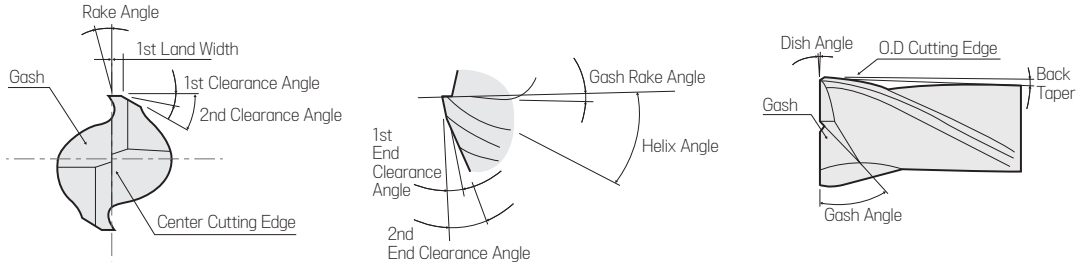


Technical Data



Technical Data

Nomenclature of Endmill



Application range of Grade

Workpiece	Grade
Carbon Steel, Alloy Steels, Tool Steel, Metal Mold Steel	· Micro Grain Carbide · P30
Cast Iron, Ductile	· Micro Grain Carbide · K10~K20
Heat Treatment Steel(HRc 40~60)	· Ultrafinest Carbide
Aluminium, Nonferrous Material	· Micro Grain Carbide- K10

Formula of End Milling

① Cutting Speed	$V = \frac{\pi \times D \times N}{1000} \text{ (m/min)}$	V : Cutting Speed D : Diameter of End Mill N : End Mill revolution	(m/min) (mm) (RPM)
② Feed per tooth	$fz = \frac{F}{Z \times N} \text{ (mm/tooth)}$	fz : Feed per tooth F : Table feed rate Z : No. of teeth N : End Mill revolution	(mm/tooth) (tooth) (RPM)
③ Table Feed rate	$F = fz \times Z \times N$	F : Feed rate fz : Feed per tooth Z : No. of teeth N : End Mill revolution	(mm/min) (mm/tooth) (tooth) (RPM)
④ Cutting Time	$Tc = \frac{L}{F}$	Tc : Cutting Time F : Table feed rate L : Length of cut (Workpiece Length+Diameter of Endmill+α)	(min) (mm/min) (mm)

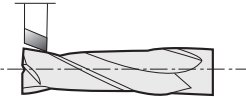
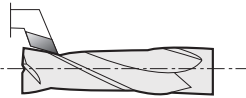
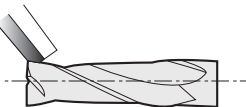


For Regrinding

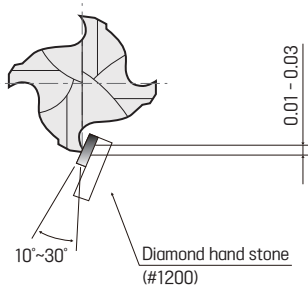
► Regrinding range

Application Range	Cutter Dia	Amount Of Flank Wear
Finish Machining	~ $\varnothing 10$	0.05 ~ 0.1
	$\varnothing 11 \sim \varnothing 30$	0.1 ~ 0.25
	$\varnothing 31 \sim \varnothing 50$	0.2 ~ 0.35
Rough Machining	~ $\varnothing 10$	0.08 ~ 0.15
	$\varnothing 11 \sim \varnothing 30$	0.15 ~ 0.35
	$\varnothing 31 \sim \varnothing 50$	0.3 ~ 0.45

► Regrinding Method of Relief

		① Concave method · In case when precise outer Diameter dimension is required. · In case of aluminium machining.
		② Flat method · Excellent machinability - Applicable to ball end mill and taper end mill. · Secondary clearance angle work is required. - When Diameter is large.
		③ Eccentric method · Excellent toughness and surface roughness. · Secondary clearance angle work is not required.

