634-01510 | R0.2       | 1                      | 0.2               | 0.3      | 0.28           | 12°                  | 4              | 45                 | 1.08   | 1.12  | 1.17  | 1.22  | 1.34  |
| 2.08-00634-02005 |            | 0.5                    | 0.3               | 0.4      | 0.37           | 12°                  | 4              | 45                 | 0.58   | 0.60  | 0.62  | 0.64  | 0.69  |
| 2.08-00634-02008 |            | 0.8                    | 0.3               | 0.4      | 0.37           | 12°                  | 4              | 45                 | 0.89   | 0.93  | 0.96  | 1.00  | 1.09  |
| 2.08-00634-02010 | R0.25      | 1                      | 0.3               | 0.4      | 0.37           | 12°                  | 4              | 45                 | 1.10   | 1.14  | 1.19  | 1.24  | 1.35  |
| 2.08-00634-02510 |            | 1                      | 0.35              | 0.5      | 0.46           | 12°                  | 4              | 45                 | 1.13   | 1.16  | 1.21  | 1.26  | 1.37  |
| 2.08-00634-02515 |            | 1.5                    | 0.35              | 0.5      | 0.46           | 12°                  | 4              | 45                 | 1.65   | 1.71  | 1.78  | 1.85  | 2.03  |
| 2.08-00634-03010 | R0.3       | 1                      | 0.45              | 0.6      | 0.56           | 12°                  | 4              | 45                 | 1.12   | 1.16  | 1.20  | 1.25  | 1.35  |
| 2.08-00634-03015 |            | 1.5                    | 0.45              | 0.6      | 0.56           | 12°                  | 4              | 45                 | 1.64   | 1.71  | 1.77  | 1.84  | 2.02  |
| 2.08-00634-03020 |            | 2                      | 0.45              | 0.6      | 0.56           | 12°                  | 4              | 45                 | 2.17   | 2.25  | 2.34  | 2.44  | 2.68  |
| 2.08-00634-05020 | R0.5       | 2                      | 0.75              | 1        | 0.95           | 12°                  | 4              | 45                 | 2.18   | 2.26  | 2.34  | 2.43  | 2.65  |
| 2.08-00634-05025 |            | 2.5                    | 0.75              | 1        | 0.95           | 12°                  | 4              | 45                 | 2.70   | 2.80  | 2.91  | 3.03  | 3.31  |
| 2.08-00634-05030 |            | 3                      | 0.75              | 1        | 0.95           | 12°                  | 4              | 45                 | 3.22   | 3.35  | 3.48  | 3.63  | 3.97  |
| 2.08-00634-07503 | R0.75      | 3                      | 1.1               | 1.5      | 1.45           | 12°                  | 4              | 45                 | 3.21   | 3.33  | 3.45  | 3.58  | 3.89  |
| 2.08-00634-07504 |            | 4                      | 1.1               | 1.5      | 1.45           | 12°                  | 4              | 45                 | 4.26   | 4.41  | 4.59  | 4.78  | 5.22  |
| 2.08-00634-10003 | R1         | 3                      | 1.5               | 2        | 1.94           | 12°                  | 4              | 45                 | 3.23   | 3.33  | 3.44  | 3.56  | 3.85  |
| 2.08-00634-10004 |            | 4                      | 1.5               | 2        | 1.94           | 12°                  | 4              | 45                 | 4.27   | 4.42  | 4.58  | 4.76  | 5.17  |
| 2.08-00634-10006 |            | 6                      | 1.5               | 2        | 1.94           | 12°                  | 4              | 45                 | 6.36   | 6.60  | 6.86  | 7.15  | 7.83  |
| 2.08-00634-15006 | R1.5       | 6                      | 2.5               | 3        | 2.85           | 12°                  | 6              | 60                 | 6.56   | 6.78  | 7.03  | 7.31  | 7.95  |
| 2.08-00634-15008 |            | 8                      | 2.5               | 3        | 2.85           | 12°                  | 6              | 60                 | 8.64   | 8.96  | 9.31  | 9.70  | 10.60 |
| 2.08-00634-15010 |            | 10                     | 2.5               | 3        | 2.85           | 12°                  | 6              | 60                 | 10.73  | 11.14 | 11.59 | 12.09 | 13.26 |
| 2.08-00634-20008 | R2         | 8                      | 3                 | 4        | 3.8            | 12°                  | 6              | 65                 | 8.74   | 9.05  | 9.38  | 9.74  | 10.60 |
| 2.08-00634-20010 |            | 10                     | 3                 | 4        | 3.8            | 12°                  | 6              | 65                 | 10.83  | 11.22 | 11.66 | 12.14 | 13.25 |
| 2.08-00634-20012 |            | 12                     | 3                 | 4        | 3.8            | 12°                  | 6              | 65                 | 12.91  | 13.40 | 13.94 | 14.53 | 15.91 |
| 2.08-00634-30010 | R3         | 10                     | 6                 | 6        | 5.7            | -                    | 6              | 65                 | Free   | Free  | Free  | Free  | Free  |
| 2.08-00634-30015 |            | 15                     | 6                 | 6        | 5.7            | -                    | 6              | 65                 | Free   | Free  | Free  | Free  | Free  |
| 2.08-00634-30020 |            | 20                     | 6                 | 6        | 5.7            | -                    | 6              | 65                 | Free   | Free  | Free  | Free  | Free  |

How to Order When you order, indicate MRBSH330(R)×(ℓ1).

※(γ) is reference value.

