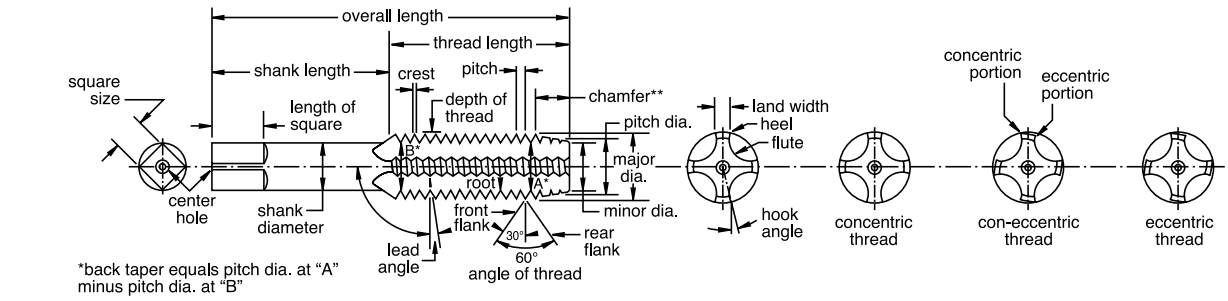
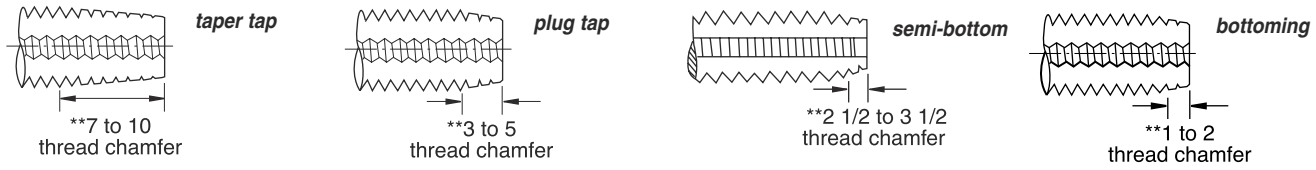
## Tap Nomenclature




**Allowance** - A prescribed difference between the maximum material limits of mating parts. It is the minimum clearance (positive allowance) or maximum interference (negative allowance) between such parts.

**Angle of Thread** - The angle included between the flanks of the thread measured in an axial plane.

**Back Taper** - A slight axial relief on the thread of the tap that makes the pitch diameter of the thread near the shank somewhat smaller than that of the chamfered end.

**Basic** - The theoretical or nominal standard size from which all variations are made.

**Chamfer** - The tapering of the threads at the front end of each land of a tap by cutting away and relieving the crest of the first few teeth to distribute the cutting action over several teeth. When the tapering amounts to 7 to 10 threads, the tap is called a "taper" tap; 3 to 5 threads, a "plug" tap; and 1 to 2 threads, a "bottoming" tap.

**Chamfer Relief** - The gradual decrease in land height from cutting edge to heel on the chamfered portion, to provide clearance for the cutting action as the tap advances.

**Class of Fit** - An alphanumeric designation to indicate the standard grade of tolerance and allowance specified for a thread.

*1A (external) and 1B (internal)* - Used for applications where quick and easy assembly is required. An allowance is provided on the external thread, but is not enough for plating or coating.

*2A (external) and 2B (internal)* - The most commonly used class for general applications such as bolts, screws, nuts, and other threaded fasteners. The allowance provided on the external thread can accommodate plated finishes or coatings.

*3A (external) and 3B (internal)* - Used where closeness of fit and accuracy of lead and angle are important. No allowance is provided on the external thread.

**Crest** - The top surface joining the two flanks of a thread. The crest of an external thread is at its major diameter, while the crest of an internal thread is at its minor diameter.

**Cutting Face** - The leading side of the land in the direction of rotation for cutting on which the chip impinges.

**Dry Seal** - A pipe-threaded connection for both external and internal application designed for use where the assembled product must withstand high fluid or gas pressures without the use of a sealing compound, or where a sealer is functionally objectionable.

**Flutes** - The longitudinal channels formed in a tap to create cutting edges on the thread profile and to provide chip spaces and cutting fluid passages.

**Height of Thread** - The distance between the crest and the root of a thread measured normal to the axis.

**Helical Flute** - A flute with uniform axial lead and constant helix.

**Hook Face** - A concave cutting face, usually specified as either chordal hook or tangential hook.

*chordal hook* - The angle between the chord passing through the root and crest of a thread form at the cutting face, and a radial line through the crest at the cutting edge.

*tangential hook* - The angle between a line tangent to a hook cutting face at the cutting edge and a radial line to the same point.

**Interrupted Thread** - A tap having an odd number of lands, with every other tooth along the thread helix removed.

**Land** - One of the threaded sections between the flutes on a tap.

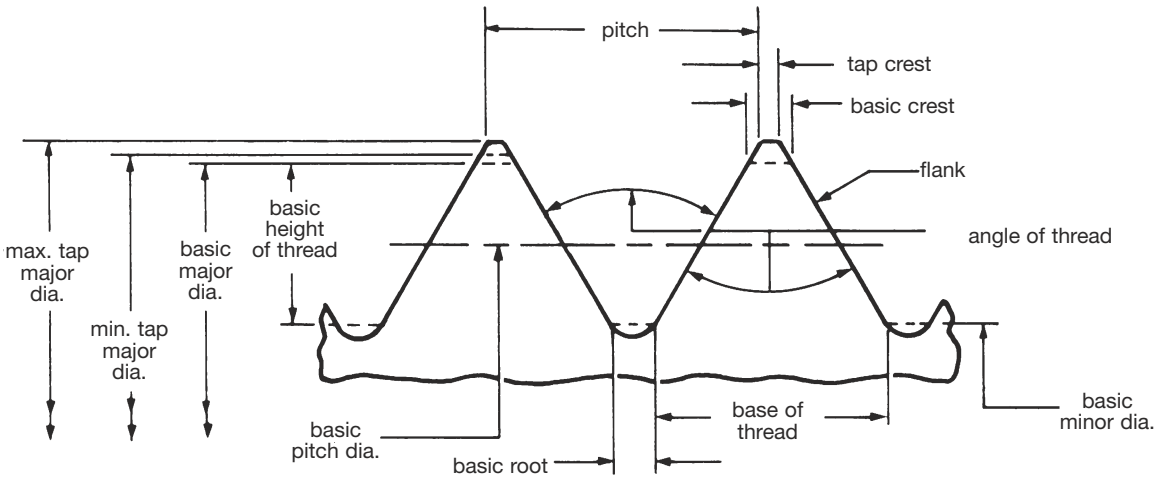
**Lead** - The distance a screw thread advances axially in one complete turn. On a single-lead screw or tap, the lead and the pitch are identical. On a double-lead screw or tap, the lead is twice the pitch, etc.

**Threads Per Inch** - The number of threads in one inch of length.

**Major Diameter** - The largest diameter of a straight thread. On a taper thread, the largest diameter at any given plane normal to the axis.

*(Continued on next page.)*

## Tap Nomenclature (cont'd.)




**Minor Diameter** - The smallest diameter of a straight thread. On a taper thread, the smallest diameter at any given plane normal to the axis.

**Percent of Thread** - One-half the difference between the basic major diameter and the actual minor diameter of an internal thread, divided by the basic thread height, expressed as percentage.

**Pitch** - The distance from any point on a screw or tap thread to a corresponding point on the next thread, measured parallel to the axis. The pitch equals one divided by the number of threads per inch.

**Pitch Diameter** - On a straight thread, the diameter of an imaginary co-axial cylinder, the surface of which would pass through the thread profile at such points as to make equal the width of the threads and the width of the spaces cut by the surface of the cylinder.

On a taper thread, the diameter at a given distance from a reference plane perpendicular to the axis of an imaginary co-axial cone, the surface of which would pass through the thread profile at such points as to make equal the width of the threads and the width of the spaces cut by the surface of the cone.

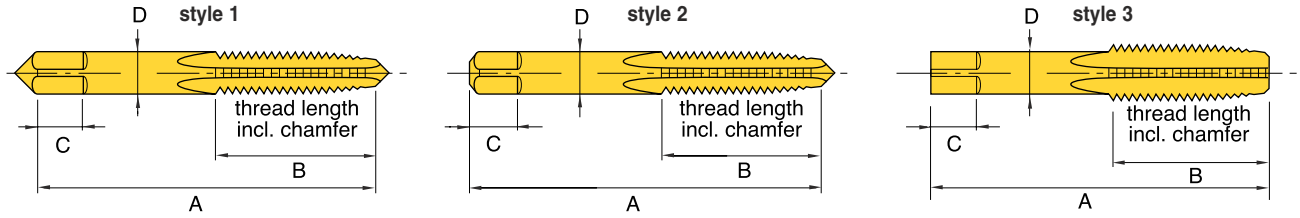
**Rake** - Any deviation of a straight cutting face of the tooth from a radial line. Positive rake means that the crest of the cutting face is angularly advanced ahead of the balance of the face of the tooth. Negative rake means that the same point is angulary behind the balance of the cutting face of the tooth. Zero rake means that the cutting face is directly on the center line.

**Root** - The bottom surface joining the flanks of two adjacent threads. The root of an external thread is at its minor diameter, while the root of an internal thread is at its major diameter.

**Spiral Point** - A supplementary angular fluting cut in the cutting face of the land at the chamfer end. It is slightly longer than the chamfer on the tap and of the opposite hand to that of rotation.

**Thread Relief** - The clearance produced by removal of metal from behind the cutting edge. When the thread angle is relieved from the heel to cutting edge, the tap is said to have "eccentric" relief. If relieved from heel for only a portion of land width, the tap is said to have "con-eccentric" relief.

## General Dimensions – USCTI Standards




| nominal dia. range (inches) over | nominal dia. range (inches) to (incl.) | mach. screw size no. | nominal fractional diameter (inches) | nominal soft metric diameter (mm) | style | tap dimensions (inches) overall length A | thread length B | square length C | shank diameter D | size of square E |
|---|---|---|---|---|---|---|---|---|---|---|
| .052 | .065 | 0 | 1/16 | M1,6 | 1 | 1 5/8 | 5/16 | 3/16 | .141 | .110 |
| .065 | .078 | 1 | — | M1,8 | 1 | 1 11/16 | 3/8 | 3/16 | .141 | .110 |
| .078 | .091 | 2 | — | M2, M2.2 | 1 | 1 3/4 | 7/16 | 3/16 | .141 | .110 |
| .091 | .104 | 3 | 3/32 | M2,5 | 1 | 1 13/16 | 1/2 | 3/16 | .141 | .110 |
| .104 | .117 | 4 | — | — | 1 | 1 7/8 | 9/16 | 3/16 | .141 | .110 |
| .117 | .130 | 5 | 1/8 | M3, M3,15 | 1 | 1 15/16 | 5/8 | 3/16 | .141 | .110 |
| .130 | .145 | 6 | — | M3,5 | 1 | 2 | 11/16 | 3/16 | .141 | .110 |
| .145 | .171 | 8 | 5/32 | M4 | 1 | 2 1/8 | 3/4 | 1/4 | .168 | .131 |
| .171 | .197 | 10 | 3/16 | M4,5, M5 | 1 | 2 3/8 | 7/8 | 1/4 | .194 | .152 |
| .197 | .223 | 12 | 7/32 | — | 1 | 2 3/8 | 15/16 | 9/32 | .220 | .165 |
| .223 | .260 | 14 | 1/4 | M6, M6,3 | 2 | 2 1/2 | 1 | 5/16 | .255 | .191 |
| .260 | .323 | — | 5/16 | M7, M8 | 2 | 2 23/32 | 1 1/8 | 3/8 | .318 | .238 |
| .323 | .395 | — | 3/8 | M10 | 2 | 2 15/16 | 1 1/4 | 7/16 | .381 | .286 |
| .395 | .448 | — | 7/16 | — | 3 | 3 5/32 | 1 7/16 | 13/32 | .323 | .242 |
| .448 | .510 | — | 1/2 | M12, M12,5 | 3 | 3 3/8 | 1 21/32 | 7/16 | .367 | .275 |
| .510 | .573 | — | 9/16 | M14 | 3 | 3 19/32 | 1 21/32 | 1/2 | .429 | .322 |
| .573 | .635 | — | 5/8 | M16 | 3 | 3 13/16 | 1 13/16 | 9/16 | .480 | .360 |
| .635 | .709 | — | 11/16 | M18 | 3 | 4 1/32 | 1 13/16 | 5/8 | .542 | .406 |
| .709 | .760 | — | 3/4 | — | 3 | 4 1/4 | 2 | 11/16 | .590 | .442 |
| .760 | .823 | — | 13/16 | M20 | 3 | 4 15/32 | 2 | 11/16 | .652 | .489 |
| .823 | .885 | — | 7/8 | M22 | 3 | 4 11/16 | 2 7/32 | 3/4 | .697 | .523 |
| .885 | .948 | — | 15/16 | M24 | 3 | 4 29/32 | 2 7/32 | 3/4 | .760 | .570 |
| .948 | 1.010 | — | 1 | M25 | 3 | 5 1/8 | 2 1/2 | 13/16 | .800 | .600 |
| 1.010 | 1.073 | — | 1 1/16 | M27 | 3 | 5 1/8 | 2 1/2 | 7/8 | .896 | .672 |
| 1.073 | 1.135 | — | 1 1/8 | — | 3 | 5 7/16 | 2 9/16 | 7/8 | .896 | .672 |
| 1.135 | 1.198 | — | 1 3/16 | M30 | 3 | 5 7/16 | 2 9/16 | 1 | 1.021 | .766 |
| 1.198 | 1.260 | — | 1 1/4 | — | 3 | 5 3/4 | 2 9/16 | 1 | 1.021 | .766 |
| 1.260 | 1.323 | — | 1 5/16 | M33 | 3 | 5 3/4 | 2 9/16 | 1 1/16 | 1.108 | .831 |
| 1.323 | 1.385 | — | 1 3/8 | — | 3 | 6 1/16 | 3 | 1 1/16 | 1.108 | .831 |
| 1.385 | 1.448 | — | 1 7/16 | M36 | 3 | 6 1/16 | 3 | 1 1/8 | 1.233 | .925 |
| 1.448 | 1.510 | — | 1 1/2 | — | 3 | 6 3/8 | 3 | 1 1/8 | 1.233 | .925 |
| 1.510 | 1.635 | — | 1 5/8 | M39 | 3 | 6 11/16 | 3 3/16 | 1 1/8 | 1.305 | .979 |
| 1.635 | 1.760 | — | 1 3/4 | M42 | 3 | 7 | 3 3/16 | 1 1/4 | 1.430 | 1.072 |
| 1.760 | 1.885 | — | 1 7/8 | — | 3 | 7 5/16 | 3 9/16 | 1 1/4 | 1.519 | 1.139 |
| 1.885 | 1.010 | — | 2 | M48 | 3 | 7 5/8 | 3 9/16 | 1 3/8 | 1.644 | 1.233 |