► Honing

 10°~30° Diamond hand stone (#1200) 0.01~0.03	1. Recommend honing for machining mold metal and high Hardness Workpiece. -The amount of honing shall be less than that of feed per blade. 2. When using end mill without honing, machine for 10 to 30 seconds at feed rate of less than 0.01 mm/blade and then machine at normal feed rate. 3. Honing is not required for machining aluminium and non-ferrous metal.
---	---

Technical Data

Trouble Shooting for End Milling

Problem	Cause	Solution
(1) Rupture	· High feed · High slotting volume · High protrusion volume · Worn out of flute · Longer cutting length	· Reduce feed · Reduce slotting volume · Reduce protrusion volume · Regrind at the beginning · Reduce cutting length
(2) Wear / Burning	· High speed · Small rake angle · High Hardness of material	· Reduce speed, Supply enough oil · Correct to proper rake angle · Supply Dry > soluble > Non-water soluble oil and do surface treatment"
(3) Chattering	· Improper cutting condition · Lack of Strength in machinery and chuck · Poorly fixed material · High protrusion volume · Large clearance of rake angle	· Adjust cutting and feed speed · Replace machinery and chuck · Contain a material firmly · Reduce protrusion volume · Reduce clearance of rake angle
(4) Defective of cutting edge	· Hige feed · Small rake angle · Chattering occurs · Poorly sealed material · High slotting volume · High protrusion volume · Lack of Strength in machinery	· Reduce feed · Adjust angle properly · Reduce Chattering by lowing the number of turning · Contain a material firmly · Reduce slotting volume · Reduce protrusion volume · Replace machinery
(5) Bad Cutability	· Worn out of cutting edge · Improper endmill · Small rake angle	· Regrind at the beginning · Replace proper endmill · Correct to proper rake angle
(6) Poor chip emission	· Low injection pressure of the oil · Small chip pocket · Worn out of cutting edge · High slotting volume	· Increase oil volume and pressure · Use fewer flute endmill or Reduce feed · Regrind at the beginning · Reduce slotting volume
(7) Burr on surface	· High feed · Low speed · Worn out of cutting edge · High slotting volume	· Reduce feed · Speed up · Regrind at the beginning · Reduce slotting volume
(8) Incorrect dimension	· Incorrect machinery or chuck · Incorrect rigidity of machinery or chuck · longer cutting length · Fewer number of flutes	· Correct machinery or chuck · Replace machinery or chuck · Reduce cutting length · Replace to larger number of flutes endmill
(9) Fusion	· Lack of oil or affination between tool and material	· Supply Dry > soluble > Non-water soluble oil · For Alloy Steels, use active type non-water soluble oil



ZE702, ZE712 SERIES ► Slotting

Workpiece	Hardened Steels Heat Resistant Steels		Hardened Steels									
Hardness	HRc30 ~ HRc40		HRc40 ~ HRc50		HRc50 ~ HRc55		HRc55 ~ HRc60		HRc60 ~ HRc65		HRc 65 ~ HRc70	
Diameter (mm)	RPM	FEED	RPM	FEED	RPM	FEED	RPM	FEED	RPM	FEED	RPM	FEED
0.2	50,000	130	45,000	115	40,000	95	33,000	60	33,000	45	26,400	30
0.3	50,000	190	45,000	140	40,000	115	33,000	70	25,000	50	20,000	35
0.4	50,000	235	45,000	180	40,000	140	33,000	90	25,000	55	20,000	40
0.5	50,000	370	45,000	280	40,000	220	33,000	140	25,000	85	20,000	60
0.6	50,000	470	45,000	360	40,000	285	30,000	160	25,000	105	20,000	75
0.8	50,000	600	40,000	440	30,000	295	25,000	185	19,000	110	15,200	80
0.9	49,000	655	39,000	520	27,800	330	22,700	205	17,500	125	14,000	90
1	48,000	750	38,000	570	25,500	360	20,500	215	16,000	135	12,500	85
2	33,300	850	26,000	680	17,500	420	14,500	260	11,000	160	9,500	115
3	21,800	850	17,300	680	11,500	420	9,500	260	7,500	160	6,400	115
4	16,700	880	13,200	700	8,800	440	7,200	270	5,600	170	4,750	118
5	15,700	1,000	12,500	805	8,300	500	6,400	285	5,100	180	4,450	132
6	13,100	950	10,350	770	6,900	480	5,300	280	4,200	180	3,700	130
8	9,880	930	7,800	720	5,200	445	4,000	255	3,200	165	2,800	120
10	7,800	850	6,150	680	4,100	415	3,200	240	2,550	155	2,200	112
12	6,650	850	5,250	680	3,500	415	2,650	240	2,100	155	1,860	112
16	4,900	730	3,900	580	2,600	365	2,000	210	1,600	135	1,400	95
20	3,900	660	3,100	525	2,050	335	1,600	195	1,300	125	1,100	85

