Allen Benjamin

# Engineering Data

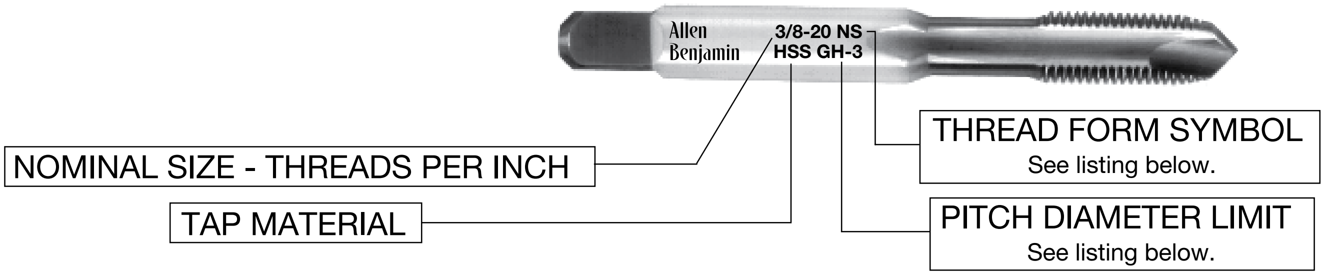
## Catalog No. 3-11

*"In The Pursuit Of Perfection"*

# Engineering Data

## Standard System of Tap Marking

Taps, dies and other types of threading tools are marked according to the Standard System of Marking Ground Thread Taps. Tools are marked with the nominal size, number of threads per inch (pitch), and the appropriate thread form symbol and pitch diameter symbol. *Symbols typically used are listed.*




## PITCH DIAMETER LIMIT SYMBOLS

All standard ground thread taps are marked with the letter "G" to designate Ground Thread. The letter G will be followed by the letter "H" to designate above basic; or the letter "L" to designate below basic. The number following H or L signifies the number of .0005" steps above or below the basic pitch diameter. *For instance, the tap pictured above is a 3/8" dia. tap with 20 threads per inch (pitch), and has a NS (American National Special Thread) thread form. The tap is made from High Speed Steel, and the GH-3 pitch diameter limit symbol indicates a Ground Thread tap with pitch diameter limits .0010 to .0015 over basic.*

Pitch Diameter Limits for taps to 1" diameter inclusive:

- L1 = Basic to Basic minus .0005
- H1 = Basic to Basic plus .0005
- H2 = Basic plus .0005 to Basic plus .0010
- H3 = Basic plus .0010 to Basic plus .0015
- H4 = Basic plus .0015 to Basic plus .0020
- H5 = Basic plus .0020 to Basic plus .0025
- H6 = Basic plus .0025 to Basic plus .0030

Taps larger than 1" dia. are ground to a .0010" tolerance on the pitch diameter and are, for example,

H4 (Basic plus .0010" to Basic plus .0020" ).

## THREAD FORM SYMBOLS

| | |
|---|---|
| ACME-C | Acme Thread-Centralizing |
| ACME-G | Acme Thread-General Purpose |
| AMO | American Standard Microscope Objective Thread |
| ANPT | Aeronautical National Form Taper Pipe Thread (Ground thread tap marked NPT) |
| BA | British Association Standard Thread |
| BSF | British Standard Fine Thread Series |
| BSP | British Standard Pipe |
| BSPP | British Standard Pipe (Parallel) Thread |
| BSPT | British Standard Taper Pipe Thread |
| BSW | British Standard Whitworth Coarse Thread Series |
| M | Metric ScrewThread Series |
| N | American National 8, 12 and 16 Thread Series (8N, 12N, 16N) |
| N | BUTT American Buttress Screw Thread |
| NC | American National Coarse Thread Series |
| NEF | American National Extra Fine Thread Series |
| NF | American National Fine Thread Series |
| NGO | National Gas Outlet Thread |
| NGT | National Gas Taper Thread (see "SGT") |
| NH | American National Hose Coupling and Fire Hose Coupling Threads |
| NPS | For tap marking only (See NPSC, NPSM) |
| NPSC | American National Standard Straight Pipe Thread in Pipe Couplings (Tap marked NPS) |
| NPSF | Dryseal American National Standard Fuel Internal Straight Pipe Thread |
| NPSH | American National Standard Straight Pipe Thread for Hose Couplings |
| NPSI | Dryseal American National Standard Intermediate Internal Straight Pipe Thread |
| NPSL | American National Standard Straight Pipe Thread for Loose Fitting Mechanical Joints with Locknuts |
| NPSM | American National Standard Straight Pipe Threads for Free-Fitting Mechanical Joints for Fixtures (Tap marked NPS) |
| NPT | American National Standard Taper Pipe Thread (See ANPT, NPTR) |
| NPTF | Dryseal American National Standard Taper Pipe Thread |
| NPTR | American National Standard Taper Pipe Thread for Railing Joints (Tap marked NPT) |
| NS | American National Thread-Special |
| PG | Panzer Gewinde |
| PTF | Dryseal SAE Short Taper Pipe Thread |
| SGT | Special Gas Taper Thread |
| SPL-PTF | Dryseal Special Taper Pipe Thread |
| STI | Special Thread for Helical Coil Wire Screw Thread Inserts |
| Stub Acme | Stub Acme Thread |
| *UN | Unified Constant Pitch Thread Series |
| *UNC | Unified Coarse Thread Series |
| *UNEF | Unified Extra Fine Thread Series |
| *UNF | Unified Fine Thread Series |
| UNJ** | Unified Thread Series with a 0.15011P to 0.18042P Controlled Root Radius on External Thread only. |
| UNJC | Unified Coarse Thread Series with a 0.15011P to 0.18042P Controlled Root Radius on External Thread only. |
| UNJF | Unified Fine Thread Series with a 0.15011P to 0.18042P Controlled Root Radius on External Thread only. |
| UNM | Unified Miniature Thread Series |
| UNR | Unified Constant Pitch Thread Series with a 0.108P to 0.144P Controlled Root Radius; Ext. thread only. |
| UNRC | Unified Coarse Thread Series with a 0.108P to 0.144P Controlled Root Radius; Ext. thread only. |
| UNRF | Unified Fine Thread Series with a 0.108P to 0.144P Controlled Root Radius; External thread only. |
| *UNS | Unified Thread-Special |
| V | A 60° "V" thread with Truncated Crest and Root. The theoretical "V" Form is usually flatted to the user's specifications. |
| WHIT | British Standard Whitworth Special Thread |

*Taps are not marked with "U" but with the symbol for the corresponding American Standard thread form with which it is compatible.

