Undercutting Guide

Undercutting end mills, often referred to as lollipop cutters, are extremely versatile tools. Harvey tool offers a variety of reach and wrap angles to provide an answer for even the most difficult of applications. Due to the varying neck lengths and the applications, specific machining parameters must be calculated to avoid breakage.

Speeds & Feeds calculations:
1. Determine the correct SFM and Base Chip Load (IPT) for the cutter, material and application (see application descriptions Figure 1.)
2. Adjust Chip Load to account for neck length to cutter diameter ratio. (see Table 2)
3. Calculate the Speed (RPM) and Linear Feed (IPM)
4. Determine correct number of passes

Example: Tool #990608 to machine for a Deburring application in 4140 steel at 32 Rc.

1. Using Figure 1 (upper right), determine the type of application you will be performing.
   From Speeds & Feeds chart (next page), SFM is 200 and Base Chip Load (IPT) for Deburring is .00024.
2. Calculate the neck length to neck diameter ratio for the tool. Calculate adjusted chipload based on values in Table 1.

   Neck Length Ratio = (Neck Length / Neck Diameter)
   = (.093 / .053)
   = 1.7

   Adjusted Chip Load = Adjustment Factor x Base Chip Load
   = 1.2 x .00024
   = .00029

3. Calculate Speed (RPM) and Linear Feed (IPM)

   RPM = (SFM x 3.82) / Cutter Diameter
   = (200 x 3.82) / .125
   = 6112

   Linear Feed (IPM) = RPM x IPT x Number of Flutes
   = 6112 x .00029 x 4
   = 7.09

4. From Speeds & Feeds chart (next page), the number of passes for a deburring operation in 4140 steel is 1 pass.

5. Conclusion

   In this example, the tool would run at 6112 RPM, 7.1 IPM and make 1 pass.

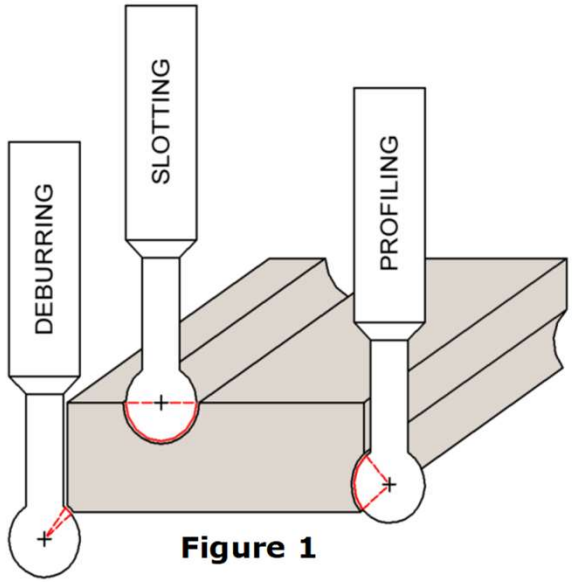

Figure 1

Chip Loads are provided for the 3 applications illustrated above:
Deburring involves applying a slight edge break to a part and assumes an engagement around the ball of 20° or less.
Profiling assumes 90° engagement along the ball for generating specialized shapes and contours.
Slotting assumes full engagement along 180° of the ball end.

Table 1

Neck Length Multiple	Chip Load
3x	120%
5x	100%
8x	80%
12x	65%
15x	55%

HARVEY TOOL

Speeds & Feeds

Product Table: Undercutting End Mills - 300°
Characteristics: Standard Helix, 4 Flutes
Series: 7386xx, 7388xx, 7390xx, 7946xx, 8346xx, 8432xx, 8779xx, 9119xx, 9269xx, 9330xx, 9401xx, 9436xx, 9523xx, 9792xx, 9840xx, 9906xx

Hardness: ≤ 28 Rc (≤ 271 HBn)

