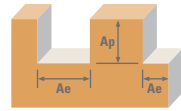


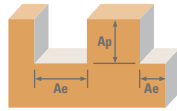
Series ZR Fractional	Hardness	Profile	Ae x DC	Ap x DC	Vc (sfm)							
						1/4	3/8	1/2	5/8	3/4		
CARBON STEELS 1018, 1040, 1080, 1090, 10L50, 1140, 1212, 12L15, 1525, 1536	≤ 275 Bhn or ≤ 28 HRc	Profile	≤ 0.25	≤ APMX	675 (540-810)	RPM	10314	6876	5157	4126	3438	
						Fz	0.0017	0.0029	0.0041	0.0045	0.0048	
						Feed (ipm)	70	80	85	73	66	
		Slot	1	≤ 1	450 (360-540)	RPM	6876	4584	3438	2750	2292	
						Fz	0.0014	0.0025	0.0035	0.0039	0.0042	
						Feed (ipm)	39	45	48	42	39	
			Plunge	1	≤ 1	640 (512-768)	RPM	9779	6519	4890	3912	3260
						Fz	0.0013	0.0022	0.0032	0.0035	0.0038	
						Feed (ipm)	49	58	62	54	49	
ALLOY STEELS 4140, 4150, 4320, 5120, 5150, 8630, 86L20, 50100	≤ 375 Bhn or ≤ 40 HRc	Profile	≤ 0.25	≤ APMX	525 (420-630)	RPM	8022	5348	4011	3209	2674	
						Fz	0.0011	0.0024	0.0036	0.0039	0.0042	
						Feed (ipm)	35	50	58	50	45	
		Slot	1	≤ 1	350 (280-420)	RPM	5348	3565	2674	2139	1783	
						Fz	0.0010	0.0021	0.0031	0.0034	0.0037	
						Feed (ipm)	21	29	33	29	26	
			Plunge	1	≤ 1	500 (400-600)	RPM	7640	5093	3820	3056	2547
						Fz	0.0009	0.0019	0.0028	0.0031	0.0033	
						Feed (ipm)	28	38	43	38	34	
TOOL STEELS A2, D2, H13, L2, M2, P20, S7, T15, W2	≤ 375 Bhn or ≤ 40 HRc	Profile	≤ 0.25	≤ APMX	240 (192-288)	RPM	3667	2445	1834	1467	1222	
						Fz	0.0009	0.0018	0.0026	0.0030	0.0033	
						Feed (ipm)	13	17	19	17	16	
		Slot	1	≤ 0.5	160 (128-192)	RPM	2445	1630	1222	978	815	
						Fz	0.0008	0.0016	0.0023	0.0026	0.0028	
						Feed (ipm)	8	10	11	10	9	
			Plunge	1	≤ 0.5	220 (176-264)	RPM	3362	2241	1681	1345	1121
						Fz	0.0007	0.0014	0.0021	0.0023	0.0025	
						Feed (ipm)	10	13	14	12	11	
STAINLESS STEELS (FREE MACHINING) 303, 416, 420F, 430F, 440F	≤ 275 Bhn or ≤ 28 HRc	Profile	≤ 0.25	≤ APMX	540 (432-648)	RPM	8251	5501	4126	3300	2750	
						Fz	0.0011	0.0022	0.0032	0.0035	0.0038	
						Feed (ipm)	36	47	53	46	42	
		Slot	1	≤ 1	360 (288-432)	RPM	5501	3667	2750	2200	1834	
						Fz	0.0010	0.0019	0.0028	0.0031	0.0033	
						Feed (ipm)	22	28	31	27	24	
			Plunge	1	≤ 1	510 (408-612)	RPM	7793	5195	3896	3117	2598
						Fz	0.0009	0.0017	0.0025	0.0028	0.0030	
						Feed (ipm)	28	36	39	34	31	
STAINLESS STEELS (DIFFICULT) 304, 304L, 316, 316L	≤ 275 Bhn or ≤ 28 HRc	Profile	≤ 0.25	≤ APMX	375 (300-450)	RPM	5730	3820	2865	2292	1910	