** See page 49 for additional information on UNJ taps.

## INCH SCREW THREADS - UNJ PROFILE
### Controlled Root Radius with Increased Minor Diameter

The UNJ thread standard (ASME B1.15) defines a system of threads for highly stressed applications requiring high fatigue strength. It was derived from a military specification (MIL-S-8879). MIL-S-8879 was primarily thought of and used for aerospace fastener and threaded component applications. Due to the increase in both its use and types of applications, the American Society of Mechanical Engineers developed and published ASME B1.15 in 1995.

**Form.** UNJ screw threads are of the same form as Unified Screw Threads to ASME/ANSI B1.1 except:

*External threads:* the root has a maximum and minimum prescribed continuous radius, and is not merely rounded due to tool wear.

*Internal threads:* the minor diameter is increased to accomodate the maximum root radius of the external thread. There is no radius requirement for either the crest or the root of the internal thread.

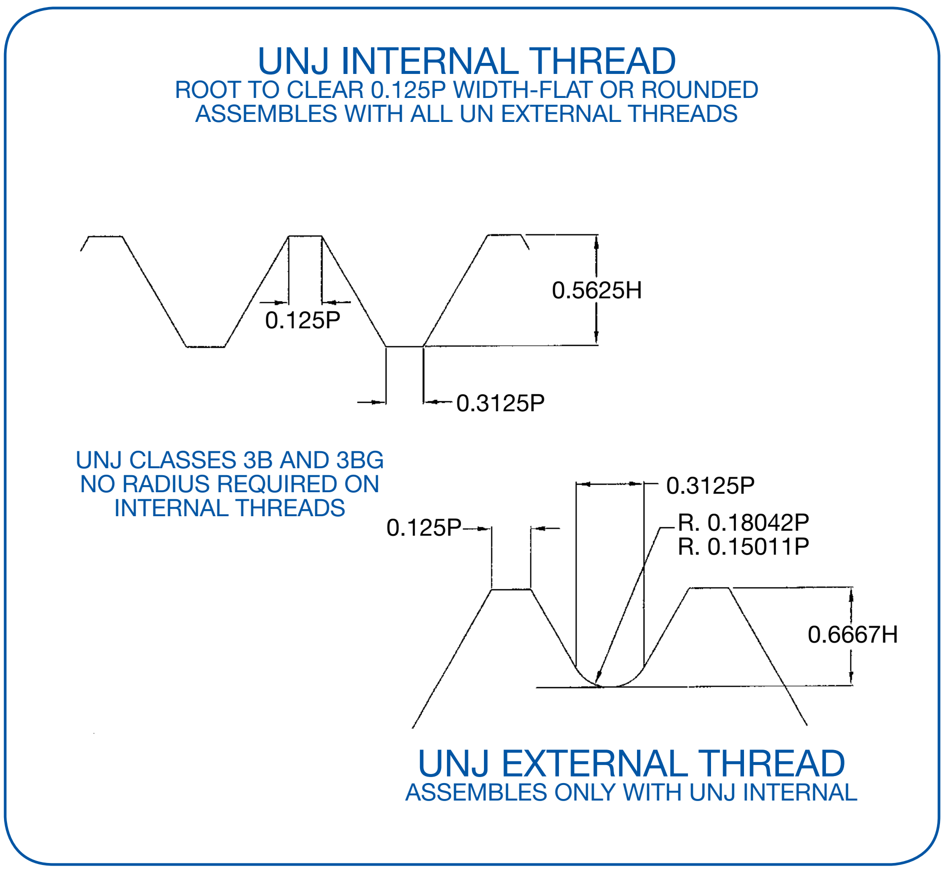
**Designation.** UNJ product threads are identified by the letter "J" in the thread symbol, and a thread class symbol including an "A" for external threads or a "B" for internal threads.

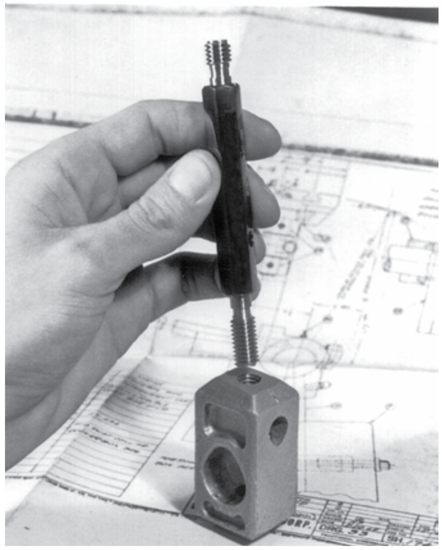
**Use of Unified Tooling.** Many of the UNJ thread form characteristics are the same as for UN threads. Therefore, some of the tooling used to produce one form can be used to produce the other.

*External UNJ* threads must be produced with a prescribed root radius; therefore, standard Unified Screw Thread (UN) tooling may not be used.

*Internal UNJ* threads are not required to have a root radius; therefore, ground thread taps designed to produce Unified Screw Threads of the proper class of fit may be used. The letter "J" need not be marked on the tap. The larger product minor diameter of the UNJ internal thread requires the use of a larger tap drill than is used when producing Unified Screw Threads.

- UNJ Thread Form: Unified Thread Series with a 0.15011P to 0.18042P controlled root radius on external thread only. (As defined by MIL-S-8879C)
- UNJ internal threads do not require radius; only external thread requires radius on root.
- UNJ external thread assembles only with UNJ internal thread.
- UNJ tap is standard 3B class of fit.





**CLASSES OF THREADS AND TAP SIZE:** There is a direct relationship between the size of a tap and the size of the thread that it cuts. Size refers to pitch diameter and its relationship to the class of fit required. If two threaded parts are assembled, the looseness or tightness of the fit is determined by contact on the flanks of the threads only. This contact is controlled by the pitch diameters of each part.

**CLASSES OF THREAD:** When threaded parts are mated, the two parts must assemble with a degree of tightness dictated by the use of the fastener. In addition, the internal thread must be large enough to allow the external thread to enter it for the required length of engagement. A system of thread classes, each representing a comparative degree of tightness, has been established and universally adopted, to provide manufacturers and users of threaded products with a common language of specification. The thread classes designate minimum and maximum pitch diameters for internal and external threads. It is important to remember that classes of thread actually represents manufacturing tolerances. The closer the tolerance required, the higher the cost involved in producing the parts. Therefore, designers and engineers should always try to select the class of thread with the widest permissible tolerance.

