M9 Series Application Guide (metric) • Speed & Feed

ISO Classification	Work Material	Type of Cut	Axial DOC	Radial DOC	Number of Flutes	Speed (M/Min)	Feed (MM per Tooth) 6,0	10,0	12,0	16,0	20,0	25,0
P	Low Carbon Steel	Slotting	1 x D	1 x D	4	107	0.0163	0.0325	0.0540	0.0650	0.0865	0.1079
	1018, 12L14, 8620	Peripheral - Rough	1.25 x D	.5 x D	4	130	0.0203	0.0406	0.0675	0.0813	0.1081	0.1349
		Peripheral - HEM	2 x D	.15 x D	4	160	0.0389	0.0778	0.1292	0.1556	0.2070	0.2583
		Finish	1.5 x D	.015 x D	4	152	0.0226	0.0451	0.0749	0.0903	0.1201	0.1499
	Medium Carbon Steels	Slotting	1 x D	1 x D	4	91	0.0152	0.0305	0.0506	0.0610	0.0811	0.1012
	4140, 4340	Peripheral - Rough	1.25 x D	.5 x D	4	114	0.0191	0.0381	0.0632	0.0762	0.1013	0.1265
		Peripheral - HEM	2 x D	.15 x D	4	145	0.0356	0.0711	0.1181	0.1423	0.1892	0.2362
		Finish	1.5 x D	.015 x D	4	137	0.0212	0.0423	0.0702	0.0846	0.1126	0.1405
	Martensitic Stainless Steel	Slotting	.75 x D	1 x D	4	91	0.0150	0.0299	0.0497	0.0599	0.0796	0.0994
	416, 410, 440C	Peripheral - Rough	1.25 x D	.3 x D	4	114	0.0187	0.0374	0.0621	0.0748	0.0995	0.1242
		Peripheral - HEM	2 x D	.15 x D	4	145	0.0356	0.0711	0.1181	0.1423	0.1892	0.2362
		Finish	1.5 x D	.015 x D	4	137	0.0190	0.0381	0.0632	0.0762	0.1013	0.1264
K	Cast Iron	Slotting	1 x D	1 x D	4	99	0.0152	0.0305	0.0506	0.0610	0.0811	0.1012
	Gray	Peripheral - Rough	1.25 x D	.5 x D	4	122	0.0191	0.0381	0.0632	0.0762	0.1013	0.1265
		Peripheral - HEM	2 x D	.15 x D	4	152	0.0333	0.0667	0.1107	0.1334	0.1774	0.2214
		Finish	1.5 x D	.015 x D	4	145	0.0212	0.0423	0.0702	0.0846	0.1126	0.1405
	Cast Iron	Slotting	1 x D	1 x D	4	91	0.0137	0.0274	0.0455	0.0549	0.0730	0.0911
	Ductile	Peripheral - Rough	1.25 x D	.5 x D	4	114	0.0171	0.0343	0.0569	0.0686	0.0912	0.1138
		Peripheral - HEM	2 x D	.15 x D	4	145	0.0278	0.0556	0.0923	0.1111	0.1478	0.1845
		Finish	1.5 x D	.015 x D	4	137	0.0190	0.0381	0.0632	0.0762	0.1013	0.1264
	Cast Iron	Slotting	.75 x D	1 x D	4	76	0.0137	0.0274	0.0455	0.0549	0.0730	0.0911
	Malleable	Peripheral - Rough	1.25 x D	.5 x D	4	99	0.0171	0.0343	0.0569	0.0686	0.0912	0.1138
		Peripheral - HEM	2 x D	.15 x D	4	130	0.0278	0.0556	0.0923	0.1111	0.1478	0.1845
		Finish	1.5 x D	.015 x D	4	122	0.0190	0.0381	0.0632	0.0762	0.1013	0.1264
M	Austenitic Stainless Steels	Slotting	.75 x D	1 x D	4	84	0.0166	0.0333	0.0552	0.0665	0.0885	0.1104
	303, 304, 316	Peripheral - Rough	1.25 x D	.3 x D	4	99	0.0208	0.0416	0.0690	0.0831	0.1106	0.1380
		Peripheral - HEM	2 x D	.10 x D	4	130	0.0397	0.0794	0.1318	0.1588	0.2111	0.2635
		Finish	1.5 x D	.015 x D	4	122	0.0212	0.0423	0.0702	0.0846	0.1126	0.1405
	Precipition Hardening Stainless Steels	Slotting	.5 x D	1 x D	4	76	0.0127	0.0255	0.0423	0.0510	0.0678	0.0846
	17-4 PH, 15-5 PH, 13-8 PH	Peripheral - Rough	1.25 x D	.3 x D	4	91	0.0159	0.0319	0.0529	0.0637	0.0848	0.1058
		Peripheral - HEM	1.5 x D	.1 x D	4	122	0.0331	0.0661	0.1098	0.1323	0.1759	0.2196
		Finish	1.5 x D	.015 x D	4	114	0.0162	0.0324	0.0539	0.0649	0.0863	0.1077
H	Tool & Die Steels < 48 Rc	Slotting	.75 x D	1 x D	4	91	0.0150	0.0299	0.0497	0.0599	0.0796	0.0994
	A2, D2, H13, P20	Peripheral - Rough	1.25 x D	.3 x D	4	114	0.0187	0.0374	0.0621	0.0748	0.0995	0.1242
		Peripheral - HEM	2 x D	.15 x D	4	145	0.0300	0.0600	0.0996	0.1200	0.1597	0.1993
		Finish	1.5 x D	.015 x D	4	137	0.0190	0.0381	0.0632	0.0762	0.1013	0.1264
S	Titanium Alloys	Slotting	.5 x D	1 x D	4	76	0.0127	0.0255	0.0423	0.0510	0.0678	0.0846
		Peripheral - Rough	1.25 x D	.3 x D	4	91	0.0159	0.0319	0.0529	0.0637	0.0848	0.1058
		Peripheral - HEM	1.5 x D	.10 x D	4	122	0.0304	0.0609	0.1010	0.1217	0.1619	0.2020
		Finish	1.5 x D	.015 x D	4	114	0.0162	0.0324	0.0539	0.0649	0.0863	0.1077
	High Temperature Alloys	Slotting	.25 x D	1 x D	4	18	0.0135	0.0270	0.0448	0.0540	0.0718	0.0896
	Inconel, Haynes, Stellite, Hastalloy	Peripheral - Rough	1.25 x D	.25 x D	4	27	0.0169	0.0337	0.0560	0.0675	0.0897	0.1120
		Peripheral - HEM	1.5 x D	.1 x D	4	69	0.0225	0.0450	0.0747	0.0900	0.1196	0.1493
		Finish	1.5 x D	.01 x D	4	38	0.0198	0.0396	0.0658	0.0793	0.1054	0.1316