MATERIAL	SFM		Chip Load (IPT) By Cutter Diameter												Depth of Cut
			0.062	0.078	0.093	0.125	0.187	0.250	0.312	0.375	0.500	0.625	0.750	1.000	Passes
ALUMINUM ALLOYS Casting (2xx, 5xx, 7xx, 8xx)	750	Deburring	.00035	.00044	.00053	.00071	.00106	.00142	.00178	.00213	.00285	.00356	.00427	.00569	1
		Profiling	.00031	.00039	.00046	.00062	.00093	.00124	.00154	.00186	.00248	.00309	.00371	.00495	2
Wrought (1xxx, 2xxx, 3xxx, 5xxx, 6xxx, 7xxx, 8xxx)	1000	Slotting	.00031	.00039	.00046	.00062	.00093	.00124	.00154	.00186	.00248	.00309	.00371	.00495	3
Casting - 3%-5% Si (3xx, A3xx, C3xx, 4xx, A4xx, B4xx)	750	Deburring	.00032	.00040	.00048	.00064	.00096	.00128	.00160	.00192	.00256	.00320	.00384	.00512	1
Casting - 5%-8% Si (3xx, A3xx, C3xx, 4xx, A4xx, B4xx)	700														
Casting - 8%-12% Si (3xx, A3xx, C3xx, 4xx, A4xx, B4xx)	650	Profiling	.00028	.00035	.00041	.00056	.00083	.00111	.00139	.00167	.00223	.00278	.00334	.00446	2
Casting - 12%-16% Si (3xx, A3xx, C3xx, 4xx, A4xx, B4xx)	475														
Wrought - 5%-8% Si (4xxx)	1000	Slotting	.00028	.00035	.00041	.00056	.00083	.00111	.00139	.00167	.00223	.00278	.00334	.00446	3
Wrought - 8%-12% Si (4xxx)	800														
MAGNESIUM ALLOYS	1500	Deburring	.00035	.00044	.00053	.00071	.00106	.00142	.00178	.00213	.00285	.00356	.00427	.00569	1
		Profiling	.00031	.00039	.00046	.00062	.00093	.00124	.00154	.00186	.00248	.00309	.00371	.00495	2
ZINC ALLOYS	800	Slotting	.00031	.00039	.00046	.00062	.00093	.00124	.00154	.00186	.00248	.00309	.00371	.00495	3
COPPER ALLOYS High Coppers - 90%+ (C1xxxx)	225	Deburring	.00028	.00036	.00042	.00057	.00085	.00114	.00142	.00171	.00228	.00285	.00342	.00455	1
Brass (Copper Zinc alloys, C2xxxx, C3xxxx, C4xxxx, C66400-C69800)	500														
Phosphor Bronzes (Copper Tin alloys, C5xxxx)	225	Profiling	.00025	.00031	.00037	.00050	.00074	.00099	.00124	.00149	.00198	.00248	.00297	.00396	2
Aluminum Bronzes (Copper Aluminum alloys, C60600-C64200)	500														
Silicon Bronzes (Copper Silicon alloys, C64700-C66100)	500														
Copper Nickels, Nickel Silvers (Copper Nickel alloys, C7xxxx)	225														
Cast Copper Alloys (C83300-C86200, C86400-C87900, C92200-C95800, C97300-C97800, C99400-C99700)	550	Slotting	.00025	.00031	.00037	.00050	.00074	.00099	.00124	.00149	.00198	.00248	.00297	.00396	3

Hardness: 29-37 Rc (279-344 HBn)