**TAP SIZE:** Due to material variability and machining conditions, taps rarely cut their own size. The thread size produced is usually larger, but can be smaller due to shrinkage. Tap manufacturers realized that to tap a specified class of thread, several different ground thread tap limits would be required. These limits represent small, defined variations in tap size. A numbering system was developed to designate each series of limits, but these limit numbers are not to be confused with the classes of threads. Ground thread tap limits are designated by the letter H (high) above basic pitch diameter, or L (low) below basic pitch diameter, and these numbers establish the tolerance range in relation to basic pitch diameter. As an example, in sizes 1" and smaller, an H1 tap has a tolerance range of from basic to .0005" over basic; an H2 tap from .0005" over basic to .001" over basic, (see chart 1A on this page). In addition, metric threads are also designated in much the same way. The thread tap limits are designated by the letter D (ground, high) above basic pitch diameter, or U (ground, low) below basic pitch diameter. As an example, in sizes M25 and smaller, a D1 tap has a size of .0005" over basic to tap max. P.D.; a D2 tap has a size of .001" over basic to tap max. P.D., (see Chart 1B). The Tables on pages 57-59 list recommended limit numbers for different classes of thread. Several different limit numbers are available for each diameter and pitch combination. Consequently, it is possible to select the "H" or "L" limit, or the "D" or "U" limit most suitable for the required tapping operation. Please contact Allen Benjamin for questions regarding tap limits and their relation to classes of fit.

*CHART 1A*

Pitch Diameter Limits for taps to 1" diameter inclusive:

L1 = Basic to Basic minus .0005
H1 = Basic to Basic plus .0005
H2 = Basic plus .0005 to Basic plus .0010
H3 = Basic plus .0010 to Basic plus .0015
H4 = Basic plus .0015 to Basic plus .0020
H5 = Basic plus .0020 to Basic plus .0025
H6 = Basic plus .0025 to Basic plus .0030

Taps larger than 1" dia. are ground to a .0010" tolerance on the pitch diameter and are, for example,
H4 (Basic plus .0010" to Basic plus .0020" ).

*CHART 1B*

Pitch Diameter Limits for taps to 1" diameter inclusive:
(Metric taps generally have more manufacturing tolerance than .0005 to the minus side.)

U1 = Basic minus .0005 = min. tap P.D.
D1 = Basic plus .0005 = max. tap P.D.
D2 = Basic plus .0010 = max. tap P.D.
D3 = Basic plus .0015 = max. tap P.D.
D4 = Basic plus .0020 = max. tap P.D.
D5 = Basic plus .0025 = max. tap P.D.
D6 = Basic plus .0030 = max. tap P.D.

On Charts 2A and 2B (below), examples of the relationship of Class of Fit to various tap limit sizes is shown for both Imperial and Metric sizes. In chart 2A, using a 1/4”-20NC or UNC thread size, it is obvious that an H5 limit (+.0025” over basic pitch diameter) can be used to cut the tightest class of thread in most machining situations, as can the H1 limit (+.0005” over basic P.D.). However, tool wear would force the discarding of the H1 tap long before the H5 would be worn to an undersize condition. **The rule is obvious: always select the largest “H” limit possible to achieve proper class of fit, and maximum tool life.**

*CHART 2A*

**COMPARISON OF PITCH DIAMETER LIMITS TO CLASS OF FIT**

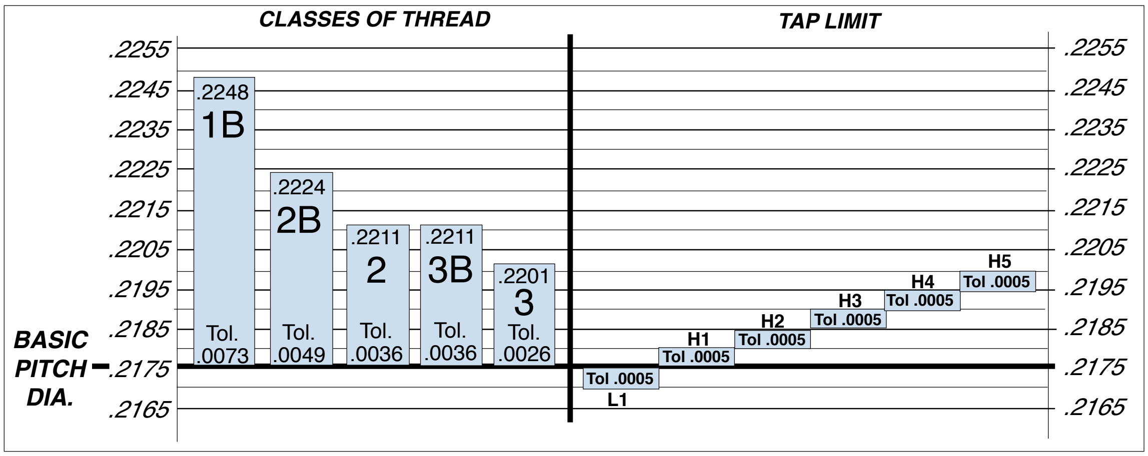
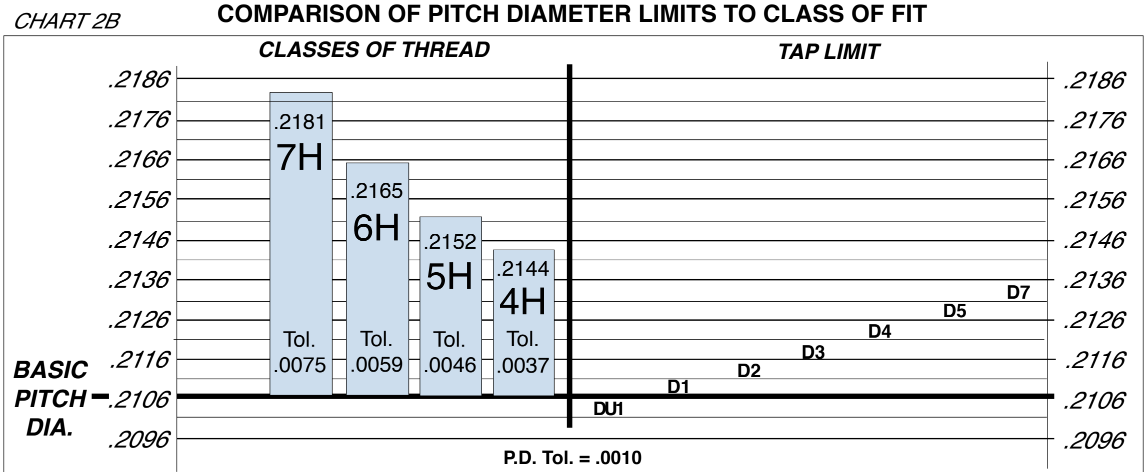



