POW - R - ARC Application Guide – Speed & Feed (inch)

ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	No. of Flutes	Speed (SFM)	Feed (Inches per Tooth)				
							1/4	3/8	1/2	5/8	3/4
K	Cast Iron- Gray ASTM-A48 Class 20, 25,30,35 & 40	Ball 3D Roughing	0.50 x D	0.080 x D	6 , 8	470	.00125	.00188	.0025	.00313	.00375
		Ball Nose Slotting	0.040 x D	1.000 x D	6 , 8	450	.00170	.00255	.0034	.00425	.00510
		Finishing 3D Facing	0.03 x D	0.020 x D	6 , 8	550	.00200	.00300	.0040	.00500	.00600
		Peripheral Machining	2.50 x D	0.080 x D	6 , 8	430	.00200	.00300	.0040	.00500	.00600
	Cast Iron- Ductile	Ball 3D Roughing	0.50 x D	0.080 x D	6 , 8	440	.00115	.00173	.0023	.00288	.00345
		Ball Nose Slotting	0.040 x D	1.000 x D	6 , 8	390	.00150	.00225	.0030	.00375	.00450
		Finishing 3D Facing	0.03 x D	0.020 x D	6 , 8	535	.00180	.00270	.0036	.00450	.00540
		Peripheral Machining	2.50 x D	0.080 x D	6 , 8	420	.00165	.00248	.0033	.00413	.00495
	Cast Iron- Malleable	Ball 3D Roughing	0.50 x D	0.080 x D	6 , 8	440	.00110	.00165	.0022	.00275	.00330
		Ball Nose Slotting	0.040 x D	1.000 x D	6 , 8	410	.00145	.00218	.0029	.00363	.00435
		Finishing 3D Facing	0.03 x D	0.020 x D	6 , 8	535	.00160	.00240	.0032	.00400	.00480
		Peripheral Machining	2.50 x D	0.080 x D	6 , 8	420	.00160	.00240	.0032	.00400	.00480
P	Low Carbon Steel ≤38 HRc 1018, 1020, 12L14, 5120, 8620	Ball 3D Roughing	0.50 x D	0.080 x D	6 , 8	505	.00115	.00173	.0023	.00288	.00345
		Ball Nose Slotting	0.040 x D	1.000 x D	6 , 8	500	.00175	.00263	.0035	.00438	.00525
		Finishing 3D Facing	0.03 x D	0.020 x D	6 , 8	585	.00195	.00293	.0039	.00488	.00585
		Peripheral Machining	2.50 x D	0.080 x D	6 , 8	520	.00205	.00308	.0041	.00513	.00615
	Medium Carbon Steel ≤48 HRc 1045, 4140, 4340, 5140	Ball 3D Roughing	0.50 x D	0.080 x D	6 , 8	470	.00110	.00165	.0022	.00275	.00330
		Ball Nose Slotting	0.040 x D	1.000 x D	6 , 8	470	.00155	.00233	.0031	.00388	.00465
		Finishing 3D Facing	0.03 x D	0.020 x D	6 , 8	550	.00180	.00270	.0036	.00450	.00540
		Peripheral Machining	2.50 x D	0.080 x D	6 , 8	485	.00200	.00300	.0040	.00500	.00600
	Tool & Die Steels ≤40 HRc A2, D2, O1, S7, P20, H13	Ball 3D Roughing	0.50 x D	0.080 x D	6 , 8	450	.00100	.00150	.0020	.00250	.00300
		Ball Nose Slotting	0.040 x D	1.000 x D	6 , 8	425	.00150	.00225	.0030	.00375	.00450
		Finishing 3D Facing	0.03 x D	0.020 x D	6 , 8	510	.00150	.00225	.0030	.00375	.00450
		Peripheral Machining	2.50 x D	0.075 x D	6 , 8	450	.00180	.00270	.0036	.00450	.00540
H	Tool & Die Steels 40-48 HRc	Ball 3D Roughing	0.50 x D	0.065 x D	6 , 8	380	.00085	.00128	.0017	.00213	.00255
		Ball Nose Slotting	0.030 x D	1.000 x D	6 , 8	375	.00110	.00165	.0022	.00275	.00330
		Finishing 3D Facing	0.02 x D	0.020 x D	6 , 8	450	.00135	.00203	.0027	.00338	.00405
		Peripheral Machining	2.00 x D	0.065 x D	6 , 8	400	.00110	.00165	.0022	.00275	.00330
M	Martensitic & Ferritic Stainless Steels 410, 416, 440	Ball 3D Roughing	0.50 x D	0.080 x D	6 , 8	520	.00080	.00120	.0016	.00200	.00240
		Ball Nose Slotting	0.040 x D	1.000 x D	6 , 8	465	.00145	.00218	.0029	.00363	.00435
		Finishing 3D Facing	0.03 x D	0.020 x D	6 , 8	540	.00180	.00270	.0036	.00450	.00540
		Peripheral Machining	2.50 x D	0.075 x D	6 , 8	490	.00205	.00308	.0041	.00513	.00615
	Austenitic Stainless Steels FeNi Alloys 303, 304, 316,Invar, Kovar	Ball 3D Roughing	0.50 x D	0.070 x D	6 , 8	500	.00075	.00113	.0015	.00188	.00225
		Ball Nose Slotting	0.040 x D	1.000 x D	6 , 8	425	.00130	.00195	.0026	.00325	.00390
		Finishing 3D Facing	0.03 x D	0.020 x D	6 , 8	510	.00165	.00248	.0033	.00413	.00495
		Peripheral Machining	2.50 x D	0.075 x D	6 , 8	490	.00185	.00278	.0037	.00463	.00555
	Precipitation Hardening Stainless Steel 17-4, 15-5, 13-8	Ball 3D Roughing	0.50 x D	0.080 x D	6 , 8	490	.00075	.00113	.0015	.00188	.00225
		Ball Nose Slotting	0.040 x D	1.000 x D	6 , 8	390	.00105	.00158	.0021	.00263	.00315
		Finishing 3D Facing	0.030 x D	0.020 x D	6 , 8	470	.00140	.00210	.0028	.00350	.00420
		Peripheral Machining	2.00 x D	0.065 x D	6 , 8	480	.00150	.00225	.0030	.00375	.00450

