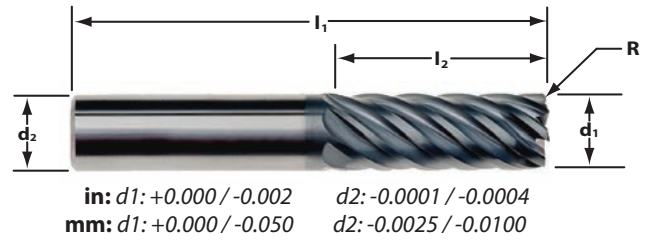


IPT9 POW•R•PATH



For high-efficiency machining (HEM) in materials ranging from low carbon steels to hi-temp alloys. The IPT9 POW•R•PATH end mill is engineered specifically for HEM tool paths with great core strength and 9 flutes for increased feed rates and excellent surface finishes. The unique design runs up to 3.5 x the tool diameter deep, generating high metal removal rates.



Cutter Dia d1	Shank Dia d2	Max Axial Depth xD	Length of Cut L2	Overall Length L1	Order Code by Corner Radius			
					.015 CR	.030 CR	.060 CR	.125 CR
1/4	1/4	2	1/2	2	0340488	0340489	-	-
		2.5	5/8	2-1/2	0340490	0340491	-	-
		3	3/4	2-1/2	0340492	0340493	-	-
		3.5	7/8	3	0340494	0340495	-	-
3/8	3/8	2	3/4	2-1/2	0340496	0340497	-	-
		2.5	15/16	2-1/2	0340498	0340499	-	-
		3	1-1/8	3	0340500	0340501	-	-
		3.5	1-5/16	3-1/2	0340502	0340503	-	-
1/2	1/2	2	1	3	-	0340504	0340505	-
		2.5	1-1/4	3-1/4	-	0340506	0340507	-
		3	1-1/2	3-1/2	-	0340508	0340509	-
		3.5	1-3/4	4	-	0340510	0340511	-
5/8	5/8	2	1-1/4	3-1/2	-	0340512	0340513	-
		2.5	1-9/16	4	-	0340514	0340515	-
		3	1-7/8	4	-	0340516	0340517	-
		3.5	2-3/16	4-1/2	-	0340518	0340519	-
3/4	3/4	2	1-1/2	4	-	0340520	0340521	0340522
		2.5	1-7/8	4-1/2	-	0340523	0340524	0340525
		3	2-1/4	5	-	0340526	0340527	0340528
		3.5	2-5/8	5	-	0340529	0340530	0340531
1	1	2	2	5	-	0340532	0340533	0340534
		2.5	2-1/2	5-1/2	-	0340535	0340536	0340537
		3	3	6	-	0340538	0340539	0340540
		3.5	3-1/2	6-1/2	-	0340541	0340542	0340543

D = Tool Diameter

Cutter Dia d1	Shank Dia d2	Max Axial Depth xD	Length of Cut l2	Overall Length l1	Order Code by Corner Radius			
					0.5 CR	1.0 CR	1.5 CR	3.0 CR
6	6	2	12	57	0340787	0340788	-	-
		2.5	15	57	0340789	0340790	-	-
		3	18	63	0340791	0340792	-	-
		3.5	21	75	0340793	0340794	-	-
8	8	2.5	20	63	0340795	0340796	-	-
		3	24	63	0340797	0340798	-	-
		3.5	28	75	0340799	0340800	-	-
10	10	2	20	66	0340801	0340802	-	-
		2.5	25	72	0340803	0340804	-	-
		3	30	75	0340805	0340806	-	-
		3.5	35	88	0340807	0340808	-	-
12	12	2	24	75	-	0340809	0340810	-
		2.5	30	83	-	0340811	0340812	-
		3	36	88	-	0340813	0340814	-
		3.5	42	93	-	0340815	0340816	-
16	16	2	32	92	-	0340817	0340818	-
		2.5	40	100	-	0340819	0340820	-
		3	48	110	-	0340821	0340822	-
		3.5	56	110	-	0340823	0340824	-
20	20	2	40	104	-	0340825	0340826	0340827
		2.5	50	115	-	0340828	0340829	0340830
		3	60	125	-	0340831	0340832	0340833
		3.5	70	135	-	0340834	0340835	0340836
25	25	2	50	120	-	0340837	-	0340838
		2.5	63	135	-	0340839	-	0340840
		3	75	150	-	0340841	-	0340842
		3.5	88	165	-	0340843	-	0340844

D = Tool Diameter

TOOL TIP

Determining Power Requirements.