Chart 2B shows the same relationship with a metric thread. Using a M6 X 1.0, it is obvious that a D5 limit (+.0025” over basic pitch diameter) can be used to cut the standard class of thread in most machining situations, as can the D1 limit (+.0005” over basic P.D.). However, tool wear would force the discarding of the D1 tap long before the D5 would be worn to an undersize condition. **The rule is obvious: always select the largest “D” limit possible to achieve proper class of fit, and maximum tool life.**

*CHART 2B*

**COMPARISON OF PITCH DIAMETER LIMITS TO CLASS OF FIT**




## SCREW THREAD CLASSES OVERVIEW

Screw thread classes are distinguished from each other by the amount of tolerance and allowance.

*Class 1A and Class 1B:* The combination of Class 1A for external threads and Class 1B for internal threads is intended to cover the manufacture of threaded parts where quick and easy assembly is necessary or desired, and an allowance is provided to permit ready assembly.

*Class 2A and Class 2B:* The combination of Class 2A for external threads and Class 2B for internal threads designed for screws, bolts and nuts, is also suitable for a variety of other applications. A similar allowance is provided which minimizes galling and seizure encountered in assembly and use. It also accomodates, to a limited extent, plating, finishes or coatings.

*Class 3A and 3B:* The combination of Class 3A for external threads and Class 3B for internal threads is provided for those applications where closeness of fit and accuracy of lead and angle of thread are important. These threads are obtained consistently only by use of high quality production equipment supported by a very efficient system of gauging and inspection.

No allowance is provided.

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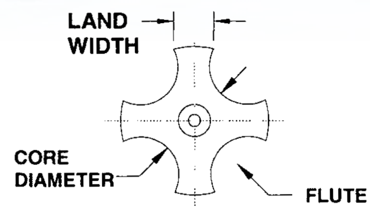
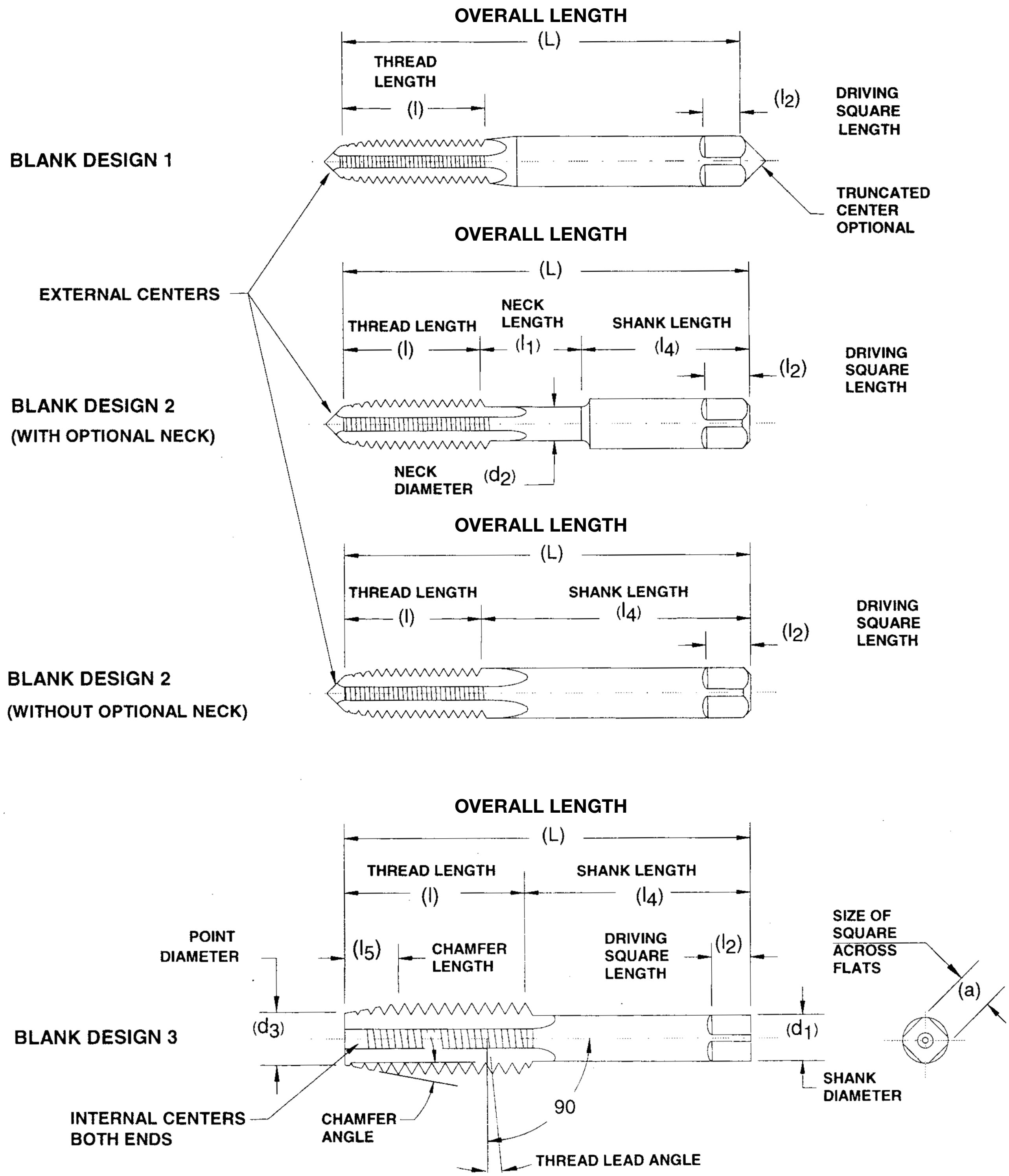
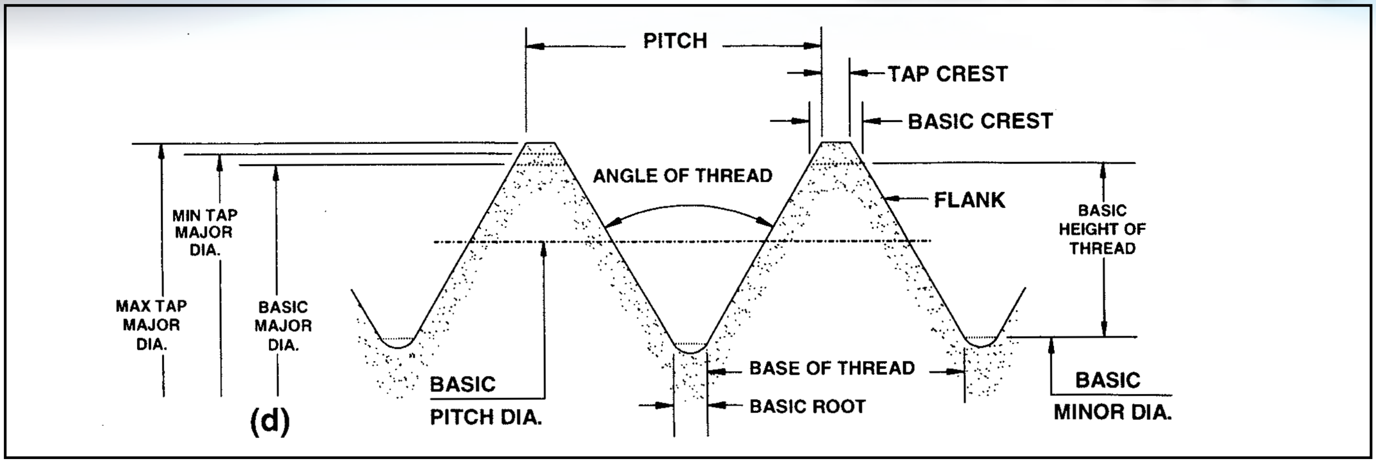
# Engineering Data