## Recommended Milling Conditions (Metric)

| Work Material |                   |      | High Speed Steels/Hardened Steels<br>SKH51·SKD11 (~62HRC) |       |        |                   | High Speed Steels<br>SKH55·HAP40 (~66HRC) |       |        |                   | High Speed Steels<br>SKH57·HAP72 (~70HRC) |       |        |                   |
|---------------|-------------------|------|---|-------|--------|-------------------|---|-------|--------|-------------------|---|-------|--------|-------------------|
| Radius        | Under Neck Length | L/D  | Depth of Cut  |       | Feed   | Spindle Speed     | Depth of Cut                              |       | Feed   | Spindle Speed     | Depth of Cut                              |       | Feed   | Spindle Speed     |
|               |                   |      | ap mm   | ae mm | mm/min | min <sup>-1</sup> | ap mm                                     | ae mm | mm/min | min <sup>-1</sup> | ap mm                                     | ae mm | mm/min | min <sup>-1</sup> |
| R0.1          | 0.3               | 1.5  | 0.006   | 0.007 | 450    | 40,000            | 0.004                                     | 0.005 | 300    | 40,000            | 0.004                                     | 0.005 | 220    | 40,000            |
|               | 0.5               | 2.5  | 0.006   | 0.007 | 400    | 40,000            | 0.004                                     | 0.005 | 250    | 40,000            | 0.004                                     | 0.005 | 190    | 40,000            |
| R0.15         | 0.5               | 1.7  | 0.01  | 0.01  | 450    | 40,000            | 0.005                                     | 0.005 | 400    | 40,000            | 0.005                                     | 0.005 | 300    | 40,000            |
|               | 0.6               | 2    | 0.007   | 0.007 | 450    | 40,000            | 0.005                                     | 0.005 | 350    | 40,000            | 0.005                                     | 0.005 | 270    | 40,000            |
|               | 0.75              | 2.5  | 0.007   | 0.007 | 400    | 40,000            | 0.005                                     | 0.005 | 350    | 40,000            | 0.005                                     | 0.005 | 250    | 40,000            |
| R0.2          | 1                 | 3.3  | 0.007   | 0.007 | 350    | 40,000            | 0.005                                     | 0.005 | 300    | 40,000            | 0.005                                     | 0.005 | 220    | 40,000            |
|               | 0.5               | 1.25 | 0.035   | 0.04  | 1,100  | 40,000            | 0.013                                     | 0.02  | 850    | 40,000            | 0.013                                     | 0.02  | 650    | 35,000            |
|               | 0.8               | 2    | 0.03  | 0.03  | 1,000  | 40,000            | 0.012                                     | 0.02  | 850    | 40,000            | 0.012                                     | 0.02  | 600    | 35,000            |
| R0.25         | 1                 | 2.5  | 0.03  | 0.03  | 1,000  | 40,000            | 0.012                                     | 0.02  | 850    | 40,000            | 0.012                                     | 0.02  | 600    | 35,000            |
|               | 1                 | 2    | 0.03  | 0.03  | 1,300  | 40,000            | 0.015                                     | 0.02  | 1,000  | 35,000            | 0.015                                     | 0.02  | 700    | 30,000            |
| R0.3          | 1.5               | 3    | 0.015   | 0.03  | 1,000  | 40,000            | 0.01                                      | 0.02  | 800    | 35,000            | 0.01                                      | 0.02  | 500    | 30,000            |
|               | 1                 | 1.7  | 0.045   | 0.06  | 1,500  | 40,000            | 0.03                                      | 0.05  | 1,100  | 30,000            | 0.03                                      | 0.05  | 800    | 25,000            |
|               | 1.5               | 2.5  | 0.045   | 0.06  | 1,500  | 40,000            | 0.03                                      | 0.05  | 1,100  | 30,000            | 0.03                                      | 0.05  | 800    | 25,000            |
| R0.5          | 2                 | 3.3  | 0.045   | 0.06  | 1,500  | 40,000            | 0.03                                      | 0.05  | 1,100  | 30,000            | 0.03                                      | 0.05  | 800    | 25,000            |
|               | 2                 | 2    | 0.15  | 0.2   | 3,000  | 30,000            | 0.12                                      | 0.1   | 2,000  | 25,000            | 0.075                                     | 0.1   | 1,500  | 20,000            |
|               | 2.5               | 2.5  | 0.15  | 0.2   | 3,000  | 30,000            | 0.12                                      | 0.1   | 2,000  | 25,000            | 0.075                                     | 0.1   | 1,500  | 20,000            |
| R0.75         | 3                 | 3    | 0.15  | 0.2   | 3,000  | 30,000            | 0.12                                      | 0.1   | 2,000  | 25,000            | 0.075                                     | 0.1   | 1,500  | 20,000            |
|               | 3                 | 2    | 0.15  | 0.3   | 3,800  | 30,000            | 0.15                                      | 0.2   | 3,000  | 25,000            | 0.09                                      | 0.2   | 2,200  | 20,000            |
| R1            | 4                 | 2.7  | 0.15  | 0.3   | 3,000  | 25,000            | 0.15                                      | 0.2   | 2,400  | 22,000            | 0.09                                      | 0.2   | 1,800  | 18,000            |
|               | 3                 | 1.5  | 0.3   | 0.5   | 3,800  | 25,000            | 0.22                                      | 0.3   | 3,000  | 20,000            | 0.15                                      | 0.3   | 2,200  | 16,000            |
|               | 4                 | 2    | 0.3   | 0.5   | 3,800  | 25,000            | 0.22                                      | 0.3   | 3,000  | 20,000            | 0.15                                      | 0.3   | 2,200  | 16,000            |
| R1.5          | 6                 | 3    | 0.3   | 0.3   | 3,000  | 22,000            | 0.22                                      | 0.3   | 2,400  | 20,000            | 0.15                                      | 0.3   | 1,800  | 16,000            |
|               | 6                 | 2    | 0.3   | 0.6   | 3,800  | 18,000            | 0.25                                      | 0.5   | 3,000  | 15,000            | 0.15                                      | 0.5   | 2,250  | 12,000            |
|               | 8                 | 2.7  | 0.3   | 0.6   | 3,800  | 18,000            | 0.25                                      | 0.5   | 3,000  | 15,000            | 0.15                                      | 0.5   | 2,250  | 12,000            |
| R2            | 10                | 3.3  | 0.3   | 0.6   | 3,200  | 18,000            | 0.25                                      | 0.5   | 2,600  | 15,000            | 0.15                                      | 0.5   | 2,000  | 12,000            |
|               | 8                 | 2    | 0.3   | 0.8   | 3,800  | 15,000            | 0.25                                      | 0.6   | 3,000  | 12,000            | 0.18                                      | 0.6   | 2,250  | 9,500             |
|               | 10                | 2.5  | 0.3   | 0.8   | 3,800  | 15,000            | 0.25                                      | 0.6   | 3,000  | 12,000            | 0.18                                      | 0.6   | 2,250  | 9,500             |
| R3            | 12                | 3    | 0.3   | 0.8   | 3,800  | 15,000            | 0.25                                      | 0.6   | 3,000  | 12,000            | 0.18                                      | 0.6   | 2,250  | 9,500             |
|               | 10                | 1.7  | 0.38  | 1.2   | 3,800  | 8,000             | 0.25                                      | 1     | 3,000  | 7,000             | 0.18                                      | 1     | 2,250  | 5,500             |
|               | 15                | 2.5  | 0.38  | 1.2   | 3,800  | 8,000             | 0.25                                      | 1     | 3,000  | 7,000             | 0.18                                      | 1     | 2,250  | 5,500             |
|               | 20                | 3.3  | 0.38  | 1.2   | 3,800  | 8,000             | 0.25                                      | 1     | 3,000  | 7,000             | 0.18                                      | 1     | 2,250  | 5,500             |

