KYOCERA

SGS
Solid Carbide Tools

Z5 High Performance Roughers

CARB-HPR
HIGH PERFORMANCE ROUGHER

www.kyocera-sgstool.com

ISO 9001 Certified

Z-CARB-HPR

HIGH PERFORMANCE ROUGHER

INTRODUCING THE NEXT GENERATION Z-CARB

The Z-Carb HPR Five Flute Roughing End Mills are ideal for achieving high material removal rates (MRR) and superior finishes. The specialized five flute design is engineered for increased productivity over three and four flute end mills. The variable indexing geometry allows for improved chatter suppression over symmetrical designs. The series is offered in a variety of length, square, and corner radius options and is coated with Ti-NAMITE-M and Ti-NAMITE-A for superior performance in difficult to machine materials like Titanium and Stainless Steel.

THE Z-CARB HPR MATERIAL REMOVAL RATES (MRR) MAKE THIS TOOL IDEAL FOR THE FOLLOWING TARGET MARKETS:

- Aerospace Structural Components
- Medical Implants
- Automotive & Heavy Transportation
- Energy & Power Generation
- Castings & Forgings
- General Engineering

EXPANSIVE OFFERING

- Over 450 items in portfolio
- Available in stub and regular lengths
- Full complement of corner radii available
- Central coolant hole option available on select diameters
- Plain and Weldon Flat options available for diameters ½" and 12mm and above (other retention methods available upon request)
- Special tooling design attributes available upon request
- Available in Ti-NAMITE-A coating ideal for Stainless Steel applications
- Available coatings are suitable for dry machining in ferrous based materials such as cast irons and many carbon steels

Ti-NAMITE-M

Features of Ti-Namite-M include high wear resistance, reduced friction, and excellent prevention of cutting edge build up. This coating provides superior material removal rates and tool life when used in high performance operations in Cast Iron and Steel and with difficult to machine materials like Titanium.

Hardness (HV): 3600
Oxidation Temperature: 1150°C / 2100°F
Coefficient of Friction: 0.45
Thickness: 1 – 4 Microns (based on tool diameter)

Ti-NAMITE-A

The Z-Carb HPR is available with an abrasive resistant and hard coating, Aluminum Titanium Nitride (AlTiN) or Ti-NAMITE-A. The coating has a high hardness giving ultimate protection against abrasive wear and erosion. Ideal for high temperature alloys 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)

FEATURES

RADIAL RAKE

- Specially designed radial rake balances positive cutting action and edge strength
- End grind features include: (1) Positive axial rake for high performance shearing and lifting of material; and (2) Increased clearances to eliminate edge build-up during ramping

THROUGH COOLANT

- Central hole delivers coolant effectively to the cutting zone
- Enhances chip removal when pocketing or slotting
- Select fractional and metric diameters in stock

FLUTING & HELIX ANGLE

- Specialized five flute design is engineered for strength, chip evacuation, and increased productivity over three and four flute end mills by 20–40%
- The variable flute pattern provides excellent chatter suppression over a range of spindle speeds
- Open center design delivers efficiency during entry movements into the work-piece
- Helix angle engineered for balance between positive cutting action and reduced contact area to control tool pressure and spindle load

CAPABILITIES

RAMPING

- Typical ramp angles of 5 degrees are common; greater than 5 degree ramp angles are obtainable with reduced feed rates
- Entry feed rates can achieve 100% of the slotting value
- The open center provides an ideal exit for central coolant and chip flushing while maintaining the 5 degree ramp angle

ROUGHING

- One times diameter slotting capability is typical
- 50% radial by 150% axial heavy profiling capability is common

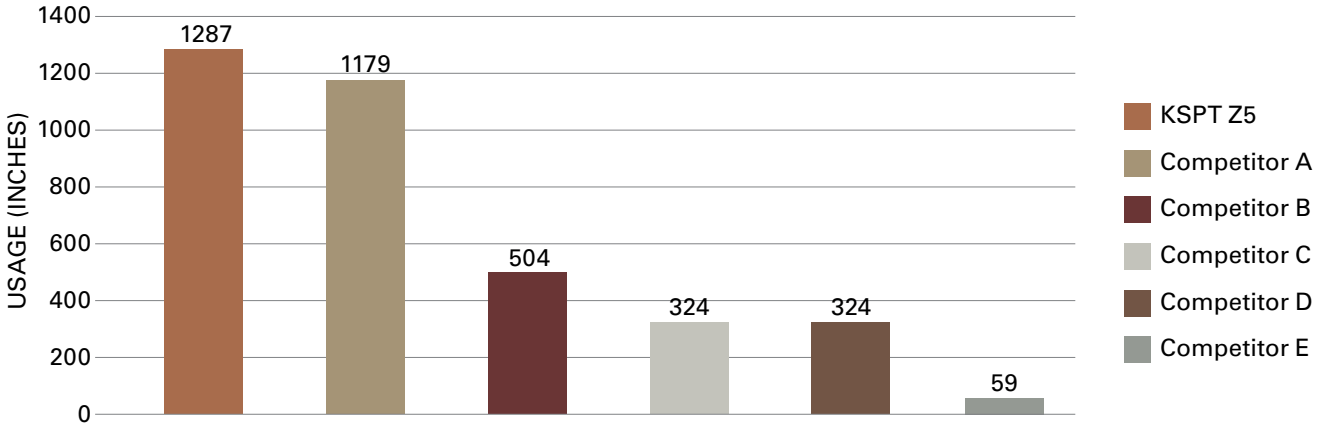
FINISHING

- Variable geometry contributes to exceptional finishing capabilities
- 10 µin. Ra possible

HIGH-SPEED MACHINING

- Variable geometry design and open fluting eliminate vibration to enable increased rates for High Speed Machining
- Exclusive Ti-NAMITE-M coating for higher heat resistance to enhance tool life in difficult to machine materials like Titanium
- Available with Ti-NAMITE-A coating for superior wear, edge build-up resistance and extended tool life in difficult to machine materials like Stainless Steel