RPM = rev / min
FEED = mm / min

ap : 0.05D

ap : 0.02D

ZE702, ZE712 SERIES ► Side Cutting

Workpiece	Hardened Steels Heat Resistant Steels		Hardened Steels									
Hardness	HRc30 ~ HRc40		HRc40 ~ HRc50		HRc50 ~ HRc55		HRc55 ~ HRc60		HRc60 ~ HRc65		HRc 65 ~ HRc70	
Diameter (mm)	RPM	FEED	RPM	FEED	RPM	FEED	RPM	FEED	RPM	FEED	RPM	FEED
1	48,000	1,050	38,000	820	25,500	510	20,500	310	16,000	190	12,500	125
2	33,300	1,200	26,000	970	17,500	600	14,500	370	11,000	230	9,500	165
3	21,800	1,200	17,300	970	11,500	600	9,500	370	7,500	230	6,400	165
4	16,700	1,250	13,200	1,000	8,800	625	7,200	385	5,600	240	4,750	170
5	15,700	1,450	12,500	1,150	8,300	710	6,400	410	5,100	260	4,450	190
6	13,100	1,350	10,350	1,100	6,900	690	5,300	400	4,200	255	3,700	185
8	9,880	1,320	7,800	1,030	5,200	635	4,000	365	3,200	235	2,800	170
10	7,800	1,200	6,150	970	4,100	590	3,200	340	2,550	220	2,200	160
12	6,650	1,200	5,250	970	3,500	590	2,650	340	2,100	220	1,860	160
16	4,900	1,050	3,900	840	2,600	520	2,000	300	1,600	190	1,400	140
20	3,900	950	3,100	750	2,050	475	1,600	275	1,300	175	1,100	125

RPM = rev / min
FEED = mm / min

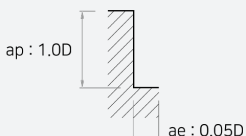
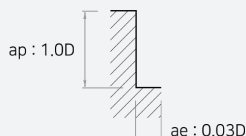
ap : 1.0D
ae : 0.03D

Technical Data

ZE704, ZE714, ZE724 SERIES ► Side Cutting

Workpiece	Hardened Steels Heat Resistant Steels		Hardened Steels									
Hardness	HRC30 ~ HRC40		HRC40 ~ HRC50		HRC50 ~ HRC55		HRC55 ~ HRC60		HRC60 ~ HRC65		HRC 65 ~ HRC70	
Diameter (mm)	RPM	FEED	RPM	FEED	RPM	FEED	RPM	FEED	RPM	FEED	RPM	FEED
1	48,000	1,480	38,000	1,050	25,500	710	20,500	430	16,000	270	12,500	175
2	33,300	1,750	26,000	1,250	17,500	840	14,500	520	11,000	320	9,500	230
3	21,800	1,750	17,300	1,250	11,500	840	9,500	520	7,500	320	6,400	230
4	16,700	1,800	13,200	1,300	8,800	880	7,200	540	5,600	335	4,750	240
5	15,700	2,000	12,500	1,500	8,300	1,000	6,400	580	5,100	370	4,450	270
6	13,100	1,950	10,350	1,400	6,900	950	5,300	560	4,200	350	3,700	260
8	9,880	1,880	7,800	1,350	5,200	900	4,000	520	3,200	330	2,800	240
10	7,800	1,750	6,150	1,260	4,100	840	3,200	480	2,550	310	2,200	220
12	6,650	1,750	5,250	1,260	3,500	840	2,650	480	2,100	300	1,860	220
16	4,900	1,500	3,900	1,100	2,600	730	2,000	420	1,600	270	1,400	200
20	3,900	1,300	3,100	970	2,050	650	1,600	380	1,300	250	1,100	180

