MILLSTAR® Cutting Edge Solutions

Aggressive Recommendations for HSC Milling with Millstar Ball Nose End Mills (inch)

1. Prerequisites: Maximum tool extension length to tool shank diameter L/D = 5/1. Use a rigid machine, part and set-up.
2. For finishing with small step-over/pick feed (a_e), use a feed per tooth (f_z) equal to step-over: $f_z = a_e$ (Small step-over is defined as a_e = 2% of tool diameter D or less).
3. On longer tool extension (max. L/shank D = 7/1): reduce feed and speed to 60%
4. Use of coolant: for all stainless steel (SS) use through the spindle or flood coolant (9 -10% concentration). This will lubricate and not only cool the cutting edge for longer tool life, reduced chip welding and better the finish. Vegetable based oil mist works best in MQL/mist use. For gray cast iron use air or coolant. For all other die/mold materials use air-mist (MQL) or air blow, air blow only over 40 HRc.

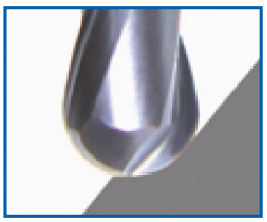
The recommendations are for aggressive cutting with Millstar ball nose tools and coatings as shown in table 1 and tool engagement shown below. When tip cutting only on flat surfaces, feed rate and spindle speed may be increased by up to 30%. For other materials or for specific application cases, contact the factory with as much detail as possible.

Table 1

Work Material Specifications USA / W.-Nr. / JIS	Material Hardness HRc	Cutting depth a_p maximum	Cutting width a_e maximum	Recommended Coating Type	Recommended Cutting speed range at D V_c (m/minute)
H13 / 1.2344 / SKD61	< 41	0.10 D	0.45 D	TLN-Exalon	800 - 1200
H13 / 1.2344 / SKD61	41-54	0.06 D	0.40 D	TLN-Exalon	800 - 1200
H13 / 1.2344 / SKD61	55 +	0.05 D	0.35 D	TLN-Exalon	600
A2 / 1.2363 / SKD12	< 41	0.10 D	0.40 D	TLN-Exalon	800 - 1200
A2 / 1.2363 / SKD12	41-54	0.06 D	0.40.D	TLN-Exalon	600 - 800
A2 / 1.2363 / SKD12	55 +	0.05 D	0.35 D	TLN-Exalon	600 - 800
P 20 / 1.2330	< 41	0.10 D	0.45 D	TLN-Exalon	800 - 1200
P 20 / 1.2330	41-54	0.06 D	0.40 D	TLN-Exalon	600 - 800
D 2 / DieVar/1.2379 / SKD11	< 41	0.10 D	0.45 D	TLN-Exalon	600 - 800
D 2 / DieVar/1.2379 / SKD11	41-54	0.06 D	0.40 D	TLN-Exalon	600 - 800
D 2 / DieVar/1.2379 / SKD11	55 +	0.05 D	0.35 D	TLN-Exalon	345 - 460
NAK 55	< 41	0.10 D	0.45 D	TLN-Exalon	600 - 1200
NAK 80	< 41	0.10 D	0.40 D	TLN-Exalon	600 - 1200
4130 - 4150	< 41	0.10 D	0.45 D	TLN-Exalon	600 - 1200
Finkl FX1 & 2		0.12 D	0.45 D	TLN-Exalon	800 - 1500
PX5		0.12 D	0.45 D	TLN-Exalon	1200 - 1500
Gray Cast Iron / GG	< 41	0.20 D	0.75 D	TLN-Exalon	1150 - 3000
Cast Iron / GGG	41+	0.06D	0.40 D	TLN-Exalon	820 - 1300
400 series stainless	< 41	0.10 D	0.45 D	TLN-Exalon	600 - 3000
400 series stainless	41-54	0.08 D	0.40 D	TLN-Exalon	600 - 1200
300 series stainless	< 41	0.10 D	0.45 D	TLN-Exalon	345 - 800
CPM 9V & 10V	< 41	0.10 D	0.40 D	TLN-Exalon	600 - 1200
CPM 9V & 10V	41+	0.06 D	0.35 D	TLN-Exalon	350 - 800
Titanium (6Al 4V)		0.10 D	0.45 D	TLN-Exalon	600 - 1200

Tip Cutting

Slope Cutting



Side Cutting

Aggressive Recommendations for HSC Milling with Millstar Ball Nose End Mills (inch)

Recommended Chip Load (Feed per Tooth f_z) with Millstar Ball Nose End Mills Series "BI..EX"

