

**MILLING RECOMMENDATIONS - GENERAL PURPOSE ENDMILLS**



**PROFILING**

| Workpiece Material Group |  | Hardness   | Surface Feet Per Minute (SFM)<br>Radial Depth of Cut (RDOC) |     |     |     |     | Inches Per Tooth (IPT) |        |        |        |        |        |  |
|--------------------------|--|------------|---|-----|-----|-----|-----|------------------------|--------|--------|--------|--------|--------|--|
|                          |  |            | SFM based on RDOC   |     |     |     |     | IPT *(BASELINE)        |        |        |        |        |        |  |
|                          |  |            | Cutting Diameter Engaged                                    |     |     |     |     | Cutting Diameter       |        |        |        |        |        |  |
|                          |  |            | 5%  | 10% | 20% | 30% | 50% | 5/16                   | 3/8    | 1/2    | 5/8    | 3/4    | 1      |  |
| Steels                   | Free Machining & Low Carbon: 10XX, 11XX, 12XX, 12LXX, ASTM A27, ASTM A36   | P ≤ 28 Rc  | 1050  | 700 | 385 | 375 | 350 |                        |        |        |        |        |        |  |
|                          | Medium Carbon, High Carbon Steels, Alloy Steels & Easy to Machine Tool: 13XX, 41XX, 43XX, 51XX, 86XX, 93XX       | P 28-38 Rc | 630   | 420 | 320 | 250 | 210 | 0.0027                 | 0.0032 | 0.0045 | 0.0054 | 0.0063 | 0.0090 |  |
| Tool & Die Steels        | A2, H13, L6, P20, S7   | P 28-44 Rc | 525   | 350 | 300 | 275 | 250 | 0.0027                 | 0.0032 | 0.0045 | 0.0054 | 0.0063 | 0.0090 |  |
| Stainless Steel          | Easy to Machine, 430F, 301, 303, 410, 416 Annealed, 420F, 430, 430F  | M ≤ 28 Rc  | 650   | 600 | 550 | 500 | 450 |                        |        |        |        |        |        |  |
|                          | Moderately Difficult to Machine, Nitronic 50, Nitronic 60, 301, 303 304, 304L Incoloy 27-7MO, 316 316L, 321, 347 | M ≤ 28 Rc  | 525   | 400 | 350 | 300 | 250 | 0.0027                 | 0.0032 | 0.0045 | 0.0054 | 0.0063 | 0.0090 |  |
|                          | Difficult to Machine, 302B, 304B, 309, 310, 316, 316B, 316L, 316Ti, 317, 317L, 321, PH13-8Mo, Nitronics          | M > 28 Rc  | 525   | 400 | 350 | 300 | 250 |                        |        |        |        |        |        |  |
| Super Alloys             | High Temp, Nimonic, Inconel, Monel, Hastelloy  | S ≤ 42 Rc  | 265   | 200 | 175 | 150 | 100 | 0.0014                 | 0.0016 | 0.0023 | 0.0027 | 0.0032 | 0.0045 |  |
|                          | Titanium: Ti 3Al-2.5V, Ti 6Al-4V Ti 10V-2Fe-3Al  | S ≤ 42 Rc  | 230   | 200 | 175 | 150 | 125 |                        |        |        |        |        |        |  |
| Hardened Materials       |  | H 45-55 Rc | 250   | 240 | 230 | 210 | 200 | 0.0018                 | 0.0021 | 0.0030 | 0.0036 | 0.0042 | 0.0060 |  |
|                          |  | H 55-65 Rc | 200   | 180 | 160 | 150 | 100 | 0.0013                 | 0.0014 | 0.0021 | 0.0024 | 0.0029 | 0.0041 |  |
| Cast-Iron                | Gray: SAE J431, ASTM A48   | K ≤ 240 HB | 425   | 400 | 375 | 350 | 300 |                        |        |        |        |        |        |  |
|                          | Ductile & Malleable: ASTM A536, ASTM 897, ASTM A47, ASTM A220 ASTM A602  | K > 240 HB | 320   | 300 | 250 | 225 | 200 | 0.0027                 | 0.0032 | 0.0045 | 0.0054 | 0.0063 | 0.0090 |  |
| Non-Ferrous              | Aluminum, Brass, Bronze, Copper, Plastics, Graphite  | N          | 1000  | 960 | 920 | 880 | 840 | 0.0027                 | 0.0032 | 0.0045 | 0.0054 | 0.0063 | 0.0090 |  |