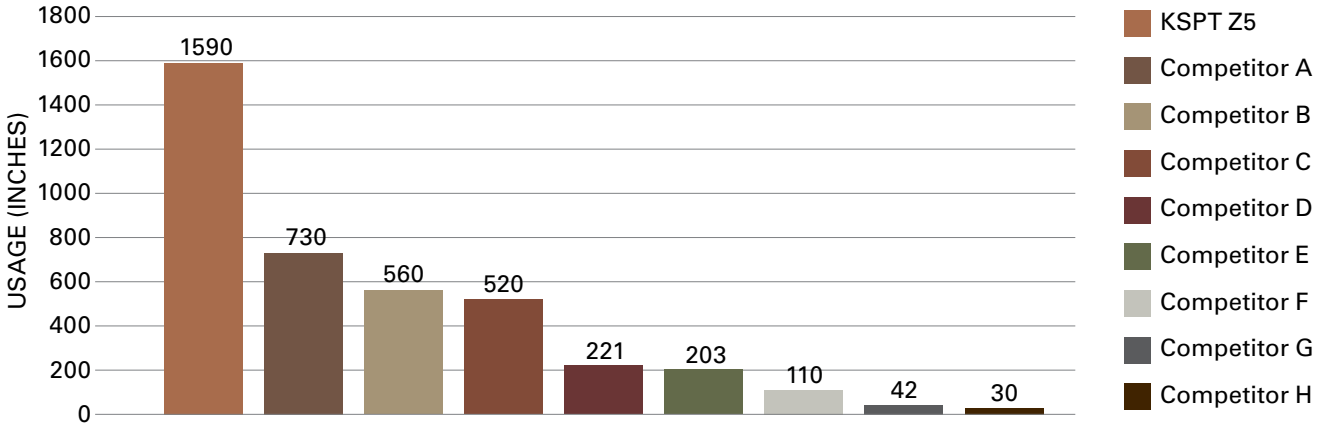
LAB TESTING RESULTS – HEAVY PROFILING IN TITANIUM



RESULTS IN TITANIUM 6AL4V @ 32HRC Z5CR 1/2" TESTED AT 1643 RPM X 16.4 IPM
.250" RADIAL WIDTH OF CUT X .750" AXIAL DEPTH OF CUT

Ti-NAMITE-M

LAB TESTING RESULTS – HEAVY PROFILING IN STAINLESS STEEL



RESULTS IN STAINLESS STEEL 316 @ 160HB Z5CR 1/2" TESTED AT 2540 RPM X 31.7 IPM
.250" RADIAL WIDTH OF CUT X .750" AXIAL DEPTH OF CUT

Ti-NAMITE-A

CASE STUDY

INDUSTRY
GENERAL ENGINEERING

MATERIAL
304LP Stainless Steel

PRODUCT
KSPT Z-CARB HPR

APPLICATION
MILLING

COMPETITOR
INSERT CUTTER

COOLANT
FLOOD

TOOL INFORMATION
.625 DIA / 1.25" LOC / 3.5" OAL

GOALS

The goals of this study were to significantly reduce job cost through increasing tool life, reducing cycle time and improving manufacturing efficiency.

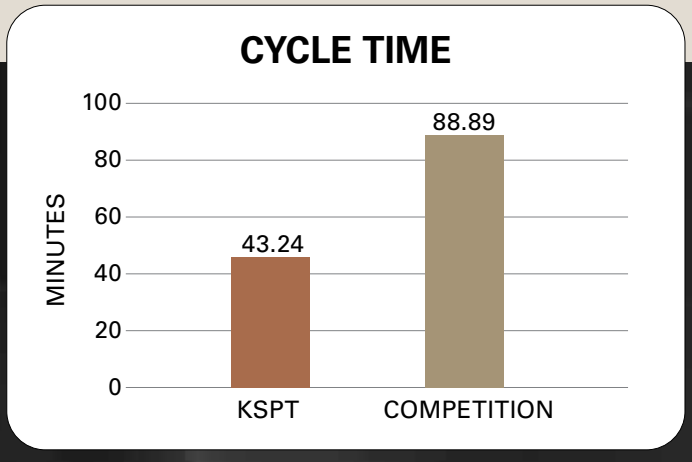
STRATEGY

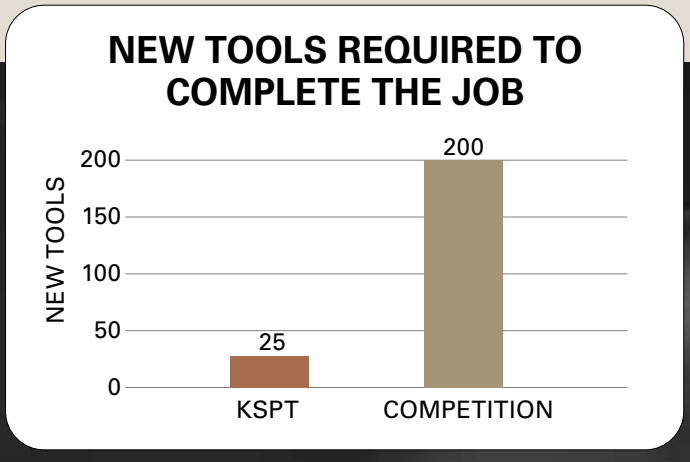
KSPT approached this job with a 5 flute Z-Carb high performance rougher (HPR) end mill. KSPT's Z-Carb HPR is ideal for achieving high metal removal rates, while at the same time achieving an optimal surface finish. The Ti-Namite M coating was selected for its outstanding performance in Titanium.

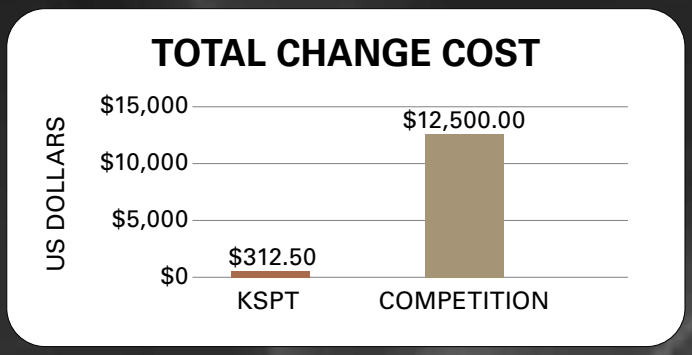
	KSPT	COMPETITOR
TOOL DIAMETER	.6250"	2" (INDEXABLE)
SPEED	1850 RPM	1200 RPM
FEED	18.5 IPM	9.0 IPM
RADIAL CUT (AE)	.1250"	.0500"
AXIAL CUT (AP)	1.4000"	.3000"
TOTAL MACHINING HOURS	72.07 HOURS	148.15 HOURS