## USCTI Standard Dimensions

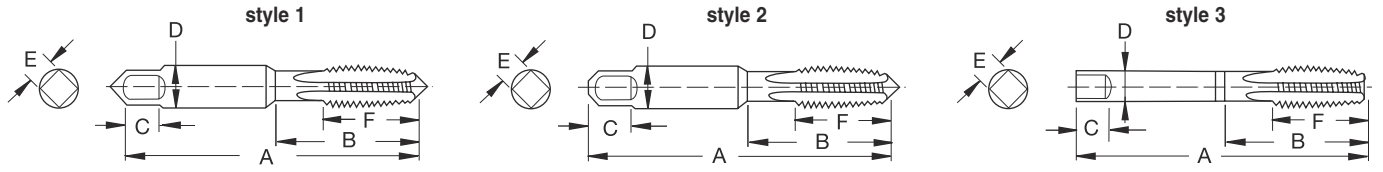
(over 1" diameter)

| nominal dia. range (inches) over | nominal dia. range (inches) to (incl.) | nominal fractional diameter (inches) | nominal metric diameter (mm) | style | shank diameter D | table 302 long series overall length A | table 302 long series thread length B | table 302 long series square length C | table 302 long series size of square E | * table 303 short series overall length A | * table 303 short series thread length B | * table 303 short series square length C | * table 303 short series size of square E |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.010 | 1.073 | 1 1/16 | M27 | 3 | .896 | 5 1/8 | 2 1/2 | 7/8 | .672 | 4 | 1 1/2 | 7/8 | .672 |
| 1.073 | 1.135 | 1 1/8 | — | 3 | .896 | 5 7/16 | 2 9/16 | 7/8 | .672 | 4 | 1 1/2 | 7/8 | .672 |
| 1.135 | 1.198 | 1 3/16 | M30 | 3 | 1.021 | 5 7/16 | 2 9/16 | 1 | .766 | 4 | 1 1/2 | 1 | .766 |
| 1.198 | 1.260 | 1 1/4 | — | 3 | 1.021 | 5 3/4 | 2 9/16 | 1 | .766 | 4 | 1 1/2 | 1 | .766 |
| 1.260 | 1.323 | 1 5/16 | M33 | 3 | 1.108 | 5 3/4 | 2 9/16 | 1 1/16 | .831 | 4 | 1 1/2 | 1 | .831 |
| 1.323 | 1.385 | 1 3/8 | — | 3 | 1.108 | 6 1/16 | 3 | 1 1/16 | .831 | 4 | 1 1/2 | 1 | .831 |
| 1.385 | 1.448 | 1 7/16 | M36 | 3 | 1.233 | 6 1/16 | 3 | 1 1/8 | .925 | 4 | 1 1/2 | 1 | .925 |
| 1.448 | 1.510 | 1 1/2 | — | 3 | 1.233 | 6 3/8 | 3 | 1 1/8 | .925 | 4 | 1 1/2 | 1 | .925 |
| 1.510 | 1.635 | 1 5/8 | M39 | 3 | 1.305 | 6 11/16 | 3 3/16 | 1 1/8 | .979 | 5 | 2 | 1 1/8 | .979 |
| 1.635 | 1.760 | 1 3/4 | M42 | 3 | 1.430 | 7 | 3 3/16 | 1 1/4 | 1.072 | 5 | 2 | 1 1/4 | 1.072 |
| 1.760 | 1.885 | 1 7/8 | — | 3 | 1.519 | 7 5/16 | 3 9/16 | 1 1/4 | 1.139 | 5 | 2 | 1 1/4 | 1.139 |
| 1.885 | 2.010 | 2 | M48 | 3 | 1.644 | 7 5/8 | 3 9/16 | 1 3/8 | 1.233 | 5 | 2 | 1 3/8 | 1.233 |
| 2.010 | 2.135 | 2 1/8 | — | 3 | 1.769 | 8 | 3 9/16 | 1 3/8 | 1.327 | 5 1/4 | 2 | 1 3/8 | 1.327 |
| 2.135 | 2.260 | 2 1/4 | M56 | 3 | 1.894 | 8 1/4 | 3 9/16 | 1 7/16 | 1.420 | 5 1/4 | 2 | 1 7/16 | 1.420 |
| 2.260 | 2.385 | 2 3/8 | — | 3 | 2.019 | 8 1/2 | 4 | 1 7/16 | 1.514 | 5 1/4 | 2 | 1 7/16 | 1.514 |
| 2.385 | 2.510 | 2 1/2 | — | 3 | 2.100* | 8 3/4 | 4 | 1 1/2 | 1.575 | 5 1/4 | 2 | 1 1/2 | 1.575 |
| 2.510 | 2.635 | 2 5/8 | M64 | 3 | 2.225* | 8 3/4 | 4 | 1 1/2 | 1.669 | 5 1/2 | 2 | 1 1/2 | 1.575 |
| 2.635 | 2.760 | 2 3/4 | — | 3 | 2.350* | 9 1/4 | 4 | 1 9/16 | 1.762 | 5 1/2 | 2 | 1 1/2 | 1.575 |
| 2.760 | 2.885 | 2 7/8 | M72 | 3 | 2.475* | 9 1/4 | 4 | 1 | 1.856 | 5 1/2 | 2 | 1 1/2 | 1.575 |
| 2.885 | 3.010 | 3 | — | 3 | 2.543* | 9 3/4 | 4 9/16 | 1 5/8 | 1.907 | 5 1/2 | 2 | 1 1/2 | 1.575 |
| 3.010 | 3.135 | 3 1/8 | — | 3 | 2.668* | 9 3/4 | 4 9/16 | 1 5/8 | 2.001 | 5 3/4 | 2 | 1 1/2 | 1.575 |
| 3.135 | 3.260 | 3 1/4 | M80 | 3 | 2.793* | 10 | 4 9/16 | 1 3/4 | 2.095 | 5 3/4 | 2 | 1 1/2 | 1.575 |
| 3.260 | 3.385 | 3 3/8 | — | 3 | 2.883* | 10 | 4 9/16 | 1 3/4 | 2.162 | 5 3/4 | 2 | 1 1/2 | 1.575 |
| 3.385 | 3.510 | 3 1/2 | — | 3 | 3.008* | 10 1/4 | 4 15/16 | 2 | 2.256 | 5 3/4 | 2 | 1 1/2 | 1.575 |
| 3.510 | 3.635 | 3 5/8 | M90 | 3 | 3.133* | 10 1/4 | 4 15/16 | 2 | 2.350 | 6 | 2 | 1 3/4 | 1.575 |
| 3.635 | 3.760 | 3 3/4 | — | 3 | 3.217* | 10 1/2 | 5 5/16 | 2 1/8 | 2.413 | 6 | 2 | 1 3/4 | 1.575 |
| 3.760 | 3.885 | 3 7/8 | — | 3 | 3.342* | 10 1/2 | 5 5/16 | 2 1/8 | 2.506 | 6 | 2 | 1 3/4 | 1.575 |
| 3.885 | 4.010 | 4 | M100 | 3 | 3.467* | 10 3/4 | 5 5/16 | 2 1/4 | 2.600 | 6 | 2 | 1 3/4 | 1.575 |

**Short series blanks, 2.385"-4.010" diameters, have a shank diameter of 2.100".*

## USCTI Standard Dimensions (High-Performance Taps)

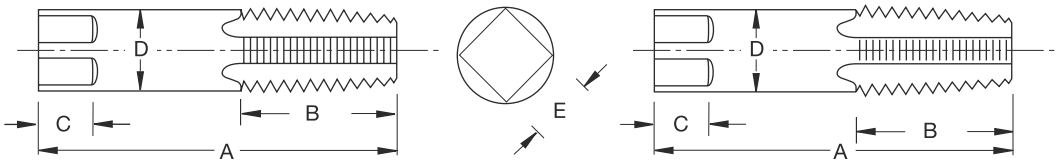
(optional necks and optional shortened thread length)




| nominal dia. range (inches) over | nominal dia. range (inches) to (incl.) | mach. screw size no. | nominal fractional diameter (inches) | nominal soft metric diameter (mm) | style | tap dimensions (inches) overall length A | length B | square length C | shank diameter D | size of square E | length of thread F |
|---|---|---|---|---|---|---|---|---|---|---|---|
| .104 | .117 | 4 | — | — | 1 | 1 7/8 | 9/16 | 3/16 | .141 | .110 | 5/16 |
| .117 | .130 | 5 | 1/8 | M3, M3,15 | 1 | 1 15/16 | 5/8 | 3/16 | .141 | .110 | 5/16 |
| .130 | .145 | 6 | — | M3,5 | 1 | 2 | 11/16 | 3/16 | .141 | .110 | 3/8 |
| .145 | .171 | 8 | 5/32 | M4 | 1 | 2 1/8 | — | 1/4 | .168 | .131 | 3/8 |
| .171 | .197 | 10 | 3/16 | M4,5, M5 | 1 | 2 3/8 | 3/4 | 1/4 | .194 | .152 | 1/2 |
| .197 | .223 | 12 | 7/32 | — | 1 | 2 3/8 | 7/8 | 9/32 | .220 | .165 | 1/2 |
| .223 | .260 | 14 | 1/4 | M6, M6,3 | 2 | 2 1/2 | 15/16 | 5/16 | .255 | .191 | 5/8 |
| .260 | .323 | — | 5/16 | M7, M8 | 2 | 2 23/32 | 1 | 3/8 | .318 | .238 | 11/16 |
| .323 | .395 | — | 3/8 | M10 | 2 | 2 15/16 | 1 1/8 | 7/16 | .381 | .286 | 3/4 |
| .395 | .448 | — | 7/16 | — | 3 | 3 5/32 | 1 1/4 | 13/32 | .323 | .242 | 7/8 |
| .448 | .510 | — | 1/2 | M12, M12,5 | 3 | 3 3/8 | — | 7/16 | .367 | .275 | 15/16 |
| .510 | .573 | — | 9/16 | M14 | 3 | 3 19/32 | — | 1/2 | .429 | .322 | 1 |
| .573 | .635 | — | 5/8 | M16 | 3 | 3 13/16 | — | 9/16 | .480 | .360 | 1 3/32 |
| .635 | .709 | — | 11/16 | M18 | 3 | 4 1/32 | — | 5/8 | .542 | .406 | 1 3/32 |
| .709 | .760 | — | 3/4 | — | 3 | 4 1/4 | — | 11/16 | .590 | .442 | 1 7/32 |
| .760 | .823 | — | 13/16 | M20 | 3 | 4 15/32 | — | 11/16 | .652 | .489 | 1 7/32 |
| .823 | .885 | — | 7/8 | M22 | 3 | 4 11/16 | — | 3/4 | .697 | .523 | 1 11/32 |
| .885 | .948 | — | 15/16 | M24 | 3 | 4 29/32 | — | 3/4 | .760 | .570 | 1 11/32 |
| .948 | 1.010 | — | 1 | M25 | 3 | 5 1/8 | — | 13/16 | .800 | .600 | 1 1/2 |
| 1.010 | 1.073 | — | 1 1/16 | M27 | 3 | 5 1/16 | — | 7/8 | .896 | .672 | 1 17/32 |
| 1.073 | 1.135 | — | 1 1/8 | — | 3 | 5 7/16 | — | 7/8 | .896 | .672 | 1 17/32 |
| 1.198 | 1.260 | — | 1 1/4 | — | 3 | 5 3/4 | — | 1 | 1.021 | .766 | 1 17/32 |
| 1.198 | 1.260 | — | 1 1/4 | — | 3 | 5 3/4 | — | 1 | 1.021 | .766 | 1 17/32 |
| 1.323 | 1.385 | — | 1 3/8 | — | 3 | 6 1/16 | — | 1 1/16 | 1.108 | .831 | 1 13/16 |
| 1.323 | 1.385 | — | 1 3/8 | — | 3 | 6 1/16 | — | 1 1/16 | 1.108 | .831 | 1 13/16 |
| 1.448 | 1.510 | — | 1 1/2 | — | 3 | 6 3/8 | — | 1 1/8 | 1.233 | .925 | 1 13/16 |
| 1.448 | 1.510 | — | 1 1/2 | — | 3 | 6 3/8 | — | 1 1/8 | 1.233 | .925 | 1 13/16 |
| 1.635 | 1.760 | — | 1 3/4 | M42 | 3 | 7 | — | 1 1/4 | 1.430 | 1.072 | 1 15/16 |
| 1.885 | 2.010 | — | 2 | M48 | 3 | 7 5/8 | — | 1 3/8 | 1.644 | 1.233 | 1 15/16 |

