KYOCERA
SGS Precision Tools

SGS
Solid Carbide Tools

SERIES 33 Three Flute End Mills

SERIES 33
THREE FLUTE END MILLS

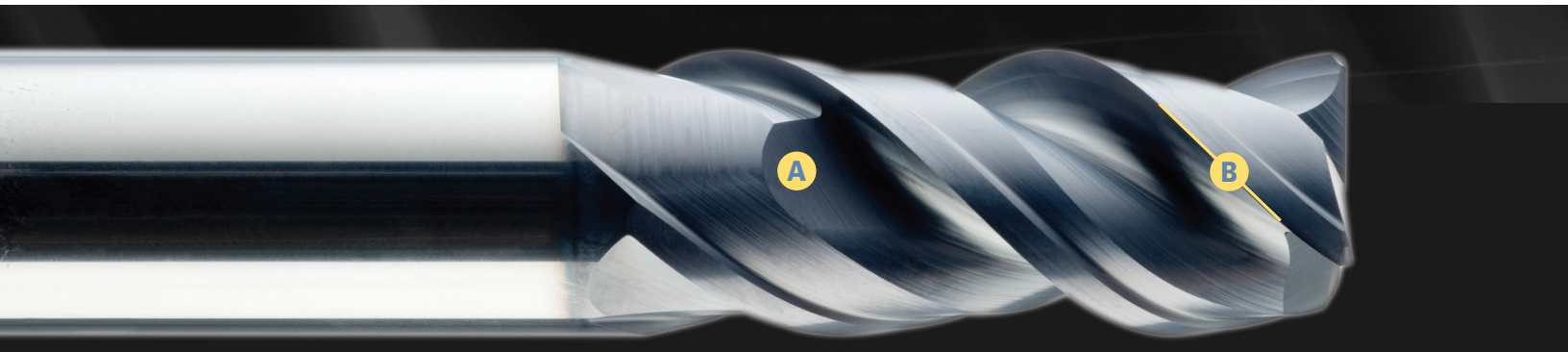
www.kyocera-sgstool.com

ISO 9001 Certified

SERIES 33
THREE FLUTE END MILLS

Using the latest in engineering design and grinding capabilities, Series 33 High Performance End Mills are ideal for aggressive ramping, pocketing, and slotting in difficult to machine materials such as Stainless Steel, Titanium, and Inconel. Designed for applications challenged by heavy chip evacuation, this 3-Flute design offers increased chip clearance and a reduction in harmonics.

- Proprietary 3-Flute design allows for more controlled chip formation and efficient chip evacuation.
- Specially engineered stepped core design provides stability for aggressive ramping and rigidity when flutes are completely engaged.
- Open design at the axial end accommodates material flow and load reduction during operations.
- Variable geometry design provides superior chatter and vibration suppression during aggressive milling.
- Available with KSPT Patented Jet Stream Technology for precise coolant placement.
- Exclusively coated with Ti-NAMITE-A, which helps to prevent edge build-up while ensuring superior wear and enhanced tool life.



A

Stepped Core Design
Increased chip space at the axial end of the tool for aggressive slotting, improved rigidity, and optimized chip formation.

B

Proprietary Variable Geometry
Engineered variable helix and pitch configuration offer chatter and vibration suppression.

THE SERIES 33 IS IDEAL FOR AGGRESSIVE RAMPING, POCKETING AND SLOTTING IN DIFFICULT TO MACHINE MATERIALS:

- Aerospace Structural Components
- Medical Implants
- Automotive Performance Components
- Stainless Steel Valves

Ti-NAMITE-A

Series 33 is exclusively available with the abrasive resistant AlTiN hard coating, Ti-NAMITE-A. With excellent thermal and chemical resistance, Ti-NAMITE-A allows for dry cutting and improved performance of carbide. The coating has a high hardness ensuring the ultimate protection against abrasive wear and erosion. Ideal for cast iron, high temperature alloys, titanium, steels, and stainless steel applications.

Hardness (HV): 3700

Oxidation Temperature: 1100°C / 2010°F

Coefficient of Friction: 0.30

Thickness: 1 – 4 Microns
(based on tool diameter)

C

Symmetrical End Gashing
Superior balance combined with a high level of strength and ramping capabilities.