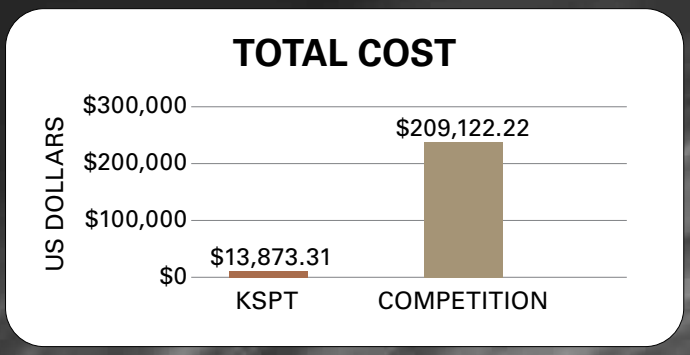
RESULTS

The overall findings of this study indicate that **KSPT's Z-Carb HPR outperformed the competition in every statistical category.** The HPR was able to be run more than **35% faster than the competition,** while maintaining a **feed rate that was double the competition.** Given those increased efficiencies, the HPR was able to **produce 8 times as many parts with 8 times less new tools.** With the limited number of new tools necessary to complete the job, the **tool change cost savings was over $12,000.** Additionally, the smaller number of new tools lead to a **total new tool cost more than $171,000 less than the competition.** The HPR outperformed the competition so impressively that the **total machining cost savings for the job was $11,411 and the total cost savings was $195,248.91!**



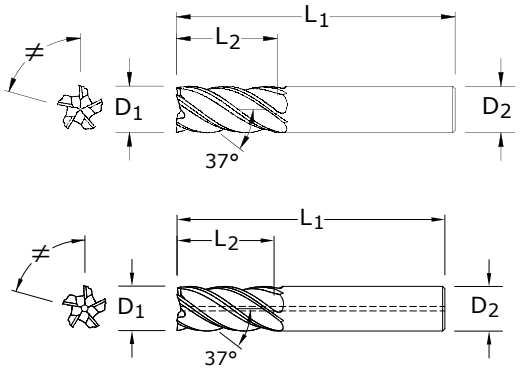






TOLERANCES (inch)

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

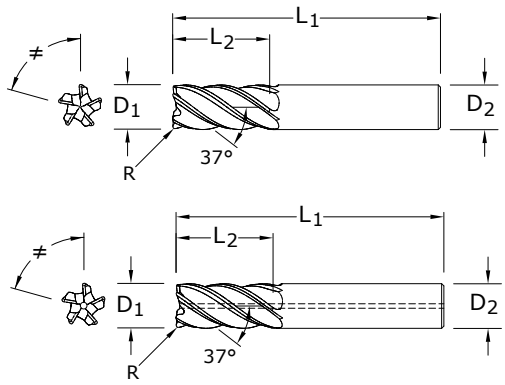


CARB-HPR
HIGH PERFORMANCE ROUGHER

Square
Straight
Weldon Flat
Right Spiral
Stub and Regular
Flute Spacing Unequal
Positive Rake Angle
Internal Coolant
External Coolant
5 Flutes

Cutting Diameter D_1	Length of Cut L_2	Overall Length L_1	Shank Diameter D_2	Ti-Namite-A (TA) EDP No.	Ti-Namite-A (TA) EDP No. w/Flat	Ti-Namite-A (TA) w/Internal Coolant	Ti-Namite-M (TM) EDP No.	Ti-Namite-M (TM) EDP No. w/ Flat	Ti-Namite-M (TM) EDP No. w/Internal Coolant
1/8	1/4	1-1/2	1/8	–	–	–	37000	–	–
1/8	3/8	1-1/2	1/8	37180	–	–	37002	–	–
3/16	5/16	2	3/16	–	–	–	37004	–	–
3/16	1/2	2	3/16	37182	–	–	37006	–	–
1/4	3/8	2-1/2	1/4	38502	–	–	37008	–	–
1/4	1/2	2-1/2	1/4	37184	–	–	37011	–	–
5/16	7/16	2-1/2	5/16	–	–	–	37014	–	–
5/16	5/8	2-1/2	5/16	38504	–	–	37016	–	–
3/8	1/2	2-1/2	3/8	–	–	–	37018	–	–
3/8	3/4	2-1/2	3/8	37187	–	–	37021	–	–
7/16	5/8	2-1/2	7/16	37168	–	–	37159	–	–
7/16	7/8	2-3/4	7/16	37170	–	–	37169	–	–
1/2	5/8	3	1/2	38506	38512	37320	37024	37030	37321
1/2	1	3	1/2	38507	38513	37322	37036	37042	37323
1/2	1-1/4	3-1/4	1/2	37190	37194	37324	37048	37054	37325
5/8	3/4	3-1/2	5/8	–	38514	–	37060	37067	37260
5/8	1-1/4	3-1/2	5/8	37198	37202	–	37074	37081	37267
3/4	7/8	4	3/4	38508	38515	–	37088	37095	37274
3/4	1-1/2	4	3/4	37206	37210	–	37102	37109	37281
1	1-1/8	4	1	–	–	–	37116	37123	37288
1	1-1/2	4	1	37214	37218	–	37130	37137	37295
1	2	4-1/2	1	–	38517	–	37144	37151	37302

