Ball Nose Milling Strategy

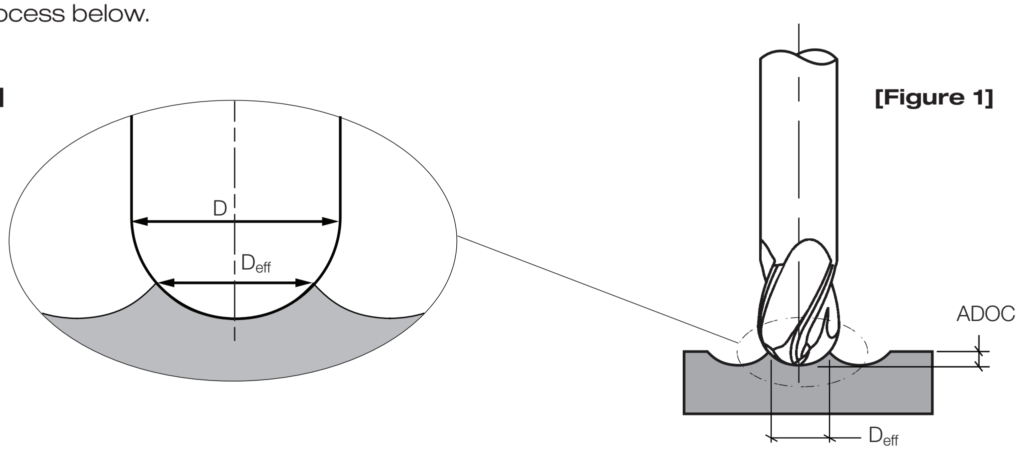
90°

Ball nose end mills are ideal for machining 3-dimensional contour shapes typically found in the die and mold industry, manufacturing of turbine blades and establishing general part radius requirements.

To properly employ a ball nose end mill (with no tilt angle) and gain the optimal tool life and part finish, is to follow the 2-step process below.

[Detail A]

[Figure 1]



Step One

Calculate Your Effective Cutting Diameter (D_{eff}) – Implemented when using a ball nose end mill that is utilizing a ADOC that is less than the full radius of the ball. This can be done using the chart below (see Figure 2) that represents some common tool diameters and ADOC combinations or by using the traditional calculation (see Figure 3).

[Figure 2]

		AXIAL DEPTH OF CUT (ADOC)														
		.010	**.020**	**.030**	**.050**	**.070**	**.090**	**.120**	**.150**	**.180**	**.220**	**.260**	**.300**	**.350**	**.400**	**.450**
TOOL DIAMETER	1/8	.068	.092	.107	.122	.124	.112	.049								
	1/4	.098	.136	.162	.200	.224	.240	.250	.245	.224	.162					
	3/8	.121	.169	.203	.255	.292	.320	.350	.367	.375	.369	.346	.300	.187		
	1/2	.140	.196	.237	.300	.347	.384	.427	.458	.480	.496	.500	.490	.458	.400	.300
	5/8	.157	.220	.267	.339	.394	.438	.492	.533	.565	.596	.615	.624	.620	.600	.561
	3/4	.172	.242	.294	.374	.436	.487	.550	.600	.641	.683	.714	.735	.748	.748	.735
	1	.199	.280	.341	.436	.510	.572	.650	.714	.768	.828	.877	.917	.954	.980	.995

[Figure 3]

$$D_{eff} = 2 \times \sqrt{ADOC \times (D-ADOC)}$$

Step Two

Calculate Your New Velocity Adjustment (V_{adj}) - This new velocity adjustment will be calculated using the new effective cutting diameter (D_{eff}). If you are using less than the cutter diameter, then its likely your RPM's will need to be adjusted upward (see Figure 4).