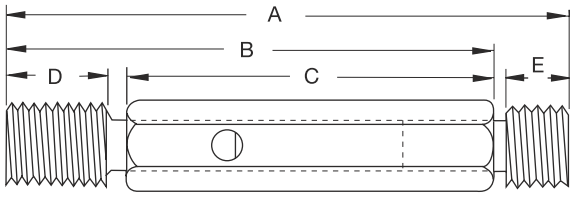
## General Dimensions – USCTI Standard Dimensions

(taper and straight pipe)




| nominal pipe size | overall length A | thread length B | square length C | shank diameter D | size of square E |
|---|---|---|---|---|---|
| 1/16 | 2 1/8 | 11/16 | 3/8 | .3125 | .234 |
| 1/8 | 2 1/8 | 3/4 | 3/8 | .3125 | .234 |
| 1/8 | 2 1/8 | 3/4 | 3/8 | .4375 | .328 |
| 1/4 | 2 7/16 | 1 1/16 | 7/16 | .5625 | .421 |
| 3/8 | 2 9/16 | 1 1/16 | 1/2 | .7 | .531 |
| 1/2 | 3 1/8 | 1 3/8 | 5/8 | .6875 | .515 |
| 3/4 | 3 1/4 | 1 3/8 | 11/16 | .9063 | .679 |
| 1 | 3 3/4 | 1 3/4 | 13/16 | 1.125 | .843 |
| 1 1/4 | 4 | 1 3/4 | 15/16 | 1.3125 | .984 |
| 1 1/2 | 4 1/4 | 1 3/4 | 1 | 1.5 | 1.125 |
| 2 | 4 1/2 | 1 3/4 | 1 1/8 | 1.875 | 1.406 |

## Thread Plug Gages




| nominal size | | length | | | | | handle | |
|---|---|---|---|---|---|---|---|---|
| inch | mm | A overall | B GO member + handle | C handle only | D GO member | E NO GO (HI) member | hex size | number |
| 0, 1, 2, 3 | 1,6, 2, 2,5 | 2 1/2 | 2 1/32 | 1 1/2 | 1/4 | 3/16 | 3/16 | 000 |
| 4, 5, 6 | 3, 3,5 | 2 31/32 | 2 2/5 | 1 3/4 | 5/16 | 7/32 | 1/4 | 00 |
| 8, 10, 12 | 4, 4,5, 5 | 3 3/16 | 2 21/32 | 2 | 13/32 | 9/32 | 5/16 | 0 |
| 1/4, 5/16 | 6, 6,3, 7, 8 | 4 1/16 | 3 1/2 | 2 3/4 | 1/2 | 5/16 | 3/8 | 1 |
| 3/8, 7/16, 1/2 | 10, 12 | 4 5/8 | 4 | 3 | 3/4 | 3/8 | 1/2 | 2 |
| 9/16, 5/8, 3/4 | 14, 16, 18, 20 | 5 1/8 | 4 3/8 | 3 1/4 | 7/8 | 1/2 | 11/16 | 3 |
| 7/8, 1, 1 1/8 | 24 | 5 7/8 | 4 15/16 | 3 5/8 | 1 | 5/8 | 7/8 | 4 |
| 1 1/4, 1 3/8, 1 1/2 | — | 5 1/2 + D | 4 3/8 + D | 4 | — | 3/4 | 1 | 5 |

*D = 1" for 12 threads per inch and finer.*
*1 1/4" for threads per inch coarser than 12.*
*Length of sizes 0-6 does not include length of male point.*

*Gaging member shanks fit into corresponding holes in the handles. Therefore, while worn members may be discarded, handles may be saved for use with new members.*

## Ground Thread Tap Limits

In addition to the nominal size and pitch of a tap, there is another important dimensional factor to be considered in selecting a ground thread tap for a given job. This factor is the "H" and "L" pitch diameter tap limits. "H" represents (high) above basic pitch diameter; "L" (low) is below basic pitch diameter. Tap limits have been established to provide a choice in the selection of the tap size best suited to produce the class of thread desired.

**Figure 1** illustrates the numbering system and the .0005 diameter increment separation between successive limits. Since the starting point is basic pitch diameter, dividing the limit number by two establishes, in thousandths of an inch, the amount the maximum tap pitch diameter is above basic in the "H" series and the amount the minimum tap pitch diameter is under basic in the "L" series.

**Figure 2** illustrates the positioning of the tap limits in relation to the various classes of threads for a 1/4-20 size.

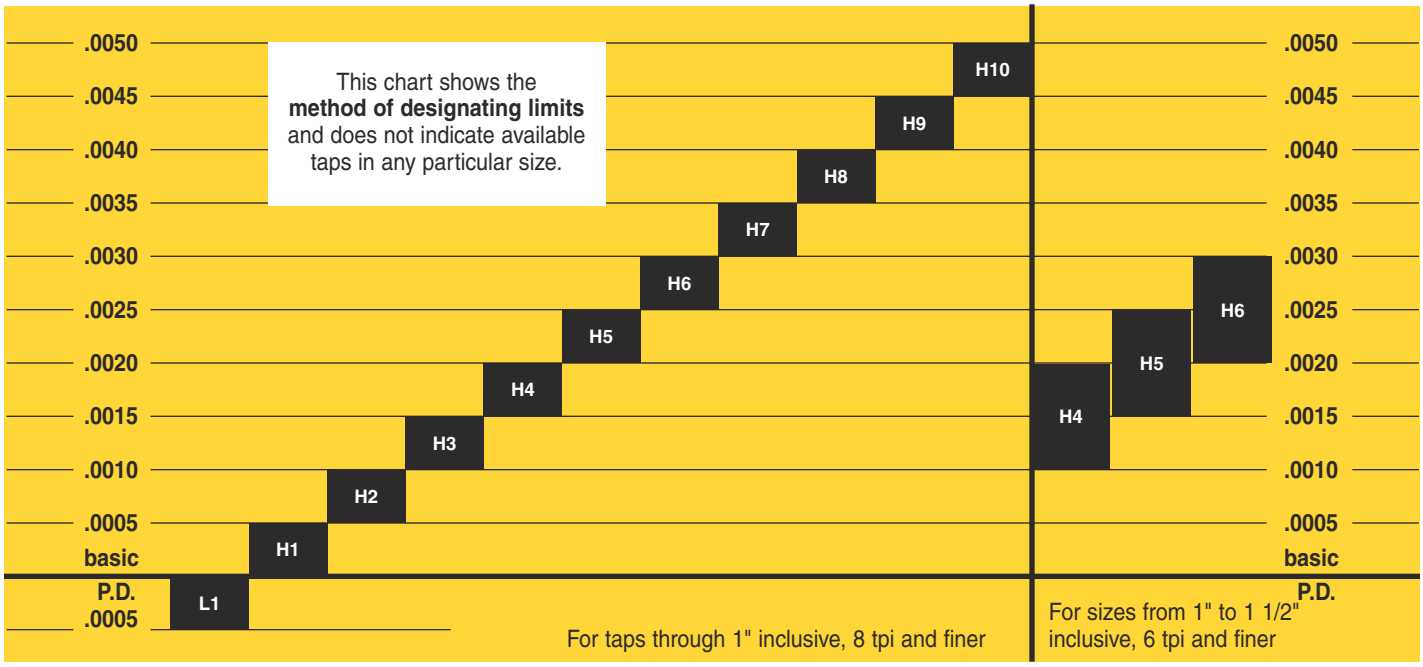



Figure 1

Class of Thread – 1/4 -20 UNC and NC

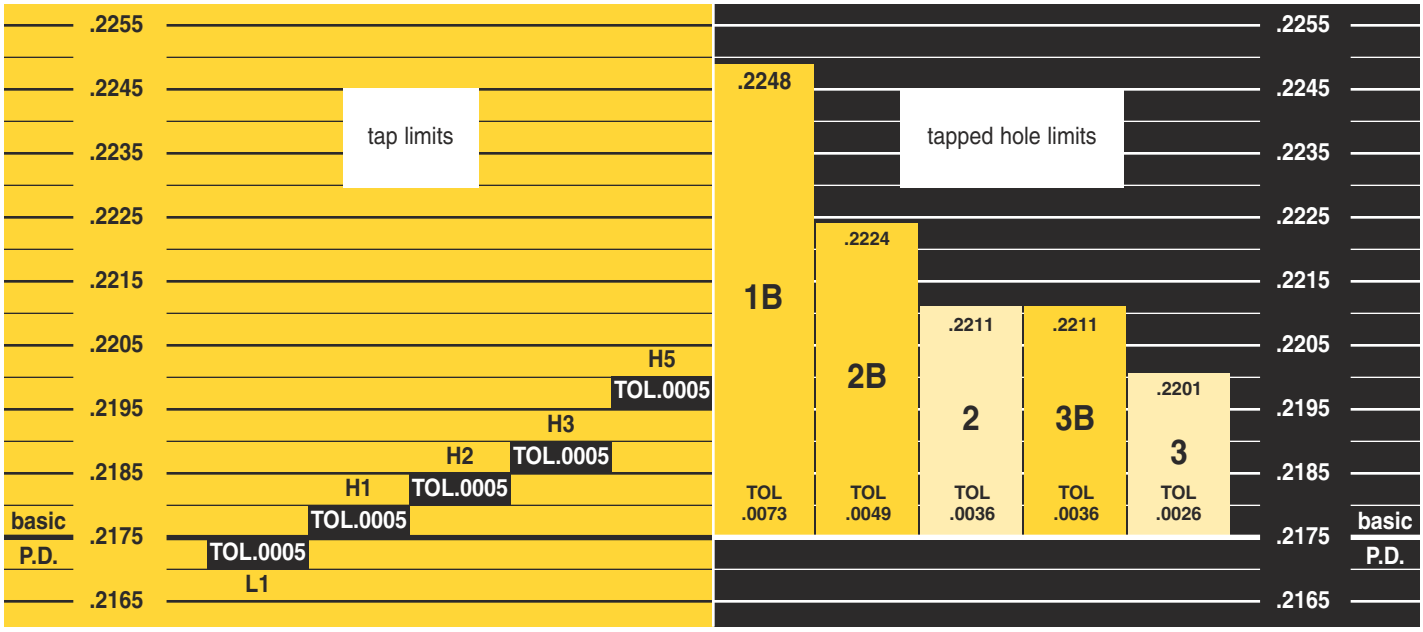



Figure 2

## Tap Thread Limits

(machine screw sizes – ground thread – Unified and American National thread series)

| size | threads per inch | | | major diameter | | | basic pitch dia. | pitch diameter limits | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | H1 limit | | H2 limit | | H3 limit | | * H7 limit | |
| | NC UNC | NF UNF | NS UNS | basic | ** min. | † max. | | min. | max. | min. | max. | min. | max. | min. | max. |
| 0 | — | 80 | — | .0600 | .0605 | .0616 | .0519 | .0519 | .0524 | .0524 | .0529 | — | — | — | — |
| 1 | 64 | — | — | .0730 | .0736 | .0750 | .0629 | .0629 | .0634 | .0634 | .0639 | — | — | — | — |
| 1 | — | 72 | — | .0730 | .0736 | .0748 | .0640 | .0640 | .0645 | .0645 | .0650 | — | — | — | — |
| 2 | 56 | — | — | .0860 | .0867 | .0883 | .0744 | .0794 | .0749 | .0749 | .0754 | — | — | — | — |
| 2 | — | 64 | — | .0860 | .0866 | .0880 | .0759 | — | — | .0764 | .0769 | — | — | — | — |
| 3 | 48 | — | — | .0990 | .0999 | .1017 | .0855 | .0855 | .0860 | .0860 | .0865 | — | — | — | — |
| 3 | — | 56 | — | .0990 | .0997 | .1013 | .0874 | .0874 | .0879 | .0879 | .0884 | — | — | — | — |
| 4 | — | — | 36 | .1120 | .1135 | .1156 | .0940 | — | — | .0945 | .0950 | — | — | — | — |
| 4 | 40 | — | — | .1120 | .1133 | .1152 | .0958 | .0958 | .0963 | .0963 | .0968 | — | — | — | — |
| 4 | — | 48 | — | .1120 | .1129 | .1147 | .0985 | .0985 | .0990 | .0990 | .0995 | — | — | — | — |
| 5 | 40 | — | — | .1250 | .1263 | .1282 | .1088 | .1088 | .1093 | .1093 | .1098 | — | — | — | — |
| 5 | — | 44 | — | .1250 | .1263 | .1280 | .1102 | — | — | .1107 | .1112 | — | — | — | — |
| 6 | 32 | — | — | .1380 | .1401 | .1421 | .1177 | .1177 | .1182 | .1182 | .1187 | .1187 | .1192 | .1207 | .1212 |
| 6 | — | 40 | — | .1380 | .1393 | .1412 | .1218 | .1218 | .1223 | .1223 | .1228 | — | — | — | — |
| 8 | 32 | — | — | .1640 | .1661 | .1681 | .1437 | .1437 | .1442 | .1442 | .1447 | .1447 | .1452 | .1467 | .1472 |
| 8 | — | 36 | — | .1640 | .1655 | .1676 | .1460 | — | — | .1465 | .1470 | — | — | — | — |
| 10 | 24 | — | — | .1900 | .1927 | .1954 | .1629 | .1629 | .1634 | .1634 | .1639 | .1639 | .1644 | .1659 | .1664 |
| 10 | — | 32 | — | .1900 | .1921 | .1941 | .1697 | .1697 | .1702 | .1702 | .1707 | .1707 | .1712 | .1727 | .1732 |
| 12 | 24 | — | — | .2160 | .2187 | .2214 | .1889 | — | — | — | — | .1899 | .1904 | — | — |
| 12 | — | 28 | — | .2160 | .2183 | .2206 | .1928 | — | — | — | — | .1938 | .1942 | — | — |

