HARVEY TOOL

## 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 1)
3. Calculate the Speed (RPM) and Linear Feed (IPM)
4. Determine correct number of passes

Example: Tool #23206 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 .00027.

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)
   = (.375 / .054)
   = 6.9
   Adjusted Chip Load = Adjustment Factor x Base Chip Load
   = .8 x .00027
   = .00022

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

   RPM = (SFM x 3.82) / Cutter Diameter
   = (200 x 3.82) / .093
   = 8215

   Linear Feed (IPM) = RPM x IPT x Number of Flutes
   = 8215 x .00022 x 2
   = 3.6

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 8215 RPM, 3.6 IPM and make 1 pass.

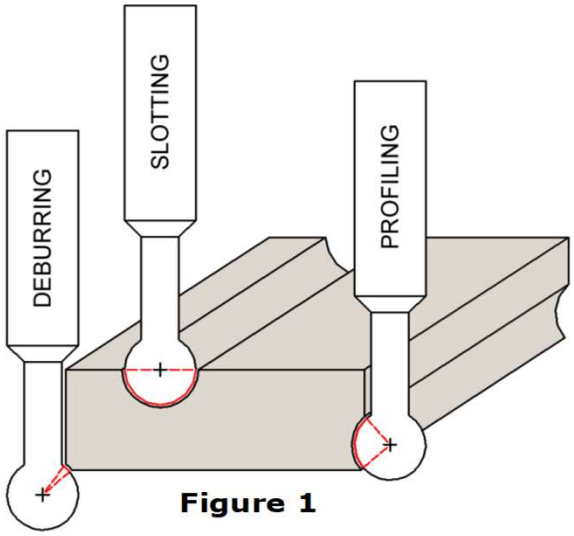


**Figure 1**

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% |

Speeds & Feeds

**Product Table:** Undercutting End Mills - 270°
**Characteristics:** Standard Helix, 2 Flutes
**Series:** 231xx (2 FL), 232xx (2 FL), 397xx (2 FL), 528xx, 529xx (2 FL), 546xx, 552xx, 7742xx, 7754xx, 7898xx, 7943xx, 8677xx, 9051xx, 9090xx, 9742xx