| *CHIP THINNING Adjustments |              |
|----------------------------|--------------|
| RDOC                       | Increase IPT |
| 50%                        | None         |
| 30%                        | 1.1 x        |
| 25%                        | 1.2 x        |
| 20%                        | 1.3 x        |
| 15%                        | 1.4 x        |
| 10%                        | 1.8 x        |
| 7%                         | 2.0 x        |
| 5%                         | 2.3 x        |
| 3%                         | 3.0 x        |
| 2%                         | 3.5 x        |
| 1%                         | 5.0 x        |



**SLOTTING**

| Workpiece Material Group |  | Hardness   | Surface Feet Per Minute (SFM)<br>Radial Depth of Cut (RDOC) |     |      | Inches Per Tooth (IPT) |        |        |        |        |        |
|--------------------------|--|------------|---|-----|------|------------------------|--------|--------|--------|--------|--------|
|                          |  |            | SFM   |     |      | IPT *(BASELINE)        |        |        |        |        |        |
|                          |  |            | Cutting Diameter Engaged                                    |     |      | Cutting Diameter       |        |        |        |        |        |
|                          |  |            | 25%   | 50% | 100% | 5/16                   | 3/8    | 1/2    | 5/8    | 3/4    | 1      |
| Steels                   | Free Machining & Low Carbon: 10XX, 11XX, 12XX, 12LXX, ASTM A27, ASTM A36   | P ≤ 28 Rc  | 385   | 370 | 350  |                        |        |        |        |        |        |
|                          | Medium Carbon, High Carbon Steels, Alloy Steels & Easy to Machine Tool: 13XX, 41XX, 43XX, 51XX, 86XX, 93XX       | P 28-38 Rc | 245   | 230 | 2210 | 0.0016                 | 0.0019 | 0.0025 | 0.0031 | 0.0038 | 0.0050 |
| Tool & Die Steels        | A2, H13, L6, P20, S7   | P 28-44 Rc | 210   | 195 | 175  | 0.0016                 | 0.0019 | 0.0025 | 0.0031 | 0.0038 | 0.0050 |
| Stainless Steel          | Easy to Machine, 430F, 301, 303, 410, 416 Annealed, 420F, 430, 430F  | M ≤ 28 Rc  | 385   | 370 | 350  |                        |        |        |        |        |        |
|                          | Moderately Difficult to Machine, Nitronic 50, Nitronic 60, 301, 303 304, 304L Incoloy 27-7MO, 316 316L, 321, 347 | M ≤ 28 Rc  | 245   | 210 | 175  | 0.0016                 | 0.0019 | 0.0025 | 0.0031 | 0.0038 | 0.0050 |
|                          | Difficult to Machine, 302B, 304B, 309, 310, 316, 316B, 316L, 316Ti, 317, 317L, 321, PH13-8Mo, Nitronics          | M > 28 Rc  | 210   | 195 | 175  |                        |        |        |        |        |        |
| Super Alloys             | High Temp, Nimonic, Inconel, Monel, Hastelloy  | S ≤ 42 Rc  | 125   | 105 | 90   | 0.0008                 | 0.0010 | 0.0013 | 0.0016 | 0.0017 | 0.0026 |
|                          | Titanium: Ti 3Al-2.5V, Ti 6Al-4V Ti 10V-2Fe-3Al  | S ≤ 42 Rc  | 100   | 90  | 80   |                        |        |        |        |        |        |
| Hardened Materials       |  | H 34-45 Rc | 245   | 230 | 210  | 0.0016                 | 0.0019 | 0.0025 | 0.0031 | 0.0038 | 0.0050 |
|                          |  | H 45-55 Rc | 175   | 160 | 140  | 0.0008                 | 0.0010 | 0.0013 | 0.0016 | 0.0020 | 0.0025 |
|                          |  | H 55-65 Rc | 150   | 125 | 100  | 0.0004                 | 0.0005 | 0.0008 | 0.0008 | 0.0010 | 0.0012 |
| Cast-Iron                | Gray: SAE J431, ASTM A48   | K ≤ 240 HB | 450   | 400 | 350  |                        |        |        |        |        |        |
|                          | Ductile & Malleable: ASTM A536, ASTM 897, ASTM A47, ASTM A220 ASTM A602  | K > 240 HB | 300   | 250 | 225  | 0.0016                 | 0.0019 | 0.0025 | 0.0031 | 0.0038 | 0.0050 |
| Non-Ferrous              | Aluminum, Brass, Bronze, Copper, Plastics, Graphite  | N          | 750   | 600 | 450  | 0.0016                 | 0.0019 | 0.0025 | 0.0031 | 0.0038 | 0.0050 |