**Major diameter for H7 limit taps is .002 larger than values shown in columns 6 and 7.*
***Column 6.*
*†Column 7.*

## Tap Thread Limits

(fractional size – ground thread – Unified and American National thread series)

| size | threads per inch | | | major diameter | | | pitch diameter limits | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NC UNC | NF UNF | NS UNS | basic | min. | max. | basic pitch dia. | H1 limit min. | H1 limit max. | H2 limit min. | H2 limit max. | H3 limit min. | H3 limit max. | H4 limit min. | H4 limit max. | H5 limit min. | H5 limit max. | H6 limit min. | H6 limit max. |
| 1/4 | 20 | — | — | .2500 | .2533 | .2565 | .2175 | .2175 | .2180 | .2180 | .2185 | .2185 | .2190 | — | — | .2195 | .2200 | — | — |
| 1/4 | — | 28 | — | .2500 | .2523 | .2546 | .2268 | .2268 | .2273 | .2273 | .2278 | .2278 | .2283 | .2283 | .2288 | — | — | — | — |
| 5/16 | 18 | — | — | .3125 | .3161 | .3197 | .2764 | .2764 | .2769 | .2769 | .2774 | .2774 | .2779 | — | — | .2784 | .2789 | — | — |
| 5/16 | — | 24 | — | .3125 | .3152 | .3179 | .2854 | .2854 | .2859 | .2859 | .2864 | .2864 | .2869 | .2869 | .2874 | — | — | — | — |
| 3/8 | 16 | — | — | .3750 | .3790 | .3831 | .3344 | .3344 | .3349 | .3349 | .3354 | .3354 | .3359 | — | — | .3364 | .3369 | — | — |
| 3/8 | — | 24 | — | .3750 | .3777 | .3804 | .3479 | .3479 | .3484 | .3484 | .3489 | .3489 | .3494 | .3494 | .3499 | — | — | — | — |
| 7/16 | 14 | — | — | .4375 | .4422 | .4468 | .3911 | — | — | .3916 | .3921 | .3921 | .3926 | — | — | .3931 | .3936 | — | — |
| 7/16 | — | 20 | — | .4375 | .4408 | .4440 | .4050 | — | — | — | — | .4060 | .4065 | — | — | .4070 | .4075 | — | — |
| 1/2 | 13 | — | — | .5000 | .5050 | .5100 | .4500 | .4500 | .4505 | .4505 | .4510 | .4510 | .4515 | — | — | .4520 | .4525 | — | — |
| 1/2 | — | 20 | — | .5000 | .5033 | .5065 | .4675 | .4675 | .4680 | .4680 | .4685 | .4685 | .4690 | — | — | .4695 | .4700 | — | — |
| 9/16 | 12 | — | — | .5625 | .5679 | .5733 | .5084 | — | — | — | — | .5094 | .5099 | — | — | .5104 | .5109 | — | — |
| 9/16 | — | 18 | — | .5625 | .5661 | .5697 | .5264 | — | — | .5269 | .5274 | .5274 | .5279 | — | — | .5284 | .5289 | — | — |
| 5/8 | 11 | — | — | .6250 | .6309 | .6368 | .5660 | — | — | .5665 | .5670 | .5670 | .5675 | — | — | .5680 | .5685 | — | — |
| 5/8 | — | 18 | — | .6250 | .6286 | .6322 | .5889 | — | — | .5894 | .5899 | .5899 | .5904 | — | — | .5909 | .5914 | — | — |
| 11/16 | — | — | 11 | .6875 | .6934 | .6993 | .6285 | — | — | — | — | .6295 | .6300 | — | — | — | — | — | — |
| 11/16 | — | — | 16 | .6875 | .6915 | .6956 | .6469 | — | — | — | — | .6479 | .6484 | — | — | — | — | — | — |
| 3/4 | 10 | — | — | .7500 | .7565 | .7630 | .6850 | — | — | .6855 | .6860 | .6860 | .6865 | — | — | .6870 | .6875 | — | — |
| 3/4 | — | 16 | — | .7500 | .7540 | .7581 | .7094 | .7094 | .7099 | .7099 | .7104 | .7104 | .7109 | — | — | .7114 | .7119 | — | — |
| 7/8 | 9 | — | — | .8750 | .8822 | .8894 | .8028 | — | — | — | — | — | — | .8043 | .8048 | — | — | .8053 | .8058 |
| 7/8 | — | 14 | — | .8750 | .8797 | .8843 | .8286 | — | — | .8291 | .8296 | — | — | .8301 | .8306 | — | — | .8311 | .8316 |
| 1 | 8 | — | — | 1.0000 | 1.0081 | 1.0162 | .9188 | — | — | — | — | — | — | .9203 | .9208 | — | — | .9213 | .9218 |
| 1 | — | 12 | — | 1.0000 | 1.0054 | 1.0108 | .9459 | — | — | — | — | — | — | .9474 | .9479 | — | — | — | — |
| 1 | — | — | 14 | 1.0000 | 1.0047 | 1.0093 | .9536 | — | — | — | — | — | — | .9551 | .9556 | — | — | — | — |
| 1 1/8 | 7 | — | — | 1.1250 | 1.1343 | 1.1436 | 1.0322 | — | — | — | — | — | — | 1.0332 | 1.0342 | — | — | — | — |
| 1 1/8 | — | 12 | — | 1.1250 | 1.1304 | 1.1358 | 1.0709 | — | — | — | — | — | — | 1.0719 | 1.0729 | — | — | — | — |
| 1 1/4 | 7 | — | — | 1.2500 | 1.2593 | 1.2686 | 1.1572 | — | — | — | — | — | — | 1.1582 | 1.1592 | — | — | — | — |
| 1 1/4 | — | 12 | — | 1.2500 | 1.2554 | 1.2608 | 1.1959 | — | — | — | — | — | — | 1.1969 | 1.1979 | — | — | — | — |
| 1 3/8 | 6 | — | — | 1.3750 | 1.3859 | 1.3967 | 1.2667 | — | — | — | — | — | — | 1.2677 | 1.2687 | — | — | — | — |
| 1 3/8 | — | 12 | — | 1.3750 | 1.3804 | 1.3858 | 1.3209 | — | — | — | — | — | — | 1.3219 | 1.3229 | — | — | — | — |
| 1 1/2 | 6 | — | — | 1.5000 | 1.5109 | 1.5217 | 1.3917 | — | — | — | — | — | — | 1.3927 | 1.3937 | — | — | — | — |
| 1 1/2 | — | 12 | — | 1.5000 | 1.5054 | 1.5108 | 1.4459 | — | — | — | — | — | — | 1.4469 | 1.4479 | — | — | — | — |

## Metric Tap Thread Limits (inches)



Basic pitch diameter is the same as minimum pitch diameter of internal thread class 6H — Table 21, ANSI B1.13M-1979.

**Angle Tolerance**

| pitch (mm) | deviation of half angle |
|---|---|
| over 0,25 to 2,5 inc. | 30' (plus or minus) |
| over 2,5 to 4 inc. | 25' (plus or minus) |
| over 4 to 6 inc. | 20' (plus or minus) |

A maximum lead deviation of ±.0005 within any two threads, not more than 1" apart, is permitted.

| nom. dia. (mm) | pitch (mm) | major dia. (inches) | | | pitch diameter limits | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | basic | min. | max. | basic | D3 min. | D3 max. | D4 min. | D4 max. | D5 min. | D5 max. | D6 min. | D6 max. | D7 min. | D7 max. | D8 min. | D8 max. | D9 min. | D9 max. |
| 1,6 | 0,35 | .06299 | .06409 | .06508 | .05406 | .05500 | .05559 | — | — | — | — | — | — | — | — | — | — | — | — |
| 2 | 0,4 | .07874 | .08000 | .08098 | .06850 | .06945 | .07004 | — | — | — | — | — | — | — | — | — | — | — | — |
| 2,5 | 0,45 | .09843 | .09984 | .10083 | .08693 | .08787 | .08846 | — | — | — | — | — | — | — | — | — | — | — | — |
| 3 | 0,5 | .11811 | .11969 | .12067 | .10531 | .10626 | .10685 | — | — | — | — | — | — | — | — | — | — | — | — |
| 3,5 | 0,6 | .13780 | .13969 | .14067 | .12244 | — | — | .12370 | .12449 | — | — | — | — | — | — | — | — | — | — |
| 4 | 0,7 | .15748 | .15969 | .16130 | .13957 | — | — | .14083 | .14161 | — | — | — | — | — | — | — | — | — | — |
| 4,5 | 0,75 | .17717 | .17953 | .18114 | .15799 | — | — | .15925 | .16004 | — | — | — | — | — | — | — | — | — | — |
| 5 | 0,8 | .19685 | .19937 | .20098 | .17638 | — | — | .17764 | .17843 | — | — | — | — | — | — | — | — | — | — |
| 6 | 1 | .23622 | .23937 | .24098 | .21063 | — | — | — | — | .21220 | .21319 | — | — | — | — | — | — | — | — |
| 7 | 1 | .27559 | .27874 | .28035 | .25000 | — | — | — | — | .25157 | .25256 | — | — | — | — | — | — | — | — |
| 8 | 1,25 | .31496 | .31890 | .32142 | .28299 | — | — | — | — | .28433 | .28555 | — | — | — | — | — | — | — | — |
| 10 | 1,5 | .39370 | .39843 | .40094 | .35535 | — | — | — | — | — | — | .35720 | .35843 | — | — | — | — | — | — |
| 12 | 1,75 | .47244 | .47795 | .48047 | .42768 | — | — | — | — | — | — | .42953 | .43075 | — | — | — | — | — | — |
| 14 | 2 | .55118 | .55748 | .56000 | .50004 | — | — | — | — | — | — | — | — | .50201 | .50362 | — | — | — | — |
| 16 | 2 | .62992 | .63622 | .63874 | .57878 | — | — | — | — | — | — | — | — | .58075 | .58236 | — | — | — | — |
| 20 | 2,5 | .78740 | .79528 | .79780 | .72346 | — | — | — | — | — | — | — | — | .72543 | .72705 | — | — | — | — |
| 24 | 3 | .94488 | .95433 | .95827 | .86815 | — | — | — | — | — | — | — | — | — | — | .87063 | .87224 | — | — |
| 30 | 3,5 | 1.18110 | 1.19213 | 1.19606 | 1.09161 | — | — | — | — | — | — | — | — | — | — | — | — | 1.09417 | 1.09622 |
| 36 | 4 | 1.41732 | 1.42992 | 1.43386 | 1.31504 | — | — | — | — | — | — | — | — | — | — | — | — | 1.31760 | 1.31965 |

## General Purpose Taps

(tapping torque vs. thread strength)

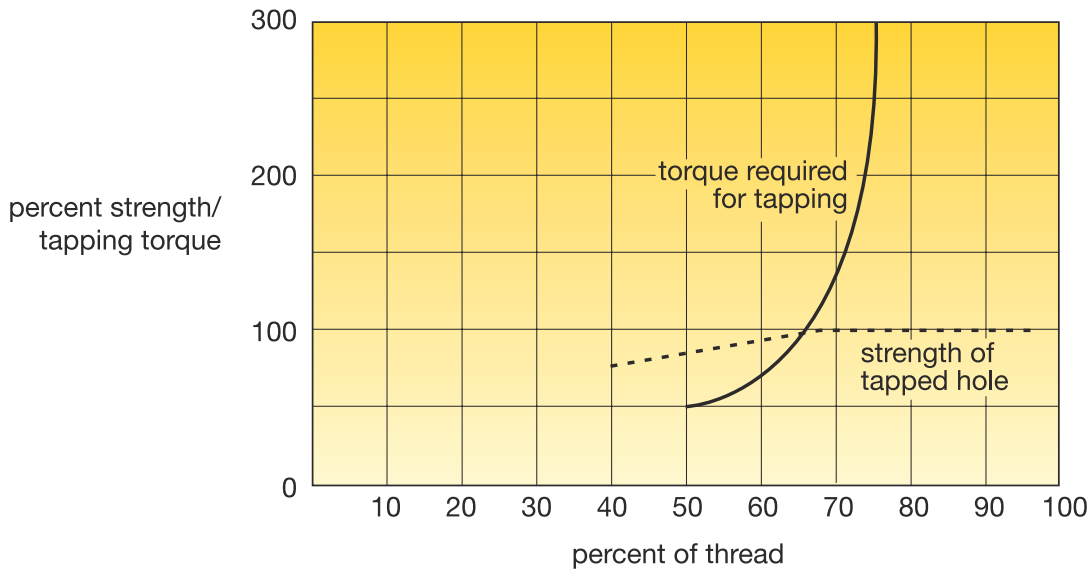
It stands to reason that it takes more power to tap to a full depth of thread than it does to tap to a partial depth of thread. The higher the metal removal rate, the more torque required to produce the cut.

It would also stand to reason that the greater the depth of thread, the stronger the tapped hole. This is true, but only to a point. Beyond that point (usually about 75% of full thread) the strength of the hole does not increase, yet the torque required to tap the hole rises exponentially. Also, it becomes more difficult to hold size, and the likelihood of tap breakage increases. With this in mind, it does not make good tapping sense to generate threads deeper than the required strength of the thread dictates.

As a general rule, the tougher the material, the less the percentage of thread is needed to create a hole that is strong enough to do the job for which it was intended. In some harder materials such a stainless steel, Monel, and some heat-treated alloys, it is possible to tap to as little as 50% of full thread without sacrificing the usefulness of the tapped hole.