						Fz	0.0009	0.0018	0.0026	0.0030	0.0034	
						Feed (ipm)	21	27	30	28	26	
		Slot	1	≤ 0.5	250 (200-300)	RPM	3820	2547	1910	1528	1273	
						Fz	0.0008	0.0016	0.0023	0.0026	0.0029	
						Feed (ipm)	12	16	18	16	15	
			6° Ramp	1	≤ 0.5	350 (280-420)	RPM	5348	3565	2674	2139	1783
						Fz	0.0007	0.0014	0.0021	0.0023	0.0026	
						Feed (ipm)	15	20	22	20	19	
STAINLESS STEELS (PH) 13-8 PH, 15-5PH, 17-4 PH, CUSTOM 450	≤ 325 Bhn or ≤ 35 HRc	Profile	≤ 0.25	≤ APMX	360 (288-432)	RPM	5501	3667	2750	2200	1834	
						Fz	0.0009	0.0018	0.0026	0.0030	0.0034	
						Feed (ipm)	20	26	29	26	25	
		Slot	1	≤ 1	240 (192-288)	RPM	3667	2445	1834	1467	1222	
						Fz	0.0008	0.0016	0.0023	0.0026	0.0029	
						Feed (ipm)	12	15	17	15	14	
			6° Ramp	1	≤ 1	340 (272-408)	RPM	5195	3463	2598	2078	1732
						Fz	0.0007	0.0014	0.0021	0.0023	0.0026	
						Feed (ipm)	15	19	22	20	18	

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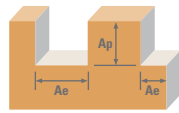
Series ZR Fractional	Hardness	Profile 	Ae x DC	Ap x DC	Vc (sfm)							
						1/4	3/8	1/2	5/8	3/4		
CAST IRONS (LOW & MEDIUM ALLOY) Gray, Malleable, Ductile	≤ 220 Bhn or ≤ 19 HRc		≤ 0.25	≤ APMX	630 (504-756)	RPM	9626	6418	4813	3851	3209	
						Fz	0.0013	0.0023	0.0033	0.0038	0.0042	
						Feed (ipm)	50	59	64	58	54	
			1	≤ 1	420 (336-504)	RPM	6418	4278	3209	2567	2139	
						Fz	0.0011	0.0020	0.0029	0.0033	0.0037	
						Feed (ipm)	28	34	37	34	32	
		1	≤ 1	600 (480-720)	RPM	9168	6112	4584	3667	3056		
					Fz	0.0010	0.0018	0.0026	0.0030	0.0033		
					Feed (ipm)	36	44	48	44	41		
	CAST IRONS (HIGH ALLOY) Gray, Malleable, Ductile	≤ 260 Bhn or ≤ 26 HRc		≤ 0.25	≤ APMX	375 (300-450)	RPM	5730	3820	2865	2292	1910
							Fz	0.0009	0.0018	0.0026	0.0030	0.0034
							Feed (ipm)	21	27	30	28	26
			1	≤ 1	250 (200-300)	RPM	3820	2547	1910	1528	1273	
						Fz	0.0008	0.0016	0.0023	0.0026	0.0029	
						Feed (ipm)	12	16	18	16	15	
		1	≤ 1	350 (280-420)	RPM	5348	3565	2674	2139	1783		
					Fz	0.0007	0.0014	0.0021	0.0023	0.0026		
					Feed (ipm)	15	20	22	20	19		
SUPER ALLOYS (NICKEL, COBALT, IRON BASE) Inconel 601, 617, 625, Incoloy, Monel 400		≤ 300 Bhn or ≤ 32 HRc		≤ 0.25	≤ APMX	105 (84-126)	RPM	1604	1070	802	642	535
							Fz	0.0006	0.0013	0.0019	0.0023	0.0026
							Feed (ipm)	4	5	6	6	6
			1	≤ 0.375	70 (56-84)	RPM	1070	713	535	428	357	
						Fz	0.0005	0.0011	0.0017	0.0020	0.0022	
						Feed (ipm)	2	3	4	3	3	