# 4 FLUTE - DOUBLE END SQUARE



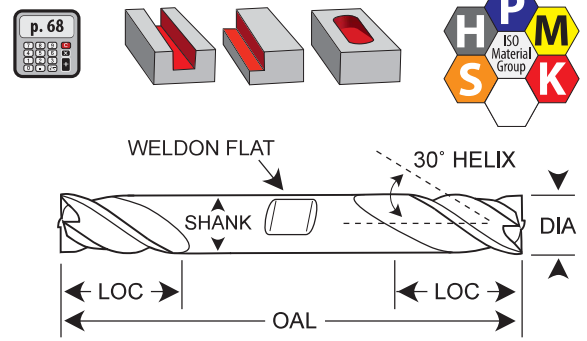
Universal 30° helix designed for proven success in various materials

Double end design for maximum savings in tooling costs

Multiple coating options for specific machining needs

C2 Sub-Micron substrate for excellent wear resistance

Four flute design offers increased core design which minimizes tool deflection and improves accuracy



DIAMETER TOLERANCE: +0.000 / -0.002" SHANK TOLERANCE: +0.0000 / -0.0005"

| DIA   | Dec In | LOC   | Shank | OAL   | Flat | Length  | Bright     | TiN        | TiCN       | AlTiN      |
|-------|--------|-------|-------|-------|------|---------|------------|------------|------------|------------|
| 1/32  | 0.0313 | 1/16  | 1/8   | 1-1/2 | No   | Stub    | 236-001001 | 236-001011 | 236-001003 | 236-001004 |
| 3/64  | 0.0469 | 3/32  | 1/8   | 1-1/2 | No   | Stub    | 236-001010 | 236-001012 | 236-001013 | 236-001014 |
| 1/16  | 0.0625 | 1/8   | 1/8   | 1-1/2 | No   | Stub    | 236-001020 | 236-001021 | 236-001028 | 236-031025 |
| 5/64  | 0.0781 | 1/8   | 1/8   | 1-1/2 | No   | Stub    | 236-001025 | 236-001026 | 236-021025 | 236-001027 |
| 3/32  | 0.0938 | 3/16  | 1/8   | 1-1/2 | No   | Stub    | 236-001030 | 236-001031 | 236-001037 | 236-001034 |
| 7/64  | 0.1094 | 3/16  | 1/8   | 1-1/2 | No   | Stub    | 236-001035 | 236-001036 | 236-021036 | 236-031035 |
| 1/8   | 0.1250 | 1/4   | 1/8   | 1-1/2 | No   | Stub    | 236-001040 | 236-001041 | 236-001045 | 236-001047 |
|       |        | 3/8   | 3/8   | 3     | Yes  | Regular | 239-001001 | 239-001002 | —          | 239-001003 |
| 9/64  | 0.1406 | 5/16  | 3/16  | 2     | No   | Stub    | 236-001042 | 236-001044 | 236-021044 | 236-031042 |
| 5/32  | 0.1563 | 5/16  | 3/16  | 2     | No   | Stub    | 236-001050 | 236-001051 | 236-001053 | 236-001054 |
|       |        | 7/16  | 3/8   | 3     | Yes  | Regular | 239-001010 | —          | —          | 239-001013 |
| 11/64 | 0.1719 | 5/16  | 3/16  | 2     | No   | Stub    | 236-001055 | 236-001056 | 236-021055 | 236-001057 |
| 3/16  | 0.1875 | 3/8   | 3/16  | 2     | No   | Stub    | 236-001060 | 236-001061 | 236-001062 | 236-001064 |