### Suggested Percentage of Full Thread in Tapped Holes

| workpiece material | deep hole tapping | average commercial work | thin sheet stock or stampings |
|---|---|---|---|
| **hard or tough**<br>cast steel<br>drop forgings<br>Monel metal<br>nickel steel<br>stainless steel | 55%-65% | 60%-70% | — |
| **free-cutting**<br>aluminum<br>brass<br>bronze<br>cast iron<br>copper<br>mild steel<br>tool steel | 60%-70% | 65%-75% | 75%-85% |



## General Purpose Taps

(tapping torque and horsepower for general purpose taps)

In the chart below, numbers in bold type represent foot-pounds. All other numbers are inch-pounds. The values given are for 1010 mild steel. To calculate approximate torque and settings for other materials, multiply the value in the chart by the factor assigned.

## Torque Setting Data for HSS Straight Flute Plug Taps

| tap size and pitch | min. tapping torque | max. tapping torque | tap breaking torque (low strength) | tap breaking torque (high strength) | required horsepower (min.) | tap holder setting (normal) | tap holder setting (min.) | tap holder setting (max.) |
|---|---|---|---|---|---|---|---|---|
| #0-#2 | — | — | — | — | — | — | — | — |
| NC & NF | 10 | 18 | 25 | 50 | 1/4 | 20 | 15 | 25 |
| #3 & #4 | — | — | — | — | — | — | — | — |
| NC & NF | 10 | 20 | 30 | 50 | 1/4 | 20 | 15 | 30 |
| #5 & #6 | — | — | — | — | — | — | — | — |
| NC & NF | 10 | 20 | 30 | 50 | 1/4 | 20 | 15 | 30 |
| 8-30 | 20 | 30 | 40 | 60 | 1/4 | 25 | 20 | 40 |
| 8-32 | 20 | 30 | 40 | 60 | 1/4 | 25 | 20 | 40 |
| 10-32 | 20 | 30 | 40 | 60 | 1/3 | 25 | 20 | 40 |
| 10-24 | 25 | 50 | 40 | 60 | 1/3 | 30 | 25 | 50 |
| 12-28 | 25 | 50 | 40 | 70 | 1/3 | 30 | 25 | 50 |
| 12-24 | 25 | 50 | 40 | 70 | 1/3 | 30 | 25 | 50 |
| 1/4-28 | 30 | 60 | 50 | 100 | 1/2 | 40 | 30 | 60 |
| 1/4-20 | 40 | 80 | 50 | 100 | 1/2 | 50 | 40 | 80 |
| 5/16-24 | 40 | 80 | 75 | 150 | 1/2 | 60 | 50 | 100 |
| 5/16-18 | 60 | 120 | 75 | 150 | 1/2 | 90 | 80 | 150 |
| 3/8-24 | 60 | 120 | 180 | 260 | 3/4 | 90 | 80 | 150 |
| 3/8-16 | 100 | 200 | 180 | 260 | 3/4 | 130 | 110 | 220 |
| 7/16-20 | 80 | 160 | 180 | 300 | 3/4 | 130 | 110 | 220 |
| 7/16-14 | 100 | 200 | 180 | 300 | 1 | 200 | 180 | 300 |
| 1/2-20 | 100 | 250 | 300 | 600 | 3/4 | 300 | 300 | 450 |
| 1/2-13 | 150 | 300 | 300 | 600 | 1 | 300 | 300 | 450 |
| 9/16-18 | 150 | 350 | 500 | 800 | 3/4 | 350 | 350 | 500 |
| 9/16-12 | 200 | 500 | 500 | 800 | 1 1/4 | 350 | 350 | 500 |
| 5/8-18 | 200 | 600 | 800 | 1200 | 3/4 | 450 | 450 | 650 |
| 5/8-11 | 300 | 800 | 800 | 1200 | 1 1/2 | 450 | 450 | 650 |
| 3/4-16 | 300 | 800 | 1000 | 1500 | 1 | 650 | 650 | 950 |
| 3/4-10 | 500 | 1000 | 1000 | 1500 | 1 3/4 | 650 | 650 | 950 |
| 7/8-14 | 500 | 1000 | 1500 | 2000 | 1 | 850 | 850 | 1500 |
| 7/8-9 | 800 | 1500 | 1500 | 2000 | 2 | 850 | 850 | 1500 |
| 1"-12 & 14 | 700 | 1800 | 2000 | 2500 | 1 1/2 | 1100 | 1100 | 1800 |
| 1"-8 | 1000 | 1800 | 2000 | 2500 | 2 1/2 | 1100 | 1100 | 1800 |
| 1 1/8-12 | **50** | **80** | **170** | **220** | 1 1/2 | **125** | **125** | **180** |
| 1 1/8-7 & 8 | **60** | **120** | **170** | **220** | 3 | **125** | **125** | **180** |
| 1 1/4-12 | **50** | **80** | **250** | **300** | 1 1/2 | **145** | **145** | **200** |
| 1 1/4-7 & 8 | **70** | **150** | **250** | **300** | 3 | **145** | **145** | **200** |
| 1 3/8-12 | **60** | **120** | **300** | **380** | 1 1/2 | **180** | **180** | **260** |
| 1 3/8-8 | **70** | **150** | **300** | **380** | 3 | **180** | **180** | **260** |

## Torque and Horsepower Calculation Factors

| material | factor | material | factor |
|---|---|---|---|
| aluminum | .2 | magnesium | .5 |
| brass | .4 | malleable iron | .7 |
| bronze | .4 | zinc | .4 |
| cast iron | .6 | titanium | 1.4 |
| copper | .5 | | |

| carbon (mild) steel 1008-1095 | | free-cutting steel 1111-1213 | | alloy steel 1330-8642 | | alloy steel 1330-8642 | |
|---|---|---|---|---|---|---|---|
| HB | factor | HB | factor | HB | factor | HB | factor |
| 90 | 1.0 | 140 | .7 | 175 | .9 | 240 | 1.5 |
| 130 | 1.1 | 170 | .8 | 190 | 1.0 | 250 | 1.6 |
| 170 | 1.2 | 230 | .9 | 200 | 1.1 | 330 | 2.1 |
| 190 | 1.3 | | | 205 | 1.2 | 390 | 2.5 |
| 250 | 1.4 | | | 210 | 1.3 | 470 | 2.9 |

## General Purpose Taps

(recommended tapping speeds)

Proper tapping speeds are very important in obtaining efficient tapping results. The optimum speed for tapping is the highest speed that conditions permit, consistent with economic tool life. Proper tapping speed is best determined through experimentation. In the table below, speeds shown should be used only as a starting point. Adjustments should be made until the best results are obtained. Many factors affect tapping speed. Some of them are listed here.

**Material Factors:**

- thermo-conductivity of the material and wall thickness, as it affects heat dispersion
- variations in carbon content of steel
- hard spots in workpiece material
- depth of hole (the speed should be lowered as depth of hole increases, because accumulated chips may interfere with lubrication by increasing friction)
- percentage of full thread to be tapped (speed should be lowered as height of thread increases)

**Tap Factors:**

- major diameters, pitch, and lead (larger diameter coarse thread taps should be run slower than fine thread taps of the same diameter)
- tap style (plug taps can be run faster than bottoming taps...run taper threaded taps at 1/2 to 3/4 the speed of a straight tap of the same diameter)
- width of lands
- amount of hook or rake
- length of chamfer

**Mechanical Factors:**

- type of machine tool and tap holder (speeds for small diameter taps are often determined by the machine's limitations)
- condition of machine tool and spindle
- type of fixture
- vertical or horizontal tapping (speeds are faster when tapping vertically)
- method of feeding the tap
- cutting fluid used and method of application

**Formulas:**

$$sfm = \frac{rpm \times tool\ diameter}{3.82} \quad \text{or} \quad .262 \times rpm \times tool\ diameter$$

$$rpm = \frac{3.82 \times sfm}{tool\ diameter}$$

$$ipm = \frac{rpm}{tpi} \quad \text{or} \quad p \times rpm$$

$$tpi = threads\ per\ inch$$

$$p = pitch = \frac{1}{no.\ of\ threads\ per\ inch}$$

### Recommended Tapping Speeds for General Purpose Taps — rpm

| material | inch | #0-80 range | | | | #1 range | | #2 | #3 range | | #4/#5 | #6 | #8 | #10 | #12 | 1/4 | 5/16 | 3/8-7/16 | 1/2 | 9/16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | metric | M1 | M1,1 | M1,2 | M1,4 | M1,6 | M1,8 | M2 | M2,2 | M2,5 | M3 | M3,5 | M4 | M4,5 | M5 | M6 | M8 | M10 | M12 | M14 |
| structural steels | | 3820 | 3475 | 3185 | 2370 | 2389 | 2123 | 1911 | 1737 | 1529 | 1274 | 1092 | 956 | 849 | 764 | 637 | 478 | 382 | 319 | 273 |
| case hardening steels | | 2548 | 2316 | 2123 | 1820 | 1593 | 1416 | 1274 | 1158 | 1019 | 849 | 728 | 637 | 566 | 510 | 425 | 319 | 255 | 212 | 182 |
| tempered steels | | 2228 | 2026 | 1856 | 1592 | 1393 | 1238 | 1114 | 1013 | 891 | 743 | 637 | 557 | 495 | 446 | 371 | 279 | 223 | 186 | 159 |
| nitralloy steels | | 1911 | 1737 | 1593 | 1365 | 1194 | 1062 | 956 | 869 | 764 | 637 | 546 | 478 | 425 | 382 | 319 | 239 | 191 | 159 | 137 |
| cold roll steels | | 1592 | 1441 | 1326 | 1137 | 995 | 885 | 796 | 723 | 637 | 531 | 455 | 398 | 354 | 318 | 265 | 199 | 159 | 123 | 114 |
| valve steels | | 1592 | 1447 | 1326 | 1137 | 995 | 885 | 796 | 723 | 637 | 531 | 455 | 398 | 354 | 318 | 265 | 199 | 159 | 123 | 114 |
| high-temperature resisting steels | | 1274 | 1158 | 1062 | 910 | 796 | 708 | 737 | 579 | 510 | 425 | 364 | 319 | 283 | 255 | 212 | 159 | 127 | 106 | 91 |
| stainless steels | | 1592 | 1447 | 1326 | 1137 | 995 | 885 | 796 | 723 | 637 | 531 | 455 | 398 | 354 | 318 | 265 | 199 | 159 | 123 | 114 |
| free-cutting steels | | 4456 | 4051 | 3714 | 3183 | 2785 | 2476 | 2228 | 2026 | 1783 | 1485 | 1273 | 1114 | 990 | 891 | 743 | 557 | 446 | 371 | 318 |
| cast steel | | 2548 | 2316 | 2123 | 1820 | 1593 | 1416 | 1274 | 1158 | 1019 | 849 | 728 | 637 | 566 | 510 | 425 | 319 | 255 | 212 | 182 |
| malleable iron casting | | 3183 | 2894 | 2653 | 2275 | 1990 | 1769 | 1593 | 1448 | 1274 | 1062 | 910 | 796 | 708 | 637 | 531 | 398 | 318 | 265 | 227 |
| gray cast iron | | 2548 | 2316 | 2123 | 1820 | 1593 | 1416 | 1274 | 1158 | 1019 | 849 | 728 | 637 | 566 | 510 | 425 | 319 | 255 | 212 | 182 |
| spherodial casting | | 3183 | 2894 | 2653 | 2275 | 1990 | 1769 | 1593 | 1448 | 1274 | 1062 | 910 | 796 | 708 | 637 | 531 | 398 | 318 | 265 | 227 |
| copper | | 3820 | 3475 | 3185 | 2730 | 2389 | 2123 | 1911 | 1737 | 1529 | 1274 | 1092 | 956 | 849 | 764 | 637 | 478 | 383 | 319 | 273 |
| brass (producing short chips) | | 5000 | 5000 | 5000 | 5000 | 4974 | 4421 | 3979 | 3617 | 3183 | 2653 | 2274 | 1989 | 1768 | 1592 | 1326 | 995 | 796 | 663 | 568 |
| brass (producing long chips) | | 5000 | 4630 | 4244 | 3638 | 3183 | 2829 | 2546 | 2315 | 2037 | 1698 | 1455 | 1273 | 1132 | 1019 | 849 | 637 | 509 | 424 | 364 |
| red brass | | 3183 | 2894 | 2653 | 2275 | 1990 | 1769 | 1593 | 1448 | 1274 | 1062 | 910 | 796 | 708 | 637 | 531 | 398 | 318 | 265 | 227 |
| tin bronze | | 2548 | 2316 | 2123 | 1820 | 1593 | 1416 | 1274 | 1158 | 1019 | 849 | 728 | 637 | 566 | 510 | 425 | 319 | 255 | 212 | 182 |
| aluminum wrought alloys | | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 4777 | 4343 | 3822 | 3185 | 2730 | 2389 | 2123 | 1911 | 1592 | 1194 | 955 | 796 | 682 |
| aluminum cast alloys | | 5000 | 5000 | 4775 | 4093 | 3581 | 3183 | 2865 | 2604 | 2292 | 1910 | 1637 | 1432 | 1273 | 1146 | 955 | 716 | 573 | 477 | 409 |
| nickel & titanium alloys | | 955 | 868 | 796 | 682 | 597 | 531 | 478 | 434 | 382 | 318 | 273 | 239 | 212 | 191 | 159 | 119 | 96 | 80 | 68 |
| sintered materials | | 955 | 868 | 796 | 682 | 597 | 531 | 478 | 434 | 382 | 318 | 273 | 239 | 212 | 191 | 159 | 119 | 96 | 80 | 68 |
| plastics | | 5000 | 5000 | 5000 | 4549 | 3981 | 3538 | 3185 | 2895 | 2548 | 2123 | 1820 | 1592 | 1415 | 1274 | 1062 | 796 | 637 | 531 | 455 |