CARB-HPR
HIGH PERFORMANCE ROUGHER



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 (TA) EDP No.	Ti-Namite-A (TA) EDP No. w/Flat	Ti-Namite-A (TA) EDP No. w/Internal Coolant	Ti-Namite-M (TM) EDP No.	Ti-Namite-M (TM) EDP No. w/ Flat	Ti-Namite-M (TM) EDP No. w/Internal Coolant
1/8	1/4	1-1/2	1/8	.015	38525	–	–	37001	–	–
1/8	3/8	1-1/2	1/8	.015	37181	–	–	37003	–	–
3/16	5/16	2	3/16	.015	–	–	–	37005	–	–
3/16	1/2	2	3/16	.015	37183	–	–	37007	–	–
1/4	3/8	2-1/2	1/4	.015	–	–	–	37009	–	–
1/4	3/8	2-1/2	1/4	.030	38528	–	–	37010	–	–
1/4	1/2	2-1/2	1/4	.015	37185	–	–	37012	–	–
1/4	1/2	2-1/2	1/4	.030	37186	–	–	37013	–	–
5/16	7/16	2-1/2	5/16	.015	38529	–	–	37015	–	–
5/16	5/8	2-1/2	5/16	.015	38530	–	–	37017	–	–
3/8	1/2	2-1/2	3/8	.015	–	–	–	37019	–	–
3/8	1/2	2-1/2	3/8	.030	38532	–	–	37020	–	–
3/8	3/4	2-1/2	3/8	.015	37188	–	–	37022	–	–
3/8	3/4	2-1/2	3/8	.030	37189	–	–	37023	–	–
7/16	5/8	2-1/2	7/16	.015	37164	–	–	37160	–	–
7/16	5/8	2-1/2	7/16	.030	37165	–	–	37161	–	–
7/16	7/8	2-3/4	7/16	.015	37166	–	–	37162	–	–
7/16	7/8	2-3/4	7/16	.030	37167	–	–	37163	–	–
1/2	5/8	3	1/2	.015	–	38578	37330	37025	37031	37331
1/2	5/8	3	1/2	.030	–	38579	37332	37026	37032	37333
1/2	5/8	3	1/2	.060	–	38580	37334	37027	37033	37335
1/2	5/8	3	1/2	.090	–	38581	37337	37028	37034	37338
1/2	5/8	3	1/2	.120	–	–	37339	37029	37035	37340
1/2	1	3	1/2	.015	–	38583	37341	37037	37043	37342
1/2	1	3	1/2	.030	38539	38584	37343	37038	37044	37344
1/2	1	3	1/2	.060	–	38585	37345	37039	37045	37346
1/2	1	3	1/2	.090	–	–	37348	37040	37046	37349
1/2	1	3	1/2	.120	–	–	37350	37041	37047	37351
1/2	1-1/4	3-1/4	1/2	.015	37191	37195	37352	37049	37055	37353
1/2	1-1/4	3-1/4	1/2	.030	37192	37196	37354	37050	37056	37355
1/2	1-1/4	3-1/4	1/2	.060	37193	37197	37356	37051	37057	37357
1/2	1-1/4	3-1/4	1/2	.090	–	–	37359	37052	37058	37360
1/2	1-1/4	3-1/4	1/2	.120	–	–	37361	37053	37059	37362
5/8	3/4	3-1/2	5/8	.015	–	–	–	37061	37068	37261
5/8	3/4	3-1/2	5/8	.030	–	38591	–	37062	37069	37262
5/8	3/4	3-1/2	5/8	.060	–	–	–	37063	37070	37263
5/8	3/4	3-1/2	5/8	.090	–	–	–	37064	37071	37264
5/8	3/4	3-1/2	5/8	.120	38549	–	–	37065	37072	37265

(continued on next page)


Corner


Straight


Weldon Flat


Right Spiral


Stub and Regular


Flute Spacing Unequal

Positive Rake Angle


Internal Coolant


External Coolant

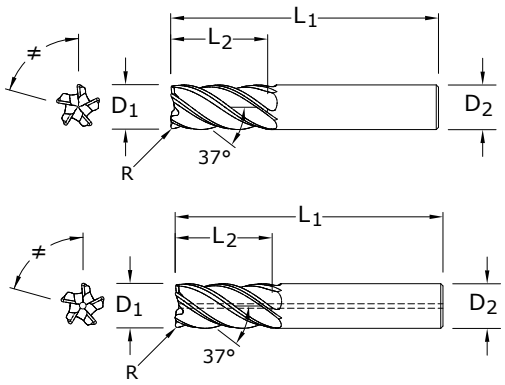
Flutes

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

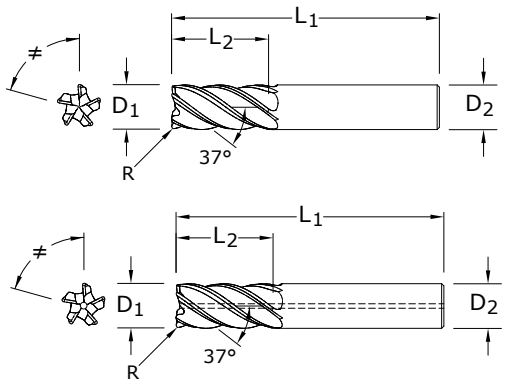


CARB-HPR
HIGH PERFORMANCE ROUGHER

Corner
Straight
Weldon Flat
Right Spiral
Stub and Regular
Flute Spacing Unequal
Positive Rake Angle
Internal Coolant
External Coolant
5 Flutes