## Notes

※ Recommended RPM based upon ideal conditions.

RPM may be adjusted to match the capabilities of your machine while maintaining constant feed rate per cutting tooth.

※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 At point where cutting load is high such as at corners, pay attention to setting cutting conditions and tool paths particularly.

※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 insufficient chip flow.

※7 Adjust both spindle speed and feed at the same rate.

※8 Overhang of end mill should be as short as possible from spindle nose.

※9 We recommend using oil mist coolant.

# Recommended Milling Conditions (Inch)

| Work Material |                   |      | High Speed Steels/Hardened Steels<br>SKH51(M2)·SKD11(D2) (~62HRC) |         |                |        |               | High Speed Steels<br>SKH55·HAP40 (~66HRC) |         |                |        |               | High Speed Steels<br>SKH57·HAP72 (~70HRC) |         |                |       |               |
|---------------|-------------------|------|---|---------|----------------|--------|---------------|---|---------|----------------|--------|---------------|---|---------|----------------|-------|---------------|
| Radius        | Under Neck Length | L/D  | Depth of Cut  |         | Feed per tooth | Feed   | Spindle Speed | Depth of Cut                              |         | Feed per tooth | Feed   | Spindle Speed | Depth of Cut                              |         | Feed per tooth | Feed  | Spindle Speed |
|               |                   |      | ap Inch   | ae Inch | IPT fz         | IPM    | RPM           | ap Inch                                   | ae Inch | IPT fz         | IPM    | RPM           | ap Inch                                   | ae Inch | IPT fz         | IPM   | RPM           |
| R0.1          | 0.3               | 1.5  | .00024  | .00028  | .00015         | 17.72  | 40,000        | .00016                                    | .00020  | .00010         | 11.81  | 40,000        | .00016                                    | .00020  | .00007         | 8.66  | 40,000        |
|               | 0.5               | 2.5  | .00024  | .00028  | .00013         | 15.75  | 40,000        | .00016                                    | .00020  | .00008         | 9.84   | 40,000        | .00016                                    | .00020  | .00006         | 7.48  | 40,000        |
| R0.15         | 0.5               | 1.7  | .00039  | .00028  | .00015         | 17.72  | 40,000        | .00020                                    | .00020  | .00013         | 15.75  | 40,000        | .00020                                    | .00020  | .00010         | 11.81 | 40,000        |
|               | 0.6               | 2    | .00028  | .00028  | .00015         | 17.72  | 40,000        | .00020                                    | .00020  | .00011         | 13.78  | 40,000        | .00020                                    | .00020  | .00009         | 10.63 | 40,000        |
|               | 0.75              | 2.5  | .00028  | .00028  | .00013         | 15.75  | 40,000        | .00020                                    | .00020  | .00011         | 13.78  | 40,000        | .00020                                    | .00020  | .00008         | 9.84  | 40,000        |
| R0.2          | 1                 | 3.3  | .00028  | .00028  | .00011         | 13.78  | 40,000        | .00020                                    | .00020  | .00010         | 11.81  | 40,000        | .00020                                    | .00020  | .00007         | 8.66  | 40,000        |
|               | 0.5               | 1.25 | .00138  | .00157  | .00036         | 43.31  | 40,000        | .00053                                    | .00079  | .00028         | 33.46  | 40,000        | .00051                                    | .00079  | .00024         | 25.59 | 35,000        |
|               | 0.8               | 2    | .00118  | .00118  | .00033         | 39.37  | 40,000        | .00049                                    | .00079  | .00028         | 33.46  | 40,000        | .00047                                    | .00079  | .00022         | 23.62 | 35,000        |
| R0.25         | 1                 | 2.5  | .00118  | .00118  | .00033         | 39.37  | 40,000        | .00049                                    | .00079  | .00028         | 33.46  | 40,000        | .00047                                    | .00079  | .00022         | 23.62 | 35,000        |
|               | 1                 | 2    | .00118  | .00118  | .00043         | 51.18  | 40,000        | .00061                                    | .00079  | .00037         | 39.37  | 35,000        | .00059                                    | .00079  | .00031         | 27.56 | 30,000        |
| R0.3          | 1.5               | 3    | .00059  | .00118  | .00033         | 39.37  | 40,000        | .00041                                    | .00079  | .00030         | 31.50  | 35,000        | .00039                                    | .00079  | .00022         | 19.69 | 30,000        |
|               | 1                 | 1.7  | .00177  | .00236  | .00049         | 59.06  | 40,000        | .00122                                    | .00197  | .00048         | 43.31  | 30,000        | .00118                                    | .00197  | .00042         | 31.50 | 25,000        |
|               | 1.5               | 2.5  | .00177  | .00236  | .00049         | 59.06  | 40,000        | .00122                                    | .00197  | .00048         | 43.31  | 30,000        | .00118                                    | .00197  | .00042         | 31.50 | 25,000        |
