M9 Series Application Guide (inch) • Speed & Feed

ISO Classification	Work Material	Type of Cut	Axial DOC	Radial DOC	Number of Flutes	Speed (SFM)	Feed (Inches per Tooth) 1/8	1/4	3/8	1/2	5/8	3/4	1
P	Low Carbon Steel	Slotting	1 x D	1 x D	4	350	.0006	.0013	.0019	.0026	.0032	.0038	.0051
	1018, 12L14, 8620	Peripheral - Rough	1.25 x D	.5 x D	4	425	.0008	.0016	.0024	.0032	.0040	.0048	.0064
		Peripheral - HEM	2 x D	.15 x D	4	525	.0015	.0031	.0046	.0061	.0077	.0092	.0123
		Finish	1.5 x D	.015 x D	4	500	.0009	.0018	.0027	.0036	.0044	.0053	.0071
	Medium Carbon Steels	Slotting	1 x D	1 x D	4	300	.0006	.0012	.0018	.0024	.0030	.0036	.0048
	4140, 4340	Peripheral - Rough	1.25 x D	.5 x D	4	375	.0008	.0015	.0023	.0030	.0038	.0045	.0060
		Peripheral - HEM	2 x D	.15 x D	4	475	.0014	.0028	.0042	.0056	.0070	.0084	.0112
		Finish	1.5 x D	.015 x D	4	450	.0008	.0017	.0025	.0033	.0042	.0050	.0067
	Martensitic Stainless Steel	Slotting	.75 x D	1 x D	4	300	.0006	.0012	.0018	.0024	.0029	.0035	.0047
	416, 410, 440C	Peripheral - Rough	1.25 x D	.3 x D	4	375	.0007	.0015	.0022	.0029	.0037	.0044	.0059
		Peripheral - HEM	2 x D	.15 x D	4	475	.0014	.0028	.0042	.0056	.0070	.0084	.0112
		Finish	1.5 x D	.015 x D	4	450	.0007	.0015	.0022	.0030	.0037	.0045	.0060
K	Cast Iron	Slotting	1 x D	1 x D	4	325	.0006	.0012	.0018	.0024	.0030	.0036	.0048
	Gray	Peripheral - Rough	1.25 x D	.5 x D	4	400	.0008	.0015	.0023	.0030	.0038	.0045	.0060
		Peripheral - HEM	2 x D	.15 x D	4	500	.0013	.0026	.0039	.0053	.0066	.0079	.0105
		Finish	1.5 x D	.015 x D	4	475	.0008	.0017	.0025	.0033	.0042	.0050	.0067
	Cast Iron	Slotting	.75 x D	1 x D	4	300	.0005	.0011	.0016	.0022	.0027	.0032	.0043
	Ductile	Peripheral - Rough	1.25 x D	.5 x D	4	375	.0007	.0014	.0020	.0027	.0034	.0041	.0054
		Peripheral - HEM	2 x D	.15 x D	4	475	.0011	.0022	.0033	.0044	.0055	.0066	.0088
		Finish	1.5 x D	.015 x D	4	450	.0007	.0015	.0022	.0030	.0037	.0045	.0060
	Cast Iron	Slotting	.75 x D	1 x D	4	250	.0005	.0011	.0016	.0022	.0027	.0032	.0043