Cutting Diameter D_1	Length of Cut L_2	Overall Length L_1	Shank Diameter D_2	Corner Radius R	Ti-Namite-A (TA) EDP No.	Ti-Namite-A (TA) EDP No. w/Flat	Ti-Namite-A (TA) w/Internal Coolant	Ti-Namite-M (TM) EDP No.	Ti-Namite-M (TM) EDP No. w/ Flat	Ti-Namite-M (TM) EDP No. w/Internal Coolant
5/8	3/4	3-1/2	5/8	.190	–	–	–	37066	37073	37266
5/8	1-1/4	3-1/2	5/8	.015	37199	37203	–	37075	37082	37268
5/8	1-1/4	3-1/2	5/8	.030	37200	37204	–	37076	37083	37269
5/8	1-1/4	3-1/2	5/8	.060	37201	37205	–	37077	37084	37270
5/8	1-1/4	3-1/2	5/8	.090	–	–	–	37078	37085	37271
5/8	1-1/4	3-1/2	5/8	.120	–	–	–	37079	37086	37272
5/8	1-1/4	3-1/2	5/8	.190	–	–	–	37080	37087	37273
3/4	7/8	4	3/4	.030	–	38599	–	37089	37096	37275
3/4	7/8	4	3/4	.060	–	–	–	37090	37097	37276
3/4	7/8	4	3/4	.090	–	–	–	37091	37098	37277
3/4	7/8	4	3/4	.120	–	–	–	37092	37099	37278
3/4	7/8	4	3/4	.190	–	–	–	37093	37100	37279
3/4	7/8	4	3/4	.250	–	–	–	37094	37101	37280
3/4	1-1/2	4	3/4	.030	37207	37211	–	37103	37110	37282
3/4	1-1/2	4	3/4	.060	37208	37212	–	37104	37111	37283
3/4	1-1/2	4	3/4	.090	–	–	–	37105	37112	37284
3/4	1-1/2	4	3/4	.120	37209	37213	–	37106	37113	37285
3/4	1-1/2	4	3/4	.190	–	–	–	37107	37114	37286
3/4	1-1/2	4	3/4	.250	–	–	–	37108	37115	37287
1	1-1/8	4	1	.030	–	38608	–	37117	37124	37289
1	1-1/8	4	1	.060	–	–	–	37118	37125	37290
1	1-1/8	4	1	.090	–	–	–	37119	37126	37291
1	1-1/8	4	1	.120	–	–	–	37120	37127	37292
1	1-1/8	4	1	.190	–	–	–	37121	37128	37293
1	1-1/8	4	1	.250	–	–	–	37122	37129	37294
1	1-1/2	4	1	.030	37215	37219	–	37131	37138	37296
1	1-1/2	4	1	.060	37216	37220	–	37132	37139	37297
1	1-1/2	4	1	.090	–	–	–	37133	37140	37298
1	1-1/2	4	1	.120	37217	37221	–	37134	37141	37299
1	1-1/2	4	1	.190	–	–	–	37135	37142	37300
1	1-1/2	4	1	.250	–	–	–	37136	37143	37301
1	2	4-1/2	1	.030	–	38617	–	37145	37152	37303
1	2	4-1/2	1	.060	–	–	–	37146	37153	37304
1	2	4-1/2	1	.090	–	–	–	37147	37154	37305
1	2	4-1/2	1	.120	–	–	–	37148	37155	37306
1	2	4-1/2	1	.190	–	–	–	37149	37156	37307
1	2	4-1/2	1	.250	–	–	–	37150	37157	37308

CARB-HPR
HIGH PERFORMANCE ROUGHER



TOLERANCES (mm)

DIAMETER	D_1	D_2
6	+0,000 / –0,030	h6
> 6 - 10	+0,000 / –0,040	h6
> 10 - 25	+0,000 / –0,050	h6

CORNER RADIUS TOLERANCES (mm)

R = +0,000 / –0,050

Cutting Diameter D_1	Length of Cut L_2	Overall Length L_1	Shank Diameter D_2	Corner Radius R	Ti-Namite-A (TA) EDP No.	Ti-Namite-A (TA) EDP No. w/Flat	Ti-Namite-A (TA) EDP No. w/Internal Coolant	Ti-Namite-M (TM) EDP No.	Ti-Namite-M (TM) EDP No. w/ Flat	Ti-Namite-M (TM) EDP No. w/Internal Coolant
6,0	9,0	54,0	6,0	0,5	–	–	–	47000	–	–
6,0	13,0	57,0	6,0	0,3	–	–	–	47001	–	–
6,0	13,0	57,0	6,0	0,5	47120	–	–	47002	–	–
6,0	13,0	57,0	6,0	1,0	–	–	–	47003	–	–
6,0	13,0	57,0	6,0	1,5	48003	–	–	47004	–	–
8,0	11,0	58,0	8,0	0,5	–	48002	–	47005	–	–
8,0	18,0	63,0	8,0	0,5	47121	–	–	47006	–	–
8,0	18,0	63,0	8,0	1,0	47122	–	–	47007	–	–
8,0	18,0	63,0	8,0	1,5	–	–	–	47008	–	–
8,0	18,0	63,0	8,0	2,0	–	–	–	47009	–	–
10,0	13,0	66,0	10,0	1,0	–	–	–	47010	–	–
10,0	22,0	72,0	10,0	0,5	47123	–	–	47011	–	–
10,0	22,0	72,0	10,0	1,0	47124	–	–	47012	–	–
10,0	22,0	72,0	10,0	1,5	–	–	–	47013	–	–
10,0	22,0	72,0	10,0	2,0	–	–	–	47014	–	–
10,0	22,0	72,0	10,0	2,5	–	–	–	47015	–	–
12,0	15,0	73,0	12,0	1,0	–	–	–	47016	47024	–
12,0	26,0	83,0	12,0	0,5	47125	47128	47160	47017	47025	47161
12,0	26,0	83,0	12,0	0,76	47126	47129	47162	47018	47026	47163
12,0	26,0	83,0	12,0	1,0	47127	47130	47164	47019	47027	47165
12,0	26,0	83,0	12,0	1,5	48012	–	47166	47020	47028	47167
12,0	26,0	83,0	12,0	2,0	–	–	47168	47021	47029	47169
12,0	26,0	83,0	12,0	2,5	–	–	47170	47022	47030	47171
12,0	26,0	83,0	12,0	3,0	–	–	47172	47023	47031	47173

(continued on next page)

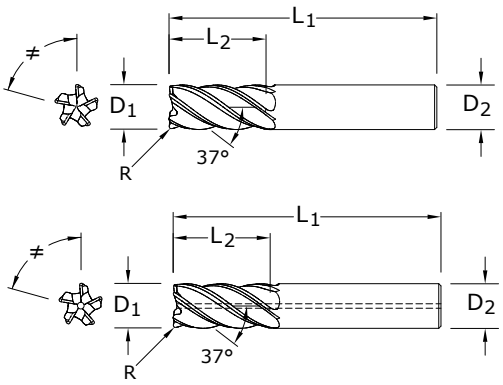
Corner
Straight
Weldon Flat
Right Spiral
Stub and Regular
Flute Spacing Unequal
Positive Rake Angle
Internal Coolant
External Coolant
5
Flutes

TOLERANCES (mm)

DIAMETER	D_1	D_2
6	+0,000 / –0,030	h6
> 6 - 10	+0,000 / –0,040	h6
> 10 - 25	+0,000 / –0,050	h6

CORNER RADIUS TOLERANCES (mm)

R = +0,000 / –0,050

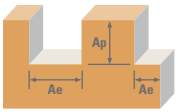


CARB-HPR
HIGH PERFORMANCE ROUGHER

Corner
Straight
Weldon Flat
Right Spiral
Stub and Regular
Flute Spacing Unequal
Positive Rake Angle
Internal Coolant
External Coolant
5 Flutes

