


# RECOMMENDED CUTTING CONDITIONS


## Shoulder milling

When machine rigidity, work material rigidity and chip discharge are enough, please select the high efficiency cutting conditions.  
When either machine rigidity, work material rigidity or chip discharge are not enough, please select the general-purpose cutting conditions.

### High efficiency cutting conditions

| Dia. (mm)    | Carbon steel, Alloy steel, Mild steel<br>S45C, SCM440, SS400, S10C                 |                                 |                    |                      |                      | Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel<br>NAK, PX5, SNCM439, SKD, SKT |                                 |                    |                      |                      | Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys<br>SUS304, SUS316, Ti-6Al-4V |                                 |                    |                      |                      | Hardened stainless steels, Cobalt chromium alloy<br>SUS630, SUS631 |                                 |                    |                      |                      |
|--------------|--|---------------------------------|--------------------|----------------------|----------------------|--|---------------------------------|--------------------|----------------------|----------------------|---|---------------------------------|--------------------|----------------------|----------------------|--|---------------------------------|--------------------|----------------------|----------------------|
|              | Cutting speed (m/min)  | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Depth of cut ap (mm) | Depth of cut ae (mm) | Cutting speed (m/min)  | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Depth of cut ap (mm) | Depth of cut ae (mm) | Cutting speed (m/min)   | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Depth of cut ap (mm) | Depth of cut ae (mm) | Cutting speed (m/min)  | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Depth of cut ap (mm) | Depth of cut ae (mm) |
| 1            | 100  | 32000                           | 720                | 1.5                  | 0.2                  | 80   | 25000                           | 530                | 1.5                  | 0.2                  | 60  | 19000                           | 430                | 1.5                  | 0.2                  | 50   | 16000                           | 340                | 1.5                  | 0.1                  |
| 1.5          | 130  | 28000                           | 1300               | 2.25                 | 0.3                  | 100  | 21000                           | 630                | 2.25                 | 0.3                  | 85  | 18000                           | 540                | 2.25                 | 0.3                  | 65   | 14000                           | 420                | 2.25                 | 0.15                 |
| 2            | 150  | 24000                           | 1800               | 3                    | 0.6                  | 120  | 19000                           | 860                | 3                    | 0.6                  | 100   | 16000                           | 620                | 3                    | 0.6                  | 75   | 12000                           | 540                | 3                    | 0.4                  |
| 3            | 150  | 16000                           | 1900               | 4.5                  | 0.9                  | 120  | 13000                           | 940                | 4.5                  | 0.9                  | 100   | 11000                           | 660                | 4.5                  | 0.9                  | 75   | 8000                            | 580                | 4.5                  | 0.6                  |
| 4            | 150  | 12000                           | 2000               | 6                    | 1.2                  | 120  | 9500                            | 940                | 6                    | 1.2                  | 100   | 8000                            | 670                | 6                    | 1.2                  | 75   | 6000                            | 590                | 6                    | 0.8                  |
| 5            | 150  | 9500                            | 1900               | 7.5                  | 1.5                  | 120  | 7600                            | 960                | 7.5                  | 1.5                  | 100   | 6400                            | 670                | 7.5                  | 1.5                  | 75   | 4800                            | 600                | 7.5                  | 1                    |
| 6            | 150  | 8000                            | 1900               | 9                    | 1.8                  | 120  | 6400                            | 960                | 9                    | 1.8                  | 100   | 5300                            | 830                | 9                    | 1.8                  | 75   | 4000                            | 600                | 9                    | 1.2                  |
| 8            | 150  | 6000                            | 1900               | 12                   | 2.4                  | 120  | 4800                            | 1000               | 12                   | 2.4                  | 100   | 4000                            | 900                | 12                   | 2.4                  | 75   | 3000                            | 630                | 12                   | 1.6                  |
| 10           | 150  | 4800                            | 1700               | 15                   | 3                    | 120  | 3800                            | 910                | 15                   | 3                    | 100   | 3200                            | 960                | 15                   | 3                    | 75   | 2400                            | 580                | 15                   | 2                    |
| 12           | 150  | 4000                            | 1400               | 18                   | 3.6                  | 120  | 3200                            | 860                | 18                   | 3.6                  | 100   | 2700                            | 890                | 18                   | 3.6                  | 75   | 2000                            | 540                | 18                   | 2.4                  |
| 16           | 150  | 3000                            | 1200               | 24                   | 4.8                  | 120  | 2400                            | 720                | 24                   | 4.8                  | 100   | 2000                            | 720                | 24                   | 4.8                  | 75   | 1500                            | 450                | 24                   | 3.2                  |
| 20           | 150  | 2400                            | 970                | 30                   | 6                    | 120  | 1900                            | 570                | 30                   | 6                    | 100   | 1600                            | 580                | 30                   | 6                    | 75   | 1200                            | 360                | 30                   | 4                    |
| Depth of cut |  |                                 |                    |                      |                      |  |                                 |                    |                      |                      |   |                                 |                    |                      |                      |  |                                 |                    |                      |                      |