It can be helpful to understand the power requirements for an application. The following formulas calculate spindle and motor horsepower and spindle torque.

STEP 1: Metal Removal Rate (MRR) =
(Tool Feed Rate) x Radial DOC x Axial DOC

STEP 2: Spindle HP = Metal Removal Rate x UHP

STEP 3: Motor HP = Spindle HP / Efficiency

STEP 4: Spindle Torque (ft. lbs.) =
(Spindle HP x 63,030) / RPM

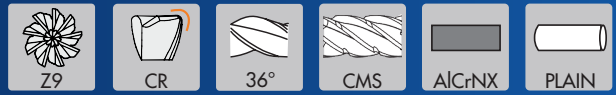
UHP Factors Rating

Material	Factor
Aluminum	0.3
Cast iron	0.8
Carbon steel	1
Alloy steel	1.1
Mold steel	1.2
Tool steel	1.2
Stainless steel	1.5
Titanium	1.8
Hi-temp alloys	2

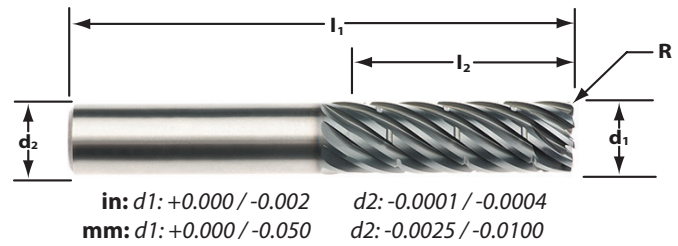
Efficiency Ratings

Spindle Type	%
Direct drive	90%
Gear drive	85%
2 Belt	70%
1 Belt	50%
Average	80%

IPC9 POW•R•PATH



For high-efficiency machining (HEM) in materials ranging from low carbon steels to hi-temp alloys. Adds the benefits of the unique **Chip Management System (CMS)** to the versatility of the IPT9 design. Breaks up long, stringy chips, which eliminates recutting chips and chip packing, and allows for deep, free cutting tool movement in a variety of materials.



Cutter Dia d1	Shank Dia d2	Max Axial Depth xD	Length of Cut I2	Overall Length I1	Order Code by Corner Radius		
					.030 CR	.060 CR	.125 CR
1/2	1/2	2	1	3	0340389	-	-
		2.5	1-1/4	3-1/4	0340555	-	-
		3	1-1/2	3-1/2	0340393	0340475	-
		3.5	1-3/4	4	0340544	0340476	-
5/8	5/8	2	1-1/4	3-1/2	0340397	-	-
		2.5	1-9/16	4	0340545	0340477	-
		3	1-7/8	4	0340401	0340478	-
		3.5	2-3/16	4-1/2	0340546	0340479	-
3/4	3/4	2	1-1/2	4	0340405	0340480	0340406
		2.5	1-7/8	4-1/2	0340547	0340481	0340548
		3	2-1/4	5	0340409	0340482	0340410
		3.5	2-5/8	5	0340411	0340483	0340412
1	1	2	2	5	0340549	0340484	0340550
		2.5	2-1/2	5-1/2	0340551	0340485	0340552
		3	3	6	0340417	0340486	0340418
		3.5	3-1/2	6-1/2	0340553	0340487	0340554

Cutter Dia d1	Shank Dia d2	Max Axial Depth xD	Length of Cut I2	Overall Length I1	Order Code by Corner Radius		
					1.0 CR	1.5 CR	3.0 CR
12	12	2	24	75	0340605	-	-
		2.5	30	83	0340445	-	-
		3	36	88	0340606	0340845	-
		3.5	42	93	0340607	0340846	-
16	16	2	32	92	0340608	-	-
		2.5	40	100	0340609	0340847	-
		3	48	110	0340610	0340848	-
		3.5	56	110	0340457	0340849	-
20	20	2	40	104	0340459	0340850	0340460
		2.5	50	115	0340611	0340851	0340612
		3	60	125	0340463	0340852	0340464
		3.5	70	135	0340613	0340853	0340614
25	25	2	50	120	0340467	-	0340468
		2.5	63	135	0853501	-	0853502
		3	75	150	0340471	-	0340472
		3.5	88	165	0853505	-	0853507