Cutting Diameter D_1	Length of Cut L_2	Overall Length L_1	Shank Diameter D_2	Corner Radius R	Ti-Namite-A (TA) EDP No.	Ti-Namite-A (TA) EDP No. w/Flat	Ti-Namite-A (TA) EDP No. w/Internal Coolant	Ti-Namite-M (TM) EDP No.	Ti-Namite-M (TM) EDP No. w/ Flat	Ti-Namite-M (TM) EDP No. w/Internal Coolant
16,0	19,0	82,0	16,0	1,0	–	–	–	47032	47039	47046
16,0	19,0	82,0	16,0	1,5	48070	–	–	–	–	–
16,0	35,0	92,0	16,0	1,0	47131	–	47134	47033	47040	47047
16,0	35,0	92,0	16,0	1,5	–	–	–	47034	47041	47048
16,0	35,0	92,0	16,0	2,0	47132	–	47135	47035	47042	47049
16,0	35,0	92,0	16,0	2,5	–	–	–	47036	47043	47050
16,0	35,0	92,0	16,0	3,0	47133	–	47136	47037	47044	47051
16,0	35,0	92,0	16,0	4,0	–	–	–	47038	47045	47052
20,0	23,0	92,0	20,0	1,0	48020	–	–	47053	47061	47069
20,0	43,0	104,0	20,0	1,0	47137	–	47140	47054	47062	47070
20,0	43,0	104,0	20,0	1,5	–	–	–	47055	47063	47071
20,0	43,0	104,0	20,0	2,0	47138	–	47141	47056	47064	47072
20,0	43,0	104,0	20,0	2,5	–	–	–	47057	47065	47073
20,0	43,0	104,0	20,0	3,0	47139	–	47142	47058	47066	47074
20,0	43,0	104,0	20,0	4,0	–	–	–	47059	47067	47075
20,0	43,0	104,0	20,0	5,0	–	–	–	47060	47068	47076
25,0	28,0	100,0	25,0	1,0	–	–	–	47077	47084	47091
25,0	53,0	121,0	25,0	1,0	47143	–	47146	47078	47085	47092
25,0	53,0	121,0	25,0	2,0	47144	–	47147	47079	47086	47093
25,0	53,0	121,0	25,0	2,5	–	–	–	47080	47087	47094
25,0	53,0	121,0	25,0	3,0	47145	–	47148	47081	47088	47095
25,0	53,0	121,0	25,0	4,0	–	–	–	47082	47089	47096
25,0	53,0	121,0	25,0	5,0	–	–	–	47083	47090	47097

CARB-HPR
HIGH PERFORMANCE ROUGHER



	Series Z5, Z5CR 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	555	RPM	16961	8480	5654	4240	3392	2827	2120
						(444-666)	Fz	0.00046	0.0012	0.0023	0.0031	0.0034	0.0037	0.0043
							Feed (ipm)	39.0	50.9	65.0	65.7	57.7	52.3	45.6
			Slot	1	≤ 1	440	RPM	13446	6723	4482	3362	2689	2241	1681
						(352-528)	Fz	0.00046	0.0012	0.0023	0.0031	0.0034	0.0037	0.0043
							Feed (ipm)	30.9	40.3	51.5	52.1	45.7	41.5	36.1
	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	0.00034	0.0009	0.0017	0.0023	0.0026	0.0028	0.0032
							Feed (ipm)	16.4	21.7	27.3	27.7	25.0	22.5	19.3
			Slot	1	≤ 1	250	RPM	7640	3820	2547	1910	1528	1273	955
						(200-300)	Fz	0.00034	0.0009	0.0017	0.0023	0.0026	0.0028	0.0032
							Feed (ipm)	13.0	17.2	21.6	22.0	19.9	17.8	15.3
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	0.00028	0.0007	0.0014	0.0018	0.0020	0.0022	0.0026
							Feed (ipm)	7.9	9.9	13.2	12.7	11.3	10.4	9.2
			Slot	1	≤ 1	145	RPM	4431	2216	1477	1108	886	739	554
						(116-174)	Fz	0.00028	0.0007	0.0014	0.0018	0.0020	0.0022	0.0026
							Feed (ipm)	6.2	7.8	10.3	10.0	8.9	8.1	7.2
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	0.00042	0.0011	0.0021	0.0028	0.0031	0.0034	0.0039
							Feed (ipm)	28.6	37.4	47.6	47.6	42.2	38.5	33.1
			Slot	1	≤ 1	355	RPM	10849	5424	3616	2712	2170	1808	1356
						(284-426)	Fz	0.00042	0.0011	0.0021	0.0028	0.0031	0.0034	0.0039
							Feed (ipm)	22.8	29.8	38.0	38.0	33.6	30.7	26.4
	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	0.00031	0.0008	0.0016	0.0021	0.0023	0.0025	0.0029
							Feed (ipm)	16.1	21.8	27.7	27.3	23.9	21.6	18.8
			Slot	1	≤ 1	270	RPM	8251	4126	2750	2063	1650	1375	1031
						(216-324)	Fz	0.00031	0.0008	0.0016	0.0021	0.0023	0.0025	0.0029
							Feed (ipm)	12.8	17.3	22.0	21.7	19.0	17.2	15.0
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	0.00034	0.0009	0.0017	0.0023	0.0026	0.0028	0.0032
							Feed (ipm)	25.5	33.7	42.4	43.1	38.9	34.9	29.9
			Slot	1	≤ 1	390	RPM	11918	5959	3973	2980	2384	1986	1490
						(312-468)	Fz	0.00034	0.0009	0.0017	0.0023	0.0026	0.0028	0.0032
							Feed (ipm)	20.3	26.8	33.8	34.3	31.0	27.8	23.8
	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	0.00027	0.0007	0.0014	0.0018	0.0020	0.0022	0.0025
							Feed (ipm)	14.0	18.2	24.2	23.4	20.8	19.0	16.2
			Slot	1	≤ 1	270	RPM	8251	4126	2750	2063	1650	1375	1031
						(216-324)	Fz	0.00027	0.0007	0.0014	0.0018	0.0020	0.0022	0.0025
							Feed (ipm)	11.1	14.4	19.3	18.6	16.5	15.1	12.9
	STAINLESS STEELS (PH) 13-8 PH, 15-5PH, 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	0.00027	0.0007	0.0014	0.0018	0.0020	0.0022	0.0025
							Feed (ipm)	12.8	16.6	22.1	21.3	18.9	17.4	14.8
			Slot	1	≤ 1	250	RPM	7640	3820	2547	1910	1528	1273	955
						(200-300)	Fz	0.00027	0.0007	0.0014	0.0018	0.0020	0.0022	0.0025
							Feed (ipm)	10.3	13.4	17.8	17.2	15.3	14.0	11.9