| R0.5          | 2                 | 3.3  | .00177  | .00236  | .00049         | 59.06  | 40,000        | .00122                                    | .00197  | .00048         | 43.31  | 30,000        | .00118                                    | .00197  | .00042         | 31.50 | 25,000        |
|               | 2                 | 2    | .00591  | .00787  | .00131         | 118.11 | 30,000        | .00490                                    | .00394  | .00105         | 78.74  | 25,000        | .00295                                    | .00394  | .00098         | 59.06 | 20,000        |
|               | 2.5               | 2.5  | .00591  | .00787  | .00131         | 118.11 | 30,000        | .00490                                    | .00394  | .00105         | 78.74  | 25,000        | .00295                                    | .00394  | .00098         | 59.06 | 20,000        |
| R0.75         | 3                 | 3    | .00591  | .00787  | .00131         | 118.11 | 30,000        | .00490                                    | .00394  | .00105         | 78.74  | 25,000        | .00295                                    | .00394  | .00098         | 59.06 | 20,000        |
|               | 3                 | 2    | .00591  | .01181  | .00166         | 149.61 | 30,000        | .00612                                    | .00787  | .00157         | 118.11 | 25,000        | .00354                                    | .00787  | .00144         | 86.61 | 20,000        |
| R1            | 4                 | 2.7  | .00591  | .01181  | .00157         | 118.11 | 25,000        | .00612                                    | .00787  | .00143         | 94.49  | 22,000        | .00354                                    | .00787  | .00131         | 70.87 | 18,000        |
|               | 3                 | 1.5  | .01181  | .01969  | .00199         | 149.61 | 25,000        | .00898                                    | .01181  | .00197         | 118.11 | 20,000        | .00591                                    | .01181  | .00180         | 86.61 | 16,000        |
|               | 4                 | 2    | .01181  | .01969  | .00199         | 149.61 | 25,000        | .00898                                    | .01181  | .00197         | 118.11 | 20,000        | .00591                                    | .01181  | .00180         | 86.61 | 16,000        |
| R1.5          | 6                 | 3    | .01181  | .01181  | .00179         | 118.11 | 22,000        | .00898                                    | .01181  | .00158         | 94.49  | 20,000        | .00591                                    | .01181  | .00148         | 70.87 | 16,000        |
|               | 6                 | 2    | .01181  | .02362  | .00277         | 149.61 | 18,000        | .01020                                    | .01969  | .00262         | 118.11 | 15,000        | .00591                                    | .01969  | .00246         | 88.58 | 12,000        |
|               | 8                 | 2.7  | .01181  | .02362  | .00277         | 149.61 | 18,000        | .01020                                    | .01969  | .00262         | 118.11 | 15,000        | .00591                                    | .01969  | .00246         | 88.58 | 12,000        |
| R2            | 10                | 3.3  | .01181  | .02362  | .00233         | 125.98 | 18,000        | .01020                                    | .01969  | .00227         | 102.36 | 15,000        | .00591                                    | .01969  | .00219         | 78.74 | 12,000        |
|               | 8                 | 2    | .01181  | .03150  | .00233         | 149.61 | 15,000        | .01020                                    | .02362  | .00328         | 118.11 | 12,000        | .00709                                    | .02362  | .00311         | 88.58 | 9,500         |
|               | 10                | 2.5  | .01181  | .03150  | .00332         | 149.61 | 15,000        | .01020                                    | .02362  | .00328         | 118.11 | 12,000        | .00709                                    | .02362  | .00311         | 88.58 | 9,500         |
| R3            | 12                | 3    | .01181  | .03150  | .00332         | 149.61 | 15,000        | .01020                                    | .02362  | .00328         | 118.11 | 12,000        | .00709                                    | .02362  | .00311         | 88.58 | 9,500         |
|               | 10                | 1.7  | .01496  | .04724  | .00623         | 149.61 | 8,000         | .01020                                    | .03937  | .00562         | 118.11 | 7,000         | .00709                                    | .03937  | .00537         | 88.58 | 5,500         |
|               | 15                | 2.5  | .01496  | .04724  | .00623         | 149.61 | 8,000         | .01020                                    | .03937  | .00562         | 118.11 | 7,000         | .00709                                    | .03937  | .00537         | 88.58 | 5,500         |
|               | 20                | 3.3  | .01496  | .04724  | .00623         | 149.61 | 8,000         | .01020                                    | .03937  | .00562         | 118.11 | 7,000         | .00709                                    | .03937  | .00537         | 88.58 | 5,500         |

## Notes

- ※ Recommended RPM based upon ideal conditions.  
RPM may be adjusted to match the capabilities of your machine while maintaining constant feed rate per cutting tooth.
- ※ 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 At point where cutting load is high such as at corners, pay attention to setting cutting conditions and tool paths particularly.
- ※ 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 insufficient chip flow.
- ※ 7 Adjust both spindle speed and feed at the same rate.
- ※ 8 Overhang of end mill should be as short as possible from spindle nose.
- ※ 9 We recommend using oil mist coolant.

