

# 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	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				
	S45C, SCM440, SS400, S10C					NAK, PX5, SNCM439, SKD, SKT					SUS304, SUS316, Ti-6Al-4V					SUS630, SUS631				
DC (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)	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

The diagram illustrates the geometry of a shoulder mill cut. It shows a cylindrical workpiece with a flat top surface. A cutting tool is shown in cross-section, cutting into the workpiece. The axial depth of cut is labeled 'ae' and the radial depth of cut is labeled 'ap'.

### 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				
	S45C, SCM440, SS400, S10C					NAK, PX5, SNCM439, SKD, SKT					SUS304, SUS316, Ti-6Al-4V					SUS630, SUS631				
DC (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)	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

The diagram illustrates the geometry of a shoulder mill cut. It shows a cylindrical workpiece with a flat top surface. A cutting tool is shown in cross-section, cutting into the workpiece. The axial depth of cut is labeled 'ae' and the radial depth of cut is labeled 'ap'.

- 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 feed rate can be increased.

## 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				
	Inconel718									
DC (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

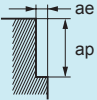
Depth of cut



### General purpose cutting conditions

Work material	Copper, Copper alloy					Heat resistant alloys				
	Inconel718									
DC (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 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				Heat resistant alloys			
	S45C, SCM440, SS400, S10C				NAK, PX5, SNCM439, SKD, SKT				SUS304, SUS316, Ti-6Al-4V				SUS630, SUS631								Inconel718			
DC (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

### 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			
DC (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

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

## 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									
DC (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									
DC (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

- 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.