## General Purpose Taps (cont'd.)



### Recommended Tapping Speeds — Pipe Taps (rpm)

| material | inches | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1/16 | 1/8 | 1/4 | 3/8 | 1/2 | 3/4 | 1 | 1 1/4 | 1 1/2 | 2 |
| steel | 316 | 242 | 182 | 145 | 116 | 93 | 74 | 58 | 51 | 41 |
| stainless steel | 151 | 116 | 87 | 70 | 56 | 44 | 36 | 28 | 24 | 19 |
| gray cast iron | 442 | 338 | 255 | 203 | 163 | 130 | 104 | 82 | 71 | 57 |
| aluminum alloys | 631 | 483 | 364 | 290 | 233 | 185 | 148 | 117 | 102 | 81 |
| brass | 631 | 483 | 364 | 290 | 233 | 185 | 148 | 117 | 102 | 81 |
| bronze | 379 | 290 | 218 | 174 | 140 | 111 | 89 | 79 | 61 | 49 |
| zinc alloys | 631 | 483 | 364 | 290 | 233 | 185 | 148 | 117 | 102 | 81 |
| malleable or ductile iron | 252 | 193 | 146 | 116 | 93 | 74 | 59 | 47 | 41 | 32 |
| magnesium | 757 | 580 | 437 | 348 | 279 | 222 | 178 | 140 | 122 | 97 |
| copper | 316 | 242 | 182 | 145 | 116 | 93 | 74 | 58 | 51 | 41 |
| Monel metals | 151 | 116 | 87 | 70 | 56 | 44 | 36 | 28 | 24 | 19 |
| thermoplastic | 379 | 290 | 218 | 174 | 140 | 111 | 89 | 70 | 61 | 49 |
| thermosetting plastic | 379 | 290 | 218 | 174 | 140 | 111 | 89 | 70 | 61 | 49 |
| high-temperature alloys | 50 | 39 | 29 | 23 | 19 | 15 | 12 | 9 | 8 | 6 |
| titanium alloys | 189 | 145 | 109 | 87 | 70 | 56 | 44 | 35 | 31 | 24 |

### Surface Treatments

| treatment | benefit | application | precautions |
|---|---|---|---|
| nitride | Increases surface hardness of the tap, thereby increasing wear resistance. | Use on ferrous and non-ferrous abrasive materials that cause dulling of the tools (cast iron, brass, bronze, die castings, aluminum, magnesium, zinc, and copper). | Brittleness can cause chipping. Avoid on taper pipe taps, fast spiral flute taps, and small diameter and fine pitch taps (especially machine screw sizes smaller than #6). |
| oxide | Prevents galling and subsequent tap chipping and thread tearing. (formerly SH-50) | Use on ferrous materials and free-machining steels. | Avoid use on non-ferrous materials because galling will occur. |
| oxide over nitride | Prevents galling and subsequent tap chipping and thread tearing. Also increases wear resistance. (formerly SH-47) | Use on ferrous materials, high-temperature alloys, titanium and titanium alloys, free-machining steels, iron, high tensile steels, and stainless steels. | Avoid use on non-ferrous materials because galling will occur. |
| TiN (titanium nitride) | Increases surface hardness of the tap, thereby increasing wear resistance and tool life, and allows for higher tapping speeds. | Use on ferrous, non-ferrous, and non-metallics; free-machining steels and irons; high tensile steels; tough machining steels; plastics; hard rubber; and fiber. | Avoid use on titanium and titanium alloys because galling will occur. |

*NOTE: Additional surface treatments and coatings are available upon request.*

# Kennametal Tap & Die

## Tap Drill Selection – Cutting Taps

(machine screw and fractional)

**To calculate tap lead:**

$$\text{pitch} = \frac{1}{\text{threads per inch}}$$

**To calculate tap drill size:**

$$\text{major diameter of top} - \left(\frac{.01299 \times \text{percent of full thread}}{\text{number of threads per inch}}\right)$$

**To calculate percentage of full thread:**

$$\text{threads per inch} \times \left(\frac{\text{major diameter} - \text{drill diameter}}{.01299}\right)$$

| tap | tap drill | decimal equiv. of tap drill | theo. % of thread | probable oversize (mean) | *probable hole size | % of thread | tap | tap drill | decimal equiv. of tap drill | theo. % of thread | probable oversize (mean) | *probable hole size | % of thread | tap | tap drill | decimal equiv. of tap drill | theo. % of thread | probable oversize (mean) | *probable hole size | % of thread |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0-80 | 56 | .0465 | 83 | .0015 | .048 | 74 | 10-24 | 24 | .1520 | 70 | .0032 | .155 | 64 | 1/2-13 | 27/64 | .4219 | 78 | .0047 | .427 | 73 |
| | 3/64 | .0469 | 81 | .0015 | .048 | 71 | | 23 | .1540 | 67 | .0032 | .157 | 61 | | 7/16 | .4375 | 63 | .0047 | .442 | 58 |
| 1-64 | 54 | .0550 | 89 | .0015 | .057 | 81 | | 5/32 | .1563 | 62 | .0032 | .160 | 56 | 1/2-20 | 29/64 | .4531 | 72 | .0047 | .458 | 65 |
| | 53 | .0595 | 67 | .0015 | .061 | 59 | | 22 | .1570 | 61 | .0032 | .160 | 55 | 9/16-12 | 15/32 | .4688 | 87 | .0048 | .474 | 82 |
| 1-72 | 53 | .0595 | 75 | .0015 | .061 | 67 | 10-32 | 5/32 | .1563 | 83 | .0032 | .160 | 75 | | 31/64 | .4844 | 72 | .0048 | .489 | 68 |
| | 1/16 | .0625 | 58 | .0015 | .064 | 50 | | 22 | .1570 | 81 | .0032 | .160 | 73 | 9/16-18 | 1/2 | .5000 | 87 | .0048 | .505 | 80 |
| 2-56 | 51 | .0670 | 82 | .0017 | .069 | 74 | | 21 | .1590 | 76 | .0032 | .162 | 68 | | 33/64 | .5156 | 65 | .0048 | .520 | 58 |
| | 50 | .0700 | 69 | .0017 | .072 | 62 | | 20 | .1610 | 71 | .0032 | .164 | 64 | 5/8-11 | 17/32 | .5313 | 79 | .0049 | .536 | 75 |
| | 49 | .0730 | 56 | .0017 | .075 | 49 | | 19 | .1660 | 59 | .0032 | .169 | 51 | | 35/64 | .5469 | 66 | .0049 | .562 | 62 |
| 2-64 | 50 | .0700 | 79 | .0017 | .072 | 70 | 12-24 | 11/64 | .1719 | 82 | .0035 | .175 | 75 | 5/8-18 | 9/16 | .5625 | 87 | .0049 | .567 | 80 |
| | 49 | .0730 | 64 | .0017 | .075 | 56 | | 17 | .1730 | 79 | .0035 | .177 | 73 | | 37/64 | .5781 | 65 | .0049 | .563 | 58 |
| 3-48 | 48 | .0760 | 85 | .0019 | .078 | 78 | | 16 | .1770 | 72 | .0035 | .181 | 66 | 3/4-10 | 41/64 | .6406 | 84 | .0050 | .646 | 80 |
| | 5/64 | .0781 | 77 | .0019 | .080 | 70 | | 15 | .1800 | 67 | .0035 | .184 | 60 | | 21/32 | .6563 | 72 | .0050 | .661 | 68 |
| | 47 | .0785 | 76 | .0019 | .080 | 69 | | 14 | .1820 | 63 | .0035 | .186 | 56 | 3/4-16 | 11/16 | .6875 | 77 | .0050 | .693 | 71 |
| | 46 | .0810 | 67 | .0019 | .083 | 60 | 12-28 | 16 | .1770 | 84 | .0035 | .181 | 77 | 7/8-9 | 49/64 | .7656 | 76 | .0052 | .771 | 72 |
| | 45 | .0820 | 63 | .0019 | .084 | 56 | | 15 | .1800 | 78 | .0035 | .184 | 70 | | 25/32 | .7812 | 65 | .0052 | .786 | 61 |
| 3-56 | 46 | .0810 | 78 | .0019 | .083 | 69 | | 14 | .1820 | 73 | .0035 | .186 | 66 | 7/8-14 | 51/64 | .7969 | 84 | .0052 | .802 | 79 |
| | 45 | .0820 | 73 | .0019 | .084 | 65 | | 13 | .1850 | 67 | .0035 | .189 | 59 | | 13/16 | .8125 | 67 | .0052 | .818 | 62 |
| | 44 | .0860 | 56 | .0020 | .088 | 47 | | 3/16 | .1875 | 61 | .0035 | .191 | 54 | 1/8 | 55/64 | .8594 | 87 | .0059 | .865 | 83 |
| 4-40 | 44 | .0860 | 80 | .0020 | .088 | 74 | 1/4-20 | 9 | .1960 | 83 | .0038 | .200 | 77 | | 7/8 | .8750 | 77 | .0059 | .881 | 73 |
| | 43 | .0890 | 71 | .0020 | .091 | 65 | | 8 | .1990 | 79 | .0038 | .203 | 73 | | 57/64 | .8906 | 67 | .0059 | .897 | 64 |
| | 42 | .0935 | 57 | .0020 | .096 | 51 | | 7 | .2010 | 75 | .0038 | .205 | 70 | | 29/32 | .9063 | 58 | .0059 | .912 | 54 |
| | 3/32 | .0938 | 56 | .0020 | .096 | 50 | | 13/64 | .2031 | 72 | .0038 | .207 | 66 | 1-12 | 29/32 | .9063 | 87 | .0059 | .912 | 81 |
| 4-48 | 42 | .0935 | 68 | .0020 | .096 | 61 | | 6 | .2040 | 71 | .0038 | .208 | 65 | | 59/64 | .9219 | 72 | .0060 | .928 | 67 |
| | 3-32 | .0938 | 68 | .0020 | .096 | 60 | | 5 | .2055 | 69 | .0038 | .209 | 63 | | 15/16 | .9375 | 58 | .0060 | .944 | 52 |
| | 41 | .0960 | 59 | .0020 | .098 | 52 | | 4 | .2090 | 63 | .0038 | .213 | 57 | 1-14 | 56/64 | .9219 | 84 | .0060 | .928 | 78 |
| 5-40 | 40 | .0980 | 83 | .0023 | .100 | 76 | 1/4-28 | 3 | .2130 | 80 | .0038 | .217 | 72 | | 15/16 | .9375 | 67 | .0060 | .944 | 61 |
| | 39 | .0995 | 79 | .0023 | .102 | 71 | | 7/32 | .2188 | 67 | .0038 | .223 | 59 | 1-1/8-7 | 31/32 | .9688 | 84 | .0062 | .975 | 81 |
| | 38 | .1015 | 72 | .0023 | .104 | 65 | | 2 | .2210 | 63 | .0038 | .225 | 55 | | 63/64 | .9844 | 76 | .0067 | .991 | 72 |
| | 37 | .1040 | 65 | .0023 | .106 | 58 | 5/16-18 | F | .2570 | 77 | .0038 | .261 | 72 | | 1 | 1.000 | 67 | .0070 | 1.007 | 64 |
| 5-44 | 38 | .1015 | 79 | .0023 | .104 | 72 | | G | .2610 | 71 | .0041 | .265 | 66 | | 1-1/64 | 1.0156 | 59 | .0070 | 1.023 | 55 |
| | 37 | .1040 | 71 | .0023 | .106 | 63 | | 17/64 | .2656 | 65 | .0041 | .270 | 59 | 1-1/8-12 | 1-1/32 | 1.0313 | 87 | .0071 | 1.038 | 80 |
| | 36 | .1065 | 63 | .0023 | .109 | 55 | | H | .2660 | 64 | .0041 | .270 | 59 | | 1-3/64 | 1.0469 | 72 | .0072 | 1.054 | 66 |
| 6-32 | 37 | .1040 | 84 | .0023 | .106 | 78 | 5/16-24 | H | .2660 | 86 | .0041 | .270 | 78 | 1-1/4-7 | 1-3/32 | 1.0938 | 84 | | | |
| | 36 | .1065 | 78 | .0023 | .109 | 72 | | I | .2720 | 75 | .0041 | .276 | 67 | | 1-7/64 | 1.1094 | 76 | | | |
| | 7/64 | .1094 | 70 | .0026 | .112 | 64 | | J | .2770 | 66 | .0041 | .281 | 58 | | 1-1/8 | 1.125 | 67 | | | |
| | 35 | .1100 | 69 | .0026 | .113 | 63 | 3/8-16 | 5/16 | .3125 | 77 | .0044 | .317 | 72 | 1-1/4-12 | 1-5/32 | 1.1563 | 87 | | | |
| | 34 | .1110 | 67 | .0026 | .114 | 60 | | O | .3160 | 73 | .0044 | .320 | 68 | | 1-11/64 | 1.1719 | 72 | | | |
| | 33 | .1130 | 62 | .0026 | .116 | 55 | | P | .3230 | 64 | .0044 | .327 | 59 | 1 -3/8-6 | 1-3/16 | 1.1875 | 87 | | | |
| 6-40 | 34 | .1110 | 83 | .0026 | .114 | 75 | 3/8-24 | 21/64 | .3281 | 87 | .0044 | .333 | 79 | | 1-13/64 | 1.2031 | 79 | | | |
| | 33 | .1130 | 77 | .0026 | .116 | 69 | | Q | .3320 | 79 | .0044 | .336 | 71 | | 1-7/32 | 1.2188 | 72 | | | |
| | 32 | .1160 | 68 | .0026 | .119 | 60 | | R | .3390 | 67 | .0044 | .343 | 58 | | 1-15/64 | 1.2344 | 65 | | | |
| 8-32 | 29 | .1360 | 69 | .0029 | .139 | 62 | 7/16-14 | T | .3580 | 86 | .0046 | .363 | 81 | 1-3/8-12 | 1-9/32 | 1.2813 | 87 | | | |
| | 28 | .1405 | 58 | .0029 | .143 | 51 | | 23/64 | .3594 | 84 | .0046 | .364 | 79 | | 1-19/64 | 1.2969 | 72 | | | |
| 8-36 | 29 | .1360 | 78 | .0029 | .139 | 70 | | U | .3680 | 75 | .0046 | .373 | 70 | 1-1/2-6 | 1-5/16 | 1.3125 | 87 | | | |
| | 28 | .1405 | 68 | .0029 | .143 | 57 | | 3/8 | .3750 | 67 | .0046 | .380 | 62 | | 1-21/64 | 1.3281 | 79 | | | |
| | 9/64 | .1406 | 68 | .0029 | .144 | 57 | | V | .3770 | 65 | .0046 | .382 | 60 | | 1-11/32 | 1.3438 | 72 | | | |
| 10-24 | 27 | .1440 | 85 | .0032 | .147 | 79 | 7/16-20 | W | .3860 | 79 | .0046 | .391 | 72 | | 1-23/64 | 1.3594 | 65 | | | |
| | 26 | .1470 | 79 | .0032 | .150 | 74 | | 25/64 | .3906 | 72 | .0046 | .395 | 65 | 1-1/2-12 | 1-13/32 | 1.4063 | 87 | | | |
| | 25 | .1495 | 75 | .0032 | .153 | 69 | | X | .3970 | 62 | .0046 | .402 | 55 | | 1-27/64 | 1.4219 | 72 | | | |

