

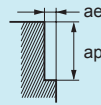
Shoulder milling

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.

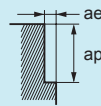
High efficiency cutting conditions

| Work material | 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 | | | | | | | | | |
| DC (mm) | Cutting speed (mm/min) | Revolution (min ⁻¹) | Feed rate (mm/min) | Hole Depth ap (mm) | Hole Depth ae (mm) | Cutting speed (mm/min) | Revolution (min ⁻¹) | Feed rate (mm/min) | Hole Depth ap (mm) | Hole Depth ae (mm) | Cutting speed (mm/min) | Revolution (min ⁻¹) | Feed rate (mm/min) | Hole Depth ap (mm) | Hole Depth ae (mm) | Cutting speed (mm/min) | Revolution (min ⁻¹) | Feed rate (mm/min) | Hole Depth ap (mm) | Hole Depth ae (mm) | Cutting speed (mm/min) | Revolution (min ⁻¹) | Feed rate (mm/min) | Hole Depth ap (mm) | Hole Depth ae (mm) |
| 3 | 150 | 16000 | 960 | 4.5 | 1.5 | 120 | 13000 | 640 | 4.5 | 1.5 | 100 | 11000 | 450 | 4.5 | 1.5 | 75 | 8000 | 330 | 4.5 | 0.9 | 180 | 19000 | 1100 | 4.5 | 1.5 |
| 4 | 150 | 12000 | 960 | 6 | 2 | 120 | 9500 | 640 | 6 | 2 | 100 | 8000 | 430 | 6 | 2 | 75 | 6000 | 330 | 6 | 1.2 | 180 | 14000 | 1100 | 6 | 2 |
| 5 | 150 | 9500 | 960 | 7.5 | 2.5 | 120 | 7600 | 640 | 7.5 | 2.5 | 100 | 6400 | 440 | 7.5 | 2.5 | 75 | 4800 | 330 | 7.5 | 1.5 | 180 | 11000 | 1100 | 7.5 | 2.5 |
| 6 | 150 | 8000 | 960 | 9 | 3 | 120 | 6400 | 680 | 9 | 3 | 100 | 5300 | 480 | 9 | 3 | 75 | 4000 | 360 | 9 | 1.8 | 180 | 9500 | 1100 | 9 | 3 |
| 7 | 150 | 6800 | 950 | 10.5 | 3.5 | 120 | 5500 | 700 | 10.5 | 3.5 | 100 | 4500 | 500 | 10.5 | 3.5 | 75 | 3400 | 380 | 10.5 | 2.1 | 180 | 8200 | 1100 | 10.5 | 3.5 |
| 8 | 150 | 6000 | 1100 | 12 | 4 | 120 | 4800 | 800 | 12 | 4 | 100 | 4000 | 570 | 12 | 4 | 75 | 3000 | 430 | 12 | 2.4 | 180 | 7200 | 1300 | 12 | 4 |
| 9 | 150 | 5300 | 1100 | 13.5 | 4.5 | 120 | 4200 | 760 | 13.5 | 4.5 | 100 | 3500 | 570 | 13.5 | 4.5 | 75 | 2700 | 430 | 13.5 | 2.7 | 180 | 6400 | 1300 | 13.5 | 4.5 |
| 10 | 150 | 4800 | 1100 | 15 | 5 | 120 | 3800 | 760 | 15 | 5 | 100 | 3200 | 570 | 15 | 5 | 75 | 2400 | 430 | 15 | 3 | 180 | 5700 | 1200 | 15 | 5 |
| 12 | 150 | 4000 | 960 | 18 | 6 | 120 | 3200 | 700 | 18 | 6 | 100 | 2700 | 540 | 18 | 6 | 75 | 2000 | 400 | 18 | 3.6 | 180 | 4800 | 1200 | 18 | 6 |
| 14 | 150 | 3400 | 880 | 21 | 7 | 120 | 2700 | 650 | 21 | 7 | 100 | 2300 | 510 | 21 | 7 | 75 | 1700 | 380 | 21 | 4.2 | 180 | 4100 | 1100 | 21 | 7 |
| 16 | 150 | 3000 | 840 | 24 | 8 | 120 | 2400 | 620 | 24 | 8 | 100 | 2000 | 500 | 24 | 8 | 75 | 1500 | 380 | 24 | 4.8 | 180 | 3600 | 1000 | 24 | 8 |
| 18 | 150 | 2700 | 810 | 27 | 9 | 120 | 2100 | 590 | 27 | 9 | 100 | 1800 | 500 | 27 | 9 | 75 | 1300 | 360 | 27 | 5.4 | 180 | 3200 | 960 | 27 | 9 |
| 20 | 150 | 2400 | 760 | 30 | 10 | 120 | 1900 | 560 | 30 | 10 | 100 | 1600 | 500 | 30 | 10 | 75 | 1200 | 360 | 30 | 6 | 180 | 2900 | 920 | 30 | 10 |