### General purpose cutting conditions

| Dia. (mm)    | Carbon steel, Alloy steel, Mild steel<br>S45C, SCM440, SS400, S10C                  |                                 |                    |                      |                      | Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel<br>NAK, PX5, SNCM439, SKD, SKT |                                 |                    |                      |                      | Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys<br>SUS304, SUS316, Ti-6Al-4V |                                 |                    |                      |                      | Hardened stainless steels, Cobalt chromium alloy<br>SUS630, SUS631 |                                 |                    |                      |                      |
|--------------|---|---------------------------------|--------------------|----------------------|----------------------|--|---------------------------------|--------------------|----------------------|----------------------|---|---------------------------------|--------------------|----------------------|----------------------|--|---------------------------------|--------------------|----------------------|----------------------|
|              | Cutting speed (m/min)   | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Depth of cut ap (mm) | Depth of cut ae (mm) | Cutting speed (m/min)  | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Depth of cut ap (mm) | Depth of cut ae (mm) | Cutting speed (m/min)   | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Depth of cut ap (mm) | Depth of cut ae (mm) | Cutting speed (m/min)  | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Depth of cut ap (mm) | Depth of cut ae (mm) |
| 1            | 100   | 32000                           | 480                | 1.5                  | 0.2                  | 80   | 25000                           | 350                | 1.5                  | 0.2                  | 60  | 19000                           | 280                | 1.5                  | 0.2                  | 50   | 16000                           | 220                | 1.5                  | 0.1                  |
| 1.5          | 120   | 25000                           | 740                | 2.25                 | 0.3                  | 100  | 21000                           | 420                | 2.25                 | 0.3                  | 80  | 17000                           | 340                | 2.25                 | 0.3                  | 65   | 14000                           | 280                | 2.25                 | 0.15                 |
| 2            | 120   | 19000                           | 940                | 3                    | 0.6                  | 100  | 16000                           | 480                | 3                    | 0.6                  | 80  | 13000                           | 340                | 3                    | 0.6                  | 70   | 11000                           | 330                | 3                    | 0.4                  |
| 3            | 120   | 13000                           | 1000               | 4.5                  | 0.9                  | 100  | 11000                           | 520                | 4.5                  | 0.9                  | 80  | 8500                            | 340                | 4.5                  | 0.9                  | 70   | 7400                            | 350                | 4.5                  | 0.6                  |
| 4            | 120   | 9500                            | 1000               | 6                    | 1.2                  | 100  | 8000                            | 520                | 6                    | 1.2                  | 80  | 6400                            | 350                | 6                    | 1.2                  | 70   | 5600                            | 370                | 6                    | 0.8                  |
| 5            | 120   | 7600                            | 980                | 7.5                  | 1.5                  | 100  | 6400                            | 530                | 7.5                  | 1.5                  | 80  | 5100                            | 350                | 7.5                  | 1.5                  | 70   | 4500                            | 370                | 7.5                  | 1                    |
| 6            | 120   | 6400                            | 1000               | 9                    | 1.8                  | 100  | 5300                            | 540                | 9                    | 1.8                  | 80  | 4200                            | 400                | 9                    | 1.8                  | 70   | 3700                            | 370                | 9                    | 1.2                  |
| 8            | 120   | 4800                            | 1000               | 12                   | 2.4                  | 100  | 4000                            | 550                | 12                   | 2.4                  | 80  | 3200                            | 430                | 12                   | 2.4                  | 70   | 2800                            | 390                | 12                   | 1.6                  |
| 10           | 120   | 3800                            | 900                | 15                   | 3                    | 100  | 3200                            | 510                | 15                   | 3                    | 80  | 2500                            | 450                | 15                   | 3                    | 70   | 2200                            | 350                | 15                   | 2                    |
| 12           | 120   | 3200                            | 760                | 18                   | 3.6                  | 100  | 2700                            | 480                | 18                   | 3.6                  | 80  | 2100                            | 420                | 18                   | 3.6                  | 70   | 1900                            | 340                | 18                   | 2.4                  |
| 16           | 120   | 2400                            | 640                | 24                   | 4.8                  | 100  | 2000                            | 400                | 24                   | 4.8                  | 80  | 1600                            | 340                | 24                   | 4.8                  | 70   | 1400                            | 280                | 24                   | 3.2                  |
| 20           | 120   | 1900                            | 510                | 30                   | 6                    | 100  | 1600                            | 320                | 30                   | 6                    | 80  | 1300                            | 270                | 30                   | 6                    | 70   | 1100                            | 220                | 30                   | 4                    |
| Depth of cut |  |                                 |                    |                      |                      |  |                                 |                    |                      |                      |   |                                 |                    |                      |                      |  |                                 |                    |                      |                      |

- 1) SMART MIRACLE coating is less electro conductive; therefore an external contact type (electric transmitted) tool setter may not work.  
When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.
- 2) Effective cutting of stainless steel, titanium alloys and heat-resistant alloys etc. can be achieved with the use of emulsion.
- 3) Chattering can still occur if the machine rigidity and clamping method are insufficient.  
In these cases the feed and speed should be reduced proportionately.
- 4) When the depth of cut is smaller than shown the feed rate can be increased.