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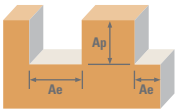
CARB-HPR
HIGH PERFORMANCE ROUGHER



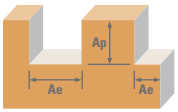
Series Z5, Z5CR Fractional	Hardness		Ae x D_1	Ap x D_1	Vc (sfm)		Diameter (D_1) (inch) 1/8	1/4	3/8	1/2	5/8	3/4	1
S													
SUPER ALLOYS (NICKEL , COBALT, IRON BASE) Inconel 601, 617, 625, Incoloy, Monel 400	≤ 300 Bhn or ≤ 32 HRc	Profile	≤ 0.5	≤ 1.5	80	RPM	2445	1222	815	611	489	407	306
					(64-96)	Fz	0.00025	0.00068	0.00128	0.00170	0.00187	0.00204	0.00238
						Feed (ipm)	3.1	4.2	5.2	5.2	4.6	4.2	3.6
		Slot	1	≤ 1	65	RPM	1986	993	662	497	397	331	248
					(52-78)	Fz	0.00025	0.00068	0.00128	0.00170	0.00187	0.00204	0.00238
						Feed (ipm)	2.5	3.4	4.2	4.2	3.7	3.4	3.0
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	0.00018	0.00048	0.00090	0.00120	0.00130	0.00140	0.00170
						Feed (ipm)	1.7	2.3	2.8	2.8	2.5	2.2	2.0
		Slot	1	≤ 1	50	RPM	1528	764	509	382	306	255	191
					(40-60)	Fz	0.00018	0.00048	0.00090	0.00120	0.00130	0.00140	0.00170
						Feed (ipm)	1.4	1.8	2.3	2.3	2.0	1.8	1.6
TITANIUM ALLOYS Pure Ttanium, 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	0.0022	0.0024	0.0028
						Feed (ipm)	9.9	13.1	16.4	16.4	14.5	13.1	11.5
		Slot	1	≤ 1	170	RPM	5195	2598	1732	1299	1039	866	649
					(136-204)	Fz	0.0003	0.0008	0.0015	0.0020	0.0022	0.0024	0.0028
						Feed (ipm)	7.8	10.4	13.0	13.0	11.4	10.4	9.1
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	0.0022	0.0024	0.0028
						Feed (ipm)	3.4	4.6	5.7	5.7	5.0	4.6	4.0
		Slot	1	≤ 1	60	RPM	1834	917	611	458	367	306	229
					(48-72)	Fz	0.0003	0.0008	0.0015	0.0020	0.0022	0.0024	0.0028
						Feed (ipm)	2.8	3.7	4.6	4.6	4.0	3.7	3.2

Note:

- Bhn (Brinell) HRc (Rockwell C)
- rpm = Vc x 3.82 / D_1
- ipm = Fz x 5 x rpm
- ramp at 5 degrees or less, using slotting speed and feed rates (do not plunge)
- 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)