MATERIAL	SFM		Chip Load (IPT) By Cutter Diameter												Depth of Cut
			0.062	0.078	0.093	0.125	0.187	0.250	0.312	0.375	0.500	0.625	0.750	1.000	Passes
CARBON STEELS Free-Machining/Low Carbon steels, 10xx - 1029 & all 10Lxx, 11xx - 1139 & all 11Lxx, 12xx - 1215 & all 12Lxx	600	Deburring	.00013	.00016	.00019	.00026	.00039	.00052	.00065	.00078	.00104	.00130	.00156	.00208	1
		Profiling	.00011	.00014	.00017	.00023	.00034	.00045	.00056	.00068	.00090	.00113	.00136	.00181	3
		Slotting	.00011	.00014	.00017	.00023	.00034	.00045	.00056	.00068	.00090	.00113	.00136	.00181	4
1030 - 1095, 1140 - 1151, 13xx, 15xx, 2xxx, 3xxx, 4xxx & 4xLxx, 5xxx & 5xLxx, 50xxx & 50Lxxx, 51xxx & 51Lxxx, 52xxx & 52Lxxx, 6xxx, 8xxx, 9xxx	200	Deburring	.00012	.00015	.00018	.00024	.00036	.00048	.00059	.00071	.00095	.00119	.00143	.00190	1
		Profiling	.00010	.00013	.00015	.00021	.00031	.00041	.00052	.00062	.00083	.00103	.00124	.00165	3
		Slotting	.00010	.00013	.00015	.00021	.00031	.00041	.00052	.00062	.00083	.00103	.00124	.00165	4
STAINLESS STEELS 203 EZ, 303 (all types), 416, 416Se, 416 Plus X, 420F, 420FSe, 430F, 430FSe, 440F, 440FSe	450	Deburring	.00013	.00016	.00019	.00026	.00039	.00052	.00065	.00078	.00104	.00130	.00156	.00208	1
		Profiling	.00011	.00014	.00017	.00023	.00034	.00045	.00056	.00068	.00090	.00113	.00136	.00181	3
		Slotting	.00011	.00014	.00017	.00023	.00034	.00045	.00056	.00068	.00090	.00113	.00136	.00181	4
201, 202, 203, 205, 301, 302, 304, 304L, 308, 309, 310, 314, 316, 316L, 317, 321, 329, 330, 347, 348, 385, 403, 405, 409, 410, 413, 420, 429, 430, 434, 436, 442, 446, 501, 502	200	Deburring	.00012	.00015	.00018	.00024	.00036	.00048	.00059	.00071	.00095	.00119	.00143	.00190	1
		Profiling	.00010	.00013	.00015	.00021	.00031	.00041	.00052	.00062	.00083	.00103	.00124	.00165	3
		Slotting	.00010	.00013	.00015	.00021	.00031	.00041	.00052	.00062	.00083	.00103	.00124	.00165	4
414, 431, 440A, 440B, 440C, 13-8, 15-5, 15-7, 17-4, 17-7	150	Deburring	.00007	.00009	.00011	.00015	.00022	.00030	.00037	.00045	.00059	.00074	.00089	.00119	1
		Profiling	.00006	.00008	.00010	.00013	.00019	.00026	.00032	.00039	.00052	.00065	.00077	.00103	3
		Slotting	.00006	.00008	.00010	.00013	.00019	.00026	.00032	.00039	.00052	.00065	.00077	.00103	4
TOOL STEELS A, L, O, P, W series	200	Deburring	.00012	.00015	.00018	.00024	.00036	.00048	.00059	.00071	.00095	.00119	.00143	.00190	1
		Profiling	.00010	.00013	.00015	.00021	.00031	.00041	.00052	.00062	.00083	.00103	.00124	.00165	3
		Slotting	.00010	.00013	.00015	.00021	.00031	.00041	.00052	.00062	.00083	.00103	.00124	.00165	4
D, H, M, T, S series	150	Deburring	.00007	.00009	.00011	.00015	.00022	.00030	.00037	.00045	.00059	.00074	.00089	.00119	1
		Profiling	.00006	.00008	.00010	.00013	.00019	.00026	.00032	.00039	.00052	.00065	.00077	.00103	3
		Slotting	.00006	.00008	.00010	.00013	.00019	.00026	.00032	.00039	.00052	.00065	.00077	.00103	4
TITANIUM ALLOYS	150	Deburring	.00007	.00009	.00011	.00015	.00022	.00030	.00037	.00045	.00059	.00074	.00089	.00119	1
		Profiling	.00006	.00008	.00010	.00013	.00019	.00026	.00032	.00039	.00052	.00065	.00077	.00103	3
		Slotting	.00006	.00008	.00010	.00013	.00019	.00026	.00032	.00039	.00052	.00065	.00077	.00103	4
HIGH TEMP ALLOYS Inconel, Hastelloy, Waspalloy, Monel, Nimonic, Haynes, Discoloy, Incoloy	70	Deburring	.00007	.00009	.00011	.00015	.00022	.00030	.00037	.00045	.00059	.00074	.00089	.00119	1
		Profiling	.00006	.00008	.00010	.00013	.00019	.00026	.00032	.00039	.00052	.00065	.00077	.00103	3
		Slotting	.00006	.00008	.00010	.00013	.00019	.00026	.00032	.00039	.00052	.00065	.00077	.00103	4