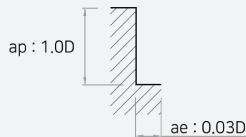
RPM = rev / min
FEED = mm / min

ZE716, ZR706, ZR736 SERIES

Workpiece	Hardened Steels Heat Resistant Steels		Hardened Steels									
Hardness	HRC30 ~ HRC40		HRC40 ~ HRC50		HRC50 ~ HRC55		HRC55 ~ HRC60		HRC60 ~ HRC65		HRC 65 ~ HRC70	
Diameter (mm)	RPM	FEED	RPM	FEED	RPM	FEED	RPM	FEED	RPM	FEED	RPM	FEED
6	24,800	5,350	23,500	4,900	16,000	4,900	13,500	3,300	10,500	2,100	8,000	1,450
8	20,000	5,500	19,000	5,000	12,000	4,600	10,000	3,100	8,000	2,000	6,000	1,400
10	16,000	4,900	15,500	4,500	9,500	4,100	8,000	2,900	6,400	1,800	4,800	1,300
12	13,000	4,500	12,500	4,100	8,000	3,800	6,600	2,500	5,300	1,600	4,000	1,150
16	10,000	4,000	9,700	3,700	6,000	3,400	5,000	2,300	4,000	1,250	3,000	870
20	8,000	3,350	7,800	3,400	4,800	3,200	4,000	2,100	3,200	1,020	2,400	690