D = Tool Diameter

IPT9/IPC9 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	1
K	Gray ASTM-A48 Class 20, 25, 30, 35 & 40	Peripheral - HEM	≤ 3 x D	.1 x D	9	400	.0036	.0054	.0072	.0090	.0108	.0144
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	400	.0032	.0049	.0065	.0081	.0097	.0130
		Peripheral - HEM	> 4 - 5 x D	.08 x D	9	390	.0029	.0043	.0058	.0072	.0086	.0115
		Finish	3 x D	.015 x D	9	450	.0013	.0020	.0026	.0033	.0039	.0052
	Cast Iron Malleable	Peripheral - HEM	≤ 3 x D	.08 x D	9	390	.0029	.0044	.0058	.0073	.0087	.0116
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	390	.0026	.0039	.0052	.0065	.0078	.0104
		Peripheral - HEM	> 4 - 5 x D	.08 x D	9	375	.0023	.0035	.0046	.0058	.0070	.0093
		Finish	3 x D	.015 x D	9	350	.0011	.0016	.0021	.0026	.0032	.0042
P	Low Carbon Steels ≤ 38 Rc 1018, 1020, 12L14, 5120, 8620	Peripheral - HEM	≤ 3 x D	.08 x D	9	485	.0038	.0056	.0075	.0094	.0113	.0150
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	485	.0034	.0051	.0068	.0084	.0101	.0135
		Peripheral - HEM	> 4 - 5 x D	.08 x D	9	465	.0030	.0045	.0060	.0075	.0090	.0120
		Finish	3 x D	.015 x D	9	420	.0014	.0021	.0028	.0035	.0042	.0056
	Medium Carbon Steels ≤ 48 HRC 1045, 4140, 4340, 5140	Peripheral - HEM	≤ 3 x D	.08 x D	9	450	.0036	.0053	.0071	.0089	.0107	.0142
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	450	.0032	.0048	.0064	.0080	.0096	.0128
		Peripheral - HEM	> 4 - 5 x D	.08 x D	9	425	.0028	.0043	.0057	.0071	.0085	.0114
		Finish	3 x D	.015 x D	9	390	.0013	.0019	.0025	.0031	.0038	.0050
	Tool and Die Steels ≤ 48 Rc A2, D2, O1, S7, P20, H13	Peripheral - HEM	≤ 3 x D	.08 x D	9	420	.0032	.0048	.0064	.0080	.0096	.0128
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	420	.0029	.0043	.0058	.0072	.0086	.0115
		Peripheral - HEM	> 4 - 5 x D	.08 x D	9	395	.0026	.0038	.0051	.0064	.0077	.0102
		Finish	3 x D	.015 x D	9	365	.0011	.0016	.0021	.0026	.0032	.0042
M	Martensitic & Ferritic Stainless Steels 410, 416, 440	Peripheral - HEM	≤ 3 x D	.08 x D	9	450	.0038	.0056	.0075	.0094	.0113	.0150
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	450	.0034	.0051	.0068	.0084	.0101	.0135
		Peripheral - HEM	> 4 - 5 x D	.08 x D	9	425	.0030	.0045	.0060	.0075	.0090	.0120
		Finish	3 x D	.015 x D	9	390	.0013	.0019	.0025	.0031	.0038	.0050
	Austenitic Stainless Steels, FeNi Alloys 303, 304, 316, Invar, Kovar	Peripheral - HEM	≤ 3 x D	.08 x D	9	450	.0032	.0048	.0064	.0080	.0096	.0128
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	440	.0029	.0043	.0058	.0072	.0086	.0115
		Peripheral - HEM	> 4 - 5 x D	.07 x D	9	425	.0026	.0038	.0051	.0064	.0077	.0102
		Finish	3 x D	.015 x D	9	390	.0012	.0018	.0024	.0030	.0036	.0048
	Precipitation Hardening Stainless Steels 17-4, 15-5	Peripheral - HEM	≤ 3 x D	.08 x D	9	440	.0031	.0047	.0062	.0078	.0093	.0124
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	440	.0028	.0042	.0056	.0070	.0084	.0112
		Peripheral - HEM	> 4 - 5 x D	.07 x D	9	415	.0025	.0037	.0050	.0062	.0074	.0099
		Finish	3 x D	.015 x D	9	380	.0010	.0015	.0020	.0025	.0030	.0040
S	Titanium Alloys 6Al-4V, 6-2-4	Peripheral - HEM	≤ 3 x D	.1 x D	9	405	.0021	.0031	.0041	.0051	.0062	.0082
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	405	.0018	.0028	.0037	.0046	.0055	.0074
		Peripheral - HEM	> 4 - 5 x D	.08 x D	9	390	.0016	.0025	.0033	.0041	.0049	.0066
		Finish	3 x D	.015 x D	9	350	.0008	.0012	.0016	.0020	.0024	.0032
	Difficult-to-Machine Titanium Alloys 10-2-3	Peripheral - HEM	≤ 2.5 x D	.08 x D	9	335	.0020	.0030	.0040	.0050	.0060	.0080
		Peripheral - HEM	> 2.5 - 3.5 x D	.07 x D	9	325	.0018	.0027	.0036	.0045	.0054	.0072
	Precipitation Hardening Stainless Steel M 13-8	Peripheral - HEM	> 3.5 - 4 x D	.06 x D	9	305	.0016	.0024	.0032	.0040	.0048	.0064
		Finish	3 x D	.01 x D	9	290	.0007	.0011	.0014	.0018	.0021	.0028
	Hastalloy, Waspalloy	Peripheral - HEM	≤ 1.5 x D	.08 x D	9	100	.0045	.0068	.0090	.0113	.0135	.0180
		Peripheral - HEM	> 1.5 - 2.5 x D	.08 x D	9	95	.0041	.0061	.0081	.0101	.0122	.0162
		Peripheral - HEM	> 2.5 - 3.5 x D	.06 x D	9	85	.0036	.0054	.0072	.0090	.0108	.0144
		Finish	2 x D	.01 x D	9	90	.0024	.0036	.0048	.0060	.0072	.0096
	Inconel 718, Rene 88	Peripheral - HEM	≤ 1.5 x D	.07 x D	9	95	.0046	.0068	.0091	.0114	.0137	.0182
		Peripheral - HEM	> 1.5 - 2.5 x D	.06 x D	9	90	.0041	.0061	.0082	.0102	.0123	.0164
		Peripheral - HEM	> 2.5 - 3 x D	.06 x D	9	85	.0036	.0055	.0073	.0091	.0109	.0146
		Finish	2 x D	.01 x D	9	85	.0023	.0035	.0046	.0058	.0069	.0092