# Machining case

## HAP40 (64HRC) Two-stage pocket mold

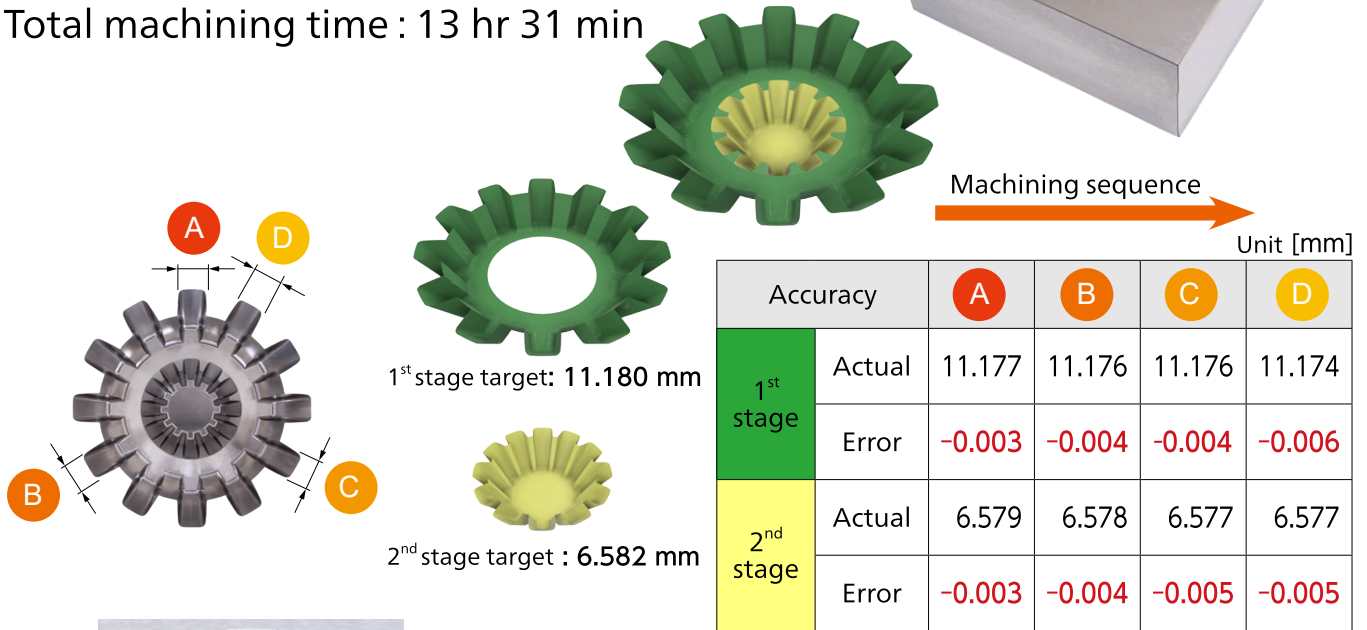
Realize long tool life and high efficiency machining for complex shapes even on hardened steels

Work Material : **HAP40 (64HRC)**  
as the same as SKH40

Work size : **100 × 100 mm**

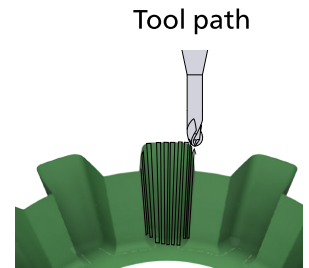
Coolant : Oil mist

Total machining time : 13 hr 31 min



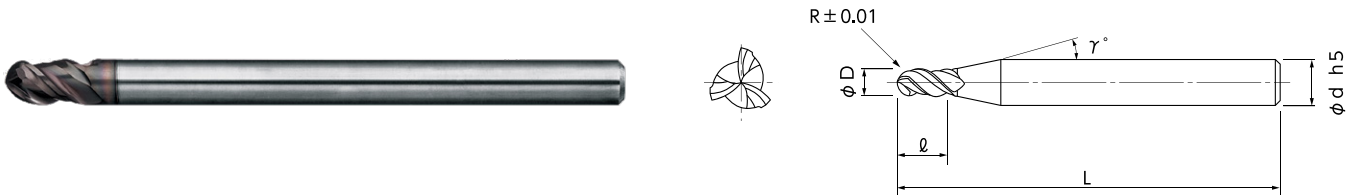
Unit [μm]

| Surface roughness |       |       |       |       |
|-------------------|-------|-------|-------|-------|
|                   | 1     | 2     | 3     | 4     |
| Ra                | 0.053 | 0.067 | 0.065 | 0.070 |



| Machining position                 | 1 <sup>st</sup> stage |                    | 2 <sup>nd</sup> stage | 1 <sup>st</sup> stage |                    | 2 <sup>nd</sup> stage |                 |                 |
|------------------------------------|-----------------------|--------------------|-----------------------|-----------------------|--------------------|-----------------------|-----------------|-----------------|
|                                    | Roughing              | Semi-Roughing      | Roughing              | Semi-Finishing        | Finishing          | Semi-Roughing         | Semi-Finishing  | Finishing       |
| Tool                               | MRBSH330 R3 × 20      | MRBSH330 R1.5 × 10 |                       | MRBSH330 R1.5 × 10    | MRBSH330 R1.5 × 10 | MRBSH330 R1 × 6       | MRBSH330 R1 × 6 | MRBSH330 R1 × 6 |
| Spindle speed [min <sup>-1</sup> ] | 7,000                 | 15,000             | 15,000                | 10,000                | 10,000             | 15,000                | 13,000          | 13,000          |
| Feed [mm/min]                      | 2,500                 | 2,000              | 2,500                 | 1,800                 | 1,500              | 1,500                 | 1,500           | 1,300           |
| Depth of cut ap × ae [mm]          | 0.25 × 1              | 0.15 × 0.1         | 0.2 × 0.8             | 0.05 × 0.05           | 0.035 × 0.035      | 0.15 × 0.1            | 0.04 × 0.04     | 0.03 × 0.03     |
| Stock [mm]                         | 0.1                   | 0.08               | 0.1                   | 0.035                 | 0                  | 0.08                  | 0.03            | 0               |
| Machining time                     | 2hr 5min              | 54min              | 38min                 | 2hr 30min             | 4hr 4min           | 10min                 | 1hr 23min       | 1hr 47min       |

## 3-flute high helix angle ball end mill for prehardened steels and hardened steels up to 65HRC



- MUGEN COATING PREMIUM realizes long tool life for machining on high-hardened steel.
- Original 3-flute design and unequal flute spacing to suppress chattering realize high efficient machining.