		1	≤ 0.5	100 (80-120)	RPM	1528	1019	764	611	509		
					Fz	0.0005	0.0010	0.0015	0.0018	0.0020		
					Feed (ipm)	3	4	5	4	4		
	SUPER ALLOYS (NICKEL, COBALT, IRON BASE) Inconel 718, X-750, Incoloy, Waspaloy, Hastelloy, Rene	≤ 400 Bhn or ≤ 43 HRc		≤ 0.25	≤ APMX	60 (48-72)	RPM	917	611	458	367	306
							Fz	0.0006	0.0011	0.0016	0.0020	0.0024
							Feed (ipm)	2	3	3	3	3
			1	≤ 0.375	40 (32-48)	RPM	611	407	306	244	204	
						Fz	0.0005	0.0010	0.0014	0.0018	0.0021	
						Feed (ipm)	1	2	2	2	2	
		1	≤ 0.5	50 (40-60)	RPM	764	509	382	306	255		
					Fz	0.0005	0.0009	0.0013	0.0016	0.0019		
					Feed (ipm)	1	2	2	2	2		
TITANIUM ALLOYS Pure Titanium, Ti6Al4V, Ti6Al2Sn4Zr2Mo, Ti4Al4Mo2Sn0.5Si		≤ 350 Bhn or ≤ 38 HRc		≤ 0.25	≤ APMX	270 (216-324)	RPM	4126	2750	2063	1650	1375
							Fz	0.0010	0.0019	0.0027	0.0032	0.0036
							Feed (ipm)	17	20	22	21	20
			1	≤ 0.5	180 (144-216)	RPM	2750	1834	1375	1100	917	
						Fz	0.0009	0.0017	0.0024	0.0028	0.0031	
						Feed (ipm)	10	12	13	12	11	
		1	≤ 0.5	250 (200-300)	RPM	3820	2547	1910	1528	1273		
					Fz	0.0008	0.0015	0.0022	0.0025	0.0028		
					Feed (ipm)	12	15	17	15	14		
	TITANIUM ALLOYS (DIFFICULT) Ti10Al2Fe3Al, Ti5Al5V5Mo3Cr, Ti7Al4Mo, Ti3Al8V6Cr4Zr4Mo, Ti6Al6V6Sn, Ti15V3 Cr3Sn3Al	≤ 440 Bhn or ≤ 47 HRc		≤ 0.25	≤ APMX	150 (120-180)	RPM	2292	1528	1146	917	764
							Fz	0.0009	0.0017	0.0025	0.0030	0.0034
							Feed (ipm)	8	10	11	11	10
			1	≤ 0.375	100 (80-120)	RPM	1528	1019	764	611	509	
						Fz	0.0008	0.0015	0.0022	0.0026	0.0030	
						Feed (ipm)	5	6	7	6	6	
		1	≤ 0.5	140 (112-168)	RPM	2139	1426	1070	856	713		
					Fz	0.0007	0.0014	0.0020	0.0023	0.0027		
					Feed (ipm)	6	8	9	8	8		

- Note:**
- Bhn (Brinell) HRc (Rockwell C)
 - rpm = Vc x 3.82 / DC
 - ipm = Fz x 4 x rpm
 - Reduce speed and feed for materials harder than listed
 - Reduce feed and Ae when finish milling (.02 x DC maximum)
 - Refer to the KYOCERA SGS APEX® for complete technical information (www.kyocera-sgstool.com)



Series ZR Metric	Hardness	Ae x DC	Ap x DC	Vc (m/min)	DC • mm							
					6	8	10	12	16	20		
CARBON STEELS 1018, 1040, 1080, 1090, 10L50, 1140, 1212, 12L15, 1525, 1536	≤ 275 Bhn or ≤ 28 HRC	Profile 	≤ 0.25	≤ APMX	206 (165-247)	RPM	10920	8190	6552	5460	4095	3276
						Fz	0.0464	0.0668	0.0870	0.1071	0.1247	0.1376
						Feed (mm/min)	2025	2189	2280	2338	2043	1803
	Slot 	1	≤ 1	137 (110-165)	RPM	7280	5460	4368	3640	2730	2184	