D = Tool Diameter

POW - R - ARC Application Guide – Speed & Feed (inch)

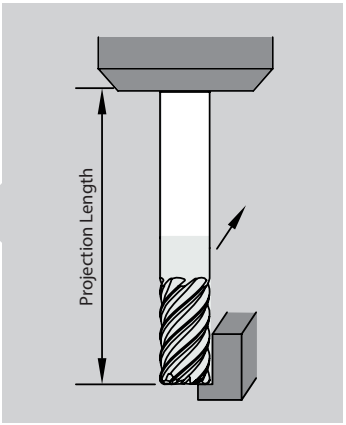
ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	No. of Flutes	Speed (SFM)	Feed (Inches per Tooth)				
							1/4	3/8	1/2	5/8	3/4
S	Titanium Alloys 6AL-4V, 6-2-4	Ball 3D Roughing	0.50 x D	0.080 x D	6 , 8	390	.00200	.00300	.0040	.00500	.00600
		Ball Nose Slotting	0.040 x D	1.000 x D	6 , 8	395	.00100	.00150	.0020	.00250	.00300
		Finishing 3D Facing	0.030 x D	0.020 x D	6 , 8	450	.00130	.00195	.0026	.00325	.00390
		Peripheral Machining	2.50 x D	0.080 x D	6 , 8	440	.00200	.00300	.0040	.00500	.00600
	Difficult to machine titanium alloys 10-2-3	Ball 3D Roughing	0.45 x D	0.070 x D	6 , 8	320	.00175	.00263	.0035	.00438	.00525
		Ball Nose Slotting	0.035 x D	1.000 x D	6 , 8	322	.00075	.00113	.0015	.00188	.00225
		Finishing 3D Facing	0.030 x D	0.020 x D	6 , 8	380	.00115	.00173	.0023	.00288	.00345
		Peripheral Machining	2.50 x D	0.080 x D	6 , 8	400	.00175	.00263	.0035	.00438	.00525
	Nickel Based Super Alloys Hastalloy, Waspalloy	Ball 3D Roughing	0.50 x D	0.065 x D	6 , 8	325	.00150	.00225	.0030	.00375	.00450
		Ball Nose Slotting	0.030 x D	1.000 x D	6 , 8	352	.00800	.01200	.0160	.02000	.02400
		Finishing 3D Facing	0.025 x D	0.020 x D	6 , 8	390	.00120	.00180	.0024	.00300	.00360
		Peripheral Machining	2.50 x D	0.080 x D	6 , 8	325	.00150	.00225	.0030	.00375	.00450
	Nickel Chromium based Super Alloys Inconel 718, Rene 88	Ball 3D Roughing	0.50 x D	0.075 x D	6 , 8	200	.00200	.00300	.0040	.00500	.00600
		Ball Nose Slotting	0.025 x D	1.000 x D	6 , 8	110	.00070	.00105	.0014	.00175	.00210
		Finishing 3D Facing	0.025 x D	0.020 x D	6 , 8	125	.00170	.00255	.0034	.00425	.00510
		Peripheral Machining	1.50 x D	0.070 x D	6 , 8	200	.00175	.00263	.0035	.00438	.00525
N	Aluminum alloys 2024, 6061, 7075	Ball 3D Roughing	0.50 x D	0.050 x D	6 , 8	1200	.00200	.00300	.0040	.00500	.00600
		Ball Nose Slotting	0.040 x D	1.000 x D	6 , 8	1200	.00180	.00270	.0036	.00450	.00540