**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

## Hardness: ≤ 28 Rc (≤ 271 HBn)

| MATERIAL | SFM | Chip Load (IPT) By Cutter Diameter | 0.015 | 0.031 | 0.047 | 0.062 | 0.078 | 0.093 | 0.125 | 0.187 | 0.250 | 0.312 | 0.375 | 0.500 | Depth of Cut Passes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ALUMINUM ALLOYS** | | | | | | | | | | | | | | | |
| Casting (2xx, 5xx, 7xx, 8xx) | 750 | Deburring | .00013 | .00027 | .00042 | .00055 | .00069 | .00082 | .00111 | .00166 | .00221 | .00276 | .00332 | .00443 | 1 |
| | | Profiling | .00012 | .00024 | .00036 | .00048 | .00060 | .00072 | .00096 | .00144 | .00193 | .00240 | .00289 | .00385 | 2 |
| Wrought (1xxx, 2xxx, 3xxx, 5xxx, 6xxx, 7xxx, 8xxx) | 1000 | Slotting | .00012 | .00024 | .00036 | .00048 | .00060 | .00072 | .00096 | .00144 | .00193 | .00240 | .00289 | .00385 | 3 |
| Casting - 3%-5% Si (3xx, A3xx, C3xx, 4xx, A4xx, B4xx) | 750 | Deburring | .00012 | .00025 | .00037 | .00049 | .00062 | .00074 | .00100 | .00149 | .00199 | .00249 | .00299 | .00398 | 1 |
| Casting - 5%-8% Si (3xx, A3xx, C3xx, 4xx, A4xx, B4xx) | 700 | | | | | | | | | | | | | | |
| Casting - 8%-12% Si (3xx, A3xx, C3xx, 4xx, A4xx, B4xx) | 650 | Profiling | .00010 | .00021 | .00033 | .00043 | .00054 | .00064 | .00087 | .00130 | .00173 | .00216 | .00260 | .00347 | 2 |
| Casting - 12%-16% Si (3xx, A3xx, C3xx, 4xx, A4xx, B4xx) | 475 | | | | | | | | | | | | | | |
| Wrought - 5%-8% Si (4xxx) | 1000 | Slotting | .00010 | .00021 | .00033 | .00043 | .00054 | .00064 | .00087 | .00130 | .00173 | .00216 | .00260 | .00347 | 3 |
| Wrought - 8%-12% Si (4xxx) | 800 | | | | | | | | | | | | | | |
| **MAGNESIUM ALLOYS** | 1500 | Deburring | .00013 | .00027 | .00042 | .00055 | .00069 | .00082 | .00111 | .00166 | .00221 | .00276 | .00332 | .00443 | 1 |
| | | Profiling | .00012 | .00024 | .00036 | .00048 | .00060 | .00072 | .00096 | .00144 | .00193 | .00240 | .00289 | .00385 | 2 |
| **ZINC ALLOYS** | 800 | Slotting | .00012 | .00024 | .00036 | .00048 | .00060 | .00072 | .00096 | .00144 | .00193 | .00240 | .00289 | .00385 | 3 |
| **COPPER ALLOYS** | | | | | | | | | | | | | | | |
| High Coppers - 90%+ (C1xxxx) | 225 | Deburring | .00011 | .00022 | .00033 | .00044 | .00055 | .00066 | .00089 | .00132 | .00177 | .00221 | .00266 | .00354 | 1 |
| Brass (Copper Zinc alloys, C2xxxx, C3xxxx, C4xxxx, C66400-C69800) | 500 | | | | | | | | | | | | | | |
| Phosphor Bronzes (Copper Tin alloys, C5xxxx) | 225 | | | | | | | | | | | | | | |
| Aluminum Bronzes (Copper Aluminum alloys, C60600-C64200) | 500 | Profiling | .00009 | .00019 | .00029 | .00038 | .00048 | .00057 | .00077 | .00115 | .00154 | .00192 | .00231 | .00308 | 2 |
| 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 | .00009 | .00019 | .00029 | .00038 | .00048 | .00057 | .00077 | .00115 | .00154 | .00192 | .00231 | .00308 | 3 |