					Fz	0.0365	0.0526	0.0685	0.0843	0.0982	0.1083	
					Feed (mm/min)	1063	1149	1197	1227	1072	946	
	Plunge 	1	≤ 1	195 (156-234)	RPM	10354	7765	6212	5177	3883	3106	
					Fz	0.0334	0.0482	0.0627	0.0772	0.0882	0.0992	
					Feed (mm/min)	1384	1496	1558	1598	1369	1232	
ALLOY STEELS 4140, 4150, 4320, 5120, 5150, 8630, 86L20, 50100	≤ 375 Bhn or ≤ 40 HRC	Profile 	≤ 0.25	≤ APMX	160 (128-192)	RPM	8493	6370	5096	4247	3185	2548
						Fz	0.0324	0.0518	0.0727	0.0932	0.1096	0.1207
						Feed (mm/min)	1100	1320	1481	1584	1396	1230
	Slot 	1	≤ 1	107 (85-128)	RPM	5662	4247	3397	2831	2123	1699	
					Fz	0.0255	0.0408	0.0572	0.0734	0.0863	0.0950	
					Feed (mm/min)	578	693	777	831	733	645	
	Plunge 	1	≤ 1	152 (122-183)	RPM	8089	6067	4853	4044	3033	2427	
					Fz	0.0233	0.0374	0.0524	0.0672	0.0771	0.0870	
					Feed (mm/min)	755	906	1017	1087	935	844	
TOOL STEELS A2, D2, H13, L2, M2, P20, S7, T15, W2	≤ 375 Bhn or ≤ 40 HRC	Profile 	≤ 0.25	≤ APMX	73 (59-88)	RPM	3883	2912	2330	1941	1456	1165
						Fz	0.0259	0.0396	0.0541	0.0685	0.0826	0.0935
						Feed (mm/min)	402	462	504	532	481	436
	Slot 	1	≤ 0.5	49 (39-59)	RPM	2588	1941	1553	1294	971	777	
					Fz	0.0204	0.0312	0.0426	0.0539	0.0650	0.0736	
					Feed (mm/min)	211	242	265	279	252	229	
	Plunge 	1	≤ 0.5	67 (54-80)	RPM	3559	2669	2135	1780	1335	1068	
					Fz	0.0187	0.0286	0.0390	0.0493	0.0584	0.0674	
					Feed (mm/min)	266	305	333	351	312	288	
STAINLESS STEELS (FREE MACHINING) 303, 416, 420F, 430F, 440F	≤ 275 Bhn or ≤ 28 HRC	Profile 	≤ 0.25	≤ APMX	165 (132-198)	RPM	8736	6552	5242	4368	3276	2621
						Fz	0.0328	0.0488	0.0659	0.0829	0.0981	0.1090
						Feed (mm/min)	1145	1278	1382	1449	1285	1142
	Slot 	1	≤ 1	110 (88-132)	RPM	5824	4368	3494	2912	2184	1747	
					Fz	0.0258	0.0384	0.0519	0.0653	0.0772	0.0858	
					Feed (mm/min)	601	671	725	761	674	600	
	Plunge 	1	≤ 1	155 (124-187)	RPM	8251	6188	4950	4125	3094	2475	
					Fz	0.0236	0.0352	0.0475	0.0598	0.0692	0.0786	
					Feed (mm/min)	780	870	941	987	856	778	
STAINLESS STEELS (DIFFICULT) 304, 304L, 316, 316L	≤ 275 Bhn or ≤ 28 HRC	Profile 	≤ 0.25	≤ APMX	114 (91-137)	RPM	6067	4550	3640	3033	2275	1820
						Fz	0.0255	0.0390	0.0537	0.0683	0.0846	0.0979
						Feed (mm/min)	620	710	782	829	770	713
	Slot 	1	≤ 0.5	76 (61-91)	RPM	4044	3033	2427	2022	1517	1213	
					Fz	0.0201	0.0307	0.0423	0.0538	0.0666	0.0771	
					Feed (mm/min)	325	372	411	435	404	374	