SGS TOOL WIZARD

CARB-HPR
HIGH PERFORMANCE ROUGHER



	Series Z5MCR Metric	Hardness		Ae x D_1	Ap x D_1	Vc (m/min)		Diameter (D_1) (mm) 6	8	10	12	16	20	25
P	CARBON STEELS 1018, 1040, 1080, 1090, 10L50, 1140, 1212, 12L15, 1525, 1536	≤ 275 Bhn or ≤ 28 HRc	Profile	≤ 0.5	≤ 1.5	169	RPM	8967	6725	5380	4484	3363	2690	2152
						(135-203)	Fz	0.029	0.049	0.061	0.074	0.087	0.099	0.108
							Feed (mm/min)	1291	1650	1650	1668	1463	1327	1157
			Slot	1	≤ 1	134	RPM	7109	5332	4265	3555	2666	2133	1706
						(107-161)	Fz	0.029	0.049	0.061	0.074	0.087	0.099	0.108
							Feed (mm/min)	1024	1308	1308	1322	1160	1052	917
	ALLOY STEELS 4140, 4150, 4320, 5120, 5150, 8630, 86L20, 50100	≤ 375 Bhn or ≤ 40 HRc	Profile	≤ 0.5	≤ 1.5	96	RPM	5089	3817	3054	2545	1909	1527	1221
						(77-115)	Fz	0.022	0.036	0.045	0.055	0.067	0.075	0.080
							Feed (mm/min)	550	692	692	702	635	570	489
			Slot	1	≤ 1	76	RPM	4039	3029	2424	2020	1515	1212	969
						(61-91)	Fz	0.022	0.036	0.045	0.055	0.067	0.075	0.080
							Feed (mm/min)	436	549	549	557	504	452	388
H	TOOL STEELS A2, D2, H13, L2, M2, P20, S7, T15, W2	≤ 375 Bhn or ≤ 40 HRc	Profile	≤ 0.5	≤ 1.5	56	RPM	2989	2242	1793	1495	1121	897	717
						(45-68)	Fz	0.017	0.030	0.037	0.043	0.051	0.059	0.065
							Feed (mm/min)	251	335	335	323	287	263	233
			Slot	1	≤ 1	44	RPM	2343	1757	1406	1171	879	703	562
						(35-53)	Fz	0.017	0.030	0.037	0.043	0.051	0.059	0.065
							Feed (mm/min)	197	262	262	253	225	206	183
K	CAST IRONS (LOW & MEDIUM ALLOY) Gray, Malleable, Ductile	≤ 220 Bhn or ≤ 19 HRc	Profile	≤ 0.5	≤ 1.5	136	RPM	7190	5392	4314	3595	2696	2157	1726
						(109-163)	Fz	0.026	0.045	0.056	0.067	0.079	0.091	0.098
							Feed (mm/min)	949	1208	1208	1208	1070	978	841
			Slot	1	≤ 1	108	RPM	5736	4302	3441	2868	2151	1721	1377
						(87-130)	Fz	0.026	0.045	0.056	0.067	0.079	0.091	0.098
							Feed (mm/min)	757	964	964	964	853	780	671
	CAST IRONS (HIGH ALLOY) Gray, Malleable, Ductile	≤ 260 Bhn or ≤ 26 HRc	Profile	≤ 0.5	≤ 1.5	104	RPM	5493	4120	3296	2747	2060	1648	1318
						(83-124)	Fz	0.020	0.034	0.043	0.050	0.059	0.067	0.073
							Feed (mm/min)	554	703	703	692	606	549	478
			Slot	1	≤ 1	82	RPM	4362	3272	2617	2181	1636	1309	1047
						(66-99)	Fz	0.020	0.034	0.043	0.050	0.059	0.067	0.073
							Feed (mm/min)	440	558	558	550	482	436	380
M	STAINLESS STEELS (FREE MACHINING) 303, 416, 420F, 430F, 440F	≤ 275 Bhn or ≤ 28 HRc	Profile	≤ 0.5	≤ 1.5	149	RPM	7917	5938	4750	3958	2969	2375	1900
						(119-179)	Fz	0.022	0.036	0.045	0.055	0.067	0.075	0.080
							Feed (mm/min)	855	1077	1077	1092	988	887	760
			Slot	1	≤ 1	119	RPM	6301	4726	3781	3151	2363	1890	1512
						(95-143)	Fz	0.022	0.036	0.045	0.055	0.067	0.075	0.080
							Feed (mm/min)	680	857	857	869	786	706	605
	STAINLESS STEELS (DIFFICULT) 304, 304L, 316, 316L	≤ 275 Bhn or ≤ 28 HRc	Profile	≤ 0.5	≤ 1.5	104	RPM	5493	4120	3296	2747	2060	1648	1318
						(83-124)	Fz	0.017	0.030	0.037	0.043	0.051	0.059	0.063
							Feed (mm/min)	461	615	615	593	527	483	412
			Slot	1	≤ 1	82	RPM	4362	3272	2617	2181	1636	1309	1047
						(66-99)	Fz	0.017	0.030	0.037	0.043	0.051	0.059	0.063
							Feed (mm/min)	366	489	489	471	419	384	327
	STAINLESS STEELS (PH) 13-8 PH, 15-5PH, 17-4 PH, CUSTOM 450	≤ 325 Bhn or ≤ 35 HRc	Profile	≤ 0.5	≤ 1.5	94	RPM	5009	3756	3005	2504	1878	1503	1202
						(76-113)	Fz	0.017	0.030	0.037	0.043	0.051	0.059	0.063
							Feed (mm/min)	421	561	561	541	481	441	376
			Slot	1	≤ 1	76	RPM	4039	3029	2424	2020	1515	1212	969
						(61-91)	Fz	0.017	0.030	0.037	0.043	0.051	0.059	0.063
							Feed (mm/min)	339	452	452	436	388	355	303

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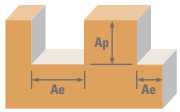

Series Z5MCR Metric	Hardness		Ae x D_1	Ap x D_1	Vc (m/min)		Diameter (D_1) (mm)						
S	**SUPER ALLOYS (NICKEL , COBALT, IRON BASE) Inconel 601, 617, 625, Incoloy, Monel 400**	≤ 300 Bhn or ≤ 32 HRc	Profile	≤ 0.5	≤ 1.5	24	RPM	1293	969	776	646	485	388	310
						(20-29)	Fz	0.0160	0.0272	0.0340	0.0409	0.0478	0.0531	0.0599
							Feed (mm/min)	103	132	132	132	116	103	93
			Slot	1	≤ 1	20	RPM	1050	788	630	525	394	315	252
						(16-24)	Fz	0.0160	0.0272	0.0340	0.0409	0.0478	0.0531	0.0599
							Feed (mm/min)	84	107	107	107	94	84	75
	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	1002	751	601	501	376	301	240
						(15-23)	Fz	0.0112	0.0192	0.0239	0.0284	0.0333	0.0371	0.0420
							Feed (mm/min)	56	72	72	71	63	56	50
			Slot	1	≤ 1	15	RPM	808	606	485	404	303	242	194
						(12-18)	Fz	0.0112	0.0192	0.0239	0.0284	0.0333	0.0371	0.0420
							Feed (mm/min)	45	58	58	57	50	45	41
	TITANIUM ALLOYS Pure Ttanium, Ti6Al4V, Ti6Al2Sn4Zr2Mo, Ti4Al4Mo2Sn0.5Si	≤ 350 Bhn or ≤ 38 HRc	Profile	≤ 0.5	≤ 1.5	66	RPM	3474	2605	2084	1737	1303	1042	834
						(52-79)	Fz	0.019	0.032	0.040	0.048	0.056	0.064	0.070
							Feed (mm/min)	333	417	417	417	367	333	292
			Slot	1	≤ 1	52	RPM	2747	2060	1648	1373	1030	824	659
						(41-62)	Fz	0.019	0.032	0.040	0.048	0.056	0.064	0.070
							Feed (mm/min)	264	330	330	330	290	264	231
	TITANIUM ALLOYS (DIFFICULT) Ti10Al2Fe3Al, Ti5Al5V5Mo3Cr, Ti7Al4Mo, Ti3Al8V6Cr4Zr4Mo, Ti6Al6V6Sn, Ti15V3 Cr3Sn3Al	≤ 440 Bhn or ≤ 47 HRc	Profile	≤ 0.5	≤ 1.5	23	RPM	1212	909	727	606	454	364	291
						(18-27)	Fz	0.019	0.032	0.040	0.048	0.056	0.064	0.071
							Feed (mm/min)	116	145	145	145	128	116	103
			Slot	1	≤ 1	18	RPM	969	727	582	485	364	291	233
						(15-22)	Fz	0.019	0.032	0.040	0.048	0.056	0.064	0.071
							Feed (mm/min)	93	116	116	116	102	93	83

Note:
- Bhn (Brinell) HRc (Rockwell C)
- rpm = (Vc x 1000) / (D_1 x 3.14)
- mm/min = Fz x 5 x rpm
- ramp at 5 degrees or less, using slotting speed and feed rates (do not plunge)
- 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)

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