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 | | | | | | | | | |
| DC (mm) | Cutting speed (mm/min) | Revolution (min ⁻¹) | Feed rate (mm/min) | Hole Depth ap (mm) | Hole Depth ae (mm) | Cutting speed (mm/min) | Revolution (min ⁻¹) | Feed rate (mm/min) | Hole Depth ap (mm) | Hole Depth ae (mm) | Cutting speed (mm/min) | Revolution (min ⁻¹) | Feed rate (mm/min) | Hole Depth ap (mm) | Hole Depth ae (mm) | Cutting speed (mm/min) | Revolution (min ⁻¹) | Feed rate (mm/min) | Hole Depth ap (mm) | Hole Depth ae (mm) | Cutting speed (mm/min) | Revolution (min ⁻¹) | Feed rate (mm/min) | Hole Depth ap (mm) | Hole Depth ae (mm) |
| 3 | 120 | 13000 | 610 | 4.5 | 1.5 | 100 | 11000 | 430 | 4.5 | 1.5 | 80 | 8500 | 280 | 4.5 | 1.5 | 70 | 7400 | 240 | 4.5 | 0.9 | 140 | 15000 | 700 | 4.5 | 1.5 |
| 4 | 120 | 9500 | 610 | 6 | 2 | 100 | 8000 | 430 | 6 | 2 | 80 | 6400 | 280 | 6 | 2 | 70 | 5600 | 240 | 6 | 1.2 | 140 | 11000 | 700 | 6 | 2 |
| 5 | 120 | 7600 | 610 | 7.5 | 2.5 | 100 | 6400 | 430 | 7.5 | 2.5 | 80 | 5100 | 280 | 7.5 | 2.5 | 70 | 4500 | 250 | 7.5 | 1.5 | 140 | 8900 | 720 | 7.5 | 2.5 |
| 6 | 120 | 6400 | 610 | 9 | 3 | 100 | 5300 | 450 | 9 | 3 | 80 | 4200 | 300 | 9 | 3 | 70 | 3700 | 270 | 9 | 1.8 | 140 | 7400 | 720 | 9 | 3 |
| 7 | 120 | 5500 | 620 | 10.5 | 3.5 | 100 | 4500 | 480 | 10.5 | 3.5 | 80 | 3600 | 320 | 10.5 | 3.5 | 70 | 3200 | 290 | 10.5 | 2.1 | 140 | 6400 | 720 | 10.5 | 3.5 |
| 8 | 120 | 4800 | 720 | 12 | 4 | 100 | 4000 | 570 | 12 | 4 | 80 | 3200 | 380 | 12 | 4 | 70 | 2800 | 340 | 12 | 2.4 | 140 | 5600 | 840 | 12 | 4 |
| 9 | 120 | 4200 | 670 | 13.5 | 4.5 | 100 | 3500 | 510 | 13.5 | 4.5 | 80 | 2800 | 360 | 13.5 | 4.5 | 70 | 2500 | 320 | 13.5 | 2.7 | 140 | 5000 | 800 | 13.5 | 4.5 |
| 10 | 120 | 3800 | 670 | 15 | 5 | 100 | 3200 | 510 | 15 | 5 | 80 | 2500 | 360 | 15 | 5 | 70 | 2200 | 310 | 15 | 3 | 140 | 4500 | 790 | 15 | 5 |
| 12 | 120 | 3200 | 610 | 18 | 6 | 100 | 2700 | 470 | 18 | 6 | 80 | 2100 | 340 | 18 | 6 | 70 | 1900 | 300 | 18 | 3.6 | 140 | 3700 | 710 | 18 | 6 |
| 14 | 120 | 2700 | 560 | 21 | 7 | 100 | 2300 | 440 | 21 | 7 | 80 | 1800 | 320 | 21 | 7 | 70 | 1600 | 280 | 21 | 4.2 | 140 | 3200 | 670 | 21 | 7 |
| 16 | 120 | 2400 | 540 | 24 | 8 | 100 | 2000 | 410 | 24 | 8 | 80 | 1600 | 320 | 24 | 8 | 70 | 1400 | 280 | 24 | 4.8 | 140 | 2800 | 630 | 24 | 8 |
| 18 | 120 | 2100 | 500 | 27 | 9 | 100 | 1800 | 400 | 27 | 9 | 80 | 1400 | 310 | 27 | 9 | 70 | 1200 | 270 | 27 | 5.4 | 140 | 2500 | 600 | 27 | 9 |
| 20 | 120 | 1900 | 480 | 30 | 10 | 100 | 1600 | 380 | 30 | 10 | 80 | 1300 | 310 | 30 | 10 | 70 | 1100 | 270 | 30 | 6 | 140 | 2200 | 560 | 30 | 10 |