RPM = rev / min
FEED = mm / min

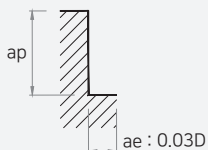





ZSLNS20, ZSLNS40 SERIES

Workpiece	Alloy Steels, Heat Resistant Steels			Hardened Steels			Hardened Steels			Copper, Copper alloy		
Hardness	HRc30 ~ HRc45			HRc45 ~ HRc55			HRc55 ~ HRc65			-		
Diameter (mm)	RPM	FEED	Ae (mm)	RPM	FEED	Ae(mm)	RPM	FEED	Ae (mm)	RPM	FEED	Ae (mm)
0.4	34,100 ~ 50,000	350 ~ 590	0.005 ~ 0.028	30,500 ~ 35,200	295 ~ 340	0.003 ~ 0.020	18,300 ~ 24,600	120 ~ 200	0.002 ~ 0.012	48,000 ~ 50,000	790 ~ 920	0.008 ~ 0.048
0.5	25,650 ~ 33,000	370 ~ 470	0.006 ~ 0.035	23,750 ~ 26,000	285 ~ 315	0.004 ~ 0.025	14,200 ~ 18,000	115 ~ 130	0.003 ~ 0.015	44,000 ~ 50,000	800 ~ 1,150	0.010 ~ 0.060
0.6	20,900 ~ 35,200	330 ~ 560	0.007 ~ 0.030	19,900 ~ 22,000	260 ~ 290	0.005 ~ 0.021	11,900 ~ 15,500	100 ~ 120	0.003 ~ 0.013	37,500 ~ 50,000	770 ~ 1,250	0.011 ~ 0.051
0.8	16,150 ~ 26,400	360 ~ 590	0.009 ~ 0.040	15,200 ~ 16,700	280 ~ 310	0.006 ~ 0.028	9,000 ~ 11,700	110 ~ 125	0.004 ~ 0.017	28,500 ~ 47,000	770 ~ 1,300	0.015 ~ 0.068
1.0	12,300 ~ 18,700	350 ~ 540	0.011 ~ 0.028	10,500 ~ 11,500	250 ~ 280	0.008 ~ 0.020	6,300 ~ 8,050	100 ~ 115	0.005 ~ 0.012	22,500 ~ 34,000	810 ~ 1,300	0.018 ~ 0.048
1.2	10,450 ~ 17,600	350 ~ 590	0.025 ~ 0.070	9,100 ~ 10,000	250 ~ 280	0.015 ~ 0.042	5,400 ~ 7,000	100 ~ 115	0.009 ~ 0.026	22,500 ~ 31,500	950 ~ 1,350	0.036 ~ 0.101
1.5	9,100 ~ 17,600	430 ~ 830	0.017 ~ 0.077	7,000 ~ 8,000	250 ~ 280	0.012 ~ 0.055	4,300 ~ 5,500	100 ~ 115	0.007 ~ 0.033	14,500 ~ 25,000	770 ~ 1,320	0.028 ~ 0.132
2.0	6,350 ~ 10,550	340 ~ 570	0.021 ~ 0.140	6,100 ~ 6,700	270 ~ 300	0.015 ~ 0.100	3,600 ~ 4,700	100 ~ 120	0.009 ~ 0.060	11,500 ~ 18,500	770 ~ 1,250	0.036 ~ 0.240
3.0	4,300 ~ 7,050	550 ~ 900	0.056 ~ 0.210	3,990 ~ 4,600	445 ~ 515	0.040 ~ 0.150	2,400 ~ 3,200	105 ~ 310	0.024 ~ 0.090	9,000 ~ 13,000	1,400 ~ 2,110	0.096 ~ 0.360
4.0	3,200 ~ 5,300	400 ~ 675	0.074 ~ 0.280	3,000 ~ 3,400	335 ~ 380	0.053 ~ 0.200	1,800 ~ 2,400	75 ~ 230	0.032 ~ 0.120	6,750 ~ 9,750	1,050 ~ 1,575	0.128 ~ 0.480

RPM = rev / min
FEED = mm / min

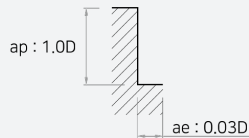


Technical Data

ZR702, ZR732 SERIES ► Side Cutting

Workpiece	Hardened Steels Heat Resistant Steels		Hardened Steels									
Hardness	HRc30 ~ HRc40		HRc40 ~ HRc50		HRc50 ~ HRc55		HRc55 ~ HRc60		HRc60 ~ HRc65		HRc 65 ~ HRc70	
Diameter (mm)	RPM	FEED	RPM	FEED	RPM	FEED	RPM	FEED	RPM	FEED	RPM	FEED
2	33,300	960	26,000	776	17,500	480	14,500	296	11,000	184	9,500	132
3	21,800	960	17,300	776	11,500	480	9,500	296	7,500	184	6,400	132
4	16,700	1,000	13,200	800	8,800	500	7,200	308	5,600	192	4,750	136
5	15,700	1,160	12,500	920	8,300	568	6,400	328	5,100	208	4,450	152
6	13,100	1,080	10,350	880	6,900	552	5,300	320	4,200	204	3,700	148
8	9,880	1,056	7,800	824	5,200	508	4,000	292	3,200	188	2,800	136
10	7,800	960	6,150	776	4,100	472	3,200	272	2,550	176	2,200	128
12	6,650	960	5,250	776	3,500	472	2,650	272	2,100	176	1,860	128
16	4,900	840	3,900	672	2,600	416	2,000	240	1,600	152	1,400	112
20	3,900	760	3,100	600	2,050	380	1,600	220	1,300	140	1,100	100