CASE STUDY

KYOCERA SGS Precision Tools

SAVES AN END USER $263,100 ANNUALLY BY INCREASING METAL REMOVAL RATE & OPTIMIZING CYCLE TIME

SERIES 33
THREE FLUTE END MILLS

INDUSTRY
Lift Equipment

COMPONENT
Hook Plate

MATERIAL
ASTM A514 HTSTL PLT 100 KSI

PRODUCT
KSPT Series 33 End Mill
AlTiN Coated

APPLICATION
Peripheral Machining

CNC INFO
Haas VF7

SPINDLE
CAT 50 Milling Chuck

COMPETITOR
3 Flute End Mill

COOLANT
Water Soluble

TOOL INFORMATION
1" DIA / 2 ¼" LOC / 5" OAL

BACKGROUND

The hook plate is a primary support piece of a fork lift assembly and requires precise machining tolerances. The application calls for machining .230" from the peripheral of the part at an axial depth of 1-1/2": the A514 material used in this application is similar to 4140. The competitor tool was performing this in four rough passes followed by a single finish pass. KYOCERA SGS Precision Tools (KSPT) proposed a single roughing and finishing pass utilizing a 1" Series 33 End Mill.

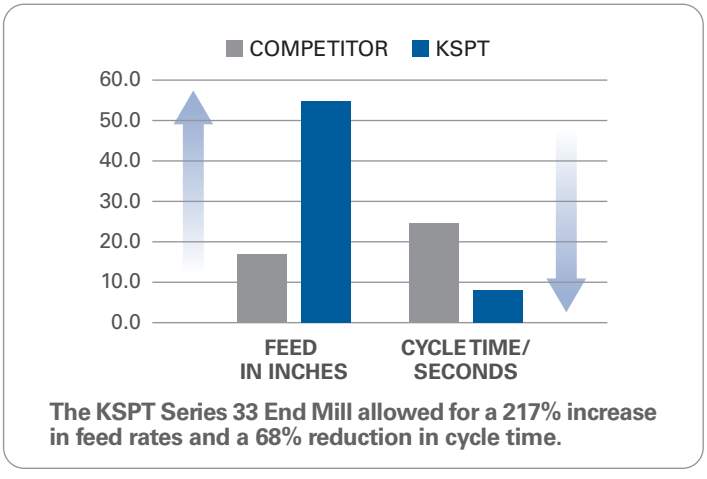
GOALS

The primary goals of this test were to reduce cycle time, increase tool life, and decrease overall tooling cost.

STRATEGY

Working with the end user to understand their needs, KSPT approached the application with a 1" three flute Series 33 End Mill, allowing for increased tool life and greater feed rates to improve cycle times.

	KSPT	COMPETITOR
TOOL DIAMETER	1.0	1.0
SPEED	2500 SFM	1578 SFM
FEED	54 IPM	17 IPM
RADIAL CUT (AE)	.030"	.030"
AXIAL CUT (AP)	1.5"	1.5"
CYCLE TIME	7.69 seconds	24.37 seconds
METAL REMOVAL RATES	2.46 cubic inches	.78 cubic inches



The KSPT Series 33 End Mill allowed for a 217% increase in feed rates and a 68% reduction in cycle time.

Increased Feed Rates
Increased Material Removal
Increased Tool Life

RESULTS

The changes made to the application combined with the high performance geometry of the KSPT Series 33 End Mill resulted in an annual gain of 104.25 production hours. In addition to meeting the goal for improved cycle times, tool life was increased from 20 to 240 parts per tool. This reduced the tooling cost per part by 91%, allowing the end user to achieve a total annual cost savings of $263,100.

CYCLE TIME SAVED PER PART 16.68 Seconds	**MACHINE COST SAVED ANNUALLY** $10,425
NUMBER OF PARTS PER YEAR 22,500	**TOOL LIFE IMPROVEMENT** 220 Additional Parts
CYCLE TIME SAVED ANNUALLY 104.25 Hours	**TOOLING COST SAVED PER PART** $11.23
COST TO MACHINE PER HOUR $100	**TOOLING COST SAVED ANNUALLY** $252,675