D = Tool Diameter HEM = High-efficiency machining (chip thinning calculations have already been applied to HEM parameters)

≈ Approximately Equals
 ≤ Less Than or Equal To
 ≥ Greater Than or Equal To
 × Multiply
 < Less Than
 > Greater Than
 = Equals

Common Machining Formulas

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

$$\text{SFM} = \text{RPM} \times D \times .262$$

$$\text{IPM} = \text{RPM} \times \text{IPT} \times Z$$

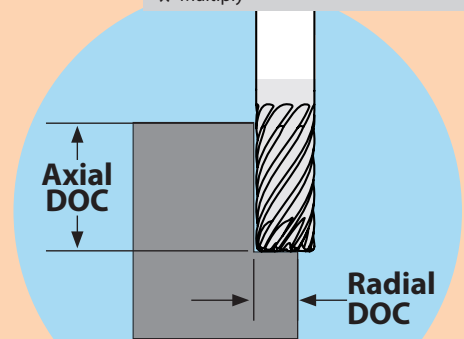
$$\text{MRR} = \text{RDOC} \times \text{ADOC} \times \text{IPM}$$

$$\text{RPM} = \frac{\text{M/min} \times 318.3}{D}$$

$$\text{M/min} = \text{RPM} \times D \times .00314$$

$$\text{MMPM} = \text{RPM} \times \text{MMPT} \times Z$$

$$\text{MRR} = \text{RDOC} \times \text{ADOC} \times \text{MMPM}$$



IPT9/IPC9 Application Guide – Speed & Feed (metric)