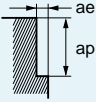
## RECOMMENDED CUTTING CONDITIONS

### Shoulder milling

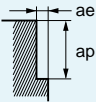
When machine rigidity, work material rigidity and chip discharge are enough, please select the high efficiency cutting conditions.

When either machine rigidity, work material rigidity or chip discharge are not enough, please select the general-purpose cutting conditions.

#### High efficiency cutting conditions

| Work material | Copper, Copper alloy   |                       |                                 |                    |                      | Heat resistant alloys<br>Inconel718 |                       |                                 |                    |                      |                      |
|---------------|--|-----------------------|---------------------------------|--------------------|----------------------|-------------------------------------|-----------------------|---------------------------------|--------------------|----------------------|----------------------|
|               | Dia. (mm)  | Cutting speed (m/min) | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Depth of cut ap (mm) | Depth of cut ae (mm)                | Cutting speed (m/min) | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Depth of cut ap (mm) | Depth of cut ae (mm) |
| 1             | 120  | 38000                 | 860                             | 1.5                | 0.2                  | 40                                  | 13000                 | 160                             | 1.5                | 0.05                 |                      |
| 1.5           | 150  | 32000                 | 1400                            | 2.25               | 0.3                  | 40                                  | 8500                  | 170                             | 2.25               | 0.08                 |                      |
| 2             | 180  | 29000                 | 2200                            | 3                  | 0.6                  | 40                                  | 6400                  | 170                             | 3                  | 0.2                  |                      |
| 3             | 180  | 19000                 | 2300                            | 4.5                | 0.9                  | 40                                  | 4200                  | 180                             | 4.5                | 0.3                  |                      |
| 4             | 180  | 14000                 | 2300                            | 6                  | 1.2                  | 40                                  | 3200                  | 180                             | 6                  | 0.4                  |                      |
| 5             | 180  | 11000                 | 2300                            | 7.5                | 1.5                  | 40                                  | 2500                  | 180                             | 7.5                | 0.5                  |                      |
| 6             | 180  | 9500                  | 2300                            | 9                  | 1.8                  | 40                                  | 2100                  | 190                             | 9                  | 0.6                  |                      |
| 8             | 180  | 7200                  | 2300                            | 12                 | 2.4                  | 40                                  | 1600                  | 190                             | 12                 | 0.8                  |                      |
| 10            | 180  | 5700                  | 2100                            | 15                 | 3                    | 40                                  | 1300                  | 220                             | 15                 | 1                    |                      |
| 12            | 180  | 4800                  | 1700                            | 18                 | 3.6                  | 40                                  | 1100                  | 210                             | 18                 | 1.2                  |                      |
| 16            | 180  | 3600                  | 1500                            | 24                 | 4.8                  | 40                                  | 800                   | 150                             | 24                 | 1.6                  |                      |
| 20            | 180  | 2900                  | 1200                            | 30                 | 6                    | 40                                  | 640                   | 120                             | 30                 | 2                    |                      |
| Depth of cut  |  |                       |                                 |                    |                      |                                     |                       |                                 |                    |                      |                      |

#### General purpose cutting conditions

| Work material | Copper, Copper alloy  |                       |                                 |                    |                      | Heat resistant alloys<br>Inconel718 |                       |                                 |                    |                      |                      |
|---------------|---|-----------------------|---------------------------------|--------------------|----------------------|-------------------------------------|-----------------------|---------------------------------|--------------------|----------------------|----------------------|
|               | Dia. (mm)   | Cutting speed (m/min) | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Depth of cut ap (mm) | Depth of cut ae (mm)                | Cutting speed (m/min) | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Depth of cut ap (mm) | Depth of cut ae (mm) |
| 1             | 120   | 38000                 | 560                             | 1.5                | 0.2                  | 30                                  | 9500                  | 75                              | 1.5                | 0.05                 |                      |
| 1.5           | 140   | 30000                 | 890                             | 2.25               | 0.3                  | 30                                  | 6400                  | 82                              | 2.25               | 0.07                 |                      |
| 2             | 140   | 22000                 | 1100                            | 3                  | 0.6                  | 30                                  | 4800                  | 86                              | 3                  | 0.2                  |                      |
| 3             | 140   | 15000                 | 1200                            | 4.5                | 0.9                  | 30                                  | 3200                  | 89                              | 4.5                | 0.3                  |                      |
| 4             | 140   | 11000                 | 1200                            | 6                  | 1.2                  | 30                                  | 2400                  | 90                              | 6                  | 0.4                  |                      |
| 5             | 140   | 8900                  | 1200                            | 7.5                | 1.5                  | 30                                  | 1900                  | 90                              | 7.5                | 0.5                  |                      |
| 6             | 140   | 7400                  | 1200                            | 9                  | 1.8                  | 30                                  | 1600                  | 95                              | 9                  | 0.6                  |                      |
| 8             | 140   | 5600                  | 1200                            | 12                 | 2.4                  | 30                                  | 1200                  | 95                              | 12                 | 0.8                  |                      |
| 10            | 140   | 4500                  | 1100                            | 15                 | 3                    | 30                                  | 950                   | 110                             | 15                 | 1                    |                      |
| 12            | 140   | 3700                  | 880                             | 18                 | 3.6                  | 30                                  | 800                   | 100                             | 18                 | 1.2                  |                      |
| 16            | 140   | 2800                  | 750                             | 24                 | 4.8                  | 30                                  | 600                   | 76                              | 24                 | 1.6                  |                      |
| 20            | 140   | 2200                  | 590                             | 30                 | 6                    | 30                                  | 480                   | 61                              | 30                 | 2                    |                      |
| Depth of cut  |  |                       |                                 |                    |                      |                                     |                       |                                 |                    |                      |                      |