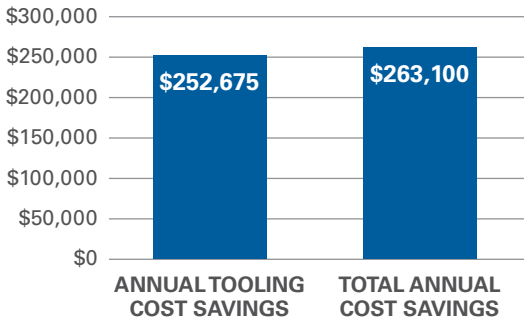
CONCLUSION

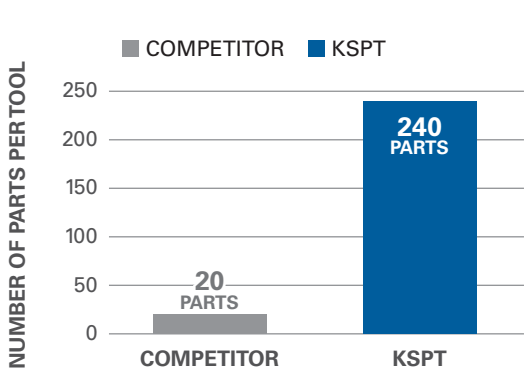
KSPT was able to achieve the primary goals of cycle time reduction and decreased tooling cost by recommending a high performance tool for the application. This allowed for increased feed and speed rates, resulted in greater metal removal rates and drastically improved tool life.

$263,100
ANNUAL COST SAVINGS

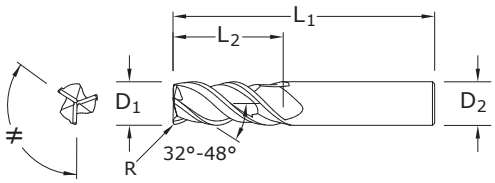
13 DAYS
ADDITIONAL PRODUCTIVITY

91%
REDUCTION IN TOOLING COST





The KSPT Series 33 End Mill allowed for a 1100% increase!



TOLERANCES (inch)

DIAMETER	D_1	D_2
1/8 - 1/4	+0.0000 / –0.0012	h6
> 1/4 - 3/8	+0.0000 / –0.0016	h6
> 3/8 - 1	+0.0000 / –0.0020	h6

CORNER RADIUS TOLERANCES (inch)

R = +0.0000 / –0.0020

Cutting Diameter D_1	Length of Cut L_2	Overall Length L_1	Shank Diameter D_2	Corner Radius R	Ti-NAMITE-A (AlTiN) EDP No.
1/8	3/8	2-1/2	1/4	.015	33345
3/16	9/16	2-1/2	1/4	.015	33346
1/4	3/4	2-1/2	1/4	.020	33347
5/16	13/16	2-1/2	5/16	.020	33348
3/8	1	2-1/2	3/8	.020	33349
7/16	1-1/8	2-3/4	7/16	.020	33350
1/2	1-1/4	3-1/4	1/2	.030	33351
5/8	1-1/2	3-1/2	5/8	.040	33352
3/4	1-3/4	4	3/4	.040	33353
1	2-1/4	5	1	.040	33354

Corner

Straight

HAIMER Safe-Lock

Regular

Variable Right Spiral

Positive Rake Angle

External Coolant

JetStream

Flute Spacing Unequal

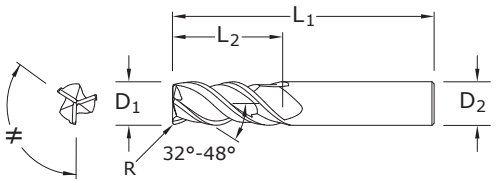
3
Flutes

TOLERANCES (mm)

DIAMETER	D_1	D_2
3 - 6	+0,000 / –0,030	h6
> 6 - 10	+0,000 / –0,040	h6
> 10 - 20	+0,000 / –0,050	h6

CORNER RADIUS TOLERANCES (mm)