|       |        | 1/2   | 3/8   | 3     | Yes  | Regular | 239-001020 | 239-001021 | —          | 239-001023 |
| 13/64 | 0.2031 | 1/2   | 1/4   | 2-1/2 | No   | Stub    | 236-001065 | 236-001066 | 236-021065 | 236-031065 |
| 7/32  | 0.2188 | 1/2   | 1/4   | 2-1/2 | No   | Stub    | 236-001070 | 236-001071 | 236-001073 | 236-001074 |
|       |        | 9/16  | 3/8   | 3-1/2 | Yes  | Regular | 239-001030 | —          | —          | 239-001033 |
| 15/64 | 0.2344 | 1/2   | 1/4   | 2-1/2 | No   | Stub    | 236-001075 | 236-001076 | 236-021075 | 236-031075 |
| 1/4   | 0.2500 | 1/2   | 1/4   | 2-1/2 | No   | Stub    | 236-001080 | 236-001081 | 236-001083 | 236-001085 |
|       |        | 5/8   | 3/8   | 3-1/2 | Yes  | Regular | 239-001040 | 239-001041 | —          | 239-001043 |
| 9/32  | 0.2813 | 1/2   | 5/16  | 2-1/2 | No   | Stub    | 236-001082 | 236-001087 | 236-001088 | 236-001089 |
|       |        | 11/16 | 3/8   | 3-1/2 | Yes  | Regular | 239-001050 | —          | —          | 239-001053 |
| 5/16  | 0.3125 | 1/2   | 5/16  | 2-1/2 | No   | Stub    | 236-001090 | 236-001091 | 236-001093 | 236-001094 |
|       |        | 3/4   | 3/8   | 3-1/2 | Yes  | Regular | 239-001060 | 239-001061 | —          | 239-001063 |
| 11/32 | 0.3438 | 9/16  | 3/8   | 2-1/2 | No   | Stub    | 236-001092 | 236-001095 | 236-001096 | 236-031092 |
|       |        | 3/4   | 3/8   | 3-1/2 | Yes  | Regular | 239-001070 | —          | —          | 239-001073 |
| 3/8   | 0.3750 | 9/16  | 3/8   | 2-1/2 | No   | Stub    | 236-001100 | 236-001101 | 236-001102 | 236-001103 |
|       |        | 3/4   | 3/8   | 3-1/2 | Yes  | Regular | 239-001080 | —          | —          | 239-001083 |
| 7/16  | 0.4375 | 9/16  | 7/16  | 2-3/4 | No   | Stub    | 236-001110 | 236-021111 | 236-001111 | 236-031110 |
|       |        | 7/8   | 1/2   | 4     | Yes  | Regular | 239-001090 | —          | —          | 239-001093 |
| 1/2   | 0.5000 | 5/8   | 1/2   | 3     | No   | Stub    | 236-001120 | 236-001121 | 236-001122 | 236-001124 |
|       |        | 1     | 1/2   | 4     | Yes  | Regular | 239-001100 | 239-001101 | 239-001102 | 239-001103 |