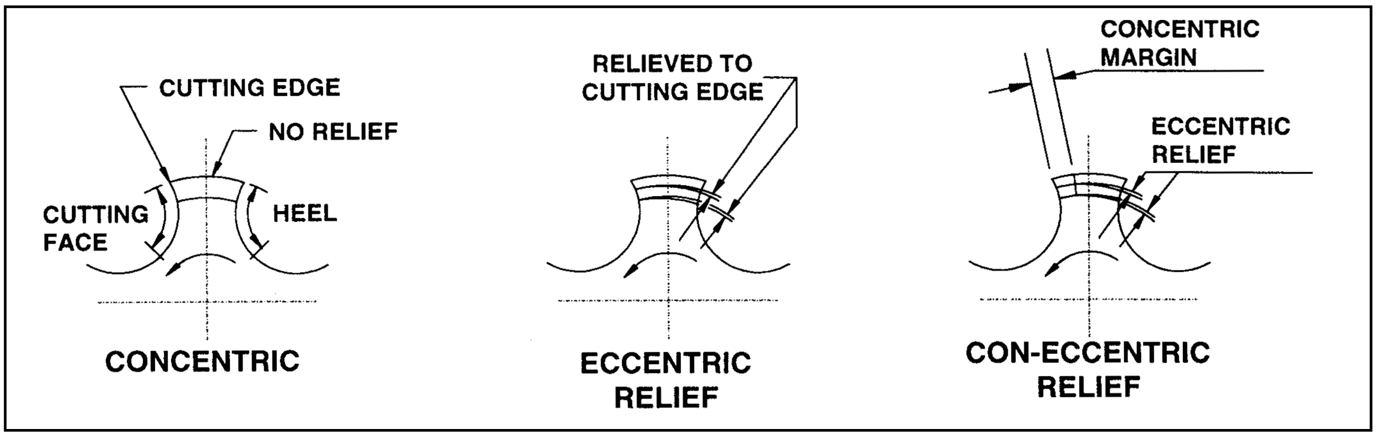
## Illustration of Terms Applying to Taps