R= +0,000 / –0,050



Corner

Straight

HAIMER Safe-Lock

Regular

Variable Right Spiral

Positive Rake Angle

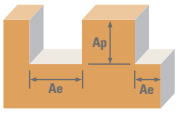
External Coolant

JetStream

Flute Spacing Unequal

3 Flutes

Cutting Diameter D_1	Length of Cut L_2	Overall Length L_1	Shank Diameter D_2	Corner Radius R	Ti-NAMITE-A (AlTiN) EDP No.
3,0	9,0	57,0	6,0	0,3	43445
3,0	9,0	57,0	6,0	0,5	43470
4,0	12,0	57,0	6,0	0,3	43446
4,0	12,0	57,0	6,0	0,5	43471
5,0	15,0	57,0	6,0	0,3	43447
5,0	15,0	57,0	6,0	0,5	43472
6,0	18,0	57,0	6,0	0,5	43448
6,0	18,0	57,0	6,0	1,0	43473
6,0	18,0	57,0	6,0	1,5	43474
6,0	18,0	57,0	6,0	2,0	43475
8,0	20,0	63,0	8,0	0,5	43449
8,0	20,0	63,0	8,0	1,0	43476
8,0	20,0	63,0	8,0	1,5	43477
8,0	20,0	63,0	8,0	2,0	43478
10,0	27,0	72,0	10,0	0,5	43450
10,0	27,0	72,0	10,0	1,0	43479
10,0	27,0	72,0	10,0	1,5	43480
10,0	27,0	72,0	10,0	2,0	43481
10,0	27,0	72,0	10,0	2,5	43482
12,0	30,0	83,0	12,0	0,5	43451
12,0	30,0	83,0	12,0	1,0	43483
12,0	30,0	83,0	12,0	1,5	43484
12,0	30,0	83,0	12,0	2,0	43485
12,0	30,0	83,0	12,0	2,5	43486
12,0	30,0	83,0	12,0	3,0	43487
12,0	30,0	83,0	12,0	4,0	43488
16,0	38,0	92,0	16,0	1,0	43452
16,0	38,0	92,0	16,0	1,5	43489
16,0	38,0	92,0	16,0	2,0	43490
16,0	38,0	92,0	16,0	2,5	43491
16,0	38,0	92,0	16,0	3,0	43492
16,0	38,0	92,0	16,0	4,0	43493
20,0	46,0	104,0	20,0	1,0	43453
20,0	46,0	104,0	20,0	2,0	43494
20,0	46,0	104,0	20,0	2,5	43495
20,0	46,0	104,0	20,0	3,0	43496
20,0	46,0	104,0	20,0	4,0	43497



	Series 33CR Fractional	Hardness		Ae x D_1	Ap x D_1	Vc (sfm)		Diameter (D_1) (inch) 1/8	1/4	3/8	1/2	5/8	3/4	1
P	**CARBON STEELS 1018, 1040, 1080, 1090, 10L50, 1140, 1212, 12L15, 1525, 1536**	≤ 275 Bhn or ≤ 28 HRc	Profile	≤ 0.5	≤ 1.5	550	RPM	16808	8404	5603	4202	3362	2801	2101
						(440-660)	Fz	0.0005	0.0012	0.0023	0.0031	0.0039	0.0040	0.0043
							Feed (ipm)	25.2	30.3	38.7	39.1	39.3	33.6	27.1
			Slot	1	≤ 1	440	RPM	13446	6723	4482	3362	2689	2241	1681
						(352-528)	Fz	0.0005	0.0012	0.0023	0.0031	0.0039	0.0040	0.0043
							Feed (ipm)	20.2	24.2	30.9	31.3	31.5	26.9	21.7
	ALLOY STEELS 4140, 4150, 4320, 5120, 5150, 8630, 86L20, 50100	≤ 375 Bhn or ≤ 40 HRc	Profile	≤ 0.5	≤ 1.5	315	RPM	9626	4813	3209	2407	1925	1604	1203