### Work material

|                     |                         |                         |                   |                                       |
|---------------------|-------------------------|-------------------------|-------------------|---------------------------------------|
| Prehardened Steel P | Hardened Steel ~60HRC H | Hardened Steel ~65HRC H | Stainless Steel M | Titanium Alloy Heat Resistant Alloy S |
| ○                   | ○                       | ○                       | ○                 | ○                                     |

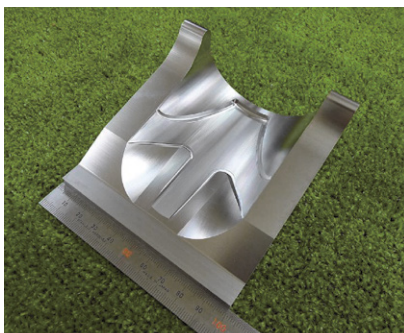
Unit [Size : mm]

| Code No.         | Radius (R) | Length of Cut (L) | Dia. (D) | Neck Taper Angle (γ) | Shank Dia. (d) | Overall Length (L) |
|------------------|------------|-------------------|----------|----------------------|----------------|--------------------|
| 2.08-00607-00050 | R0.5       | 1.5               | 1        | 12°                  | 6              | 60                 |
| 2.08-00607-00100 | R1         | 3                 | 2        | 12°                  | 6              | 60                 |
| 2.08-00607-00150 | R1.5       | 5                 | 3        | 12°                  | 6              | 60                 |
| 2.08-00607-00200 | R2         | 6                 | 4        | 12°                  | 6              | 70                 |
| 2.08-00607-00250 | R2.5       | 8                 | 5        | 12°                  | 6              | 70                 |
| 2.08-00607-00300 | R3         | 10                | 6        | —                    | 6              | 80                 |

**How to Order** When you order, indicate MSBH345(R). ※(γ) is reference value.

### Machining Case

#### Binding sample



- Work material : DC53 60HRC
- Total machining time : 15hr 16min
- Coolant : Oil mist
- Work Size : 100 x 100mm (Machining depth 50mm)

| Process                            | Roughing   | Semi-finishing | Finishing  | Stock removal |
|------------------------------------|------------|----------------|------------|---------------|
| Tool                               | MSBH345 R3 | MSBH345 R3     | MSBH345 R3 | MSBH345 R2    |
| Spindle speed [min <sup>-1</sup> ] | 7,200      |                |            | 12,000        |
| Feed [mm/min]                      | 3,000      | 3,000          | 2,200      | 2,200         |
| Depth of cut ap x ae [mm]          | 0.3x1.5    | 0.3x0.5        | 0.1x0.1    | 0.1x0.1       |
| Machining time                     | 6hr 40min  | 49min          | 7hr 20min  | 27min         |



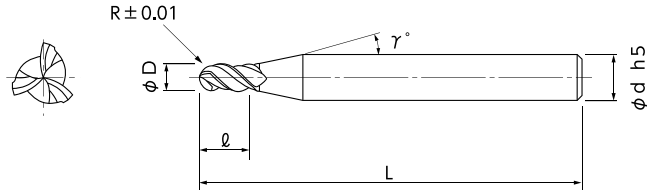
## Metric

| Work Material | Hardened Steels<br>SKD61·STAVAX (~52HRC)   |                   |        |                   | Hardened Steels<br>SKD11 (~62HRC) |                   |        |                   | High Speed Steels<br>SKH (~65HRC) |                   |        |                   |
|---------------|--|-------------------|--------|-------------------|-----------------------------------|-------------------|--------|-------------------|-----------------------------------|-------------------|--------|-------------------|
|               | Depth of Cut   |                   | Feed   | Spindle Speed     | Depth of Cut                      |                   | Feed   | Spindle Speed     | Depth of Cut                      |                   | Feed   | Spindle Speed     |
| Radius        | a <sub>p</sub> mm  | a <sub>e</sub> mm | mm/min | min <sup>-1</sup> | a <sub>p</sub> mm                 | a <sub>e</sub> mm | mm/min | min <sup>-1</sup> | a <sub>p</sub> mm                 | a <sub>e</sub> mm | mm/min | min <sup>-1</sup> |
| R0.5          | 0.1  | 0.3               | 2,500  | 30,000            | 0.1                               | 0.2               | 2,500  | 30,000            | 0.08                              | 0.1               | 2,000  | 30,000            |
| R1            | 0.2  | 0.6               | 3,000  | 20,000            | 0.2                               | 0.6               | 3,000  | 20,000            | 0.15                              | 0.3               | 2,500  | 20,000            |
| R1.5          | 0.2  | 1                 | 3,000  | 18,000            | 0.2                               | 0.8               | 3,000  | 16,000            | 0.2                               | 0.5               | 2,000  | 14,000            |
| R2            | 0.3  | 1.5               | 3,000  | 15,000            | 0.2                               | 1                 | 3,000  | 12,000            | 0.2                               | 0.6               | 2,000  | 10,000            |
| R2.5          | 0.3  | 2                 | 3,000  | 12,000            | 0.2                               | 1.2               | 3,000  | 10,000            | 0.2                               | 0.7               | 2,000  | 8,000             |
| R3            | 0.4  | 2                 | 3,000  | 9,000             | 0.3                               | 1.2               | 3,000  | 7,200             | 0.2                               | 1                 | 2,000  | 6,800             |
| Notes         | <p>※ Recommended RPM based upon ideal conditions.<br/>RPM may be adjusted to match the capabilities of your machine while maintaining constant feed rate per cutting tooth.</p> <p>※1 Depth of Cut: a<sub>p</sub>=Axial Depth of Cut / a<sub>e</sub>=Radial Depth of Cut.<br/>           ※2 We recommend using oil mist coolant.<br/>           ※3 Adjust both spindle speed and feed at the same rate.<br/>           ※4 Adjust milling conditions according to the volume of depth of cut and rigidity of machine.<br/>           ※5 Length of overhang is 4 to 5 times Dia. When it is longer than 4 to 5 times Dia., adjust the conditions listed above.</p> |                   |        |                   |                                   |                   |        |                   |                                   |                   |        |                   |