	6° Ramp 	1	≤ 0.5	107 (85-128)	RPM	5662	4247	3397	2831	2123	1699	
					Fz	0.0184	0.0281	0.0387	0.0493	0.0599	0.0706	
					Feed (mm/min)	417	477	526	558	509	480	
STAINLESS STEELS (PH) 13-8 PH, 15-5PH, 17-4 PH, CUSTOM 450	≤ 325 Bhn or ≤ 35 HRC	Profile 	≤ 0.25	≤ APMX	110 (88-132)	RPM	5824	4368	3494	2912	2184	1747
						Fz	0.0254	0.0390	0.0537	0.0683	0.0846	0.0979
						Feed (mm/min)	592	681	751	796	739	684
	Slot 	1	≤ 1	73 (59-88)	RPM	3883	2912	2330	1941	1456	1165	
					Fz	0.0200	0.0307	0.0423	0.0538	0.0666	0.0771	
					Feed (mm/min)	311	358	394	418	388	359	
	6° Ramp 	1	≤ 1	104 (83-124)	RPM	5500	4125	3300	2750	2063	1650	
					Fz	0.0183	0.0281	0.0387	0.0493	0.0599	0.0706	
					Feed (mm/min)	403	464	511	542	494	466	

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Series ZR Metric	Hardness	Ae x DC	Ap x DC	Vc (m/min)	DC • mm								
					6	8	10	12	16	20			
K CAST IRONS (LOW & MEDIUM ALLOY) Gray, Malleable, Ductile	≤ 220 Bhn or ≤ 19 HRc	Profile 	≤ 0.25	≤ APMX	192 (154-230)	RPM	10192	7644	6115	5096	3822	3058	
						Fz	0.0363	0.0526	0.0699	0.0869	0.1059	0.1218	
						Feed (mm/min)	1481	1608	1709	1771	1619	1490	
		Slot 	1	≤ 1	128 (102-154)	RPM	6795	5096	4077	3397	2548	2038	
						Fz	0.0286	0.0414	0.0550	0.0684	0.0834	0.0959	
						Feed (mm/min)	777	844	897	929	850	782	
	Plunge 	1	≤ 1	183 (146-219)	RPM	9707	7280	5824	4853	3640	2912		
					Fz	0.0262	0.0379	0.0504	0.0626	0.0752	0.0878		
					Feed (mm/min)	1017	1104	1173	1216	1095	1023		
	S CAST IRONS (HIGH ALLOY) Gray, Malleable, Ductile	≤ 260 Bhn or ≤ 26 HRc	Profile 	≤ 0.25	≤ APMX	114 (91-137)	RPM	6067	4550	3640	3033	2275	1820
							Fz	0.0255	0.0390	0.0537	0.0683	0.0846	0.0979
							Feed (mm/min)	620	710	782	829	770	713
Slot 			1	≤ 1	76 (61-91)	RPM	4044	3033	2427	2022	1517	1213	
						Fz	0.0201	0.0307	0.0423	0.0538	0.0666	0.0771	
						Feed (mm/min)	325	372	411	435	404	374	
Plunge 		1	≤ 1	107 (85-128)	RPM	5662	4247	3397	2831	2123	1699		
					Fz	0.0184	0.0281	0.0387	0.0493	0.0599	0.0706		
					Feed (mm/min)	417	477	526	558	509	480		
S SUPER ALLOYS (NICKEL, COBALT, IRON BASE) Inconel 601, 617, 625, Incoloy, Monel 400		≤ 300 Bhn or ≤ 32 HRc	Profile 	≤ 0.25	≤ APMX	32 (26-38)	RPM	1699	1274	1019	849	637	510
							Fz	0.0174	0.0287	0.0413	0.0536	0.0650	0.0735
							Feed (mm/min)	118	146	168	182	166	150
	Slot 		1	≤ 0.375	21 (17-26)	RPM	1132	849	679	566	425	340	