						(252-378)	Fz	0.0004	0.0009	0.0017	0.0023	0.0029	0.0030	0.0032
							Feed (ipm)	11.6	13.0	16.4	16.6	16.7	14.4	11.6
			Slot	1	≤ 1	250	RPM	7640	3820	2547	1910	1528	1273	955
						(200-300)	Fz	0.0004	0.0009	0.0017	0.0023	0.0029	0.0030	0.0032
							Feed (ipm)	9.2	10.3	13.0	13.2	13.3	11.5	9.2
H	**TOOL STEELS A2, D2, H13, L2, M2, P20, S7, T15, W2**	≤ 375 Bhn or ≤ 40 HRc	Profile	≤ 0.5	≤ 1.5	185	RPM	5654	2827	1885	1413	1131	942	707
						(148-222)	Fz	0.0003	0.0007	0.0014	0.0018	0.0023	0.0024	0.0025
							Feed (ipm)	5.1	5.9	7.9	7.6	7.8	6.8	5.3
			Slot	1	≤ 1	145	RPM	4431	2216	1477	1108	886	739	554
						(116-174)	Fz	0.0003	0.0007	0.0014	0.0018	0.0023	0.0024	0.0025
							Feed (ipm)	4.0	4.7	6.2	6.0	6.1	5.3	4.2
K	**CAST IRONS (LOW & MEDIUM ALLOY) Gray, Malleable, Ductile**	≤ 220 Bhn or ≤ 19 HRc	Profile	≤ 0.5	≤ 1.5	445	RPM	13599	6800	4533	3400	2720	2267	1700
						(356-534)	Fz	0.0004	0.0011	0.0021	0.0028	0.0035	0.0036	0.0039
							Feed (ipm)	14.3	22.4	28.6	28.6	28.6	24.5	19.9
			Slot	1	≤ 1	355	RPM	10849	5424	3616	2712	2170	1808	1356
						(284-426)	Fz	0.0004	0.0011	0.0021	0.0028	0.0035	0.0036	0.0039
							Feed (ipm)	11.4	17.9	22.8	22.8	22.8	19.5	15.9
	CAST IRONS (HIGH ALLOY) Gray, Malleable, Ductile	≤ 260 Bhn or ≤ 26 HRc	Profile	≤ 0.5	≤ 1.5	340	RPM	10390	5195	3463	2598	2078	1732	1299
						(272-408)	Fz	0.0003	0.0008	0.0016	0.0021	0.0026	0.0027	0.0029
							Feed (ipm)	9.4	12.5	16.6	16.4	16.2	14.0	11.3
			Slot	1	≤ 1	270	RPM	8251	4126	2750	2063	1650	1375	1031
						(216-324)	Fz	0.0003	0.0008	0.0016	0.0021	0.0026	0.0027	0.0029
							Feed (ipm)	7.4	9.9	13.2	13.0	12.9	11.1	9.0
M	**STAINLESS STEELS (FREE MACHINING) 303, 416, 420F, 430F, 440F**	≤ 275 Bhn or ≤ 28 HRc	Profile	≤ 0.5	≤ 1.5	490	RPM	14974	7487	4991	3744	2995	2496	1872
						(392-588)	Fz	0.0004	0.0010	0.0019	0.0025	0.0031	0.0032	0.0035
							Feed (ipm)	17.1	22.5	28.5	28.1	27.9	24.0	19.7
			Slot	1	≤ 1	390	RPM	11918	5959	3973	2980	2384	1986	1490
						(312-468)	Fz	0.0004	0.0010	0.0019	0.0025	0.0031	0.0032	0.0035
							Feed (ipm)	13.6	17.9	22.6	22.3	22.2	19.1	15.6

