OSG PHOENIX®

PXBE/PXBM End Mills
P H Machining Guide

Roughing & Finishing (LDR 4xD)

For LDR Greater See LDR Notes

RPM/Spindle Speed

Material		Carbon/Alloy Steel (30-40 HRC)		Tool Steel (40-50 HRC)		Tool Steel (50-60 HRC)	
Diameter		Rough	Finish	Rough	Finish	Rough	Finish
Inch	mm						
0.375	-	7135 - 8670	7135 - 8670	4080 - 5600	4080 - 5600	2040 - 3310	2040 - 3310
-	10	6800 - 8250	6800 - 8250	3890 - 5340	3890 - 5340	1945 - 3155	1945 - 3155
-	12	5660 - 6875	5660 - 6875	3235 - 4450	3235 - 4450	1620 - 2630	1620 - 2630
0.500	-	5340 - 6500	5340 - 6500	3055 - 4200	3055 - 4200	1530 - 2485	1530 - 2485
0.625	-	4280 - 5200	4280 - 5200	2450 - 3360	2450 - 3360	1225 - 1985	1225 - 1985
-	16	4250 - 5150	4250 - 5150	2425 - 3335	2425 - 3335	1215 - 1970	1215 - 1970
0.750	-	3565 - 4330	3565 - 4330	2040 - 2800	2040 - 2800	1020 - 1655	1020 - 1655
-	20	3395 - 4125	3395 - 4125	1940 - 2670	1940 - 2670	970 - 1575	970 - 1575
1.000	-	2675 - 3250	2675 - 3250	1530 - 2100	1530 - 2100	765 - 1240	765 - 1240

Chip Load/Inch Per Tooth

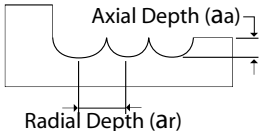
Material		Carbon/Alloy Steel (30-40 HRC)		Tool Steel (40-50 HRC)		Tool Steel (50-60 HRC)	
Diameter		Rough	Finish	Rough	Finish	Rough	Finish
Inch	mm						
0.375	-	0.0056 - 0.0070	0.0050 - 0.0063	0.0036 - 0.0045	0.0032 - 0.0040	0.0018 - 0.0023	0.0016 - 0.0020
-	10	0.0056 - 0.0070	0.0050 - 0.0063	0.0036 - 0.0045	0.0032 - 0.0040	0.0018 - 0.0023	0.0016 - 0.0020
-	12	0.0058 - 0.0072	0.0052 - 0.0065	0.0038 - 0.0047	0.0034 - 0.0042	0.0020 - 0.0025	0.0018 - 0.0022
0.500	-	0.0058 - 0.0072	0.0052 - 0.0065	0.0038 - 0.0047	0.0034 - 0.0042	0.0020 - 0.0025	0.0018 - 0.0022
0.625	-	0.0059 - 0.0074	0.0053 - 0.0067	0.0040 - 0.0050	0.0036 - 0.0045	0.0021 - 0.0026	0.0019 - 0.0023
-	16	0.0059 - 0.0074	0.0053 - 0.0067	0.0040 - 0.0050	0.0036 - 0.0045	0.0021 - 0.0026	0.0019 - 0.0023
0.750	-	0.0060 - 0.0075	0.0054 - 0.0068	0.0042 - 0.0052	0.0038 - 0.0047	0.0023 - 0.0028	0.0021 - 0.0025
-	20	0.0060 - 0.0075	0.0054 - 0.0068	0.0042 - 0.0052	0.0038 - 0.0047	0.0023 - 0.0028	0.0021 - 0.0025
1.000	-	0.0061 - 0.0076	0.0055 - 0.0069	0.0044 - 0.0054	0.0040 - 0.0049	0.0025 - 0.0030	0.0023 - 0.0027

Axial and Radial Depths

Material Hardness	Carbon/Alloy Steel (30-40 HRC)	Tool Steel (40-50 HRC)	Tool Steel (50-60 HRC)	Tool Steel (Over 60 HRC)
Axial Depth (aa)	10% of tool Dia. Max.	7% of tool Dia. Max.	5% of tool Dia. Max.	3% of tool Dia. Max.
Radial Depth (ar)	40% of tool Dia. Max.	35% of tool Dia. Max.	30% of tool Dia. Max.	25% of tool Dia. Max.

Length-to-Diameter Compensions

Overhang Length	Cutting Speed	Aa	Ar
LDR Under 4xD	100%	100%	100%
LDR 4xD to 6xD	60% - 80%	60% - 80%	100%
LDR 6xD to 10xD	40% - 60%	40% - 60%	100%

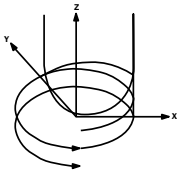


PXBE recommended for roughing and semi-finishing. PXBM recommended for finishing. Carbide shank recommended for LDR 6xD and above.