- 1) SMART MIRACLE coating has reduced electric conductivity; 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 | | | |
|---------------|---------------------------------------|---------------------------------|--------------------|----------------------|---|---------------------------------|--------------------|----------------------|--|---------------------------------|--------------------|----------------------|--|---------------------------------|--------------------|----------------------|-----------------------|---------------------------------|--------------------|----------------------|
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| DC (mm) | Cutting speed (m/min) | Revolution (min ⁻¹) | Feed rate (mm/min) | Depth of cut ap (mm) | Cutting speed (m/min) | Revolution (min ⁻¹) | Feed rate (mm/min) | Depth of cut ap (mm) | Cutting speed (m/min) | Revolution (min ⁻¹) | Feed rate (mm/min) | Depth of cut ap (mm) | Cutting speed (m/min) | Revolution (min ⁻¹) | Feed rate (mm/min) | Depth of cut ap (mm) | Cutting speed (m/min) | Revolution (min ⁻¹) | Feed rate (mm/min) | Depth of cut ap (mm) |
| 3 | 120 | 13000 | 720 | 3 | 100 | 11000 | 440 | 3 | 80 | 8500 | 340 | 3 | 60 | 6400 | 250 | 1.5 | 150 | 16000 | 890 | 3 |
| 4 | 120 | 9500 | 720 | 4 | 100 | 8000 | 450 | 4 | 80 | 6400 | 340 | 4 | 60 | 4800 | 250 | 2 | 150 | 12000 | 900 | 4 |
| 5 | 120 | 7600 | 720 | 5 | 100 | 6400 | 460 | 5 | 80 | 5100 | 300 | 5 | 60 | 3800 | 230 | 2.5 | 150 | 9500 | 900 | 5 |
| 6 | 120 | 6400 | 720 | 6 | 100 | 5300 | 460 | 6 | 80 | 4200 | 310 | 6 | 60 | 3200 | 240 | 3 | 150 | 8000 | 900 | 6 |
| 7 | 120 | 5500 | 730 | 7 | 100 | 4500 | 470 | 7 | 80 | 3600 | 330 | 7 | 60 | 2700 | 250 | 3.5 | 150 | 6800 | 950 | 7 |
| 8 | 120 | 4800 | 840 | 8 | 100 | 4000 | 560 | 8 | 80 | 3200 | 400 | 8 | 60 | 2400 | 300 | 4 | 150 | 6000 | 1100 | 8 |
| 9 | 120 | 4200 | 810 | 9 | 100 | 3500 | 540 | 9 | 80 | 2800 | 350 | 9 | 60 | 2100 | 260 | 4.5 | 150 | 5300 | 1000 | 9 |
| 10 | 120 | 3800 | 800 | 10 | 100 | 3200 | 520 | 10 | 80 | 2500 | 340 | 10 | 60 | 1900 | 260 | 5 | 150 | 4800 | 1000 | 10 |
| 12 | 120 | 3200 | 750 | 12 | 100 | 2700 | 480 | 12 | 80 | 2100 | 340 | 12 | 60 | 1600 | 260 | 6 | 150 | 4000 | 940 | 12 |
| 14 | 120 | 2700 | 670 | 14 | 100 | 2300 | 420 | 14 | 80 | 1800 | 300 | 14 | 60 | 1400 | 240 | 7 | 150 | 3400 | 840 | 14 |
| 16 | 120 | 2400 | 620 | 16 | 100 | 2000 | 380 | 16 | 80 | 1600 | 290 | 16 | 60 | 1200 | 220 | 8 | 150 | 3000 | 780 | 16 |
| 18 | 120 | 2100 | 570 | 18 | 100 | 1800 | 380 | 18 | 80 | 1400 | 260 | 18 | 60 | 1100 | 210 | 9 | 150 | 2700 | 730 | 18 |
| 20 | 120 | 1900 | 540 | 20 | 100 | 1600 | 350 | 20 | 80 | 1300 | 260 | 20 | 60 | 950 | 190 | 10 | 150 | 2400 | 680 | 20 |