D = Tool diameter

Common Machining Formulas

$$RPM = \frac{M/MIN \times 318.057}{D}$$

$$M/MIN = RPM \times D \times .00314$$

$$MM/MIN = RPM \times MMPT \times Z$$

$$MRR = RDOC \times ADOC \times MM/MIN$$

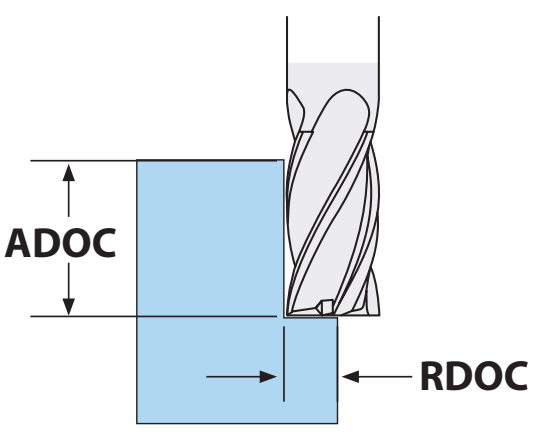
Radial Chip Thinning Adjustment

$$MMPT_{adj} = \frac{MMPT \times (D/2)}{\sqrt{(D \times RDOC) - RDOC^2}}$$

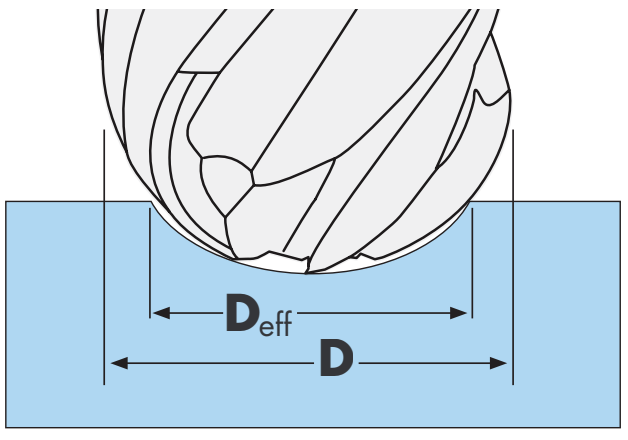
Ball Nose "Effective Diameter"