1) SMART MIRACLE coating is less electro conductive; therefore an external contact type (electric transmitted) tool setter may not work.

When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

2) Effective cutting of stainless steel, titanium alloys and heat-resistant alloys etc. can be achieved with the use of emulsion.

3) Chattering can still occur if the machine rigidity and clamping method are insufficient.

In these cases the feed and speed should be reduced proportionately.

4) When the depth of cut is smaller than shown the revolution and feed rate can be increased.

## Slotting

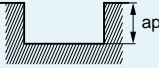
When machine rigidity, work material rigidity and chip discharge are enough, please select the high efficiency cutting conditions.

When either machine rigidity, work material rigidity or chip discharge are not enough, please select the general-purpose cutting conditions.

### High efficiency cutting conditions

| Work material | Carbon steel, Alloy steel, Mild steel |                                 |                    |                      | Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel |                                 |                    |                      | Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys |                                 |                    |                      | Hardened stainless steels, Cobalt chromium alloy |                                 |                    |                      | Copper, Copper alloy  |                                 |                    |                      | Heat resistant alloys |                                 |                    |                      |
|---------------|---------------------------------------|---------------------------------|--------------------|----------------------|---|---------------------------------|--------------------|----------------------|--|---------------------------------|--------------------|----------------------|--|---------------------------------|--------------------|----------------------|-----------------------|---------------------------------|--------------------|----------------------|-----------------------|---------------------------------|--------------------|----------------------|
|               | S45C, SCM440, SS400, S10C             |                                 |                    |                      | NAK, PX5, SNCM439, SKD, SKT                                     |                                 |                    |                      | SUS304, SUS316, Ti-6Al-4V  |                                 |                    |                      | SUS630, SUS631                                   |                                 |                    |                      |                       |                                 |                    |                      | Inconel718            |                                 |                    |                      |
| Dia. (mm)     | Cutting speed (m/min)                 | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Depth of cut ap (mm) | Cutting speed (m/min)   | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Depth of cut ap (mm) | Cutting speed (m/min)  | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Depth of cut ap (mm) | Cutting speed (m/min)                            | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Depth of cut ap (mm) | Cutting speed (m/min) | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Depth of cut ap (mm) | Cutting speed (m/min) | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Depth of cut ap (mm) |
| 1             | 100                                   | 32000                           | 380                | 0.5                  | 80  | 25000                           | 150                | 0.5                  | 60   | 19000                           | 100                | 0.5                  | 45   | 14000                           | 80                 | 0.3                  | 120                   | 38000                           | 460                | 0.5                  | 30                    | 9500                            | 60                 | 0.2                  |
| 1.5           | 130                                   | 28000                           | 590                | 0.75                 | 100   | 21000                           | 250                | 0.75                 | 85   | 18000                           | 220                | 0.75                 | 60   | 12000                           | 140                | 0.4                  | 150                   | 32000                           | 670                | 0.75                 | 30                    | 6400                            | 80                 | 0.3                  |
| 2             | 150                                   | 24000                           | 940                | 2                    | 120   | 19000                           | 460                | 2                    | 100  | 16000                           | 480                | 2                    | 60   | 9500                            | 230                | 1                    | 180                   | 29000                           | 1100               | 2                    | 30                    | 4800                            | 100                | 0.6                  |
| 3             | 150                                   | 16000                           | 1100               | 3                    | 120   | 13000                           | 550                | 3                    | 100  | 11000                           | 500                | 3                    | 60   | 6400                            | 270                | 1.5                  | 180                   | 19000                           | 1300               | 3                    | 30                    | 3200                            | 120                | 0.9                  |
| 4             | 150                                   | 12000                           | 1400               | 4                    | 120   | 9500                            | 680                | 4                    | 100  | 8000                            | 530                | 4                    | 60   | 4800                            | 350                | 2                    | 180                   | 14000                           | 1700               | 4                    | 30                    | 2400                            | 130                | 1.2                  |
| 5             | 150                                   | 9500                            | 1400               | 5                    | 120   | 7600                            | 680                | 5                    | 100  | 6400                            | 540                | 5                    | 60   | 3800                            | 350                | 2.5                  | 180                   | 11000                           | 1700               | 5                    | 30                    | 1900                            | 130                | 1.5                  |
| 6             | 150                                   | 8000                            | 1400               | 6                    | 120   | 6400                            | 770                | 6                    | 100  | 5300                            | 560                | 6                    | 60   | 3200                            | 380                | 3                    | 180                   | 9500                            | 1700               | 6                    | 30                    | 1600                            | 130                | 1.8                  |
| 8             | 150                                   | 6000                            | 1300               | 8                    | 120   | 4800                            | 720                | 8                    | 100  | 4000                            | 600                | 8                    | 60   | 2400                            | 360                | 4                    | 180                   | 7200                            | 1500               | 8                    | 30                    | 1200                            | 140                | 2.4                  |
| 10            | 150                                   | 4800                            | 1200               | 10                   | 120   | 3800                            | 630                | 10                   | 100  | 3200                            | 670                | 10                   | 60   | 1900                            | 310                | 5                    | 180                   | 5700                            | 1400               | 10                   | 30                    | 950                             | 160                | 3                    |
| 12            | 150                                   | 4000                            | 960                | 12                   | 120   | 3200                            | 580                | 12                   | 100  | 2700                            | 650                | 12                   | 60   | 1600                            | 290                | 6                    | 180                   | 4800                            | 1200               | 12                   | 30                    | 800                             | 150                | 3.6                  |
| 16            | 150                                   | 3000                            | 810                | 12                   | 120   | 2400                            | 500                | 12                   | 100  | 2000                            | 480                | 12                   | 60   | 1200                            | 250                | 8                    | 180                   | 3600                            | 970                | 12                   | 30                    | 600                             | 120                | 4.8                  |
| 20            | 150                                   | 2400                            | 650                | 12                   | 120   | 1900                            | 400                | 12                   | 100  | 1600                            | 380                | 12                   | 60   | 950                             | 200                | 10                   | 180                   | 2900                            | 780                | 12                   | 30                    | 480                             | 90                 | 6                    |