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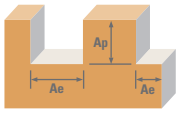
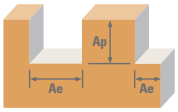


	Series 33CR Fractional	Hardness		Ae x D_1	Ap x D_1	Vc (sfm)		Diameter (D_1) (inch) 1/8	1/4	3/8	1/2	5/8	3/4	1
M	STAINLESS STEELS (DIFFICULT) 304, 304L, 316, 316L	≤ 275 Bhn or ≤ 28 HRc	Profile	≤ 0.5	≤ 1.5	340	RPM	10390	5195	3463	2598	2078	1732	1299
						(272-408)	Fz	0.0003	0.0008	0.0015	0.0020	0.0025	0.0026	0.0028
							Feed (ipm)	9.4	12.5	15.6	15.6	15.6	13.5	10.9
			Slot	1	≤ 1	270	RPM	8251	4126	2750	2063	1650	1375	1031
						(216-324)	Fz	0.0003	0.0008	0.0015	0.0020	0.0025	0.0026	0.0028
							Feed (ipm)	7.4	9.9	12.4	12.4	12.4	10.7	8.7
	STAINLESS STEELS (PH) 13-8 PH, 15-5 PH, 17-4 PH, Custom 450	≤ 325 Bhn or ≤ 35 HRc	Profile	≤ 0.5	≤ 1.5	310	RPM	9474	4737	3158	2368	1895	1579	1184
						(248-372)	Fz	0.0003	0.0008	0.0015	0.0020	0.0025	0.0026	0.0028
							Feed (ipm)	8.5	11.4	14.2	14.2	14.2	12.3	9.9
			Slot	1	≤ 1	250	RPM	7640	3820	2547	1910	1528	1273	955
						(200-300)	Fz	0.0003	0.0008	0.0015	0.0020	0.0025	0.0026	0.0028
							Feed (ipm)	6.9	9.2	11.5	11.5	11.5	9.9	8.0
S	SUPER ALLOYS (NICKEL, COBALT, IRON BASE) Inconel 601, 617, 625, Incoloy, Monel 400	≤ 300 Bhn or ≤ 32 HRc	Profile	≤ 0.5	≤ 1.5	80	RPM	2445	1222	815	611	489	407	306
						(64-96)	Fz	0.0003	0.0007	0.0013	0.0017	0.0021	0.0022	0.0024
							Feed (ipm)	1.9	2.6	3.2	3.1	3.1	2.7	2.2
			Slot	1	≤ 1	65	RPM	1986	993	662	497	397	331	248
						(52-78)	Fz	0.0003	0.0007	0.0013	0.0017	0.0021	0.0022	0.0024
							Feed (ipm)	1.5	2.1	2.6	2.5	2.5	2.2	1.8
	SUPER ALLOYS (NICKEL, COBALT, IRON BASE) Inconel 718, X-750, Incoloy, Waspaloy, Hastelloy, Rene	≤ 400 Bhn or ≤ 43 HRc	Profile	≤ 0.5	≤ 1.5	62	RPM	1895	947	632	474	379	316	237
						(50-74)	Fz	0.0002	0.0005	0.0009	0.0012	0.0015	0.0016	0.0017
							Feed (ipm)	1.1	1.4	1.7	1.7	1.7	1.5	1.2
			Slot	1	≤ 1	49	RPM	1497	749	499	374	299	250	187
						(39-59)	Fz	0.0002	0.0005	0.0009	0.0012	0.0015	0.0016	0.0017
							Feed (ipm)	0.9	1.1	1.3	1.3	1.3	1.2	1.0
	TITANIUM ALLOYS Pure Titanium, Ti6Al4V, Ti6Al2Sn4Zr2Mo, Ti4Al4Mo2Sn0.5Si	≤ 350 Bhn or ≤ 38 HRc	Profile	≤ 0.5	≤ 1.5	215	RPM	6570	3285	2190	1643	1314	1095	821
						(172-258)	Fz	0.0003	0.0008	0.0015	0.0020	0.0025	0.0026	0.0028
							Feed (ipm)	5.9	7.9	9.9	9.9	9.9	8.5	6.9
			Slot	1	≤ 1	170	RPM	5195	2598	1732	1299	1039	866	649
						(136-204)	Fz	0.0003	0.0008	0.0015	0.0020	0.0025	0.0026	0.0028
							Feed (ipm)	4.7	6.2	7.8	7.8	7.8	6.8	5.5
	TITANIUM ALLOYS (DIFFICULT) Ti10Al2Fe3Al, Ti5Al5V5Mo3Cr, Ti7Al4Mo, Ti3Al8V6Cr4Zr4Mo, Ti6Al6V6Sn, Ti15V3 Cr3Sn3Al	≤ 440 Bhn or ≤ 47 HRc	Profile	≤ 0.5	≤ 1.5	75	RPM	2292	1146	764	573	458	382	287
						(60-90)	Fz	0.0003	0.0008	0.0015	0.0020	0.0025	0.0026	0.0028
							Feed (ipm)	2.1	2.8	3.4	3.4	3.4	3.0	2.4
			Slot	1	≤ 1	60	RPM	1834	917	611	458	367	306	229
						(48-72)	Fz	0.0003	0.0008	0.0015	0.0020	0.0025	0.0026	0.0028
							Feed (ipm)	1.7	2.2	2.8	2.8	2.8	2.4	1.9

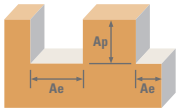
Note:
- Bhn (Brinell) HRc (Rockwell C)
- rpm = Vc x 3.82 / D_1
- ipm = Fz x 3 x rpm
- reduce speed and feed for materials harder than listed
- reduce feed and Ae when finish milling (.02 x D_1 maximum)
- refer to the KYOCERA SGS Tool Wizard for complete technical information (www.kyocera-sgstool.com)