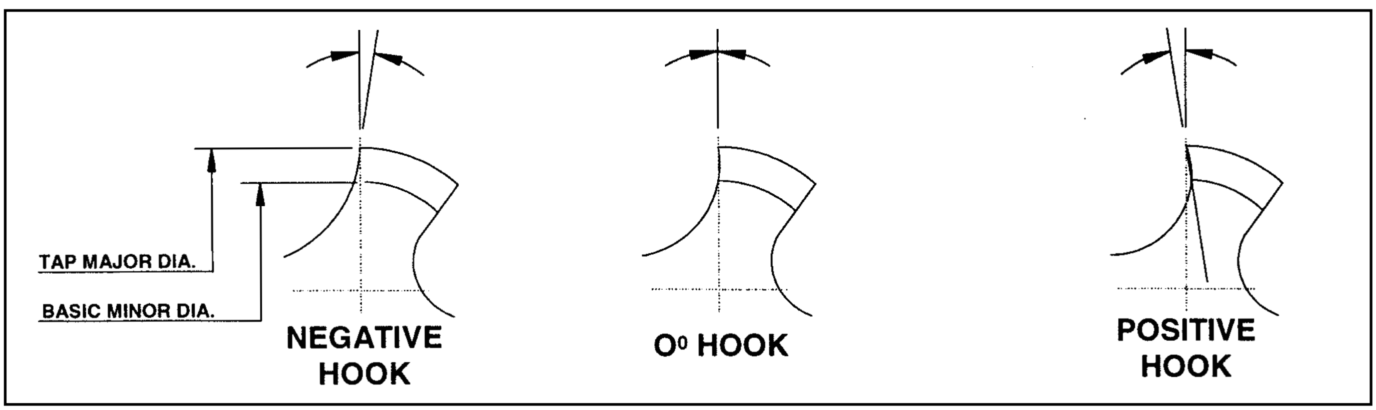





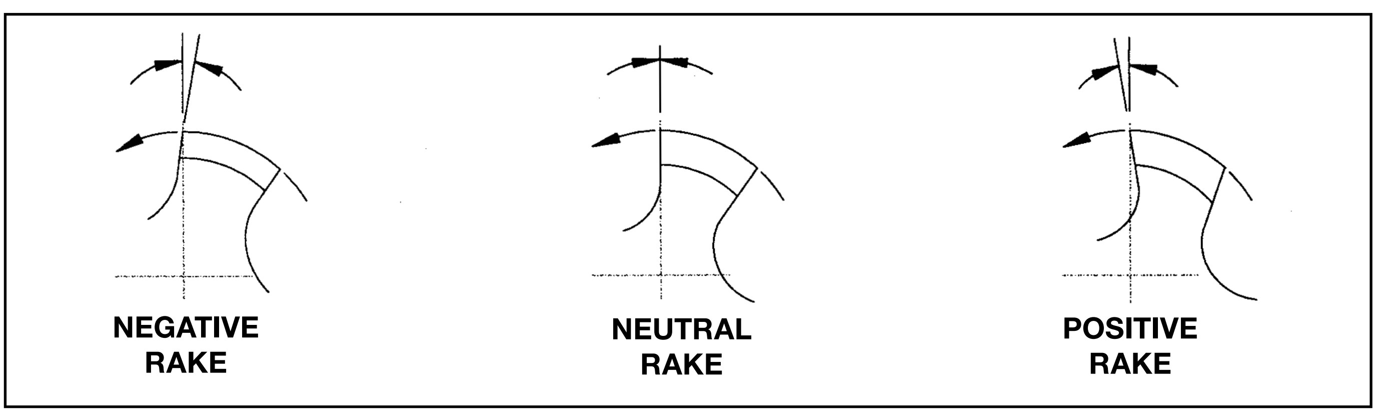
PITCH
TAP CREST
BASIC CREST
ANGLE OF THREAD
FLANK
BASIC HEIGHT OF THREAD
MIN TAP MAJOR DIA.
MAX TAP MAJOR DIA.
BASIC MAJOR DIA.
BASIC PITCH DIA.
BASE OF THREAD
BASIC ROOT
BASIC MINOR DIA.
(d)

CUTTING EDGE
NO RELIEF
CUTTING FACE
HEEL
CONCENTRIC
RELIEVED TO CUTTING EDGE
ECCENTRIC RELIEF
CONCENTRIC MARGIN
ECCENTRIC RELIEF
CON-ECCENTRIC RELIEF

TAP MAJOR DIA.
BASIC MINOR DIA.
NEGATIVE HOOK
O0 HOOK
POSITIVE HOOK

NEGATIVE RAKE
NEUTRAL RAKE
POSITIVE RAKE

### ALLOWANCE
Minimum clearance between two mating parts; the prescribed variations from the basic size.

### ANGLE OF THREAD
The angle included between the sides of the thread measured in an axial plane.

### AXIS
The imaginary straight line that forms the longitudinal centerline of the tool or threaded part.

### BACK TAPER
A gradual decrease in the diameter of the thread form on a tap from the chamfered end of the land towards the back which creates a slight radial relief in the threads.

### BASE OF THREAD
The bottom section of the thread; the greatest section between the two adjacent roots.

### BASIC SIZE
The theoretical or nominal standard size from which all variations are derived by application of allowances and tolerances.

### 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; *Taper taps* are chamfered 7-10 threads; *plug taps* are chamfered 3-5 threads; semi-*bottoming (or modified bottoming) taps* are chamfered 2-2.5 threads; *bottoming taps* are chamfered 1-2 threads; *taper pipe taps* are chamfered 2-3.5 threads.

### 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.

### CREST
The top surface joining the two sides or flanks of the 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 cutting rotation on which the chip forms.

### FLUTE
The longitudinal channels formed in a tap to create cutting edges on the thread profile, and to provide chip spaces and cutting fluid passages.

### HEEL
The edge of the land opposite the cutting edge.

### HEIGHT OF THREAD
The distance, measured radially, between the crest and the base of a thread.

### HELIX ANGLE
The angle made by the advance of the thread as it wraps around an imaginary cylinder.

### HOOK
The undercut on the face of the teeth.

### HOOK ANGLE
The inclination of a concave cutting face, usually specified either as Chordal Hook or Tangential Hook.
***Chordal Hook Angle:*** 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 Angle:*** 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 TAP
A tap having an odd number of lands with alternate teeth along the thread helix removed. In some cases alternate teeth are removed only for a portion of the thread length.

### LAND
The part of the tap body which remains after the flutes are cut, and on which the threads are finally ground. The threaded section between the flutes of a tap.

### LEAD
The axial distance a tap will advance along its axis in one complete turn. On a single start, the lead and the pitch are identical; on a double start, the lead is twice the pitch.

### MAJOR DIAMETER
Commonly known as the “outside diameter.” It is the largest diameter of the thread.

### MINOR DIAMETER
Commonly known as the “root diameter.” It is the smallest diameter of the thread.

### 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 a percentage.

### PITCH
The distance from any point on a screw thread to a corresponding point on the next thread, measured parallel to the axis and on the same side of the axis. The pitch equals one divided by the number of threads per inch.

### PITCH DIAMETER
On a straight thread, the pitch diameter is the diameter of the imaginary co-axial cylinder...the surface of which would pass through the thread profiles at such points as to make the width of the groove equal to one-half of the basic pitch. On a perfect thread this occurs at the point where the widths of the thread and groove are equal. On a taper thread, the pitch diameter at a given position on the thread axis is the diameter of the pitch cone at that position.

### RAKE
The angular relationship of the straight cutting face of a tooth with respect to a radial line through the crest of the tooth at the cutting edge. *Positive rake* means that the crest of the cutting face is angularly ahead of the balance of the cutting face of the tooth. *Negative rake* means that the crest of the cutting face is angularly behind the balance of the cutting face of the tooth. *Zero rake* means that the cutting face is directly on a radial line.

### RELIEF (or Thread Relief)
The removal of metal from behind the cutting edge to provide clearance and reduce friction between the part being threaded and the threaded land.

### ROOT
The bottom surface joining the sides of two adjacent threads, and is identical with or immediately adjacent to the cylinder or cone from which the thread projects.

### SPIRAL FLUTE
A flute with uniform axial lead in a spiral path around the axis of a tap.

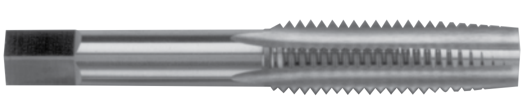
### SPIRAL POINT
The angular fluting in the cutting face of the land at the chamfered end; formed at an angle with respect to the tap axis of opposite hand to that of rotation. Its length is usually greater than the chamfer length and its angle with respect to the tap axis is usually made great enough to direct the chips ahead of the taps cutting action.