	Malleable	Peripheral - Rough	1.25 x D	.5 x D	4	325	.0007	.0014	.0020	.0027	.0034	.0041	.0054
		Peripheral - HEM	2 x D	.15 x D	4	425	.0011	.0022	.0033	.0044	.0055	.0066	.0088
		Finish	1.5 x D	.015 x D	4	400	.0007	.0015	.0022	.0030	.0037	.0045	.0060
M	Austenitic Stainless Steels	Slotting	.75 x D	1 x D	4	275	.0007	.0013	.0020	.0026	.0033	.0039	.0052
	303, 304, 316	Peripheral - Rough	1.25 x D	.3 x D	4	325	.0008	.0016	.0025	.0033	.0041	.0049	.0065
		Peripheral - HEM	2 x D	.1 x D	4	425	.0016	.0031	.0047	.0063	.0078	.0094	.0125
		Finish	1.5 x D	.015 x D	4	400	.0008	.0017	.0025	.0033	.0042	.0050	.0067
	Precipition Hardening Stainless Steels	Slotting	.5 x D	1 x D	4	250	.0005	.0010	.0015	.0020	.0025	.0030	.0040
	17-4 PH, 15-5 PH, 13-8 PH	Peripheral - Rough	1.25 x D	.3 x D	4	300	.0006	.0013	.0019	.0025	.0031	.0038	.0050
		Peripheral - HEM	1.5 x d	.1 x D	4	400	.0013	.0026	.0039	.0052	.0065	.0078	.0104
		Finish	1.5 x D	.015 x D	4	375	.0006	.0013	.0019	.0026	.0032	.0038	.0051
H	Tool & Die Steels < 48 Rc	Slotting	.75 x D	1 x D	4	300	.0006	.0012	.0018	.0024	.0029	.0035	.0047
	A2, D2, H13, P20	Peripheral - Rough	1.25 x D	.3 x D	4	375	.0007	.0015	.0022	.0029	.0037	.0044	.0059
		Peripheral - HEM	2 x D	.15 x D	4	475	.0012	.0024	.0035	.0047	.0059	.0071	.0095
		Finish	1.5 x D	.015 x D	4	450	.0007	.0015	.0022	.0030	.0037	.0045	.0060
S	Titanium Alloys	Slotting	.5 x D	1 x D	4	250	.0005	.0010	.0015	.0020	.0025	.0030	.0040
		Peripheral - Rough	1.25 x D	.3 x D	4	300	.0006	.0013	.0019	.0025	.0031	.0038	.0050
		Peripheral - HEM	1.5 x d	.1 x D	4	400	.0012	.0024	.0036	.0048	.0060	.0072	.0096
		Finish	1.5 x D	.015 x D	4	375	.0006	.0013	.0019	.0026	.0032	.0038	.0051
	High Temperature Alloys	Slotting	.25 x D	1 x D	4	60	.0005	.0011	.0016	.0021	.0027	.0032	.0042
	Inconel, Haynes, Stellite, Hastalloy	Peripheral - Rough	1.25 x D	.25 x D	4	90	.0007	.0013	.0020	.0027	.0033	.0040	.0053
		Peripheral - HEM	1.5 x d	.1 x D	4	225	.0009	.0018	.0027	.0035	.0044	.0053	.0071
		Finish	1.5 x D	.01 x D	4	125	.0008	.0016	.0023	.0031	.0039	.0047	.0062