$$D_{eff} = 2x \sqrt{R^2 - (R - ADOC)^2}$$

D	Tool Cutting Diameter
R	Tool Radius
Z	Number of Flutes
RPM	Revolutions per Minute
M/MIN	Meters per Minute
MM/Min	Millimeters per Minute
MRR	Metal Removal Rate
RDOC	Radial Depth of Cut
ADOC	Axial Depth of Cut

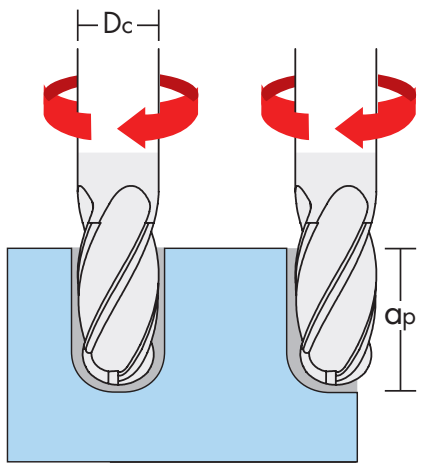


Apply chip thinning adjustment when RDOC < D



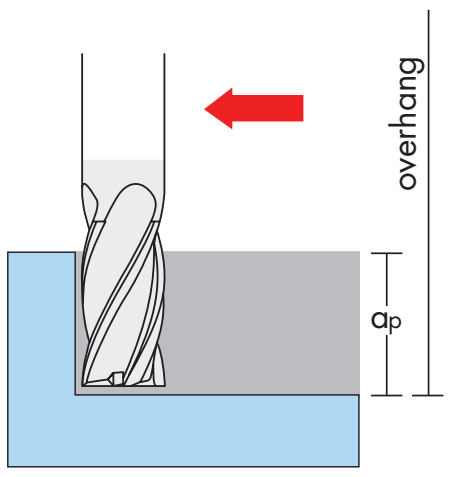
Use D_{eff} when making shallow cuts with full radius

Adjustments – Apply these adjustments when programming the following applications.



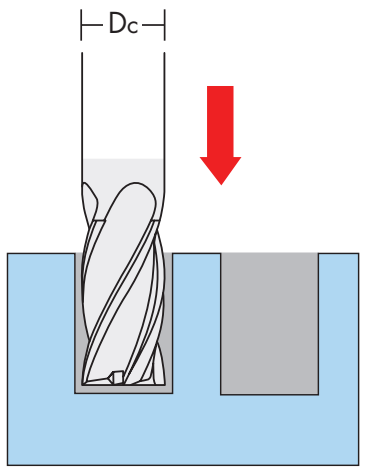
1. Ball nose end mills

- Reduce chip load by 25% from roughing/slotting recommendation when axial DOC (a_p) exceeds 75% of Dc



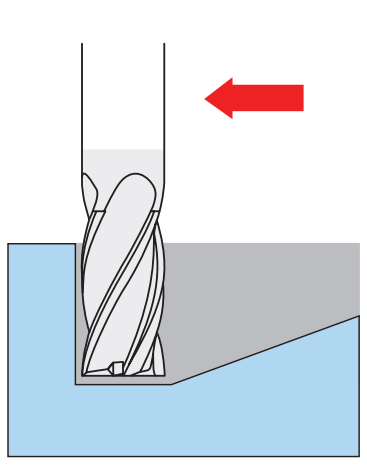
2. Long reach mills with large overhang

- Reduce speed rate and chip load by 20% each when total reach to tool diameter ratio is 5:1 or greater



3. Plunge entry into work piece

- Reduce chip load by 80% of recommended slotting rate
- Peck mill if axial DOC (ap) exceeds 50% of Dc



4. Ramp entry into work piece

- Ramp at 1.5°–2.5° angle
- Reduce chip load by 20% of recommended slotting rate