SGSTOOLWIZARD2.0
www.sgstoolwizard.com



	Series 33MCR Metric	Hardness		Ae x D_1	Ap x D_1	Vc (m/min)		Diameter (D_1) (mm) 3	6	8	10	12	16	20
P	**CARBON STEELS 1018, 1040, 1080, 1090, 10L50, 1140, 1212, 12L15, 1525, 1536**	≤ 275 Bhn or ≤ 28 HRc	Profile	≤ 0.5	≤ 1.5	168	RPM	17773	8886	6665	5332	4443	3332	2666
						(134-201)	Fz	0.012	0.029	0.049	0.061	0.074	0.100	0.107
							Feed (mm/min)	640	768	981	981	992	998	853
			Slot	1	≤ 1	134	RPM	14218	7109	5332	4265	3555	2666	2133
						(107-161)	Fz	0.012	0.029	0.049	0.061	0.074	0.100	0.107
							Feed (mm/min)	512	614	785	785	793	798	682
	ALLOY STEELS 4140, 4150, 4320, 5120, 5150, 8630, 86L20, 50100	≤ 375 Bhn or ≤ 40 HRc	Profile	≤ 0.5	≤ 1.5	96	RPM	10179	5089	3817	3054	2545	1909	1527
						(77-115)	Fz	0.010	0.022	0.036	0.045	0.055	0.074	0.080
							Feed (mm/min)	293	330	415	415	421	425	366
			Slot	1	≤ 1	76	RPM	8078	4039	3029	2424	2020	1515	1212
						(61-91)	Fz	0.010	0.022	0.036	0.045	0.055	0.074	0.080
							Feed (mm/min)	233	262	330	330	334	337	291
H	**TOOL STEELS A2, D2, H13, L2, M2, P20, S7, T15, W2**	≤ 375 Bhn or ≤ 40 HRc	Profile	≤ 0.5	≤ 1.5	56	RPM	5978	2989	2242	1793	1495	1121	897
						(45-68)	Fz	0.007	0.017	0.030	0.037	0.043	0.059	0.064
							Feed (mm/min)	129	151	201	201	194	198	172
			Slot	1	≤ 1	44	RPM	4686	2343	1757	1406	1171	879	703
						(35-53)	Fz	0.007	0.017	0.030	0.037	0.043	0.059	0.064
							Feed (mm/min)	101	118	157	157	152	155	135
K	**CAST IRONS (LOW & MEDIUM ALLOY) Gray, Malleable, Ductile**	≤ 220 Bhn or ≤ 19 HRc	Profile	≤ 0.5	≤ 1.5	136	RPM	14380	7190	5392	4314	3595	2696	2157
						(109-163)	Fz	0.008	0.026	0.045	0.056	0.067	0.090	0.096
							Feed (mm/min)	362	569	725	725	725	725	621
			Slot	1	≤ 1	108	RPM	11471	5736	4302	3441	2868	2151	1721
						(87-130)	Fz	0.008	0.026	0.045	0.056	0.067	0.090	0.096
							Feed (mm/min)	289	454	578	578	578	578	496
	CAST IRONS (HIGH ALLOY) Gray, Malleable, Ductile	≤ 260 Bhn or ≤ 26 HRc	Profile	≤ 0.5	≤ 1.5	104	RPM	10987	5493	4120	3296	2747	2060	1648
						(83-124)	Fz	0.007	0.019	0.034	0.043	0.050	0.067	0.072
							Feed (mm/min)	237	316	422	422	415	411	356
			Slot	1	≤ 1	82	RPM	8725	4362	3272	2617	2181	1636	1309
						(66-99)	Fz	0.007	0.019	0.034	0.043	0.050	0.067	0.072
							Feed (mm/min)	188	251	335	335	330	327	283
M	**STAINLESS STEELS (FREE MACHINING) 303, 416, 420F, 430F, 440F**	≤ 275 Bhn or ≤ 28 HRc	Profile	≤ 0.5	≤ 1.5	149	RPM	15834	7917	5938	4750	3958	2969	2375
						(119-179)	Fz	0.009	0.024	0.041	0.051	0.060	0.079	0.085
							Feed (mm/min)	433	570	722	722	712	707	608
			Slot	1	≤ 1	119	RPM	12602	6301	4726	3781	3151	2363	1890
						(95-143)	Fz	0.009	0.024	0.041	0.051	0.060	0.079	0.085
							Feed (mm/min)	345	454	575	575	567	563	484