ISO Code	Work Material	Type of Cut	Axial DOC	Radial DOC	No. of Flutes	Speed (M/min)	Feed (MM per Tooth)						
							6.0	8.0	10.0	12.0	16.0	20.0	25.0
	Gray ASTM-A48 Class 20, 25, 30, 35 & 40	Peripheral - HEM	≤ 3 x D	.1 x D	9	122	.0864	.1152	.1434	.1728	.2298	.2868	.3456
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	122	.0778	.1037	.1291	.1555	.2068	.2581	.3110
		Peripheral - HEM	> 4 - 5 x D	.08 x D	9	119	.0691	.0922	.1147	.1382	.1838	.2295	.2765
		Finish	3 x D	.015 x D	9	137	.0312	.0416	.0518	.0624	.0830	.1036	.1248
	Cast Iron Malleable	Peripheral - HEM	≤ 3 x D	.08 x D	9	119	.0696	.0928	.1155	.1392	.1851	.2311	.2784
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	119	.0626	.0835	.1040	.1253	.1666	.2079	.2505
		Peripheral - HEM	> 4 - 5 x D	.08 x D	9	114	.0557	.0742	.0924	.1114	.1481	.1848	.2227
		Finish	3 x D	.015 x D	9	107	.0252	.0336	.0418	.0504	.0670	.0837	.1008
	Low Carbon Steels ≤ 38 Rc 1018, 1020, 12L14, 5120, 8620	Peripheral - HEM	≤ 3 x D	.08 x D	9	148	.0900	.1200	.1494	.1800	.2394	.2988	.3600
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	148	.0810	.1080	.1344	.1620	.2154	.2689	.3240
		Peripheral - HEM	> 4 - 5 x D	.08 x D	9	142	.0720	.0960	.1195	.1440	.1915	.2390	.2880
		Finish	3 x D	.015 x D	9	128	.0336	.0448	.0558	.0672	.0894	.1115	.1344
	Medium Carbon Steels ≤ 48 HRC 1045, 4140, 4340, 5140	Peripheral - HEM	≤ 3 x D	.08 x D	9	137	.0852	.1136	.1414	.1704	.2266	.2828	.3408
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	137	.0767	.1022	.1273	.1533	.2040	.2546	.3067
		Peripheral - HEM	> 4 - 5 x D	.08 x D	9	130	.0682	.0909	.1131	.1363	.1813	.2263	.2726
		Finish	3 x D	.015 x D	9	119	.0300	.0400	.0498	.0600	.0798	.0996	.1200
	Tool and Die Steels ≤ 48 Rc A2, D2, O1, S7, P20, H13	Peripheral - HEM	≤ 3 x D	.08 x D	9	128	.0768	.1024	.1275	.1536	.2043	.2550	.3072
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	128	.0691	.0922	.1147	.1382	.1838	.2295	.2765
		Peripheral - HEM	> 4 - 5 x D	.08 x D	9	120	.0614	.0819	.1020	.1229	.1634	.2040	.2457
		Finish	3 x D	.015 x D	9	111	.0252	.0336	.0418	.0504	.0670	.0837	.1008
	Martensitic & Ferritic Stainless Steels 410, 416, 440	Peripheral - HEM	≤ 3 x D	.08 x D	9	137	.0900	.1200	.1494	.1800	.2394	.2988	.3600
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	134	.0810	.1080	.1344	.1620	.2154	.2689	.3240
		Peripheral - HEM	> 4 - 5 x D	.07 x D	9	130	.0720	.0960	.1195	.1440	.1915	.2390	.2880
		Finish	3 x D	.015 x D	9	119	.0300	.0400	.0498	.0600	.0798	.0996	.1200
	Austenitic Stainless Steels, FeNi Alloys 303, 304, 316, Invar, Kovar	Peripheral - HEM	≤ 3 x D	.08 x D	9	137	.0768	.1024	.1275	.1536	.2043	.2550	.3072
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	137	.0691	.0922	.1147	.1382	.1838	.2295	.2765