D = Tool diameter

Common Machining Formulas

$$RPM = \frac{SFM \times 3.82}{D}$$

$$SFM = RPM \times D \times .262$$

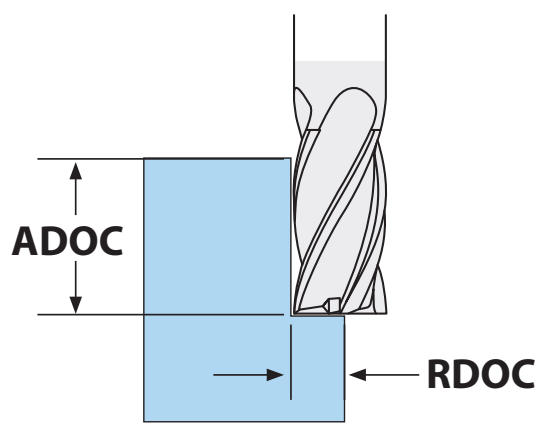
$$IPM = RPM \times IPT \times Z$$

$$MRR = RDOC \times ADOC \times IPM$$

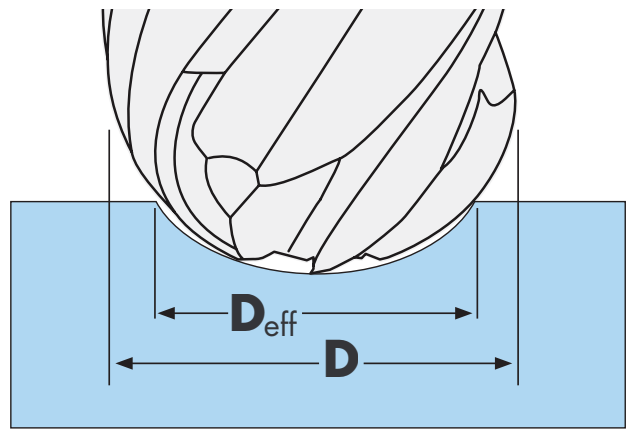
Radial Chip Thinning Adjustment $$IPT_{adj} = \frac{IPT \times (D/2)}{\sqrt{(D \times RDOC) - RDOC^2}}$$

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
SFM	Surface Feet per Minute
IPM	Inches per Minute
MRR	Metal Removal Rate
RDOC	Radial Depth of Cut
ADOC	Axial Depth of Cut

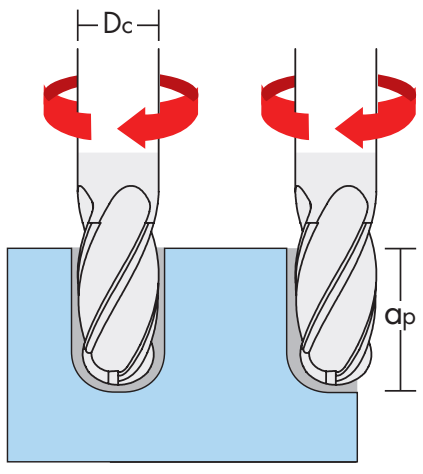


Apply chip thinning adjustment when RDOC < D



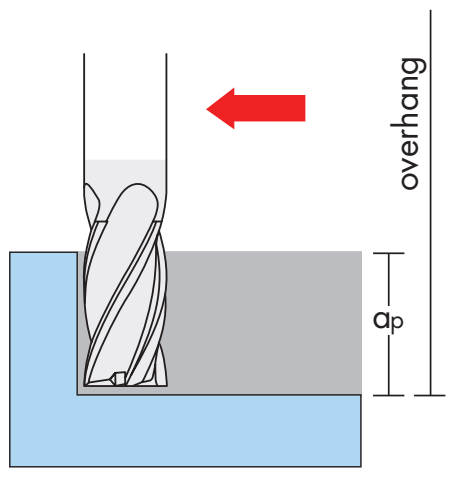
Use D_{eff} when making shallow cuts with full radius

Adjustments – Apply these adjustments when programming the following applications.



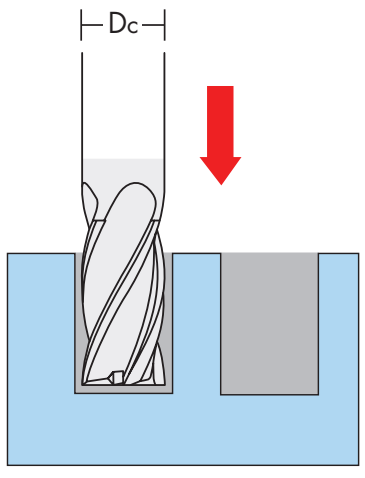
1. Ball nose end mills

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



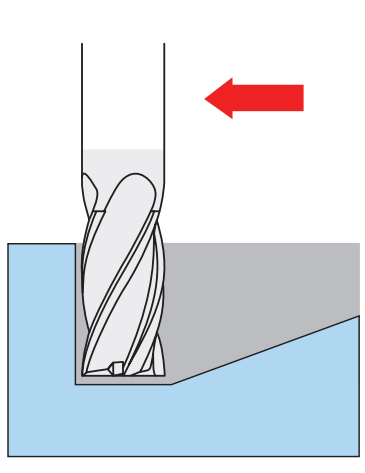
2. Long reach mills with large overhang

- 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