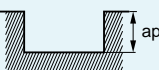
Depth of cut



### General purpose cutting conditions

| Work material | Carbon steel, Alloy steel, Mild steel |                                 |                    |                      | Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel |                                 |                    |                      | Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys |                                 |                    |                      | Hardened stainless steels, Cobalt chromium alloy |                                 |                    |                      | Copper, Copper alloy  |                                 |                    |                      | Heat resistant alloys |                                 |                    |                      |
|---------------|---------------------------------------|---------------------------------|--------------------|----------------------|---|---------------------------------|--------------------|----------------------|--|---------------------------------|--------------------|----------------------|--|---------------------------------|--------------------|----------------------|-----------------------|---------------------------------|--------------------|----------------------|-----------------------|---------------------------------|--------------------|----------------------|
|               | S45C, SCM440, SS400, S10C             |                                 |                    |                      | NAK, PX5, SNCM439, SKD, SKT                                     |                                 |                    |                      | SUS304, SUS316, Ti-6Al-4V  |                                 |                    |                      | SUS630, SUS631                                   |                                 |                    |                      |                       |                                 |                    |                      | Inconel718            |                                 |                    |                      |
| Dia. (mm)     | Cutting speed (m/min)                 | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Depth of cut ap (mm) | Cutting speed (m/min)   | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Depth of cut ap (mm) | Cutting speed (m/min)  | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Depth of cut ap (mm) | Cutting speed (m/min)                            | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Depth of cut ap (mm) | Cutting speed (m/min) | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Depth of cut ap (mm) | Cutting speed (m/min) | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Depth of cut ap (mm) |
| 1             | 100                                   | 32000                           | 250                | 0.5                  | 80  | 25000                           | 99                 | 0.5                  | 60   | 19000                           | 80                 | 0.5                  | 45   | 14000                           | 60                 | 0.3                  | 120                   | 38000                           | 300                | 0.5                  | 25                    | 8000                            | 30                 | 0.2                  |
| 1.5           | 100                                   | 21000                           | 290                | 0.75                 | 80  | 17000                           | 130                | 0.75                 | 60   | 13000                           | 100                | 0.75                 | 50   | 11000                           | 87                 | 0.4                  | 120                   | 25000                           | 350                | 0.75                 | 25                    | 5300                            | 40                 | 0.3                  |
| 2             | 100                                   | 16000                           | 410                | 2                    | 80  | 13000                           | 210                | 2                    | 60   | 9500                            | 190                | 2                    | 50   | 8000                            | 130                | 1                    | 120                   | 19000                           | 490                | 2                    | 25                    | 4000                            | 55                 | 0.6                  |
| 3             | 100                                   | 11000                           | 500                | 3                    | 80  | 8500                            | 240                | 3                    | 60   | 6400                            | 190                | 3                    | 50   | 5300                            | 150                | 1.5                  | 120                   | 13000                           | 590                | 3                    | 25                    | 2700                            | 64                 | 0.9                  |
| 4             | 100                                   | 8000                            | 630                | 4                    | 80  | 6400                            | 300                | 4                    | 60   | 4800                            | 210                | 4                    | 50   | 4000                            | 190                | 2                    | 120                   | 9500                            | 750                | 4                    | 25                    | 2000                            | 70                 | 1.2                  |
| 5             | 100                                   | 6400                            | 630                | 5                    | 80  | 5100                            | 300                | 5                    | 60   | 3800                            | 210                | 5                    | 50   | 3200                            | 190                | 2.5                  | 120                   | 7600                            | 750                | 5                    | 25                    | 1600                            | 71                 | 1.5                  |
| 6             | 100                                   | 5300                            | 630                | 6                    | 80  | 4200                            | 330                | 6                    | 60   | 3200                            | 220                | 6                    | 50   | 2700                            | 210                | 3                    | 120                   | 6400                            | 760                | 6                    | 25                    | 1300                            | 72                 | 1.8                  |
| 8             | 100                                   | 4000                            | 550                | 8                    | 80  | 3200                            | 320                | 8                    | 60   | 2400                            | 240                | 8                    | 50   | 2000                            | 200                | 4                    | 120                   | 4800                            | 670                | 8                    | 25                    | 990                             | 78                 | 2.4                  |
| 10            | 100                                   | 3200                            | 510                | 10                   | 80  | 2500                            | 270                | 10                   | 60   | 1900                            | 260                | 10                   | 50   | 1600                            | 170                | 5                    | 120                   | 3800                            | 600                | 10                   | 25                    | 800                             | 89                 | 3                    |
| 12            | 100                                   | 2700                            | 430                | 12                   | 80  | 2100                            | 250                | 12                   | 60   | 1600                            | 250                | 12                   | 50   | 1300                            | 150                | 6                    | 120                   | 3200                            | 510                | 12                   | 25                    | 660                             | 84                 | 3.6                  |
| 16            | 100                                   | 2000                            | 360                | 12                   | 80  | 1600                            | 220                | 12                   | 60   | 1200                            | 190                | 12                   | 50   | 990                             | 140                | 8                    | 120                   | 2400                            | 430                | 12                   | 25                    | 500                             | 63                 | 4.8                  |
| 20            | 100                                   | 1600                            | 290                | 12                   | 80  | 1300                            | 180                | 12                   | 60   | 950                             | 150                | 12                   | 50   | 800                             | 110                | 10                   | 120                   | 1900                            | 340                | 12                   | 25                    | 400                             | 50                 | 6                    |