### STRAIGHT FLUTE
A flute that forms a cutting edge lying in an axial plane.

### TOLERANCE
In producing a tap to given specifications, tolerance is: (a.) the total permissible variation of a size; (b.) the difference between the limits of size.

## Chamfers for Thread Cutting Taps

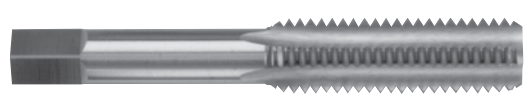
The tap chamfer is the tapering of the threads to distribute cutting action over several teeth. The type of hole to be tapped has much to do with the chamfer style of that tap that's best suited. Some holes go all the way through; some, while not through-holes, are relatively deep; some are quite shallow (a little deeper than diameter). Each of these three kinds of holes - through, deep-bottoming blind, and shallow bottoming - has a tap chamfer best suited to threading requirements.



**Taper Taps -** This style, with a **7-10 thread chamfer**, has the longest chamfer of the three to distribute action over the maximum number of teeth; and the taper also acts as a guide in starting the cutting action in the hole. Taper style taps start the thread square with the workpiece. Taper taps are commonly used in through holes and in materials where a tapered guide is necessary.

**Plug Taps -** This style, with a **3-5 thread chamfer**, is most widely used in through holes and where there is sufficient room at the bottom in blind holes.

**Semi (or Modified) Bottoming Taps -** This style, with a **2 to 2.5 thread chamfer**, should be used whenever possible in difficult material applications in blind holes, when threads are not required to the bottom of the hole.



**Bottoming Taps -** This style, designed with a **1 to 2 thread chamfer**, is made with just enough chamfer for starting in the hole; as the name implies, it is designed to thread blind holes to the bottom.

**NOTE:** Taper, plug and bottoming taps as a set, in a given size (for example: 1/4-20 NC) are identical as to size, length and vital measurements; the difference is in the chamfered threaded portion at the point. As a rule, such taps when used by hand are furnished in sets of three of a given size...namely, taper, plug and bottoming (and should be used in that order).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## HAND TAP

These standard style taps have straight flutes of a number specified as either standard or optional. Hand taps are for general purpose applications such as production tapping or hand tapping operations. Taper, plug and bottoming styles provide versatility in tough materials, blind and through holes.

## SPIRAL POINT TAP

As to general physical dimensions, spiral point taps are identical with the standard hand tap. However, the spiral point tap has the cutting face of the first few threads cut at a predetermined angle relative to the tap's axis angle to force the evacuation of chips ahead of the cutting action. This feature, plus the excellent shearing action of the flute, make spiral pointed taps ideal for production tapping of through holes. Typically, this type of tap has a shallower flute passage than conventional taps. This gives the spiral point tap more cross-sectional area, which means greater strength, allows higher tapping speeds, and requires less power to drive.

Regular (or Slow) Spiral Fluted Tap

Fast Spiral Fluted Tap

## SPIRAL FLUTED TAP

These taps, as the name implies, are made with spiral flutes instead of straight flutes. This spiral fluting feature aids in drawing chips out of a hole, or serves to bridge a gap inside the hole such as a keyway or cross-hole. Commonly available in *slow spiral* (25-30° helix angle) or *fast spiral* (45-60°).

## INTERRUPTED THREAD TAP

These taps have an odd number of lands with alternate teeth in the thread helix removed. The removal of every other tooth helps to break the chip and allows a greater supply of lubrication to reach the cutting teeth, reducing the incidence of torn threads. Ideal for tapping non-ferrous metals and low carbon steel; as well as use in titanium and high hardness alloys.

## THREAD FORMING (or Roll Form) TAP

These taps are fluteless except as optionally designed with one or more lubrication grooves. The thread form is lobed so there is a finite number of points contacting the work. This tap does not cut, so it is 'chipless', and consequently will not cause a chip problem. The tool forms the thread by extrusion, thus thread size can be closely maintained. The fluteless design allows high quality threads, faster tapping speeds, higher production, and generates no chips which simplifies tapping of blind bottoming holes (threads can be formed the full depth of the hole).

Straight Pipe Tap

Taper Pipe Tap

## PIPE TAP

These taps are for producing standard straight or tapered pipe threads in a wide range of pipe connections. Manufactured with the appropriate design variations to cut specified pipe thread forms.

## ACME THREAD TAP

Acme screw threads were devised to allow rotary and transversing motion on machines; and are also used in jacks, valves, presses and other mechanisms where heavy loads are encountered. The acme thread is characterized by a 29° included angle. Acme taps typically require specialized engineering and design due to the nature and severity of cut required in producing Acme threads.

## EXTENSION TAP

These taps are made to conventional tap dimensions, except that they have an extended shank to reach inaccessible holes. Thread length, shank diameter, and shank square are made to standard specifications listed in Table 302. Extension taps are available in both hand and spiral point styles, and in small shank style.