reaming recommended

*Probable hole size based on use of standard high-speed steel drills.*

### Recommended Pipe Tap Drill Sizes

| Drill Size | tap size | 1/16 | 1/8 | 1/4 | 3/8 | 1/2 | 3/4 | 1 | 1 1/4 | 1 1/2 | 2 | 2 1/2 | 3 | 3 1/2 | 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | taper pipe | D | R | 7/16 | 37/64 | 45/64 | 59/64 | 1 5/32 | 1 1/2 | 1 47/64 | 2 7/32 | 2 5/8 | 3 1/4 | 3 3/4 | 4 1/4 |
| | straight pipe | 1/4 | 11/32 | 7/16 | 37/64 | 23/32 | 59/64 | 1 5/32 | 1 1/2 | 1 3/4 | 2 7/32 | 2 21/32 | | | |

## Tap Drill Selection – Cutting Taps

(metric)

**To calculate metric tap drill size:**

basic major diameter (mm) – $\left(\frac{\text{percent of thread x pitch (mm)}}{76.98}\right)$ = hole size (mm)

**To calculate percentage of thread:**

$\left(\frac{76.9800}{\text{pitch (mm)}}\right)$ x [basic major diameter (mm) - drilled hole size (mm)]

| nom. size (mm) | pitch (mm) | basic major diam. (inches) | tap drill size | decimal equiv. of tap drill (inches) | theo. % of thread | probable oversize (mean) (inches) | *probable hole size (inches) | probable % of thread | nom. size (mm) | pitch (mm) | basic major diam. (inches) | tap drill size | decimal equiv. of tap drill (inches) | theo. % of thread | probable oversize (mean) (inches) | *probable hole size (inches) | probable % of thread |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,6 | 0,35 | .0630 | 1,25 mm | .0492 | 77 | .0015 | .0507 | 69 | 10 | 1,25 | .3937 | 8,7 mm | .3425 | 80 | .0046 | .3471 | 73 |
| 1,8 | 0,35 | .0709 | 1,45 mm | .0571 | 77 | .0015 | .0586 | 69 | | | | 11/32 | .3438 | 78 | .0046 | .3483 | 71 |
| 2 | 0,40 | .0787 | 1/16 | .0625 | 79 | .0015 | .0640 | 72 | | | | 8,75 mm | .3445 | 77 | .0046 | .3491 | 70 |
| | | | 1,60 mm | .0630 | 77 | .0017 | .0647 | 69 | 12 | 1,75 | .4724 | 10,25 mm | .4035 | 77 | .0047 | .4082 | 72 |
| | | | 52 | .0635 | 74 | .0017 | .0652 | 66 | | | | Y | .4040 | 76 | .0047 | .4087 | 71 |
| 2,2 | 0,45 | .0866 | 1,75 mm | .0689 | 77 | .0017 | .0706 | 70 | | | | 13/32 | .4062 | 74 | .0047 | .4109 | 69 |
| 2,5 | 0,45 | .0984 | 2,05 mm | .0807 | 77 | .0019 | .0826 | 69 | 12 | 1,25 | .4724 | 27/64 | .4219 | 79 | .0047 | .4266 | 72 |
| | | | 46 | .0810 | 76 | .0019 | .0829 | 67 | | | | 10,75 mm | .4232 | 77 | .0047 | .4279 | 70 |
| | | | 45 | .0820 | 71 | .0019 | .0839 | 63 | 14 | 2 | .5512 | 15/32 | .4688 | 81 | .0048 | .4736 | 76 |
| 3 | 0,50 | .1181 | 40 | .0980 | 79 | .0023 | .1003 | 70 | | | | 12 mm | .4724 | 77 | .0048 | .4772 | 72 |
| | | | 2,5 mm | .0984 | 77 | .0023 | .1007 | 68 | 14 | 1,5 | .5512 | 12,5 mm | .4921 | 77 | .0048 | .4969 | 71 |
| | | | 39 | .0995 | 73 | .0023 | .1018 | 64 | 16 | 2 | .6299 | 35/64 | .5469 | 81 | .0049 | .5518 | 76 |
| 3,5 | 0,60 | .1378 | 33 | .1130 | 81 | .0026 | .1156 | 72 | | | | 14 mm | .5512 | 77 | .0049 | .5561 | 72 |
| | | | 2,9 mm | .1142 | 77 | .0026 | .1168 | 68 | 16 | 1,5 | .6299 | 14,5 mm | .5709 | 77 | .0049 | .5758 | 71 |
| | | | 32 | .1160 | 71 | .0026 | .1186 | 63 | 18 | 2,5 | .7087 | 39/64 | .6094 | 78 | .0050 | .6144 | 74 |
| 4 | 0,70 | .1574 | 3,25 mm | .1280 | 82 | .0029 | .1309 | 74 | | | | 15,5 mm | .6102 | 77 | .0050 | .6152 | 73 |
| | | | 30 | .1285 | 81 | .0029 | .1314 | 73 | 18 | 1,5 | .7087 | 16,5 mm | .6496 | 77 | .0050 | .6546 | 70 |
| | | | 3,3 mm | .1299 | 77 | .0029 | .1328 | 69 | 20 | 2,5 | .7874 | 11/16 | .6875 | 78 | .0050 | .6925 | 74 |
| 4,5 | 0,75 | .1772 | 3,7 mm | .1457 | 82 | .0032 | .1489 | 74 | | | | 17,5 mm | .6890 | 77 | .0052 | .6942 | 73 |
| | | | 26 | .1470 | 79 | .0032 | .1502 | 70 | 20 | 1,5 | .7874 | 18,5 mm | .7283 | 77 | .0052 | .7335 | 70 |
| | | | 3,75 mm | .1476 | 77 | .0032 | .1508 | 69 | 22 | 2,5 | .8661 | 49/64 | .7656 | 79 | .0052 | .7708 | 75 |
| | | | 25 | .1495 | 72 | .0032 | .1527 | 64 | | 2.5 | .8661 | 19,5 mm | .7677 | 77 | .0052 | .7729 | 73 |
| 5 | 0,80 | .1968 | 4,2 mm | .1654 | 77 | .0032 | .1686 | 69 | 22 | 1,5 | .8661 | 20,5 mm | .8071 | 77 | .0052 | .8123 | 70 |
| | | | 19 | .1660 | 75 | .0032 | .1692 | 68 | 24 | 3 | | 21 mm | .8268 | 77 | .0059 | .8327 | 73 |
| 6 | 1,00 | .2362 | 10 | .1935 | 84 | .0038 | .1973 | 76 | | | .9449 | 53/64 | .8281 | 76 | .0059 | .8340 | 72 |
| | | | 9 | .1960 | 79 | .0038 | .1998 | 71 | 24 | 2 | .9449 | 22 mm | .8661 | 77 | .0059 | .8720 | 71 |
| | | | 5,0 mm | .1968 | 77 | .0038 | .2006 | 70 | 27 | 3 | 1.0630 | 15/16 | .9375 | 82 | .0060 | .9435 | 78 |
| | | | 8 | .1990 | 73 | .0038 | .2028 | 65 | | | | 24 mm | .9449 | 77 | .0062 | .9511 | 73 |
| 7 | 1,00 | .2756 | A | .2340 | 81 | .0038 | .2378 | 74 | 27 | 2 | 1.0630 | 25 mm | .9843 | 77 | .0070 | .9913 | 70 |
| | | | 15/64 | .2344 | 81 | .0038 | .2382 | 73 | | | | 63/64 | .9844 | 77 | .0070 | .9914 | 70 |
| | | | 6,0 mm | .2362 | 77 | .0038 | .2400 | 70 | 30 | 3,5 | 1.1811 | 26,5 mm | 1.0433 | 77 | | | |
| | | | B | .2380 | 74 | .0038 | .2418 | 66 | | | | 1-3/64 | 1.0469 | 75 | | | |
| 8 | 1,25 | .3150 | 6,7 mm | .2638 | 80 | .0041 | .2679 | 74 | 30 | 2 | 1.1811 | 28 mm | 1.1024 | 77 | | | |
| | | | 17/64 | .2656 | 77 | .0041 | .2697 | 71 | | | | 1-7/64 | 1.1094 | 70 | | | |
| | | | 6,75 mm | .2657 | 77 | .0041 | .2698 | 71 | 33 | 3,5 | 1.2992 | 1-5/32 | 1.1562 | 80 | | | |
| | | | H | .2660 | 77 | .0041 | .2701 | 70 | | | | 29,5 mm | 1.1614 | 77 | | | |
| | | | 6,8 mm | .2677 | 74 | .0041 | .2718 | 68 | | | | 1-11/64 | 1.1719 | 71 | | | |
| 8 | 1,00 | .3150 | 7,0 mm | .2756 | 77 | .0041 | .2797 | 69 | 33 | 2 | 1.2992 | 1-7/32 | 1.2188 | 79 | | | |
| | | | J | .2770 | 74 | .0041 | .2811 | 66 | | | | 31 mm | 1.2205 | 77 | | | |
| 10 | 1,50 | .3937 | 8,4 mm | .3307 | 82 | .0044 | .3351 | 76 | 36 | 4 | 1.4173 | 1-1/4 | 1.2500 | 82 | | | |
| | | | Q | .3320 | 80 | .0044 | .3364 | 75 | | | | 32 mm | 1.2598 | 77 | | | |
| | | | 8,5 mm | .3346 | 77 | .0044 | .3390 | 71 | 36 | 3 | 1.4173 | 33 mm | 1.2992 | 77 | | | |

reaming recommended

### Machine Screw and Fractional Size Taps for Helical Coil Wire Screw Thread Inserts (STI)

| nominal size (STI) | threads per inch | | tap dimensions (inch) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | NC | NF | overall length A | thread plus neck length B | spiral point thread length F | spiral flute thread length F | square length C | shank diameter D | size of square D | suggested tap drill size |
| 2 | 56 | — | 1.88 | 9/16 | .34 | .24 | .19 | .1410 | .110 | #41 (.0960) |
| 4 | 40 | — | 2.00 | 11/16 | .41 | .28 | .19 | .1410 | .110 | #31 (.1200) |
| 6 | 32 | — | 2.38 | 7/8 | .53 | .35 | .25 | .1940 | .152 | #25 (.1495) |
| 6 | — | 40 | 2.13 | 3/4 | .45 | .28 | .25 | .1680 | .131 | #25 (.1495) |
| 8 | 32 | — | 2.38 | 15/16 | .57 | .35 | .28 | .2200 | .165 | #16 (.1770) |
| 10 | 24 | — | 2.50 | 1 | .59 | .43 | .31 | .2550 | .191 | #5 (.2055) |
| 10 | — | 32 | 2.50 | 1 | .59 | .35 | .31 | .2550 | .191 | 13/64 (.2031) |
| 1/4 | 20 | — | 2.72 | 1 1/8 | .67 | .47 | .38 | .3180 | .238 | H (.2660) |
| 1/4 | — | 28 | 2.72 | 1 1/8 | .67 | .39 | .38 | .3180 | .238 | 6,7 mm (.2638) |
| 5/16 | 18 | — | 2.94 | 1 1/4 | .75 | .55 | .44 | .3810 | .286 | Q (.3320) |
| 5/16 | — | 24 | 2.94 | 1 1/4 | .75 | .39 | .44 | .3810 | .286 | 21/64 (.3281) |
| 3/8 | 16 | — | 3.38 | — | .98 | .63 | .44 | .3670 | .275 | X (.3970) |
| 3/8 | — | 24 | 3.16 | — | .87 | .47 | .41 | .3230 | .242 | 25/64 (.3906) |
| 7/16 | 14 | — | 3.59 | — | .98 | .71 | .50 | .4290 | .322 | 29/64 (.4531) |
| 7/16 | — | 20 | 3.38 | — | .98 | .47 | .44 | .3670 | .275 | 29/64 (.4531) |
| 1/2 | 13 | — | 3.81 | — | 1.08 | .75 | .56 | .4800 | .360 | 17/32 (.5312) |
| 1/2 | — | 20 | 3.59 | — | .98 | .51 | .50 | .4290 | .322 | 33/64 (.5156) |

## Tap Drill Selection – Forming Taps

(for Unified inch threads)

One of the most important decisions regarding forming taps is the drill selection. That's because forming taps displace metal, rather than remove metal as chips, during an application. Forming taps require a larger hole size than cutting taps because the minor diameter of the thread is produced by the inward displacement of the material being tapped. The charts that follow describe the recommended tap drill selection process.