RPM = rev / min
FEED = mm / min



ZR702, ZR732 SERIES ► Slotting

Workpiece	Hardened Steels Heat Resistant Steels		Hardened Steels									
Hardness	HRc30 ~ HRc40		HRc40 ~ HRc50		HRc50 ~ HRc55		HRc55 ~ HRc60		HRc60 ~ HRc65		HRc 65 ~ HRc70	
Diameter (mm)	RPM	FEED	RPM	FEED	RPM	FEED	RPM	FEED	RPM	FEED	RPM	FEED
2	33,300	680	26,000	544	17,500	336	14,500	208	11,000	128	9,500	92
3	21,800	680	17,300	544	11,500	336	9,500	208	7,500	128	6,400	92
4	16,700	704	13,200	560	8,800	352	7,200	216	5,600	136	4,750	94
5	15,700	800	12,500	644	8,300	400	6,400	228	5,100	144	4,450	106
6	13,100	760	10,350	616	6,900	384	5,300	224	4,200	144	3,700	104
8	9,880	744	7,800	576	5,200	356	4,000	204	3,200	132	2,800	96
10	7,800	680	6,150	544	4,100	332	3,200	192	2,550	124	2,200	90
12	6,650	680	5,250	544	3,500	332	2,650	192	2,100	124	1,860	90
16	4,900	584	3,900	464	2,600	292	2,000	168	1,600	108	1,400	78
20	3,900	528	3,100	420	2,050	268	1,600	168	1,300	100	1,100	70

RPM = rev / min
FEED = mm / min





■ ZR704, ZR714, ZR724, ZR734 SERIES ► Side Cutting

Workpiece	Hardened Steels Heat Resistant Steels		Hardened Steels									
Hardness	HRc30 ~ HRc40		HRc40 ~ HRc50		HRc50 ~ HRc55		HRc55 ~ HRc60		HRc60 ~ HRc65		HRc 65 ~ HRc70	
Diameter (mm)	RPM	FEED	RPM	FEED	RPM	FEED	RPM	FEED	RPM	FEED	RPM	FEED
1	48,000	1,480	38,000	1,050	25,500	710	20,500	430	16,000	270	12,500	175
2	33,300	1,750	26,000	1,250	17,500	840	14,500	520	11,000	320	9,500	230
3	21,800	1,750	17,300	1,250	11,500	840	9,500	520	7,500	320	6,400	230
4	16,700	1,800	13,200	1,300	8,800	880	7,200	540	5,600	335	4,750	240
5	15,700	2,000	12,500	1,500	8,300	1,000	6,400	580	5,100	370	4,450	270
6	13,100	1,950	10,350	1,400	6,900	950	5,300	560	4,200	350	3,700	260
8	9,880	1,880	7,800	1,350	5,200	900	4,000	520	3,200	330	2,800	240
10	7,800	1,750	6,150	1,260	4,100	840	3,200	480	2,550	310	2,200	220
12	6,650	1,750	5,250	1,260	3,500	840	2,650	480	2,100	300	1,860	220
16	4,900	1,500	3,900	1,100	2,600	730	2,000	420	1,600	270	1,400	200
20	3,900	1,300	3,100	970	2,050	650	1,600	380	1,300	250	1,100	180

RPM = rev / min
 FEED = mm / min

■ ZS124, ZS1(2)04, ZS204 SERIES ► Side Cutting

Workpiece	Hardened Steels Heat Resistant Steels		Hardened Steels							
Hardness	HRc30 ~ HRc40		HRc40 ~ HRc50		HRc50 ~ HRc55		HRc55 ~ HRc60		HRc 65 ~ HRc70	
Diameter (mm)	RPM	FEED	RPM	FEED	RPM	FEED	RPM	FEED	RPM	FEED
4	17,200	1,690	11,440	1,140	9,360	700	7,280	430	6,170	310
6	13,450	1,820	8,970	1,230	6,890	720	5,460	450	4,810	330
8	9,100	1,750	6,760	1,170	5,200	670	4,160	420	3,640	310
10	8,000	1,630	5,330	1,090	4,160	620	3,320	400	2,860	280
12	6,830	1,630	4,550	1,010	3,450	580	2,730	370	2,420	260

RPM = rev / min
 FEED = mm / min