

Dovetail and O-ring style cutters have a variety of applications ranging from customized grooves to tricky seals. Unfortunately, they are very fragile due to their trapezoidal profile of a large Cutter Diameter with a smaller Neck Diameter. This combination of features demands specific machining parameters to avoid breakage.

Speeds & Feeds calculations:

1. Determine the correct SFM and Chip Load (IPT) for the cutter and material
2. Calculate the Speed (RPM) and Linear Feed (IPM)
3. Adjust Linear Feed to account for Angular Velocity due to Circular Interpolation
4. Determine Radial Passes at full axial depth
5. Conclusion
6. Additional Tips

Example: Tool #23921 machining a o-ring groove (without drop hole provision) to fit a AS568-204 seal in 4140 steel at 32 Rc

1. The Cutter Diameter is .113" and is used to find SFM and calculate Speed (RPM).
The Neck Diameter is .044" and is used to find Chip Load (IPT) and calculate Linear Feed (IPM).
Using the Speeds & Feeds chart (next page), SFM is 200 and the Chip Load (IPT) is .00016.

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

$$\begin{aligned} \text{RPM} &= (\text{SFM} \times 3.82) / \text{Cutter Diameter} \\ &= (200 \times 3.82) / .113 \\ &= 6761 \end{aligned}$$

$$\begin{aligned} \text{Linear Feed (IPM)} &= \text{RPM} \times \text{IPT} \times \text{Number of Flutes} \\ &= 6761 \times .00016 \times 2 \\ &= 2.16 \end{aligned}$$

3. Adjust Linear Feed rate (see O-Ring Feed Rate Adjustment chart)

$$\begin{aligned} \text{Adjusted Feed} &= [(\text{Groove Major Dia} - \text{Cutter Dia}) / \text{Groove Major Dia}] \times \text{Linear Feed} \\ &= [(.519 - .113) / .519] \times 2.16 \\ &= 1.69 \end{aligned}$$

4. Using Table 1, locate the Item # and determine the Max Radial DOC and the Number of Radial Passes needed at full Axial depth. Then using Table 2, determine the actual descending radial stepover for each pass:

12 Radial Passes at 23%, 17%, 13%, 11%, 8%, 7%, 6%, 5%, 4%, 3%, 2% and 1% of .0335 Max Radial Depth of Cut.

5. Conclusion

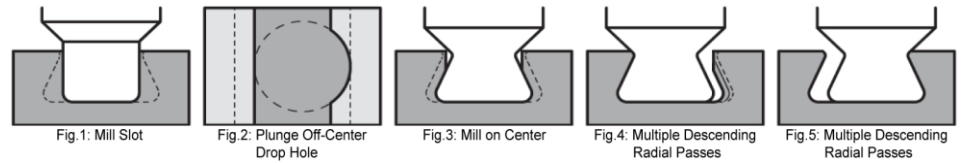
In this example, the tool would run at 6761 RPM, 1.69 IPM and make 12 radial passes of .0077, .0057, .0044, .0039, .0027, .0023, .0017, .0013, .0010, .0007, .0003 on each side of the groove at full axial depth.

6. Additional Tips

Please note that tools are very fragile (some more than others) due to reduced neck design and flute runout through neck. Given that torque is generated on the larger head diameter and is multiplied as it is transferred to neck of tool, care must be taken when using these tools. Each successive stepover will increase tool engagement, requiring a descending radial stepover to avoid breakage. Be sure to flush chips out of semi-enclosed groove and use climb milling when possible.

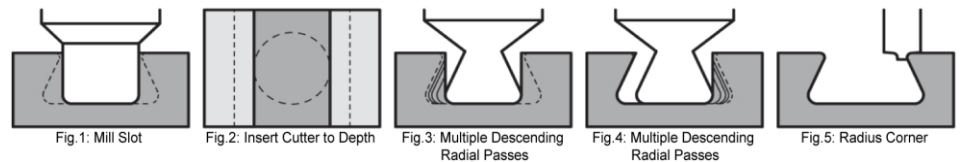
Setup and Application (Series 238xx for use with Drop Hole)

- Mill slot with appropriate O-Ring Slotting End Mill (see series 565xx) or with other comparable end mill (Fig.1).
- Plunge off-center drop hole (Fig. 2).
- Insert O-Ring Cutter through drop hole at full axial depth and mill single pass down center of groove (Fig.3). Please note that cutter is contacting both sides of part and it may be necessary to reduce the feed rate (up to 40%).
- Mill multiple passes with descending radial stepover as calculated using Tables 1 & 2 on one side of part (Fig. 4).
- Mill multiple passes with descending radial stepover as calculated using Tables 1 & 2 on other side of part (Fig. 5).