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

| MATERIAL | SFM | Chip Load (IPT) By Cutter Diameter | 0.015 | 0.031 | 0.047 | 0.062 | 0.078 | 0.093 | 0.125 | 0.187 | 0.250 | 0.312 | 0.375 | 0.500 | Depth of Cut Passes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CARBON STEELS** | | | | | | | | | | | | | | | |
| Free-Machining/Low Carbon steels, 10xx - 1029 & all 10Lxx, 11xx - 1139 & all 11Lxx, 12xx - 1215 & all 12Lxx | 600 | Deburring | .00005 | .00010 | .00015 | .00020 | .00025 | .00030 | .00040 | .00060 | .00081 | .00101 | .00121 | .00162 | 1 |
| | | Profiling | .00004 | .00009 | .00013 | .00017 | .00022 | .00026 | .00035 | .00053 | .00070 | .00088 | .00105 | .00141 | 3 |
| | | Slotting | .00004 | .00009 | .00013 | .00017 | .00022 | .00026 | .00035 | .00053 | .00070 | .00088 | .00105 | .00141 | 4 |
| 1030 - 1095, 1140 - 1151, 13xx, 15xx, 2xxx, 3xxx, 4xxx & 4xLxx, 5xxx & 5xLxx, 50xxx & 50Lxxx, 51xxx & 51Lxxx, 52xxx & 52Lxxx, 6xxx, 8xxx, 9xxx | 200 | Deburring | .00004 | .00009 | .00014 | .00018 | .00023 | .00027 | .00037 | .00055 | .00074 | .00092 | .00111 | .00148 | 1 |
| | | Profiling | .00004 | .00008 | .00012 | .00016 | .00020 | .00024 | .00032 | .00048 | .00064 | .00080 | .00096 | .00129 | 3 |
| | | Slotting | .00004 | .00008 | .00012 | .00016 | .00020 | .00024 | .00032 | .00048 | .00064 | .00080 | .00096 | .00129 | 4 |
| **STAINLESS STEELS** | | | | | | | | | | | | | | | |
| 203 EZ, 303 (all types), 416, 416Se, 416 Plus X, 420F, 420FSe, 430F, 430FSe, 440F, 440FSe | 450 | Deburring | .00005 | .00010 | .00015 | .00020 | .00025 | .00030 | .00040 | .00060 | .00081 | .00101 | .00121 | .00162 | 1 |
| | | Profiling | .00004 | .00009 | .00013 | .00017 | .00022 | .00026 | .00035 | .00053 | .00070 | .00088 | .00105 | .00141 | 3 |
| | | Slotting | .00004 | .00009 | .00013 | .00017 | .00022 | .00026 | .00035 | .00053 | .00070 | .00088 | .00105 | .00141 | 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 | .00004 | .00009 | .00014 | .00018 | .00023 | .00027 | .00037 | .00055 | .00074 | .00092 | .00111 | .00148 | 1 |
| | | Profiling | .00004 | .00008 | .00012 | .00016 | .00020 | .00024 | .00032 | .00048 | .00064 | .00080 | .00096 | .00129 | 3 |
| | | Slotting | .00004 | .00008 | .00012 | .00016 | .00020 | .00024 | .00032 | .00048 | .00064 | .00080 | .00096 | .00129 | 4 |
| 414, 431, 440A, 440B, 440C, 13-8, 15-5, 15-7, 17-4, 17-7 | 150 | Deburring | .00003 | .00006 | .00009 | .00011 | .00014 | .00017 | .00023 | .00035 | .00046 | .00058 | .00069 | .00092 | 1 |
| | | Profiling | .00002 | .00005 | .00008 | .00010 | .00013 | .00015 | .00020 | .00030 | .00040 | .00050 | .00060 | .00080 | 3 |
| | | Slotting | .00002 | .00005 | .00008 | .00010 | .00013 | .00015 | .00020 | .00030 | .00040 | .00050 | .00060 | .00080 | 4 |
| **TOOL STEELS** | | | | | | | | | | | | | | | |
| A, L, O, P, W series | 200 | Deburring | .00004 | .00009 | .00014 | .00018 | .00023 | .00027 | .00037 | .00055 | .00074 | .00092 | .00111 | .00148 | 1 |
| | | Profiling | .00004 | .00008 | .00012 | .00016 | .00020 | .00024 | .00032 | .00048 | .00064 | .00080 | .00096 | .00129 | 3 |
| | | Slotting | .00004 | .00008 | .00012 | .00016 | .00020 | .00024 | .00032 | .00048 | .00064 | .00080 | .00096 | .00129 | 4 |
| D, H, M, T, S series | 150 | Deburring | .00003 | .00006 | .00009 | .00011 | .00014 | .00017 | .00023 | .00035 | .00046 | .00058 | .00069 | .00092 | 1 |
| | | Profiling | .00002 | .00005 | .00008 | .00010 | .00013 | .00015 | .00020 | .00030 | .00040 | .00050 | .00060 | .00080 | 3 |
| | | Slotting | .00002 | .00005 | .00008 | .00010 | .00013 | .00015 | .00020 | .00030 | .00040 | .00050 | .00060 | .00080 | 4 |
| **TITANIUM ALLOYS** | 150 | Deburring | .00003 | .00006 | .00009 | .00011 | .00014 | .00017 | .00023 | .00035 | .00046 | .00058 | .00069 | .00092 | 1 |
| | | Profiling | .00002 | .00005 | .00008 | .00010 | .00013 | .00015 | .00020 | .00030 | .00040 | .00050 | .00060 | .00080 | 3 |
| | | Slotting | .00002 | .00005 | .00008 | .00010 | .00013 | .00015 | .00020 | .00030 | .00040 | .00050 | .00060 | .00080 | 4 |
| **HIGH TEMP ALLOYS** | | | | | | | | | | | | | | | |
| Inconel, Hastelloy, Waspalloy, Monel, Nimonic, Haynes, Discoloy, Incoloy | 70 | Deburring | .00003 | .00006 | .00009 | .00011 | .00014 | .00017 | .00023 | .00035 | .00046 | .00058 | .00069 | .00092 | 1 |
| | | Profiling | .00002 | .00005 | .00008 | .00010 | .00013 | .00015 | .00020 | .00030 | .00040 | .00050 | .00060 | .00080 | 3 |
| | | Slotting | .00002 | .00005 | .00008 | .00010 | .00013 | .00015 | .00020 | .00030 | .00040 | .00050 | .00060 | .00080 | 4 |