		Finishing 3D Facing	0.03 x D	0.020 x D	6 , 8	1500	.00150	.00225	.0030	.00375	.00450
		Peripheral Machining	2.50 x D	0.070 x D	6 , 8	1400	.00150	.00225	.0030	.00375	.00450
	High Silicon Aluminum alloys A380, A390	Ball 3D Roughing	0.50 x D	0.050 x D	6 , 8	965	.00210	.00315	.0042	.00525	.00630
		Ball Nose Slotting	0.040 x D	1.000 x D	6 , 8	900	.00190	.00285	.0038	.00475	.00570
		Finishing 3D Facing	0.03 x D	0.020 x D	6 , 8	1150	.00150	.00225	.0030	.00375	.00450
		Peripheral Machining	2.50 x D	0.070 x D	6 , 8	1200	.00155	.00233	.0031	.00388	.00465
	Magnesium alloys	Ball 3D Roughing	0.50 x D	0.050 x D	6 , 8	1200	.00200	.00300	.0040	.00500	.00600
		Ball Nose Slotting	0.040 x D	1.000 x D	6 , 8	1200	.00180	.00270	.0036	.00450	.00540
		Finishing 3D Facing	0.03 x D	0.020 x D	6 , 8	1400	.00150	.00225	.0030	.00375	.00450
		Peripheral Machining	2.50 x D	0.070 x D	6 , 8	1400	.00150	.00225	.0030	.00375	.00450
	Copper alloys, Brass	Ball 3D Roughing	0.50 x D	0.050 x D	6 , 8	720	.00190	.00285	.0038	.00475	.00570
		Ball Nose Slotting	0.040 x D	1.000 x D	6 , 8	825	.00170	.00255	.0034	.00425	.00510
		Finishing 3D Facing	0.030 x D	0.020 x D	6 , 8	860	.00140	.00210	.0028	.00350	.00420
		Peripheral Machining	2.50 x D	0.070 x D	6 , 8	1100	.00130	.00195	.0026	.00325	.00390
	Bronze	Ball 3D Roughing	0.50 x D	0.050 x D	6 , 8	715	.00185	.00278	.0037	.00463	.00555
		Ball Nose Slotting	0.040 x D	1.000 x D	6 , 8	825	.00165	.00248	.0033	.00413	.00495
		Finishing 3D Facing	0.030 x D	0.020 x D	6 , 8	855	.00125	.00188	.0025	.00313	.00375
		Peripheral Machining	2.50 x D	0.070 x D	6 , 8	1000	.00125	.00188	.0025	.00313	.00375
	Composites, Plastics, Fiberglass	Ball 3D Roughing	0.50 x D	0.050 x D	6 , 8	1100	.00210	.00315	.0042	.00525	.00630
		Ball Nose Slotting	0.040 x D	1.000 x D	6 , 8	900	.00190	.00285	.0038	.00475	.00570
		Finishing 3D Facing	0.03 x D	0.020 x D	6 , 8	1400	.00155	.00233	.0031	.00388	.00465
		Peripheral Machining	2.50 x D	0.070 x D	6 , 8	1200	.00200	.00300	.0040	.00500	.00600