Hardness: 38-45 Rc (353-421 HBn)

SFM		Chip Load (IPT) By Cutter Diameter												Depth of Cut
		0.062	0.078	0.093	0.125	0.187	0.250	0.312	0.375	0.500	0.625	0.750	1.000	Passes
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-	-
100	Deburring	.00010	.00013	.00016	.00021	.00031	.00042	.00052	.00063	.00084	.00105	.00126	.00168	1
	Profiling	.00009	.00011	.00014	.00018	.00027	.00036	.00045	.00055	.00073	.00091	.00109	.00146	4
	Slotting	.00009	.00011	.00014	.00018	.00027	.00036	.00045	.00055	.00073	.00091	.00109	.00146	5
90	Deburring	.00006	.00008	.00010	.00013	.00020	.00026	.00033	.00039	.00052	.00065	.00079	.00105	1
	Profiling	.00006	.00007	.00008	.00011	.00017	.00023	.00028	.00034	.00046	.00057	.00068	.00091	4
	Slotting	.00006	.00007	.00008	.00011	.00017	.00023	.00028	.00034	.00046	.00057	.00068	.00091	5
100	Deburring	.00010	.00013	.00016	.00021	.00031	.00042	.00052	.00063	.00084	.00105	.00126	.00168	1
	Profiling	.00009	.00011	.00014	.00018	.00027	.00036	.00045	.00055	.00073	.00091	.00109	.00146	4
	Slotting	.00009	.00011	.00014	.00018	.00027	.00036	.00045	.00055	.00073	.00091	.00109	.00146	5
90	Deburring	.00006	.00008	.00010	.00013	.00020	.00026	.00033	.00039	.00052	.00065	.00079	.00105	1
	Profiling	.00006	.00007	.00008	.00011	.00017	.00023	.00028	.00034	.00046	.00057	.00068	.00091	4
	Slotting	.00006	.00007	.00008	.00011	.00017	.00023	.00028	.00034	.00046	.00057	.00068	.00091	5
75	Deburring	.00006	.00008	.00010	.00013	.00020	.00026	.00033	.00039	.00052	.00065	.00079	.00105	1
	Profiling	.00006	.00007	.00008	.00011	.00017	.00023	.00028	.00034	.00046	.00057	.00068	.00091	4
	Slotting	.00006	.00007	.00008	.00011	.00017	.00023	.00028	.00034	.00046	.00057	.00068	.00091	5
50	Deburring	.00006	.00008	.00010	.00013	.00020	.00026	.00033	.00039	.00052	.00065	.00079	.00105	1
	Profiling	.00006	.00007	.00008	.00011	.00017	.00023	.00028	.00034	.00046	.00057	.00068	.00091	4
	Slotting	.00006	.00007	.00008	.00011	.00017	.00023	.00028	.00034	.00046	.00057	.00068	.00091	5

Product notes:

Posted values are Base Chip Loads and do not account for varying neck lengths. Use Table 1 (previous page) to determine the correct adjustment multiplier and calculate final adjusted chip loads.

General notes:

All posted speed and feed parameters are suggested starting values that may be increased given optimal setup conditions. Chip loads reflect uncoated cutters and may be increased 10%-20% if coated. For ferrous materials with hardness ≤ 28 Rc, chip loads can be increased 10%-20%.

If you require additional information, Harvey Tool has a team of technical experts available to assist you through even the most challenging applications. Please contact us at **800-645-5609** or **Harveytech@harveyperformance.com**.

WARNING: Cutting tools may shatter under improper use. Government regulations require use of safety glasses and other appropriate safety equipment in the vicinity of use.