						Fz	0.0137	0.0226	0.0325	0.0422	0.0512	0.0579	
						Feed (mm/min)	62	77	88	96	87	79	
	3° Ramp 	1	≤ 0.5	30 (24-37)	RPM	1618	1213	971	809	607	485		
					Fz	0.0125	0.0207	0.0298	0.0386	0.0458	0.0530		
					Feed (mm/min)	81	100	116	125	111	103		
	S SUPER ALLOYS (NICKEL, COBALT, IRON BASE) Inconel 718, X-750, Incoloy, Waspaloy, Hastelloy, Rene	≤ 400 Bhn or ≤ 43 HRc	Profile 	≤ 0.25	≤ APMX	18 (15-22)	RPM	971	728	582	485	364	291
							Fz	0.0166	0.0271	0.0386	0.0500	0.0611	0.0695
							Feed (mm/min)	65	79	90	97	89	81
Slot 			1	≤ 0.375	12 (10-15)	RPM	647	485	388	324	243	194	
						Fz	0.0131	0.0213	0.0304	0.0394	0.0481	0.0547	
						Feed (mm/min)	34	41	47	51	47	42	
3° Ramp 		1	≤ 0.5	15 (12-18)	RPM	809	607	485	404	303	243		
					Fz	0.0120	0.0195	0.0278	0.0361	0.0431	0.0501		
					Feed (mm/min)	39	47	54	58	52	49		
S TITANIUM ALLOYS Pure Titanium, Ti6Al4V, Ti6Al2Sn4Zr2Mo, Ti4Al4Mo2Sn0.5Si		≤ 350 Bhn or ≤ 38 HRc	Profile 	≤ 0.25	≤ APMX	82 (66-99)	RPM	4368	3276	2621	2184	1638	1310
							Fz	0.0286	0.0429	0.0577	0.0721	0.0894	0.1040
							Feed (mm/min)	499	563	605	630	586	545
	Slot 		1	≤ 0.5	55 (44-66)	RPM	2912	2184	1747	1456	1092	874	
						Fz	0.0225	0.0338	0.0454	0.0568	0.0704	0.0819	
						Feed (mm/min)	262	295	317	331	308	286	
	6° Ramp 	1	≤ 0.5	76 (61-91)	RPM	4044	3033	2427	2022	1517	1213		
					Fz	0.0206	0.0309	0.0416	0.0520	0.0635	0.0750		
					Feed (mm/min)	333	375	403	421	385	364		
	S TITANIUM ALLOYS (DIFFICULT) Ti10Al2Fe3Al, Ti5Al5V5Mo3Cr, Ti7Al4Mo, Ti3Al8V6Cr4Zr4Mo, Ti6Al6V6Sn, Ti15V3 Cr3Sn3Al	≤ 440 Bhn or ≤ 47 HRc	Profile 	≤ 0.25	≤ APMX	46 (37-55)	RPM	2427	1820	1456	1213	910	728
							Fz	0.0243	0.0375	0.0512	0.0648	0.0837	0.1007
							Feed (mm/min)	235	273	298	314	305	293
Slot 			1	≤ 0.375	30 (24-37)	RPM	1618	1213	971	809	607	485	
						Fz	0.0191	0.0295	0.0403	0.0510	0.0659	0.0793	
						Feed (mm/min)	124	143	156	165	160	154	
6° Ramp 		1	≤ 0.5	43 (34-51)	RPM	2265	1699	1359	1132	849	679		
					Fz	0.0175	0.0270	0.0369	0.0467	0.0596	0.0726		
					Feed (mm/min)	158	184	201	212	203	197		

- Note:**
- Bhn (Brinell) HRc (Rockwell C)
 - rpm = Vc x 3.82 / DC
 - ipm = Fz x 4 x rpm
 - Reduce speed and feed for materials harder than listed
 - Reduce feed and Ae when finish milling (.02 x DC maximum)
 - Refer to the KYOCERA SGS APEX® for complete technical information (www.kyocera-sgstool.com)