Setup and Application (Series 239xx for use without Drop Hole)

- Mill slot with appropriate O-Ring Slotting End Mill (see series 565xx) or with other comparable end mill (Fig. 1).
- Insert O-Ring Cutter into slot at full axial depth (Fig. 2).
- Mill multiple passes with descending radial stepover as calculated using Tables 1 & 2 on one side of part (Fig. 3).
- Mill multiple passes with descending radial stepover as calculated using Tables 1 & 2 on other side of part (Fig. 4).
- These tools are able to mill both Full and Half O-Ring grooves. As such, a corner radius at the top of the part (Fig. 5) must be machined for final groove form (see series 170xx).



| Item ID | Max Radial DOC | Radial Passes per Side | | |
|---------|----------------|------------------------|------------|------------|
| | | ≤ 28 Rc | 29 - 37 Rc | 38 - 45 Rc |
| 23807 | 0.0159 | 2 | 3 | 4 |
| 56307 | 0.0159 | 2 | 3 | 4 |
| 23814 | 0.0287 | 2 | 3 | 4 |
| 23821 | 0.0335 | 2 | 3 | 4 |
| 23828 | 0.0591 | 2 | 3 | 4 |
| 23835 | 0.0700 | 2 | 3 | 4 |
| 23842 | 0.0896 | 2 | 3 | 4 |
| 23907 | 0.0159 | 8 | 12 | 16 |
| 23914 | 0.0287 | 12 | 16 | 20 |
| 23921 | 0.0335 | 8 | 12 | 16 |
| 23928 | 0.0591 | 12 | 16 | 20 |
| 23935 | 0.0700 | 8 | 12 | 16 |
| 23942 | 0.0896 | 8 | 12 | 16 |

| Radial Passes | Percentage of CUTTER'S Maximum Radial Depth of Cut | | | | | | | | | | | | | | | | | | | | | | | |
|---------------|----------------------------------------------------|-----|-----|-----|----|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|----|----|----|----|
| | 2 | 3 | 4 | 5 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 2 | 3 | 4 | 5 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 |
| 2 | 70% | 30% | | | | | | | | | | | | | | | | | | | | | | |
| 3 | 50% | 30% | 20% | | | | | | | | | | | | | | | | | | | | | |
| 4 | 46% | 25% | 18% | 11% | | | | | | | | | | | | | | | | | | | | |
| 5 | 46% | 25% | 16% | 8% | 5% | | | | | | | | | | | | | | | | | | | |
| 6 | 43% | 22% | 16% | 10% | 6% | 3.0% | | | | | | | | | | | | | | | | | | |
| 8 | 32% | 21% | 16% | 12% | 9% | 6.0% | 3.0% | 1.0% | | | | | | | | | | | | | | | | |
| 10 | 27% | 19% | 15% | 12% | 9% | 7.0% | 5.0% | 3.0% | 2.0% | 1.0% | | | | | | | | | | | | | | |
| 12 | 23% | 17% | 13% | 11% | 8% | 7.0% | 6.0% | 5.0% | 4.0% | 3.0% | 2.0% | 1.0% | | | | | | | | | | | | |
| 14 | 19% | 15% | 13% | 11% | 9% | 7.5% | 6.5% | 5.5% | 4.5% | 3.5% | 2.5% | 1.5% | 1.0% | 0.5% | | | | | | | | | | |
| 16 | 13% | 11% | 10% | 10% | 9% | 9.0% | 8.0% | 7.0% | 6.0% | 5.0% | 4.0% | 3.0% | 2.0% | 1.5% | 1.0% | 0.5% | | | | | | | | |
| 18 | 12% | 10% | 9% | 9% | 8% | 8.0% | 7.0% | 7.0% | 6.0% | 6.0% | 5.0% | 4.0% | 3.0% | 2.0% | 1.0% | 0.5% | 0.5% | | | | | | | |
| 20 | 11% | 10% | 9% | 8% | 8% | 7.0% | 7.0% | 6.0% | 6.0% | 5.0% | 5.0% | 4.0% | 4.0% | 3.0% | 2.0% | 2.0% | 1.0% | 1.0% | 0.5% | 0.5% | | | | |