**Other issues to consider when using forming taps include:**

**Torque -** The torque requirement for forming taps usually is higher than that for cutting taps and varies by material. Conventional tapping equipment is used.

**Speeds -** Tapping speed can be increased to usually double the spindle speeds recommended for cutting taps.

**Lubrication -** During form tapping, it is more effective to use a fluid that has good lubricating properties rather than cooling properties. Form taps over #5 are designed with oil grooves to assist in the distribution of lubricating fluid.

**Taper -** Forming taps are tapered at the front end, not chamfered. Therefore, they cannot be resharpened.

**Pitch Diameter Limits -** Higher pitch diameter limits should be used because some materials may have a tendency to close in after being displaced.

**max. drill size:**

basic major diameter - $\frac{3}{8N}$

**min. drill size:**

basic major diameter - $\frac{1}{2N}$

N = number of threads per inch

### Recommended Drill Sizes for Inch Thread Forming Taps

| nominal size & pitch (mm) | theoretical drill size | | drill approximately 65% thread | decimal equivalent (inch) | tap suggested for class of thread | | |
|---|---|---|---|---|---|---|---|
| | min. approx. 55% thread | max. approx. 75% thread | | | 2B | 3B | 2 |
| 0-80 NF | .0553 | .0537 | 54 | .055 | H3 | H2 | H2 |
| 1-64 NC | .0671 | .0652 | 51 | .067 | H3 | H2 | H2 |
| 1-72 NF | .0678 | .0661 | 51 | .067 | H3 | H2 | H2 |
| 2-56 NC | .0793 | .0771 | 5/64 | .0781 | H3 | H2 | H2 |
| 2-64 NF | .0801 | .0782 | 47 | .0785 | H3 | H3 | H3 |
| 3-48 NC | .0912 | .0886 | 43 | .089 | H3 | H2 | H2 |
| 3-56 NF | .0923 | .0901 | 2,3 mm | .0905 | H3 | H2 | H2 |
| 4-40 NC | .1026 | .0995 | 38 | .1015 | H5 | H3 | H3 |
| 4-48 NF | .1042 | .1016 | 2,6 mm | .1024 | H5 | H3 | H3 |
| 5-40 NC | .1156 | .1125 | 2,9 mm | .1142 | H5 | H3 | H3 |
| 6-32 NC | .1263 | .1224 | 1/8 | .125 | H5 | H3 | H3 |
| 6-40 NF | .1286 | .1255 | 3,25 mm | .128 | H5 | H3 | H3 |
| 8-32 NC | .1523 | .1484 | 25 | .1495 | H5 | H3 | H3 |
| 8-36 NF | .1536 | .1501 | 24 | .152 | H5 | H3 | H3 |
| 10-24 NC | .1744 | .1692 | 11/64 | .1719 | H6 | H4 | H4 |
| 10-32 NF | .1783 | .1744 | 16 | .177 | H6 | H4 | H4 |
| 12-24 NC | .2004 | .1952 | 8 | .199 | H6 | H4 | H4 |
| 1/4-20 NC | .2312 | .2250 | 1 | .228 | H6 | H4 | H4 |
| 1/4-28 NF | .2366 | .2322 | 15/16 | .2344 | H5 | H4 | H4 |
| 5/16-18 NC | .2917 | .2847 | L | .29 | H7 | H5 | H5 |
| 5/16-24 NF | .2969 | .2917 | M | .295 | H7 | H5 | H5 |
| 3/8-16 NC | .3516 | .3438 | — | .348 | H7 | H5 | H5 |
| 3/8-24 NF | .3594 | .3542 | T | .358 | H7 | H5 | H5 |
| 1/2-13 NC | .4712 | .4615 | 15/32 | .4682 | H8 | H5 | H5 |
| 1/2-30 NF | .483 | .4750 | 12,25 mm | .4823 | H8 | H5 | H5 |
| 5/8-11 NC | .5909 | .5795 | 14,75 mm | .5807 | H7 | H7 | H7 |
| 5/8-18 NF | .6042 | .5972 | 15,25 mm | .6004 | H7 | H7 | H7 |
| 3/4-10 NC | .7125 | .7000 | 45/64 | .7031 | H7 | H7 | H7 |
| 3/4-16 NF | .7266 | .7188 | 23/32 | .7188 | H7 | H7 | H7 |

## Tap Drill Selection – Forming Taps

(for 60° metric threads)

**max. drill size:**
basic major diameter - 0.375P

**min. drill size:**
basic major diameter - 0.5P

NOTE: Use metric value for basic major diameter and pitch, and the drill size will be in mm.

P = pitch

### Recommended Drill Sizes for Metric Thread Forming Taps

| nominal size & pitch (mm) | recommended "D" limit class 6H threads | max. approx. 55% thread (in.) | min. approx. 75% thread (in.) | approx. 65% thread (mm) | decimal equivalent (in.) |
|---|---|---|---|---|---|
| M1,6 X 0,35 | D5 | .0578 | .0561 | 1,45 mm | .0571 |
| M2 X 0,4 | D5 | .0728 | .0709 | 1,8 mm | .0709 |
| M2,5 X 0,45 | D5 | .0918 | .0896 | 2,3 mm | .0905 |
| M3 X 0,5 | D5 | .1107 | .1083 | 7/64 | .1094 |
| M3,5 X 0,6 | D6 | .1289 | .1260 | 3,2 mm | .1260 |
| M4 X 0,7 | D6 | .1471 | .1437 | 3,7 mm | .1457 |
| M5 X 0,8 | D7 | .1850 | .1811 | 14 | .1820 |
| M6 X 1 | D8 | .2215 | .2165 | 7/32 | .2188 |
| M8 X 1,25 | D9 | .2965 | .2904 | 7,4 mm | .2913 |
| M10 X 1,5 | D10 | .3716 | .3642 | U | .3680 |
| M12 X 1,75 | D11 | .4466 | .4380 | 11,2 mm | .4409 |
| M14 X 2 | D11 | .5217 | .5118 | 33/64 | .5156 |
| M16 X 2 | D12 | .6004 | .5906 | 19/32 | .5938 |
| M20 X 2,5 | D12 | .7505 | .7382 | 19,0 mm | .7480 |
| M24 X 3 | D14 | .9006 | .8858 | 57/64 | .8906 |

# Kennametal Tap & Die

## Troubleshooting Matrix

condition

| chipped tap teeth | poor tap wear | tap binding | tap loading | heavy burr on product minor diameter | entering threads reamed out | tap breakage | torn threads | bellmouth threads | threads too small | threads too large | possible cause | suggested correction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ● | ● | ● | | | | ● | | ● | | ● | misalignment | Align tap properly with hole. |
| ● | ● | | | | | ● | | ● | | | tap runout in holder | Correct or replace holder. |
| ● | | | | | | ● | | | | | tap bottoming in blind hole | Drill deeper or tap shallower. |
| | | | | | | | | | ● | | thin-walled part closing in | Use next larger size standard tap. Use new, sharp tap without worn edges. |
| | | | | | | ● | | ● | | | tap overcutting and undercutting its lead | Decrease forward pressure for overcut, increase for undercut, eliminate lead screw backlash. |
| | | | | | | | | ● | | | tap cutting on reversal | Reduce withdrawal pressure; eliminate lead screw backlash. |
| ● | | ● | ● | | | ● | ● | | | ● | loading on tap teeth metal welds on tap | Check tapping fluid and speeds, (reduce speed and increase fluid). |
| ● | ● | ● | ● | | | ● | ● | | | | wrong or insufficient tapping fluid | Check tapping fluid. Increase flow. |
| ● | ● | ● | | | | ● | ● | | | | drilled hole too small | Use properly sharpened drills of size suggested in drill chart. See page H85. |
| ● | ● | ● | | | | ● | | | | | hole workhardened in drilling | Feed properly sharpened drill into work with ample lubricant. Keep drill cutting. |
| ● | ● | ● | | | | ● | | | | | hard spots in material | Use slower speed; anneal material if possible. |
| | | | | | | | | | | ● | gage worn undersize | Check gages frequently. Replace, if doubtful. |
| ● | ● | ● | ● | | | ● | ● | | | ● | chips packed in tap flute | Withdraw tap more often to clear chips. Recheck tap selector for proper tap. |
| ● | | | | | | ● | ● | | | | chipped tap teeth | Replace tap or omit surface treatment. |
| | ● | ● | ● | ● | | | ● | | | ● | incorrect flute hook for material being tapped | Check for proper tap. |
| | | | | | | | | | | ● | tap too large | Check for proper tap. Change to next smaller standard tap, if necessary. |
| | | | | | | | | | ● | | tap too small | Check for proper tap. Use next larger standard tap, if necessary. |
| ● | | ● | ● | ● | ● | ● | ● | | ● | | tap worn on cutting edge | Replace tap. |
| ● | ● | ● | ● | | ● | | ● | | | | incorrect chamfer | Check for proper tap. Bottom chamfer is too severe for some materials. |
| | | | ● | | | | ● | ● | | | excess speed | Recommended tapping speeds are valid only when correct tapping fluid is properly applied. |
| ● | | | | | | | | | | | nitride treatment not needed | Try taps without nitride. |

## Application Information



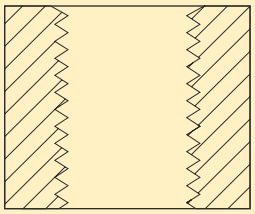
Tapping refers to the machining process in which internal threads are created in pre-drilled holes. This is done by feeding the cutting tool (tap) into the hole until the desired thread depth is achieved, then reversing the tap to back it out of the hole and remove it from the workpiece.

### Through-Hole vs. Controlled-Depth Tapping

There are two basic types of tapping operations: through-hole tapping and controlled-depth tapping. It is important to understand the difference between the two since tap and tap chuck selection are largely determined by the operation being performed.

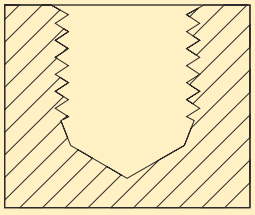
### Through-Hole Tapping

Through-hole tapping refers to the process of cutting threads the entire length of a hole that has been drilled completely through a workpiece.



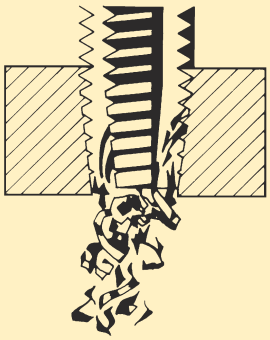
### Blind-Hole Tapping

Blind-hole tapping refers to the process of cutting threads to a specified depth. This is usually done in a hole that has been drilled into, but not completely through, the workpiece. This is sometimes called bottom-hole, or blind-hole tapping. Blind-hole tapping requires an accurate mechanism on the tap chuck to control thread depth. This is to ensure that the threads are cut to the bottom of the hole without ramming the tap into the bottom of the hole causing tool failure or unacceptable threads. Through-holes do not require accurate depth control.

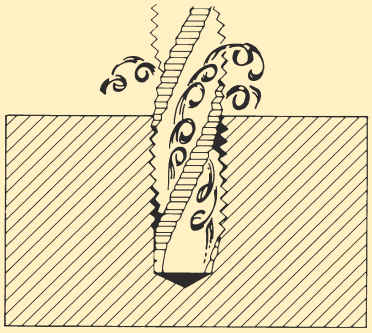


### Chip Expulsion

Tap selection is also influenced by the type of hole being threaded. Through-hole tapping usually requires a tap that pushes the chips out in front of the cutting edge and through the other end of the hole. A bottom-hole tap must pull chips up and out of the hole.



chip expulsion for through holes



chip expulsion for blind holes

### Forming Taps

Forming taps, sometimes called roll-forming, or cold-forming taps, produce threads by deforming the material near the hole walls rather than cutting the material as do other taps. This method often works well in ductile materials, however, in brittle materials it often results in unsatisfactory threads. Torque requirements for forming taps are considerably higher than for cutting taps. When forming taps are used, decrease chuck capacity by 25%. Forming taps produce no chips.

## Precautions for Tapping

Tapping problems can be minimized if the following precautions are taken before beginning the tapping operation.

### Tap Considerations:

- Do you have the correct tap for the application?
- Is the tap sharp?
- Is the tap properly aligned with the hole?
- Is there sufficient clearance between the tap and the hole to allow for retraction?
- Is the correct tapping attachment being used?

### Workpiece Considerations:

- Is the hole drilled to the correct size?
- Is the workpiece rigidly held against rotation and upward movement?
- If tapping a bottom-hole, is there sufficient chip clearance?

### Machine Tool Considerations:

- Is machine feed and speed set correctly?
- Have you set the machine stop so that the tap releases in neutral to prevent bottoming?
- When using a reversing tap chuck, is the stop arm strong enough to prevent the torque bar from bending or deflecting?
- Is the machine retraction correct for the tapping attachment being used?
- Is the torque control set to prevent tap breakage?
- Is the depth control set to correspond with the machine stop to provide the total thread depth required and prevent bottoming?
- Is the proper lubricant being used?

### Hole Preparation:

- Is the correct drill size being used?
- Is the material being workhardened by peck drilling?
- Are all chips removed from the hole?
- Using SE drills instead of KHSS drills can increase tap life up to 50%.

### NC Tapping

- Are programming instructions for the specific attachment being followed?
- Is machine feed set at 95% of tap lead?
- Is the machine speed correct for the tap being used? If machine tool is equipped with an override pot, changing the feed rate may result in tap breakage.
- When using reversing chucks, use the canned bore cycle program. Standard tapping cycle programs cannot be used with reversing chucks.
- Some customers develop their own programs for reversing chucks. These programs should include feed-in (ipr), dwell, and feed-out (ipr). A dwell should be optional. Feed-in and feed-out should be independent of each other. If the machine tool is equipped with an override pot, the feed rate should not be changed.