Table 2

Tool Number	Cutter Ø D (inch)	Die & Mold Steel 30 - 40 HRc		Die & Mold Steel 41 - 54 HRc		Die & Mold Steel 55 - 63 HRc	
		Roughing	Finishing	Roughing	Finishing	Roughing	Finishing
BI .020 EX	.020	.0004 - .0005	.0003 - .0004	.0003 - .0004	.00024 - .00032	.00024 - .00032	.0002 - .00024
BI .031 EX	.031	.0006 - .0008	.0006 - .0006	.0006 - .0006	.0004 - .0005	.0004 - .0005	.0003 - .0005
BI .062 EX	.062	.0012 - .0016	.0010 - .0012	.0010 - .0012	.0007 - .0010	.0007 - .0010	.0005 - .0007
BI .093 EX	.093	.0019 - .0023	.0015 - .0019	.0015 - .0019	.0011 - .0015	.0011 - .0015	.0007 - .0011
BI .125 EX	.125	.0025 - .0031	.0020 - .0025	.0020 - .0025	.0015 - .0020	.0015 - .0020	.0010 - .0015
BI .187 EX	.187	.0037 - .0047	.0030 - .0037	.0030 - .0037	.0022 - .0030	.0022 - .0030	.0015 - .0022
BI .250 EX	.250	.0050 - .0063	.0040 - .0050	.0040 - .0050	.0030 - .0040	.0030 - .0040	.0020 - .0030
BI .312 EX	.312	.0062 - .0078	.0050 - .0062	.0050 - .0062	.0037 - .0050	.0037 - .0050	.0025 - .0037
BI .375 EX	.375	.0075 - .0095	.0060 - .0075	.0060 - .0075	.0045 - .0060	.0045 - .0060	.0030 - .0045
BI .437 EX	.437	.0087 - .0110	.0070 - .0088	.0070 - .0088	.0052 - .0070	.0052 - .0070	.0035 - .0052
BI .500 EX	.500	.0100 - .0125	.0080 - .0100	.0080 - .0100	.0060 - .0080	.0060 - .0080	.0040 - .0060

Note: The recommended feed per tooth (f_z) values shown in Table 2 are good starting values for HSC and hard milling with Millstar ball nose tools. Specific application parameters may require lower f_z values or may enable higher values

Recommended Range of Spindle Speeds (RPM/min[1])

Table 3

Tool Number	Cutter Ø D (inch)	Die & Mold Steel 30 - 40 HRc		Die & Mold Steel 41 - 54 HRc		Die & Mold Steel 55 - 63 HRc	
		Roughing	Finishing	Roughing	Finishing	Roughing	Finishing
BI .020 EX	.020	20,000-40,000+	20,000-40,000+	20,000-40,000+	20,000-40,000+	20,000-40,000+	20,000-40,000+
BI .031 EX	.031	20,000-40,000+	20,000-40,000+	20,000-40,000+	20,000-40,000+	20,000-40,000+	20,000-40,000+
BI .062 EX	.062	20,000-40,000+	20,000-40,000+	20,000-40,000+	20,000-29,700+	20,000-40,000+	20,000-40,000+
BI .093 EX	.093	19,500-40,000+	20,000-40,000+	20,000-29,500	20,000-35,000+	18,000-32,800	20,000-29,500+
BI .125 EX	.125	14,500-36,650	20,000-30,100+	20,000-22,000	20,000-23,400+	13,400-24,450	20,000-22,000+
BI .187 EX	.187	9,700 - 24,500	20,000+	9,400-16,350	14,700+	9,000-16,300	14,700+
BI .250 EX	.250	7,250 - 18,350	15,000+	7,000-12,250	11,000+	6,700-12,200	11,000+
BI .312 EX	.312	5,800 - 14,700	12,000+	5,600-9,800	8,500+	5,400-9,800	8,800+
BI .375 EX	.375	4,850 - 12,250	10,000+	4,650-8,150	7,300+	4,500-8,150	6,300+
BI .437 EX	.437	4,150 - 10,500	8,600+	4,000-7,000	6,300+	4,850-7,000	7,300+
BI .500 EX	.500	3,650 - 9,200	7,500+	3,500-6,100	5,500+	3,350-6,100	5,500+

Note: If the lowest recommended spindle speed (RPM) in table 3 is higher than the machine's capability, use the maximum spindle speed available on the machine.

Recommendations are for most die/mold steels. Certain tough to machine steels use lower values: see Table 1 for specific cutting speed values or consult our database.

Specific application parameters may allow higher spindle speeds than recommended; please check with our application specialists for specific case parameter recommendations. For more information and specific case reports visit our web site: www.millstar.com