| MATERIAL | Hardness: ≤ 28 Rc (≤ 271 HBn) | | | | | | | | | | | | | | |
|-----------------------------------------------------------------------------------------------|-------------------------------|----------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| | SFM | Chip Load by Neck Diameter (IPT) | | | | | | | | | | | | | |
| | | 0.015 | 0.031 | 0.047 | 0.062 | 0.078 | 0.093 | 0.125 | 0.187 | 0.250 | 0.312 | 0.375 | 0.500 | 0.625 | 0.750 |
| ALUMINUM ALLOYS | | | | | | | | | | | | | | | |
| Castings (2xx, 5xx, 7xx, 8xx) | 750 | .00017 | .00034 | .00052 | .00068 | .00086 | .00102 | .00138 | .00206 | .00275 | .00343 | .00413 | .00550 | .00688 | .00825 |
| Wrought (1xxx, 2xxx, 3xxx, 5xxx, 6xxx, 7xxx, 8xxx) | 1000 | | | | | | | | | | | | | | |
| Castings - 3%-5% Si (3xx, A3xx, C3xx, 4xx, A4xx, B4xx) | 750 | | | | | | | | | | | | | | |
| Castings - 5%-8% Si (3xx, A3xx, C3xx, 4xx, A4xx, B4xx) | 700 | | | | | | | | | | | | | | |
| Castings - 8%-12% Si (3xx, A3xx, C3xx, 4xx, A4xx, B4xx) | 650 | .00015 | .00031 | .00047 | .00061 | .00077 | .00092 | .00124 | .00185 | .00248 | .00309 | .00371 | .00495 | .00619 | .00743 |
| Castings - 12%-16% Si (3xx, A3xx, C3xx, 4xx, A4xx, B4xx) | 475 | | | | | | | | | | | | | | |
| Wrought - 5%-8% Si (4xxx) | 1000 | | | | | | | | | | | | | | |
| Wrought - 8%-12% Si (4xxx) | 800 | | | | | | | | | | | | | | |
| MAGNESIUM ALLOYS | 1500 | .00017 | .00034 | .00052 | .00068 | .00086 | .00102 | .00138 | .00206 | .00275 | .00343 | .00413 | .00550 | .00688 | .00825 |
| ZINC ALLOYS | 800 | | | | | | | | | | | | | | |
| COPPER ALLOYS | | | | | | | | | | | | | | | |
| High Coppers - 90%+ (C1xxx) | 225 | | | | | | | | | | | | | | |
| Brass (Copper Zinc alloys, C2xxx, C3xxx, C4xxx, C6400-C69800) | 500 | | | | | | | | | | | | | | |
| Phosphor Bronzes (Copper Tin alloys, C5xxx) | 225 | | | | | | | | | | | | | | |
| Aluminum Bronzes (Copper Aluminum alloys, C60600-C64200) | 500 | .00013 | .00027 | .00041 | .00055 | .00069 | .00082 | .00110 | .00165 | .00220 | .00275 | .00330 | .00440 | .00550 | .00660 |
| Silicon Bronzes (Copper Silicon alloys, C64700-C66100) | 500 | | | | | | | | | | | | | | |
| Copper Nickels, Nickel Silvers (Copper Nickel alloys, C7xxx) | 225 | | | | | | | | | | | | | | |
| Cast Copper Alloys (C83300-C86200, C86400-C87900, C9200-C95800, C97300-C97800, C99400-C99700) | 550 | | | | | | | | | | | | | | |



Product Table: Dovetail Cutters - Parker Hannifin O-Ring Dovetail Cutters WITH Drop Hole Allowance
Series: 238xx, 239xx

Product Notes:

Posted Radial Passes reflect machining on one side of groove at full axial depth
 If machining on both sides of part, reduce Chip Loads (IPT) by 40%

O-Ring grooves require machining with circular interpolation. The Linear Feed must be reduced to account for angular velocity (see example).

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 5%-10% if coated. For ferrous materials with hardness ≤ 28 Rc, chip loads can be increased 5%-10%.