		Peripheral - HEM	> 4 - 5 x D	.08 x D	9	130	.0614	.0819	.1020	.1229	.1634	.2040	.2457
		Finish	3 x D	.015 x D	9	119	.0288	.0384	.0478	.0576	.0766	.0956	.1152
	Precipitation Hardening Stainless Steels 17-4, 15-5	Peripheral - HEM	≤ 3 x D	.08 x D	9	134	.0744	.0992	.1235	.1488	.1979	.2470	.2976
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	134	.0670	.0893	.1111	.1339	.1781	.2223	.2678
		Peripheral - HEM	> 4 - 5 x D	.07 x D	9	126	.0595	.0794	.0988	.1190	.1583	.1976	.2381
		Finish	3 x D	.015 x D	9	116	.0240	.0320	.0398	.0480	.0638	.0797	.0960
	Titanium Alloys 6Al-4V, 6-2-4	Peripheral - HEM	≤ 3 x D	.1 x D	9	123	.0492	.0656	.0817	.0984	.1309	.1633	.1968
		Peripheral - HEM	> 3 - 4 x D	.08 x D	9	123	.0443	.0590	.0735	.0886	.1178	.1470	.1771
		Peripheral - HEM	> 4 - 5 x D	.08 x D	9	119	.0394	.0525	.0653	.0787	.1047	.1307	.1574
		Finish	3 x D	.015 x D	9	107	.0192	.0256	.0319	.0384	.0511	.0637	.0768
	Difficult-to-Machine Titanium Alloys 10-2-3	Peripheral - HEM	≤ 2.5 x D	.08 x D	9	102	.0480	.0640	.0797	.0960	.1277	.1593	.1920
		Peripheral - HEM	> 2.5 - 3.5 x D	.07 x D	9	99	.0432	.0576	.0717	.0864	.1149	.1434	.1728
	Precipitation Hardening Stainless Steel  13-8	Peripheral - HEM	> 3.5 - 4 x D	.06 x D	9	93	.0384	.0512	.0637	.0768	.1021	.1275	.1536
		Finish	3 x D	.01 x D	9	88	.0168	.0224	.0279	.0336	.0447	.0558	.0672
	Hastalloy, Waspalloy	Peripheral - HEM	≤ 1.5 x D	.08 x D	9	30	.1080	.1440	.1793	.2160	.2873	.3585	.4320
		Peripheral - HEM	> 1.5 - 2.5 x D	.08 x D	9	29	.0972	.1296	.1613	.1944	.2585	.3227	.3888
		Peripheral - HEM	> 2.5 - 3.5 x D	.06 x D	9	26	.0864	.1152	.1434	.1728	.2298	.2868	.3456
		Finish	2 x D	.01 x D	9	27	.0576	.0768	.0956	.1152	.1532	.1912	.2304
	Inconel 718, Rene 88	Peripheral - HEM	≤ 1.5 x D	.07 x D	9	29	.1092	.1456	.1813	.2184	.2904	.3625	.4368
		Peripheral - HEM	> 1.5 - 2.5 x D	.06 x D	9	27	.0983	.1310	.1631	.1965	.2614	.3263	.3931
		Peripheral - HEM	> 2.5 - 3 x D	.06 x D	9	26	.0874	.1165	.1450	.1747	.2324	.2900	.3494
		Finish	2 x D	.01 x D	9	26	.0552	.0736	.0916	.1104	.1468	.1832	.2208

D = Tool Diameter HEM = High-efficiency machining (chip thinning calculations have already been applied to HEM parameters)

D Tool Diameter
Z Number of Flutes
RPM Revolutions per Minute
SFM Surface Feet per Minute
M/min Surface Meters per Minute
IPM Inches per Minute
MMPM Millimeters per Minute
IPT Inch per Tooth
MMPT Millimeters per Tooth
MRR Metal Removal Rate
RDOC Radial Depth of Cut
ADOC Axial Depth of Cut

Technical Resources

Information on tips and adjustments for the following milling operations can be found in our Technical Resources section beginning on page 134.

- HEM slotting
- Face milling
- Helical entry ramping
- Straight line ramping
- Long tool projection adjustments
- Ball nose milling adjustments
- Other helpful tips and calculations