Depth of cut



1) SMART MIRACLE coating is less electro conductive; therefore an external contact type (electric transmitted) tool setter may not work.

When measuring the tool length, please use an internal contact type (non-electricity type) tool setter or a laser type tool setter.

2) Effective cutting of stainless steel, titanium alloys and heat-resistant alloys etc. can be achieved with the use of emulsion.

3) Chattering can still occur if the machine rigidity and clamping method are insufficient.

In these cases the feed and speed should be reduced proportionately.

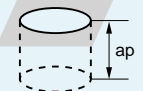
4) When the depth of cut is smaller than shown the feed rate can be increased.

# RECOMMENDED CUTTING CONDITIONS

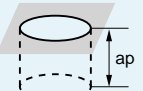
## Plunging

When machine rigidity, work material rigidity and chip discharge are enough, please select the high efficiency cutting conditions.  
When either machine rigidity, work material rigidity or chip discharge are not enough, please select the general-purpose cutting conditions.

### High efficiency cutting conditions

| Work material | Carbon steel, Alloy steel, Mild steel  |                                 |                    |                    |           | Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel |                                 |                    |                    |           | Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys |                                 |                    |                    |           | Hardened stainless steels, Cobalt chromium alloy |                                 |                    |                    |           | Copper, Copper alloy   |                                 |                    |                    |           |  |  |  |
|---------------|--|---------------------------------|--------------------|--------------------|-----------|---|---------------------------------|--------------------|--------------------|-----------|--|---------------------------------|--------------------|--------------------|-----------|--|---------------------------------|--------------------|--------------------|-----------|------------------------|---------------------------------|--------------------|--------------------|-----------|--|--|--|
|               | S45C, SCM440, SS400, S10C  |                                 |                    |                    |           | NAK, PX5, SNCM439, SKD, SKT                                     |                                 |                    |                    |           | SUS304, SUS316, Ti-6Al-4V  |                                 |                    |                    |           | SUS630, SUS631                                   |                                 |                    |                    |           |                        |                                 |                    |                    |           |  |  |  |
| Dia. (mm)     | Cutting speed (mm/min)   | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Hole Depth ap (mm) | Step (mm) | Cutting speed (mm/min)  | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Hole Depth ap (mm) | Step (mm) | Cutting speed (mm/min)   | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Hole Depth ap (mm) | Step (mm) | Cutting speed (mm/min)                           | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Hole Depth ap (mm) | Step (mm) | Cutting speed (mm/min) | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Hole Depth ap (mm) | Step (mm) |  |  |  |
| 1             | 65   | 20000                           | 160                | 0.5                | 0.1       | 50  | 16000                           | 100                | 0.5                | 0.1       | 50   | 16000                           | 50                 | 0.5                | 0.05      | 30   | 9500                            | 30                 | 0.5                | 0.05      | 75                     | 24000                           | 190                | 0.5                | 0.1       |  |  |  |
| 1.5           | 85   | 18000                           | 270                | 0.75               | 0.3       | 60  | 13000                           | 120                | 0.75               | 0.3       | 60   | 13000                           | 80                 | 0.75               | 0.1       | 35   | 7400                            | 40                 | 0.75               | 0.1       | 100                    | 21000                           | 320                | 0.75               | 0.3       |  |  |  |
| 2             | 100  | 16000                           | 480                | 2                  | 0.5       | 70  | 11000                           | 200                | 2                  | 0.4       | 60   | 9500                            | 90                 | 1                  | 0.15      | 40   | 6400                            | 60                 | 1                  | 0.1       | 120                    | 19000                           | 570                | 2                  | 0.5       |  |  |  |