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

| SFM | Chip Load (IPT) By Cutter Diameter | 0.015 | 0.031 | 0.047 | 0.062 | 0.078 | 0.093 | 0.125 | 0.187 | 0.250 | 0.312 | 0.375 | 0.500 | Depth of Cut Passes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 100 | Deburring | .00004 | .00008 | .00012 | .00016 | .00020 | .00024 | .00033 | .00049 | .00065 | .00081 | .00098 | .00130 | 1 |
| | Profiling | .00003 | .00007 | .00011 | .00014 | .00018 | .00021 | .00028 | .00042 | .00057 | .00071 | .00085 | .00113 | 4 |
| | Slotting | .00003 | .00007 | .00011 | .00014 | .00018 | .00021 | .00028 | .00042 | .00057 | .00071 | .00085 | .00113 | 5 |
| 90 | Deburring | .00002 | .00005 | .00008 | .00010 | .00013 | .00015 | .00020 | .00030 | .00041 | .00051 | .00061 | .00082 | 1 |
| | Profiling | .00002 | .00004 | .00007 | .00009 | .00011 | .00013 | .00018 | .00027 | .00035 | .00044 | .00053 | .00071 | 4 |
| | Slotting | .00002 | .00004 | .00007 | .00009 | .00011 | .00013 | .00018 | .00027 | .00035 | .00044 | .00053 | .00071 | 5 |
| 100 | Deburring | .00004 | .00008 | .00012 | .00016 | .00020 | .00024 | .00033 | .00049 | .00065 | .00081 | .00098 | .00130 | 1 |
| | Profiling | .00003 | .00007 | .00011 | .00014 | .00018 | .00021 | .00028 | .00042 | .00057 | .00071 | .00085 | .00113 | 4 |
| | Slotting | .00003 | .00007 | .00011 | .00014 | .00018 | .00021 | .00028 | .00042 | .00057 | .00071 | .00085 | .00113 | 5 |
| 90 | Deburring | .00002 | .00005 | .00008 | .00010 | .00013 | .00015 | .00020 | .00030 | .00041 | .00051 | .00061 | .00082 | 1 |
| | Profiling | .00002 | .00004 | .00007 | .00009 | .00011 | .00013 | .00018 | .00027 | .00035 | .00044 | .00053 | .00071 | 4 |
| | Slotting | .00002 | .00004 | .00007 | .00009 | .00011 | .00013 | .00018 | .00027 | .00035 | .00044 | .00053 | .00071 | 5 |
| 75 | Deburring | .00002 | .00005 | .00008 | .00010 | .00013 | .00015 | .00020 | .00030 | .00041 | .00051 | .00061 | .00082 | 1 |
| | Profiling | .00002 | .00004 | .00007 | .00009 | .00011 | .00013 | .00018 | .00027 | .00035 | .00044 | .00053 | .00071 | 4 |
| | Slotting | .00002 | .00004 | .00007 | .00009 | .00011 | .00013 | .00018 | .00027 | .00035 | .00044 | .00053 | .00071 | 5 |
| 50 | Deburring | .00002 | .00005 | .00008 | .00010 | .00013 | .00015 | .00020 | .00030 | .00041 | .00051 | .00061 | .00082 | 1 |
| | Profiling | .00002 | .00004 | .00007 | .00009 | .00011 | .00013 | .00018 | .00027 | .00035 | .00044 | .00053 | .00071 | 4 |
| | Slotting | .00002 | .00004 | .00007 | .00009 | .00011 | .00013 | .00018 | .00027 | .00035 | .00044 | .00053 | .00071 | 5 |