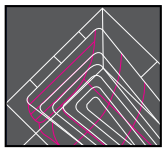
High Speed Machining Guide

Machining Tips

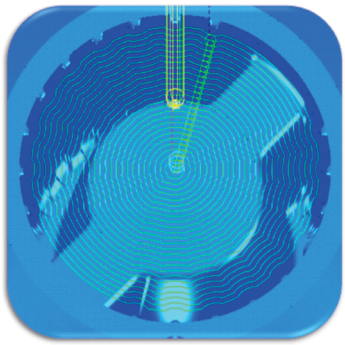
- Use Z-Level climb cutting for roughing operations.
- Use Helical for material engagement whenever possible. Use 3° ramp angle and 0.8xDiameter of cutter for the tool path arc.
- Add radiuses larger than cutter to corner of tool path for smooth operation.
- LDR should always be as short as possible.
- LDR of 4xD or less use chart on reverse side with high speed steel body.
- LDR of 6xD to 10xD use chart on reverse side with carbide body.
- **Machining is very difficult over 10xD.**
- Leave extra stock for semi-finishing to prevent gouging of surface when using long reach tools.
- Use air or oil mist for all applications except those involving gummy or sticky materials such as stainless, which machines well with water based coolant.



Helical Interpolation



Corner Rounding on Tool Path



Z-Level Machining with Climb Cutting is Highly Recommended

Diagnosing Problems

Insert Chipping - early during use means chip load too high, please reduce feed rate in increments of 20% until problem is resolved or shorten the length of the tool.

Insert Burning - of coating or glowing at the tip means RPM is too high. Reduce RPM by 20% increments until problem is resolved along with feed rate until excessive heat is subdued.

Chatter - excessive tool length is a primary cause. After reducing tool length if possible, lower RPM and feed rate until chatter is minimized.

Formulas

RPM = (3.82 x SFM) / Tool Diameter
SFM = 0.262 x RPM x Tool Diameter
IPM = RPM x # Flutes x Chip Load
Chip Load = IPM / (RPM x # Flutes)

Stock Left for Semi-Finishing

Medium parts 6" square to 24"

- No heat treat: leave 0.010" to 0.015" stock.
- Heat treat: leave 0.015" to 0.030" stock, depending on geometry.

Stock Left for Finishing

Medium parts 6" square to 24"

- Leave a minimum of 0.004" stock.

Finishing Tips for Surface Finishes

Ar = CL (Radial DOC = Chip Load)

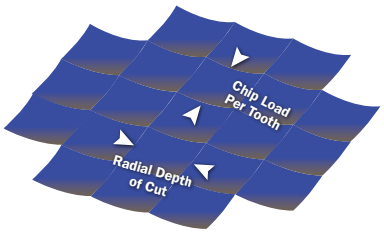
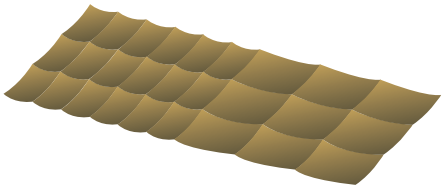


Fig. 1 (Above): Chip load and radial depth of cut must be equal to achieve best surface finish as shown.

Fig. 2 (Below): Shows non-symmetrical finish resulting from not using Ar = CL.



Radial DOC (Step Over) Calculation

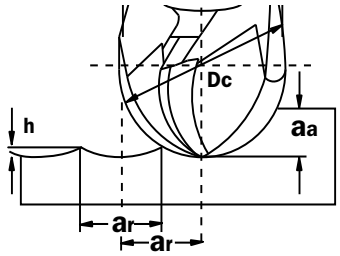
h= Cusp Height
r = Cutter Radius

$$Ar = \sqrt{hx8xr}$$

Radial DOC (Step Over) Example

50 RMS finish with $^{3}/_{8}$" Dia. BEM

h= 0.000050 (Cusp Height)
r = 0.1875"



$$Ar = \sqrt{0.000050 \times 8 \times 0.1875} = 0.0087"$$

Tool Dia.		Radial Depth or Step Over		Surface Finish (h)	
Inch	mm	Inch	mm	Inch	mm
0.250	6	0.0071	0.180	0.000050	0.00127
0.275	7	0.0074	0.188	0.000050	0.00127
0.312	8	0.0079	0.201	0.000050	0.00127
0.375	10	0.0087	0.225	0.000050	0.00127
0.500	12	0.0100	0.247	0.000050	0.00127
0.625	16	0.0112	0.285	0.000050	0.00127
0.750	20	0.0122	0.319	0.000050	0.00127
1.000	25	0.0141	0.356	0.000050	0.00127
1.187	30	0.0154	0.390	0.000050	0.00127
1.250	32	0.0158	0.402	0.000050	0.00127

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