| 3             | 100  | 11000                           | 660                | 3                  | 1         | 70  | 7400                            | 270                | 3                  | 0.6       | 60   | 6400                            | 100                | 1.5                | 0.2       | 40   | 4200                            | 60                 | 1.5                | 0.2       | 120                    | 13000                           | 780                | 3                  | 1.0       |  |  |  |
| 4             | 100  | 8000                            | 800                | 4                  | 2         | 70  | 5600                            | 340                | 4                  | 0.8       | 60   | 4800                            | 100                | 2                  | 0.4       | 40   | 3200                            | 60                 | 2                  | 0.4       | 120                    | 9500                            | 950                | 4                  | 2         |  |  |  |
| 5             | 100  | 6400                            | 960                | 5                  | 2.5       | 70  | 4500                            | 410                | 5                  | 1         | 60   | 3800                            | 100                | 2.5                | 0.5       | 40   | 2500                            | 60                 | 2.5                | 0.5       | 120                    | 7600                            | 1100               | 5                  | 2.5       |  |  |  |
| 6             | 100  | 5300                            | 950                | 6                  | 3         | 70  | 3700                            | 440                | 6                  | 1.2       | 60   | 3200                            | 100                | 3                  | 0.6       | 40   | 2100                            | 60                 | 3                  | 0.6       | 120                    | 6400                            | 1200               | 6                  | 3         |  |  |  |
| 8             | 100  | 4000                            | 720                | 8                  | 4         | 70  | 2800                            | 340                | 8                  | 1.6       | 60   | 2400                            | 70                 | 4                  | 0.6       | 40   | 1600                            | 50                 | 4                  | 0.6       | 120                    | 4800                            | 860                | 8                  | 4         |  |  |  |
| 10            | 100  | 3200                            | 580                | 10                 | 5         | 70  | 2200                            | 260                | 10                 | 2.5       | 60   | 1900                            | 60                 | 5                  | 0.6       | 40   | 1300                            | 40                 | 5                  | 0.6       | 120                    | 3800                            | 680                | 10                 | 5         |  |  |  |
| 12            | 100  | 2700                            | 490                | 12                 | 5         | 70  | 1900                            | 230                | 12                 | 3         | 60   | 1600                            | 50                 | 6                  | 0.6       | 40   | 1100                            | 30                 | 6                  | 0.6       | 120                    | 3200                            | 580                | 12                 | 5         |  |  |  |
| 16            | 100  | 2000                            | 360                | 16                 | 5         | 70  | 1400                            | 170                | 16                 | 4         | 60   | 1200                            | 40                 | 8                  | 0.6       | 40   | 800                             | 20                 | 8                  | 0.6       | 120                    | 2400                            | 430                | 16                 | 5         |  |  |  |
| 20            | 100  | 1600                            | 290                | 20                 | 5         | 70  | 1100                            | 130                | 20                 | 5         | 60   | 950                             | 30                 | 10                 | 0.6       | 40   | 640                             | 20                 | 10                 | 0.6       | 120                    | 1900                            | 340                | 20                 | 5         |  |  |  |
| Depth of cut  |  |                                 |                    |                    |           |   |                                 |                    |                    |           |  |                                 |                    |                    |           |  |                                 |                    |                    |           |                        |                                 |                    |                    |           |  |  |  |

