

MILLSTAR® Cutting Edge Solutions

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

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. $L/\text{shank } D = 7/1$): 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.

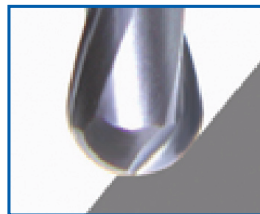
Table 1

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	244 - 365
H13 / 1.2344 /SKD61	41-54	0.06 D	0.40 D	TLN-Exalon	244 - 365
H13 / 1.2344 /SKD61	55 +	0.05 D	0.35 D	TLN-Exalon	185
A2 / 1.2363 /SKD12	< 41	0.10 D	0.40 D	TLN-Exalon	244 - 365
A2 / 1.2363 /SKD12	41-54	0.06 D	0.40.D	TLN-Exalon	183 - 244
A2 / 1.2363 /SKD12	55 +	0.05 D	0.35 D	TLN-Exalon	183 - 244
P 20 / 1.2330	< 41	0.10 D	0.45 D	TLN-Exalon	244 - 365
P 20 / 1.2330	41-54	0.06 D	0.40 D	TLN-Exalon	183 - 244
D 2 / 1.2379 / SKD11	< 41	0.10 D	0.45 D	TLN-Exalon	183 - 244
D 2 / 1.2379 / SKD11	41-54	0.06 D	0.40 D	TLN-Exalon	183 - 244
D 2 / 1.2379 / SKD11	55 +	0.05 D	0.35 D	TLN-Exalon	105 - 140
NAK 55	< 41	0.10D	0.45D	TLN-Exalon	183 - 365
NAK 80	< 41	0.10D	0.40D	TLN-Exalon	183 - 365
Gray Cast Iron / GG / FC	< 41	0.20 D	0.75 D	TLN-Exalon	350 - 900
Cast Iron / GGG / FCD	41+	0.06D	0.40 D	TLN-Exalon	250 - 400
400 series stainless steel	< 41	0.10D	0.45D	TLN-Exalon	183 - 915
400 series stainless steel	41-54	0.08D	0.40D	TLN-Exalon	183 - 365
300 series stainless steel	< 41	0.10D	0.45D	TLN-Exalon	105 - 244
4140 / 1.7225 / SCM440	< 41	0.10D	0.45D	TLN-Exalon	183 - 365
Titanium (6Al 4V)		0.10 D	0.45 D	TLN-Exalon	183 - 365

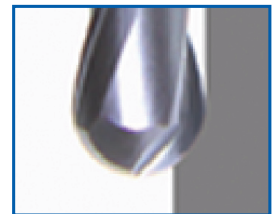
Tip Cutting



Slope Cutting



Side Cutting



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

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

Table 2

Tool Number	Cutter Ø D (mm)	Die & Mold Steel 30 - 40 HRC		Die & Mold Steel 41 - 54 HRC		Die & Mold Steel 55 - 63 HRC	
		Roughing	Finishing	Roughing	Finishing	Roughing	Finishing
BM 0.5 EX	0.5	0.010 - 0.013	0.008 - 0.010	0.008 - 0.010	0.006 - 0.008	0.006 - 0.008	0.004 - 0.006
BM 1.0 EX	1.0	0.020 - 0.025	0.016 - 0.020	0.016 - 0.020	0.012 - 0.016	0.012 - 0.016	0.008 - 0.012
BM 1.5 EX	1.5	0.030 - 0.038	0.024 - 0.030	0.024 - 0.030	0.018 - 0.024	0.018 - 0.024	0.012 - 0.018
BM 2.0 EX	2.0	0.040 - 0.050	0.032 - 0.040	0.032 - 0.040	0.024 - 0.032	0.024 - 0.032	0.016 - 0.024
BM 3.0 EX	3.0	0.060 - 0.075	0.048 - 0.060	0.048 - 0.060	0.036 - 0.048	0.036 - 0.048	0.024 - 0.036
BM 4.0 EX	4.0	0.080 - 0.100	0.064 - 0.080	0.064 - 0.080	0.048 - 0.064	0.048 - 0.064	0.032 - 0.048
BM 5.0 EX	5.0	0.100 - 0.125	0.080 - 0.100	0.080 - 0.100	0.060 - 0.080	0.060 - 0.080	0.040 - 0.060
BM 6.0 EX	6.0	0.120 - 0.150	0.096 - 0.120	0.096 - 0.120	0.072 - 0.096	0.072 - 0.096	0.048 - 0.072
BM 8.0 EX	8.0	0.160 - 0.200	0.128 - 0.160	0.128 - 0.160	0.096 - 0.128	0.096 - 0.128	0.064 - 0.096
BM 10.0 EX	10.0	0.200 - 0.250	0.160 - 0.200	0.160 - 0.200	0.120 - 0.160	0.120 - 0.160	0.080 - 0.120
BM 12.0 EX	12.0	0.240 - 0.300	0.192 - 0.240	0.192 - 0.240	0.144 - 0.192	0.144 - 0.192	0.096 - 0.144
BM 16.0 EX	16.0	0.320 - 0.400	0.256 - 0.320	0.256 - 0.320	0.192 - 0.256	0.192 - 0.256	0.128 - 0.192

Note: The recommended feed per tooth (f_z) values (mm) 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/min¹)

Table 3

Tool Number	Cutter Ø D (mm)	Die & Mold Steel 30 - 40 HRC		Die & Mold Steel 41 - 54 HRC		Die & Mold Steel 55 - 63 HRC	
		Roughing	Finishing	Roughing	Finishing	Roughing	Finishing
BM 0.5 EX	0.5	20,000 - 40,000+	20,000 - 40,000+	20,000 - 40,000+	20,000 - 40,000+	20,000 - 40,000+	20,000 - 40,000+
BM 1.0 EX	1.0	20,000 - 40,000+	20,000 - 40,000+	20,000 - 40,000+	20,000 - 40,000+	20,000 - 40,000+	20,000 - 40,000+
BM 1.5 EX	1.5	20,000 - 40,000+	20,000 - 40,000+	20,000 - 40,000+	20,000 - 29,700+	20,000 - 40,000+	20,000 - 29,700+
BM 2.0 EX	2.0	20,000 - 40,000+	20,000 - 40,000+	20,000 - 38,800	20,000 - 35,000+	20,000 - 38,800	20,000 - 35,000+
BM 3.0 EX	3.0	15,300 - 38,700	20,000 - 31,850+	14,850 - 25,900	20,000 - 23,400+	14,300 - 25,900	20,000 - 23,350+
BM 4.0 EX	4.0	11,500 - 29,000	20,000 - 23,800+	11,100 - 19,400	17,500+	10,700 - 19,400	17,500+
BM 5.0 EX	5.0	9,200 - 23,200	19,000+	8,900 - 15,500	14,000+	8,500 - 15,500	14,000+
BM 6.0 EX	6.0	7,700 - 19,350	15,900+	7,400 - 12,950	11,650+	7,150 - 12,950	11,650+
BM 8.0 EX	8.0	5,750 - 14,500	11,900+	5,550 - 9,700	8,750+	5,350 - 9,700	8,750+
BM 10.0 EX	10.0	4,600 - 11,600	9,550+	4,450 - 7,750	7,000+	4,300 - 7,760	7,000+
BM 12.0 EX	12.0	3,850 - 9,700	7,950+	3,700 - 6,500	5,800+	3,550 - 6,500	5,800+
BM 16.0 EX	16.0	2,850 - 7,250	5,950+	2,750 - 4,850	4,350+	2,650 - 4,850	4,350+

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