continued on next page



	Series 33MCR Metric	Hardness		Ae x D_1	Ap x D_1	Vc (m/min)		Diameter (D_1) (mm) 3	6	8	10	12	16	20
M	**STAINLESS STEELS (DIFFICULT) 304, 304L, 316, 316L**	≤ 275 Bhn or ≤ 28 HRc	Profile	≤ 0.5	≤ 1.5	104	RPM	10987	5493	4120	3296	2747	2060	1648
						(83-124)	Fz	0.007	0.019	0.032	0.040	0.048	0.064	0.069
							Feed (mm/min)	237	316	396	396	395	396	343
			Slot	1	≤ 1	82	RPM	8725	4362	3272	2617	2181	1636	1309
						(66-99)	Fz	0.007	0.019	0.032	0.040	0.048	0.064	0.069
							Feed (mm/min)	188	251	314	314	314	314	272
	STAINLESS STEELS (PH) 13-8 PH, 15-5 PH, 17-4 PH, Custom 450	≤ 325 Bhn or ≤ 35 HRc	Profile	≤ 0.5	≤ 1.5	94	RPM	10017	5009	3756	3005	2504	1878	1503
						(76-113)	Fz	0.007	0.019	0.032	0.040	0.048	0.064	0.069
							Feed (mm/min)	216	288	361	361	361	361	313
			Slot	1	≤ 1	76	RPM	8078	4039	3029	2424	2020	1515	1212
						(61-91)	Fz	0.007	0.019	0.032	0.040	0.048	0.064	0.069
							Feed (mm/min)	174	233	291	291	291	291	252
S	**SUPER ALLOYS (NICKEL, COBALT, IRON BASE) Inconel 601, 617, 625, Incoloy, Monel 400**	≤ 300 Bhn or ≤ 32 HRc	Profile	≤ 0.5	≤ 1.5	24	RPM	2585	1293	969	776	646	485	388
						(20-29)	Fz	0.006	0.017	0.028	0.035	0.041	0.054	0.059
							Feed (mm/min)	48	65	81	65	79	78	68
			Slot	1	≤ 1	20	RPM	2100	1050	788	630	525	394	315
						(16-24)	Fz	0.006	0.017	0.028	0.035	0.041	0.054	0.059
							Feed (mm/min)	39	53	66	66	64	64	55
	SUPER ALLOYS (NICKEL, COBALT, IRON BASE) Inconel 718, X-750, Incoloy, Waspaloy, Hastelloy, Rene	≤ 400 Bhn or ≤ 43 HRc	Profile	≤ 0.5	≤ 1.5	19	RPM	2003	1002	751	601	501	376	301
						(15-23)	Fz	0.005	0.012	0.019	0.024	0.029	0.038	0.043
							Feed (mm/min)	29	36	43	43	43	43	38
			Slot	1	≤ 1	15	RPM	1583	792	594	475	396	297	238
						(12-18)	Fz	0.005	0.012	0.019	0.024	0.029	0.038	0.043
							Feed (mm/min)	23	28	34	34	34	34	30
	TITANIUM ALLOYS Pure Titanium, Ti6Al4V, Ti6Al2Sn4Zr2Mo, Ti4Al4Mo2Sn0.5Si	≤ 350 Bhn or ≤ 38 HRc	Profile	≤ 0.5	≤ 1.5	66	RPM	6947	3474	2605	2084	1737	1303	1042
						(52-79)	Fz	0.007	0.019	0.032	0.040	0.048	0.064	0.069
							Feed (mm/min)	150	200	250	250	250	250	217
			Slot	1	≤ 1	52	RPM	5493	2747	2060	1648	1373	1030	824
						(41-62)	Fz	0.007	0.019	0.032	0.040	0.048	0.064	0.069
							Feed (mm/min)	119	158	198	198	198	198	171
	TITANIUM ALLOYS (DIFFICULT) Ti10Al2Fe3Al, Ti5Al5V5Mo3Cr, Ti7Al4Mo, Ti3Al8V6Cr4Zr4Mo, Ti6Al6V6Sn, Ti15V3 Cr3Sn3Al	≤ 440 Bhn or ≤ 47 HRc	Profile	≤ 0.5	≤ 1.5	23	RPM	2424	1212	909	727	606	454	364
						(18-27)	Fz	0.007	0.019	0.032	0.040	0.048	0.064	0.069
							Feed (mm/min)	52	70	87	87	87	87	76
			Slot	1	≤ 1	18	RPM	1939	969	727	582	485	364	291
						(15-22)	Fz	0.007	0.019	0.032	0.040	0.048	0.064	0.069
							Feed (mm/min)	42	56	70	70	70	70	60

Note:
- Bhn (Brinell) HRc (Rockwell C)
- rpm = (Vc x 1000) / (D_1 x 3.14)
- mm/min = Fz x 3 x rpm
- reduce speed and feed for materials harder than listed
- reduce feed and Ae when finish milling (.02 x D_1 maximum)
- refer to the KYOCERA SGS Tool Wizard for complete technical information (www.kyocera-sgstool.com)

SGSTOOLWIZARD2.0
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