[Figure 4]

$$V_{adj} = \frac{SFM \times 3.82}{D_{eff}}$$

KEY

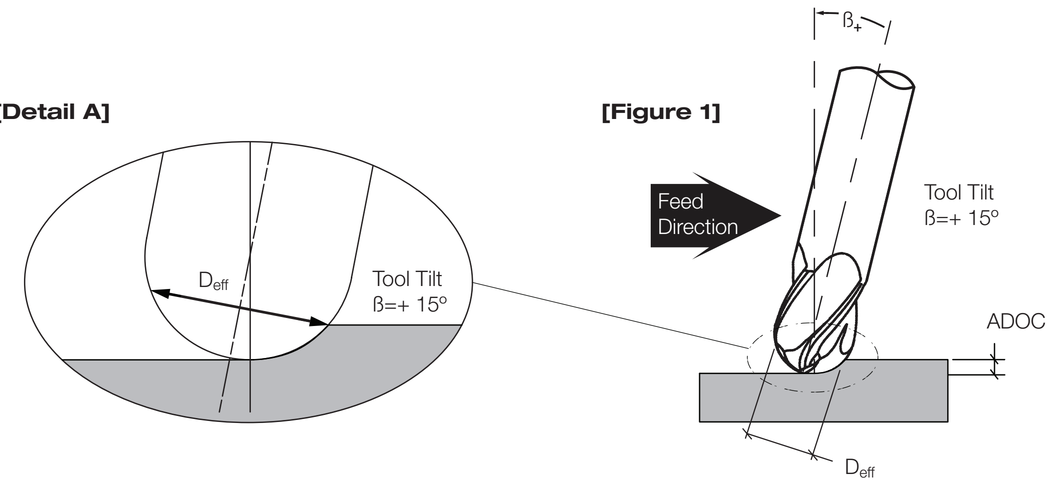
ADOC	=	Axial Depth of Cut
D	=	Cutting Diameter
D_{eff}	=	Effective Cutting Diameter
R	=	Tool Radius (Dia./2)
RDOC	=	Radial Depth of Cut
SFM	=	Surface Feet per Minute
V_{adj}	=	Adjusted Revolutions per Minute

Ball Nose Milling Strategy

At 15° Incline

It is highly recommended to use ball nose end mills on an incline (ß) to avoid a “0” SFM condition at the center of the tool, thus increasing tool life and part finish. For ball nose optimization (and in addition to tilting the tool), it is highly recommended to feed the tool in the direction of the incline and utilize a climb milling technique.

[Detail A] **[Figure 1]**



To properly employ a ball nose end mill (with a tool angle) and gain the most optimum tool life and part finish is to follow the 2-step process below.

Step One

Calculate Your Effective Cutting Diameter (D_{eff}) - To be implemented when using a ball nose end mill that is utilizing a ADOC that is less than the full radius of the ball. This can be done using the chart below (see Figure 2) that represents some common tool diameters & ADOC’s at 15° tilt angle or by using the traditional calculation (see Figure 3).

[Figure 2]

15° Tilt		AXIAL DEPTH OF CUT (ADOC)															
		.010	**.020**	**.030**	**.050**	**.070**	**.090**	**.120**	**.150**	**.180**	**.220**	**.260**	**.300**	**.350**	**.400**	**.450**	**.500**
TOOL DIAMETER	1/8	.093	.111	.120	.125	.116	.094	.018									
	1/4	.154	.185	.206	.232	.245	.250	.244	.224	.188	.108						
	3/8	.209	.249	.278	.317	.343	.360	.373	.374	.366	.340	.297	.232	.097			
	1/2	.259	.308	.343	.393	.428	.454	.480	.494	.500	.495	.477	.447	.391	.309	.186	
	5/8	.308	.364	.404	.463	.506	.539	.575	.600	.615	.625	.622	.610	.580	.534	.471	.386
	3/4	.355	.417	.463	.530	.579	.618	.663	.696	.720	.740	.749	.749	.736	710	.671	.618
	1	.446	.519	.573	.654	.715	.765	.824	.871	.908	.945	.972	.989	.999	.998	.987	.966

[Figure 3]

$$D_{eff} = D \times \text{sine}\left[\beta + \arccos\left(\frac{D-2 \times ADOC}{D}\right)\right]$$

D_{eff} = Effective Cutting Diameter
R = Tool Radius
ADOC = Axial Depth of Cut

Step Two

Calculate Your New Velocity Adjustment (V_{adj}) - This new velocity adjustment will be calculated using the new effective cutting diameter (D_{eff}). If you are using less than the cutter diameter, then its likely your RPM’s will need to be adjusted upward (see Figure 4).

[Figure 4]

$$V_{adj} = \frac{SFM \times 3.82}{D_{eff}}$$

D_{eff} = Effective Cutting Diameter (see Figure 2)
SFM = Mfg Recommended Surface Feet per Minute
V_{adj} = Adjusted RPM for lighter ADOC