D = Tool Diameter

ADJUSTMENTS FOR LONG REACH APPLICATIONS

Using long-length tools increases the amount of tool projection from the tool holder and the spindle. As the tool projection increases so does the amount of tool deflection. Tool deflection causes chatter, resulting in poor surface finish and reduced tool life. Tool options that help minimize tool deflection in long projection applications are:

- Use a larger diameter tool for the operation. Larger tools have larger cores, which reduces deflection.
- Use a tool with a necked shank, which shortens the flute length and increases the core strength of the end mill.



Speed and feed adjustments for long tool projections:

Adjustments must be made to reduce chatter and maximize tool life when using long length tools. The adjustments below are based on the total amount of tool projection and use the speed and feed data found in the application charts for each tool series.

Projection	SFM / MMPM	Feed
> 1.25 to 3 x D	SFM or M/min x .95	IPT or MMPT x .95
> 3 to 4 x D	SFM or M/min x .90	IPT or MMPT x .90
> 4 to 5 x D	SFM or MMPM x .80	IPT or MMPT x .80
> 5 to 6 x D	SFM or MMPM x .70	IPT or MMPT x .70

D = Tool diameter
IPT = Inch per tooth
MMPT = Millimeter per tooth
SFM = Surface feet per minute
MPM = Millimeters per minute

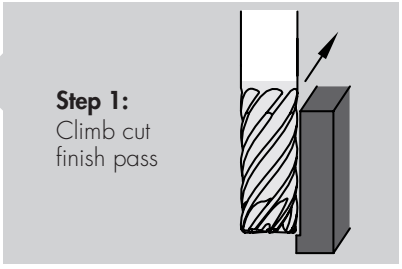
IMPORTANT NOTES: No adjustments are necessary when using the speed and feed data for HEM tool paths found in the charts for any of the POW•R•PATH and enDURO end mills. Use the data directly from the charts. This applies only when using HEM tool paths.

The M223 and M233 have the long projections adjustments already incorporated into the speed and feed charts for those series. Use the data directly from the charts with no adjustments for long projections.

Tool Tip: Eliminate Wall Taper When Finishing.

STEP 1:

Run a climb cut finish pass using speed, feed and step-over values (RDOC) from the speed and feed charts. Adjust for tool projection if needed.



STEP 2:

Re-run the path using the same speeds and feeds but in a conventional cut direction. Simply retrace the prior finish pass; do not program to remove more stock. This skim pass, traveling in the opposite direction of the first pass, will help eliminate wall taper caused by tool deflection during the first pass.