### General purpose cutting conditions

| Work material | Carbon steel, Alloy steel, Mild steel   |                                 |                    |                    |           | Pre-hardened steel, Carbon steel, Alloy steel, Alloy tool steel |                                 |                    |                    |           | Austenitic, Ferritic and Martensitic stainless steels, Titanium alloys |                                 |                    |                    |           | Hardened stainless steels, Cobalt chromium alloy |                                 |                    |                    |           | Copper, Copper alloy   |                                 |                    |                    |           |  |  |  |
|---------------|---|---------------------------------|--------------------|--------------------|-----------|---|---------------------------------|--------------------|--------------------|-----------|--|---------------------------------|--------------------|--------------------|-----------|--|---------------------------------|--------------------|--------------------|-----------|------------------------|---------------------------------|--------------------|--------------------|-----------|--|--|--|
|               | S45C, SCM440, SS400, S10C   |                                 |                    |                    |           | NAK, PX5, SNCM439, SKD, SKT                                     |                                 |                    |                    |           | SUS304, SUS316, Ti-6Al-4V  |                                 |                    |                    |           | SUS630, SUS631                                   |                                 |                    |                    |           |                        |                                 |                    |                    |           |  |  |  |
| Dia. (mm)     | Cutting speed (mm/min)  | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Hole Depth ap (mm) | Step (mm) | Cutting speed (mm/min)  | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Hole Depth ap (mm) | Step (mm) | Cutting speed (mm/min)   | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Hole Depth ap (mm) | Step (mm) | Cutting speed (mm/min)                           | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Hole Depth ap (mm) | Step (mm) | Cutting speed (mm/min) | Revolution (min <sup>-1</sup> ) | Feed rate (mm/min) | Hole Depth ap (mm) | Step (mm) |  |  |  |
| 1             | 65  | 20000                           | 160                | 0.5                | 0.05      | 50  | 16000                           | 100                | 0.5                | 0.05      | 50   | 16000                           | 50                 | 0.5                | 0.05      | 30   | 9500                            | 30                 | 0.5                | 0.05      | 75                     | 24000                           | 190                | 0.5                | 0.05      |  |  |  |
| 1.5           | 85  | 18000                           | 270                | 0.75               | 0.15      | 60  | 13000                           | 120                | 0.75               | 0.1       | 60   | 13000                           | 80                 | 0.75               | 0.05      | 35   | 7400                            | 40                 | 0.75               | 0.05      | 100                    | 21000                           | 320                | 0.75               | 0.15      |  |  |  |
| 2             | 100   | 16000                           | 480                | 2                  | 0.25      | 70  | 11000                           | 200                | 2                  | 0.2       | 60   | 9500                            | 90                 | 1                  | 0.05      | 40   | 6400                            | 60                 | 1                  | 0.05      | 120                    | 19000                           | 570                | 2                  | 0.25      |  |  |  |
| 3             | 100   | 11000                           | 660                | 3                  | 0.3       | 70  | 7400                            | 270                | 3                  | 0.3       | 60   | 6400                            | 100                | 1.5                | 0.1       | 40   | 4200                            | 60                 | 1.5                | 0.1       | 120                    | 13000                           | 780                | 3                  | 0.3       |  |  |  |
| 4             | 100   | 8000                            | 800                | 4                  | 0.4       | 70  | 5600                            | 340                | 4                  | 0.4       | 60   | 4800                            | 100                | 2                  | 0.2       | 40   | 3200                            | 60                 | 2                  | 0.2       | 120                    | 9500                            | 950                | 4                  | 0.4       |  |  |  |
| 5             | 100   | 6400                            | 960                | 5                  | 0.5       | 70  | 4500                            | 410                | 5                  | 0.5       | 60   | 3800                            | 100                | 2.5                | 0.25      | 40   | 2500                            | 60                 | 2.5                | 0.25      | 120                    | 7600                            | 1100               | 5                  | 0.5       |  |  |  |
| 6             | 100   | 5300                            | 950                | 6                  | 0.6       | 70  | 3700                            | 440                | 6                  | 0.6       | 60   | 3200                            | 100                | 3                  | 0.3       | 40   | 2100                            | 60                 | 3                  | 0.3       | 120                    | 6400                            | 1200               | 6                  | 0.6       |  |  |  |
| 8             | 100   | 4000                            | 720                | 8                  | 0.7       | 70  | 2800                            | 340                | 8                  | 0.7       | 60   | 2400                            | 70                 | 4                  | 0.3       | 40   | 1600                            | 50                 | 4                  | 0.3       | 120                    | 4800                            | 860                | 8                  | 0.7       |  |  |  |
| 10            | 100   | 3200                            | 580                | 10                 | 0.75      | 70  | 2200                            | 260                | 10                 | 0.75      | 60   | 1900                            | 60                 | 5                  | 0.3       | 40   | 1300                            | 40                 | 5                  | 0.3       | 120                    | 3800                            | 680                | 10                 | 0.75      |  |  |  |
| 12            | 100   | 2700                            | 490                | 12                 | 0.75      | 70  | 1900                            | 230                | 12                 | 0.75      | 60   | 1600                            | 50                 | 6                  | 0.3       | 40   | 1100                            | 30                 | 6                  | 0.3       | 120                    | 3200                            | 580                | 12                 | 0.75      |  |  |  |
| 16            | 100   | 2000                            | 360                | 16                 | 0.75      | 70  | 1400                            | 170                | 16                 | 0.75      | 60   | 1200                            | 40                 | 8                  | 0.3       | 40   | 800                             | 20                 | 8                  | 0.3       | 120                    | 2400                            | 430                | 16                 | 0.75      |  |  |  |
| 20            | 100   | 1600                            | 290                | 20                 | 0.75      | 70  | 1100                            | 130                | 20                 | 0.75      | 60   | 950                             | 30                 | 10                 | 0.3       | 40   | 640                             | 20                 | 10                 | 0.3       | 120                    | 1900                            | 340                | 20                 | 0.75      |  |  |  |
| Depth of cut  |  |                                 |                    |                    |           |   |                                 |                    |                    |           |  |                                 |                    |                    |           |  |                                 |                    |                    |           |                        |                                 |                    |                    |           |  |  |  |

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