## Inch

| Work Material | Hardened Steels<br>SKD61·STAVAX (~52HRC)   |                     |                |        |               | Hardened Steels<br>SKD11 (~62HRC) |                     |                |        |               | High Speed Steels<br>SKH (~65HRC) |                     |                |       |               |
|---------------|--|---------------------|----------------|--------|---------------|-----------------------------------|---------------------|----------------|--------|---------------|-----------------------------------|---------------------|----------------|-------|---------------|
|               | Depth of Cut   |                     | Feed per tooth | Feed   | Spindle Speed | Depth of Cut                      |                     | Feed per tooth | Feed   | Spindle Speed | Depth of Cut                      |                     | Feed per tooth | Feed  | Spindle Speed |
| Radius        | a <sub>p</sub> Inch  | a <sub>e</sub> Inch | IPT fz         | IPM    | RPM           | a <sub>p</sub> Inch               | a <sub>e</sub> Inch | IPT fz         | IPM    | RPM           | a <sub>p</sub> Inch               | a <sub>e</sub> Inch | IPT fz         | IPM   | RPM           |
| R0.5          | .00394   | .01181              | .00109         | 98.43  | 30,000        | .00394                            | .00787              | .00119         | 98.43  | 30,000        | .00315                            | .00390              | .00087         | 78.74 | 30,000        |
| R1            | .00787   | .02362              | .00197         | 118.11 | 20,000        | .00787                            | .02362              | .00197         | 118.11 | 20,000        | .00591                            | .01181              | .00164         | 98.43 | 20,000        |
| R1.5          | .00787   | .03937              | .00219         | 118.11 | 18,000        | .00787                            | .03150              | .00246         | 118.11 | 16,000        | .00787                            | .01969              | .00187         | 78.74 | 14,000        |
| R2            | .01181   | .05906              | .00262         | 118.11 | 15,000        | .00787                            | .03937              | .00328         | 118.11 | 12,000        | .00787                            | .02362              | .00262         | 78.74 | 10,000        |
| R2.5          | .01181   | .07874              | .00328         | 118.11 | 12,000        | .00787                            | .04724              | .00394         | 118.11 | 10,000        | .00787                            | .02756              | .00328         | 78.74 | 8,000         |
| R3            | .01575   | .07874              | .00437         | 118.11 | 9,000         | .01181                            | .04724              | .00547         | 118.11 | 7,200         | .00787                            | .03937              | .00386         | 78.74 | 6,800         |
| Notes         | <p>※ Recommended RPM based upon ideal conditions.<br/>RPM may be adjusted to match the capabilities of your machine while maintaining constant feed rate per cutting tooth.</p> <p>※1 Depth of Cut: a<sub>p</sub>=Axial Depth of Cut / a<sub>e</sub>=Radial Depth of Cut.<br/>           ※2 We recommend using oil mist coolant.<br/>           ※3 Adjust both spindle speed and feed at the same rate.<br/>           ※4 Adjust milling conditions according to the volume of depth of cut and rigidity of machine.<br/>           ※5 Length of overhang is 4 to 5 times Dia. When it is longer than 4 to 5 times Dia., adjust the conditions listed above.</p> |                     |                |        |               |                                   |                     |                |        |               |                                   |                     |                |       |               |

3-flute ball end mill.  
Realized to control chattering by unequal flute spacing



- Original 3-flute design and unequal flute spacing to suppress chattering realize high efficient machining.

### Work material

|                |               |                     |                   |                   |          |         |
|----------------|---------------|---------------------|-------------------|-------------------|----------|---------|
| Carbon Steel P | Alloy Steel P | Prehardened Steel p | Stainless Steel M | Aluminium Alloy N | Copper N | Resin O |
| ◎              | ◎             | ◎                   | ○                 | ○                 | ○        | ○       |

Unit [Size : mm]

| Code No.         | Radius (R) | Length of Cut (l) | Dia. (D) | Neck Taper Angle (γ) | Shank Dia. (d) | Overall Length (L) |
|------------------|------------|-------------------|----------|----------------------|----------------|--------------------|
| 2.08-00600-00050 | R0.5       | 1.5               | 1        | 12°                  | 6              | 60                 |
| 2.08-00600-00100 | R1         | 3                 | 2        | 12°                  | 6              | 60                 |
| 2.08-00600-00150 | R1.5       | 5                 | 3        | 12°                  | 6              | 60                 |
| 2.08-00600-00200 | R2         | 6                 | 4        | 12°                  | 6              | 70                 |
| 2.08-00600-00250 | R2.5       | 8                 | 5        | 12°                  | 6              | 70                 |
| 2.08-00600-00300 | R3         | 10                | 6        | —                    | 6              | 80                 |
| 2.08-00600-00400 | R4         | 12                | 8        | —                    | 8              | 90                 |
| 2.08-00600-00500 | R5         | 15                | 10       | —                    | 10             | 100                |
| 2.08-00600-00600 | R6         | 20                | 12       | —                    | 12             | 110                |

#### How to Order

When you order, indicate MSB345(R).

※(γ) is reference value.

## Metric

| Work Material | Carbon Steels<br>S50C |                   |        |                   | Alloy Steels•Prehardened Steels<br>SKD•HPM•NAK |                   |        |                   | Hardened Steels<br>STAVAX•SKD61 (~52HRC) |                   |        |                   |
|---------------|-----------------------|-------------------|--------|-------------------|--|-------------------|--------|-------------------|--|-------------------|--------|-------------------|
|               | Depth of Cut          |                   | Feed   | Spindle Speed     | Depth of Cut                                   |                   | Feed   | Spindle Speed     | Depth of Cut                             |                   | Feed   | Spindle Speed     |
|               | a <sub>p</sub> mm     | a <sub>e</sub> mm | mm/min | min <sup>-1</sup> | a <sub>p</sub> mm                              | a <sub>e</sub> mm | mm/min | min <sup>-1</sup> | a <sub>p</sub> mm                        | a <sub>e</sub> mm | mm/min | min <sup>-1</sup> |
| R0.5          | 0.1                   | 0.3               | 4,000  | 40,000            | 0.1  | 0.3               | 3,500  | 40,000            | 0.1                                      | 0.3               | 2,500  | 30,000            |
| R1            | 0.2                   | 0.6               | 4,500  | 30,000            | 0.2  | 0.6               | 4,000  | 30,000            | 0.2                                      | 0.6               | 3,000  | 20,000            |
| R1.5          | 0.3                   | 1                 | 4,500  | 24,000            | 0.3  | 1                 | 4,000  | 24,000            | 0.2                                      | 1                 | 3,000  | 18,000            |
| R2            | 0.4                   | 1.5               | 4,500  | 20,000            | 0.4  | 1.5               | 4,000  | 20,000            | 0.3                                      | 1.5               | 3,000  | 15,000            |
| R2.5          | 0.5                   | 1.7               | 4,500  | 16,000            | 0.5  | 1.7               | 4,000  | 16,000            | 0.3                                      | 2                 | 3,000  | 12,000            |
| R3            | 0.6                   | 2                 | 4,500  | 10,000            | 0.6  | 2                 | 4,000  | 10,000            | 0.4                                      | 2                 | 3,000  | 9,000             |
| R4            | 0.8                   | 2.5               | 4,500  | 8,000             | 0.8  | 2.5               | 4,000  | 8,000             | 0.5                                      | 2                 | 3,000  | 7,000             |
| R5            | 1.2                   | 3                 | 4,500  | 6,500             | 1.2  | 3                 | 4,000  | 6,500             | 0.7                                      | 2.5               | 3,000  | 5,500             |
| R6            | 1.5                   | 4                 | 4,500  | 5,000             | 1.5  | 4                 | 4,000  | 5,000             | 1  | 3                 | 3,000  | 4,000             |