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.

| MATERIAL | Hardness: 29-37 Rc (279-344 HBn) | | | | | | | | | | | | | | |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|----------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| | SFM | Chip Load by Neck Diameter (IPT) | | | | | | | | | | | | | |
| | | 0.015 | 0.031 | 0.047 | 0.062 | 0.078 | 0.093 | 0.125 | 0.187 | 0.250 | 0.312 | 0.375 | 0.500 | 0.625 | 0.750 |
| CARBON STEELS | | | | | | | | | | | | | | | |
| Free-Machining/Low Carbon steels, 10xx - 1029 & all 10Lxx, 11xx - 1139 & all 11Lxx, 12xx - 1215 & all 12Lxx | 600 | .00006 | .00012 | .00018 | .00023 | .00029 | .00035 | .00047 | .00071 | .00095 | .00118 | .00142 | .00189 | .00236 | .00284 |
| 1030 - 1095, 1140 - 1151, 13xx, 15xx, 20xx, 30xx, 40xx & 4xLxx, 50xx & 5xLxx, 51xxx & 50Lxxx, 51xxx & 51Lxxx, 52xxx & 52Lxxx, 60xx, 80xx, 90xx | 200 | .00005 | .00011 | .00016 | .00021 | .00027 | .00032 | .00043 | .00065 | .00086 | .00108 | .00130 | .00173 | .00216 | .00259 |
| STAINLESS STEELS | | | | | | | | | | | | | | | |
| 203 EZ, 303 (all types), 416, 416Se, 416 Plus X, 420F, 420FSe, 430F, 430FSe, 440F, 440FSe | 450 | .00006 | .00012 | .00018 | .00023 | .00029 | .00035 | .00047 | .00071 | .00095 | .00118 | .00142 | .00189 | .00236 | .00284 |
| 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 | .00005 | .00011 | .00016 | .00021 | .00027 | .00032 | .00043 | .00065 | .00086 | .00108 | .00130 | .00173 | .00216 | .00259 |
| 414, 431, 440A, 440B, 440C, 13-8, 15-5, 15-7, 17-4, 17-7 | 150 | .00003 | .00007 | .00010 | .00013 | .00017 | .00020 | .00027 | .00040 | .00054 | .00067 | .00081 | .00108 | .00135 | .00162 |
| TOOL STEELS | | | | | | | | | | | | | | | |
| A, L, O, P, W series | 200 | .00005 | .00011 | .00016 | .00021 | .00027 | .00032 | .00043 | .00065 | .00086 | .00108 | .00130 | .00173 | .00216 | .00259 |
| D, H, M, T, S series | 150 | .00003 | .00007 | .00010 | .00013 | .00017 | .00020 | .00027 | .00040 | .00054 | .00067 | .00081 | .00108 | .00135 | .00162 |
| TITANIUM ALLOYS | 150 | .00003 | .00007 | .00010 | .00013 | .00017 | .00020 | .00027 | .00040 | .00054 | .00067 | .00081 | .00108 | .00135 | .00162 |
| HIGH TEMP ALLOYS | | | | | | | | | | | | | | | |
| Inconel, Hastelloy, Waspalloy, Monel, Nimonic, Haynes, Discoloy, Incoloy | 70 | .00003 | .00007 | .00010 | .00013 | .00017 | .00020 | .00027 | .00040 | .00054 | .00067 | .00081 | .00108 | .00135 | .00162 |

| MATERIAL | Hardness: 38-45 Rc (353-421 HBn) | | | | | | | | | | | | | | |
|----------|----------------------------------|----------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| | SFM | Chip Load by Neck Diameter (IPT) | | | | | | | | | | | | | |
| | | 0.015 | 0.031 | 0.047 | 0.062 | 0.078 | 0.093 | 0.125 | 0.187 | 0.250 | 0.312 | 0.375 | 0.500 | 0.625 | 0.750 |
| | | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | 200 | .00003 | .00005 | .00008 | .00011 | .00013 | .00016 | .00022 | .00032 | .00043 | .00054 | .00065 | .00086 | .00108 | .00130 |
| | 150 | .00002 | .00003 | .00005 | .00007 | .00008 | .00010 | .00014 | .00020 | .00027 | .00034 | .00041 | .00054 | .00068 | .00081 |
| | 200 | .00003 | .00005 | .00008 | .00011 | .00013 | .00016 | .00022 | .00032 | .00043 | .00054 | .00065 | .00086 | .00108 | .00130 |
| | 150 | .00002 | .00003 | .00005 | .00007 | .00008 | .00010 | .00014 | .00020 | .00027 | .00034 | .00041 | .00054 | .00068 | .00081 |
| | 150 | .00002 | .00003 | .00005 | .00007 | .00008 | .00010 | .00014 | .00020 | .00027 | .00034 | .00041 | .00054 | .00068 | .00081 |
| | 70 | .00002 | .00003 | .00005 | .00007 | .00008 | .00010 | .00014 | .00020 | .00027 | .00034 | .00041 | .00054 | .00068 | .00081 |