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 | | | |
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| 3 | 100 | 11000 | 490 | 3 | 80 | 8500 | 300 | 3 | 60 | 6400 | 200 | 3 | 50 | 5300 | 170 | 1.5 | 120 | 13000 | 580 | 3 |
| 4 | 100 | 8000 | 490 | 4 | 80 | 6400 | 310 | 4 | 60 | 4800 | 200 | 4 | 50 | 4000 | 170 | 2 | 120 | 9500 | 580 | 4 |
| 5 | 100 | 6400 | 490 | 5 | 80 | 5100 | 310 | 5 | 60 | 3800 | 200 | 5 | 50 | 3200 | 170 | 2.5 | 120 | 7600 | 580 | 5 |
| 6 | 100 | 5300 | 490 | 6 | 80 | 4200 | 310 | 6 | 60 | 3200 | 200 | 6 | 50 | 2700 | 170 | 3 | 120 | 6400 | 580 | 6 |
| 7 | 100 | 4500 | 500 | 7 | 80 | 3600 | 320 | 7 | 60 | 2700 | 200 | 7 | 50 | 2300 | 170 | 3.5 | 120 | 5500 | 620 | 7 |
| 8 | 100 | 4000 | 600 | 8 | 80 | 3200 | 380 | 8 | 60 | 2400 | 240 | 8 | 50 | 2000 | 200 | 4 | 120 | 4800 | 720 | 8 |
| 9 | 100 | 3500 | 540 | 9 | 80 | 2800 | 330 | 9 | 60 | 2100 | 210 | 9 | 50 | 1800 | 180 | 4.5 | 120 | 4200 | 650 | 9 |
| 10 | 100 | 3200 | 540 | 10 | 80 | 2500 | 330 | 10 | 60 | 1900 | 210 | 10 | 50 | 1600 | 180 | 5 | 120 | 3800 | 640 | 10 |
| 12 | 100 | 2700 | 510 | 12 | 80 | 2100 | 320 | 12 | 60 | 1600 | 210 | 12 | 50 | 1300 | 170 | 6 | 120 | 3200 | 600 | 12 |
| 14 | 100 | 2300 | 460 | 14 | 80 | 1800 | 300 | 14 | 60 | 1400 | 190 | 14 | 50 | 1100 | 150 | 7 | 120 | 2700 | 540 | 14 |
| 16 | 100 | 2000 | 410 | 16 | 80 | 1600 | 290 | 16 | 60 | 1200 | 170 | 16 | 50 | 990 | 140 | 8 | 120 | 2400 | 500 | 16 |
| 18 | 100 | 1800 | 390 | 18 | 80 | 1400 | 260 | 18 | 60 | 1100 | 170 | 18 | 50 | 880 | 130 | 9 | 120 | 2100 | 460 | 18 |
| 20 | 100 | 1600 | 360 | 20 | 80 | 1300 | 260 | 20 | 60 | 950 | 150 | 20 | 50 | 800 | 130 | 10 | 120 | 1900 | 430 | 20 |

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