※ Recommended RPM based upon ideal conditions.

RPM may be adjusted to match the capabilities of your machine while maintaining constant feed rate per cutting tooth.

※1 Depth of Cut: a<sub>p</sub>=Axial Depth of Cut / a<sub>e</sub>=Radial Depth of Cut.

※2 Adjust both spindle speed and feed at the same rate.

※3 Adjust milling conditions according to the volume of depth of cut and rigidity of machine.

※4 Length of overhang is 4 to 5 times Dia. as standard. When it is longer than 4 to 5 times Dia., adjust the conditions listed above.

## Inch

| Work Material | Carbon Steels<br>S50C |                     |                |        |               | Alloy Steels•Prehardened Steels<br>SKD•HPM•NAK |                     |                |        |               | Hardened Steels<br>STAVAX•SKD61 (~52HRC) |                     |                |        |               |
|---------------|-----------------------|---------------------|----------------|--------|---------------|--|---------------------|----------------|--------|---------------|--|---------------------|----------------|--------|---------------|
|               | Depth of Cut          |                     | Feed per tooth | Feed   | Spindle Speed | Depth of Cut                                   |                     | Feed per tooth | Feed   | Spindle Speed | Depth of Cut                             |                     | Feed per tooth | Feed   | Spindle Speed |
|               | a <sub>p</sub> Inch   | a <sub>e</sub> Inch | IPT fz         | IPM    | RPM           | a <sub>p</sub> Inch                            | a <sub>e</sub> Inch | IPT fz         | IPM    | RPM           | a <sub>p</sub> Inch                      | a <sub>e</sub> Inch | IPT fz         | IPM    | RPM           |
| R0.5          | .00394                | .01181              | .00131         | 157.48 | 40,000        | .00394   | .01181              | .00115         | 137.80 | 40,000        | .00394                                   | .01181              | .00109         | 98.43  | 30,000        |
| R1            | .00787                | .02362              | .00197         | 177.17 | 30,000        | .00787   | .02362              | .00175         | 157.48 | 30,000        | .00787                                   | .02362              | .00197         | 118.11 | 20,000        |
| R1.5          | .01181                | .03937              | .00246         | 177.17 | 24,000        | .01181   | .03937              | .00219         | 157.48 | 24,000        | .00787                                   | .03937              | .00219         | 118.11 | 18,000        |
| R2            | .01575                | .05906              | .00295         | 177.17 | 20,000        | .01575   | .05906              | .00262         | 157.48 | 20,000        | .01181                                   | .05906              | .00262         | 118.11 | 15,000        |
| R2.5          | .01969                | .06693              | .00369         | 177.17 | 16,000        | .01969   | .06693              | .00328         | 157.48 | 16,000        | .01181                                   | .07874              | .00328         | 118.11 | 12,000        |
| R3            | .02362                | .07874              | .00590         | 177.17 | 10,000        | .02362   | .07874              | .00525         | 157.48 | 10,000        | .01575                                   | .07874              | .00437         | 118.11 | 9,000         |
| R4            | .03150                | .09843              | .00738         | 177.17 | 8,000         | .03150   | .09843              | .00656         | 157.48 | 8,000         | .01969                                   | .07874              | .00562         | 118.11 | 7,000         |
| R5            | .04724                | .11811              | .00909         | 177.17 | 6,500         | .04724   | .11811              | .00808         | 157.48 | 6,500         | .02756                                   | .09843              | .00716         | 118.11 | 5,500         |
| R6            | .05906                | .15748              | .01181         | 177.17 | 5,000         | .05906   | .15748              | .01050         | 157.48 | 5,000         | .03937                                   | .11811              | .00984         | 118.11 | 4,000         |

※ Recommended RPM based upon ideal conditions.

RPM may be adjusted to match the capabilities of your machine while maintaining constant feed rate per cutting tooth.

※1 Depth of Cut: a<sub>p</sub>=Axial Depth of Cut / a<sub>e</sub>=Radial Depth of Cut.

※2 Adjust both spindle speed and feed at the same rate.

※3 Adjust milling conditions according to the volume of depth of cut and rigidity of machine.

※4 Length of overhang is 4 to 5 times Dia. as standard. When it is longer than 4 to 5 times Dia., adjust the conditions listed above.

Exclusive long-term partner for USA and Canada

## MIKRON CORP. MONROE

200 Main Street  
Monroe, CT 06468, USA  
Phone +1 203 261 3100  
mmo@mikron.com  
us.mikrontool.com

Main Office and Logistic Center

## NS TOOL USA, INC.

2265 Building #3, Star CT,  
Rochester Hills, MI 48309, USA  
Phone +1 248 829 1960  
nsus@ns-tool.com  
us.ns-tool.com



### 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.



24'05

3-Flute ball end mill series\_A1\_202405\_In



2.MKTG.00752

Specifications may change without notice for improvement.



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