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# TAP RECOMMENDATIONS FOR CLASSES OF THREAD

*Unified and American National Screw Threads*

| Nominal Size | T.P.I. NC UNC | T.P.I. NF UNF | RECOMMENDED TAP FOR CLASS OF THREAD | | | | PITCH DIAMETER LIMITS FOR CLASS OF THREAD | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Class 2 | Class 3 | Class 2B | Class 3B | Min. All Classes (Basic) | Max. Class 2 | Max. Class 3 | Max. Class 2B | Max. Class 3B |
| 0 | — | 80 | GH1 | GH1 | GH2 | GH1 | .0519 | .0536 | .0532 | .0542 | .0536 |
| 1 | 64 | — | GH1 | GH1 | GH2 | GH1 | .0629 | .0648 | .0643 | .0655 | .0648 |
| 1 | — | 72 | GH1 | GH1 | GH2 | GH1 | .0640 | .0658 | .0653 | .0665 | .0659 |
| 2 | 56 | — | GH1 | GH1 | GH2 | GH1 | .0744 | .0764 | .0759 | .0772 | .0765 |
| 2 | — | 64 | GH1 | GH1 | GH2 | GH1 | .0759 | .0778 | .0773 | .0786 | .0779 |
| 3 | 48 | — | GH1 | GH1 | GH2 | GH1 | .0855 | .0877 | .0871 | .0885 | .0877 |
| 3 | — | 56 | GH1 | GH1 | GH2 | GH1 | .0874 | .0894 | .0889 | .0902 | .0895 |
| 4 | 40 | — | GH2 | GH1 | GH2 | GH2 | .0958 | .0982 | .0975 | .0991 | .0982 |
| 4 | — | 48 | GH1 | GH1 | GH2 | GH1 | .0985 | .1007 | .1001 | .1016 | .1008 |
| 5 | 40 | — | GH2 | GH1 | GH2 | GH2 | .1088 | .1112 | .1105 | .1121 | .1113 |
| 5 | — | 44 | GH1 | GH1 | GH2 | GH1 | .1102 | .1125 | .1118 | .1134 | .1126 |
| 6 | 32 | — | GH2 | GH1 | GH3 | GH2 | .1177 | .1204 | .1196 | .1214 | .1204 |
| 6 | — | 40 | GH2 | GH1 | GH2 | GH2 | .1218 | .1242 | .1235 | .1252 | .1243 |
| 8 | 32 | — | GH2 | GH1 | GH3 | GH2 | .1437 | .1464 | .1456 | .1475 | .1465 |
| 8 | — | 36 | GH2 | GH1 | GH2 | GH2 | .1460 | .1485 | .1478 | .1496 | .1487 |
| 10 | 24 | — | GH3 | GH1 | GH3 | GH3 | .1629 | .1662 | .1653 | .1672 | .1661 |
| 10 | — | 32 | GH2 | GH1 | GH3 | GH2 | .1697 | .1724 | .1716 | .1736 | .1726 |
| 12 | 24 | — | GH3 | GH1 | GH3 | GH3 | .1889 | .1922 | .1913 | .1933 | .1922 |
| 12 | — | 28 | GH3 | GH1 | GH3 | GH3 | .1928 | .1959 | .1950 | .1970 | .1959 |
| 1/4 | 20 | — | GH3 | GH2 | GH5 | GH3 | .2175 | .2211 | .2201 | .2224 | .2211 |
| 1/4 | — | 28 | GH3 | GH1 | GH4 | GH3 | .2268 | .2299 | .2290 | .2311 | .2300 |
| 5/16 | 18 | — | GH3 | GH2 | GH5 | GH3 | .2764 | .2805 | .2794 | .2817 | .2803 |
| 5/16 | — | 24 | GH3 | GH1 | GH4 | GH3 | .2854 | .2887 | .2878 | .2902 | .2890 |
| 3/8 | 16 | — | GH3 | GH2 | GH5 | GH3 | .3344 | .3389 | .3376 | .3401 | .3387 |
| 3/8 | — | 24 | GH3 | GH1 | GH4 | GH3 | .3479 | .3512 | .3503 | .3528 | .3516 |
| 7/16 | 14 | — | GH5 | GH3 | GH5 | GH3 | .3911 | .3960 | .3947 | .3972 | .3957 |
| 7/16 | — | 20 | GH3 | GH1 | GH5 | GH3 | .4050 | .4086 | .4076 | .4104 | .4091 |
| 1/2 | 13 | — | GH5 | GH3 | GH5 | GH3 | .4500 | .4552 | .4537 | .4565 | .4548 |
| 1/2 | — | 20 | GH3 | GH1 | GH5 | GH3 | .4675 | .4711 | .4701 | .4731 | .4717 |
| 9/16 | 12 | — | GH5 | GH3 | GH5 | GH3 | .5084 | .5140 | .5124 | .5152 | .5135 |
| 9/16 | — | 18 | GH3 | GH2 | GH5 | GH3 | .5264 | .5305 | .5294 | .5323 | .5308 |
| 5/8 | 11 | — | GH5 | GH3 | GH5 | GH3 | .5660 | .5719 | .5702 | .5732 | .5714 |
| 5/8 | — | 18 | GH3 | GH2 | GH5 | GH3 | .5889 | .5930 | .5919 | .5949 | .5934 |
| 3/4 | 10 | — | GH5 | GH3 | GH5 | GH5 | .6850 | .6914 | .6895 | .6927 | .6907 |
| 3/4 | — | 16 | GH3 | GH2 | GH5 | GH3 | .7094 | .7139 | .7126 | .7159 | .7143 |
| 7/8 | 9 | — | GH6 | GH4 | GH6 | GH4 | .8028 | .8098 | .8077 | .8110 | .8089 |
| 7/8 | — | 14 | GH4 | GH2 | GH6 | GH4 | .8286 | .8335 | .8322 | .8356 | .8339 |
| 1 | 8 | — | GH6 | GH4 | GH6 | GH4 | .9188 | .9264 | .9242 | .9276 | .9254 |
| 1 | — | 12 | GH4 | GH2 | GH6 | GH4 | .9459 | .9515 | .9499 | .9535 | .9516 |
| 1 | — | 14* | GH4 | GH2 | GH6 | GH4 | .9536 | .9585 | .9572 | .9609 | .9590 |
| 1 1/8 | 7 | — | GH8 | GH4 | GH8 | GH4 | 1.0322 | 1.0407 | 1.0381 | 1.0416 | 1.0393 |
| 1 1/8 | — | 12 | GH4 | GH4 | GH6 | GH4 | 1.0709 | 1.0765 | 1.0749 | 1.0787 | 1.0768 |
| 1 1/4 | 7 | — | GH8 | GH4 | GH8 | GH4 | 1.1572 | 1.1657 | 1.1631 | 1.1668 | 1.1644 |
| 1 1/4 | — | 12 | GH4 | GH4 | GH6 | GH4 | 1.1959 | 1.2015 | 1.1999 | 1.2039 | 1.2019 |
| 1 3/8 | 6 | — | GH8 | GH4 | GH8 | GH4 | 1.2667 | 1.2768 | 1.2738 | 1.2771 | 1.2745 |
| 1 3/8 | — | 12 | GH4 | GH4 | GH6 | GH4 | 1.3209 | 1.3265 | 1.3249 | 1.3291 | 1.3270 |
| 1 1/2 | 6 | — | GH8 | GH4 | GH8 | GH4 | 1.3917 | 1.4018 | 1.3988 | 1.4022 | 1.3996 |
| 1 1/2 | — | 12 | GH4 | GH4 | GH6 | GH4 | 1.4459 | 1.4515 | 1.4499 | 1.4542 | 1.4522 |

*UN

These are general tap recommendations to produce the Class of Thread indicated in average materials when used with reasonable care. However, if the tap specified does not give a satisfactory gage fit in the work, please consult the factory.

# METRIC TAP RECOMMENDATIONS FOR CLASSES OF THREAD

*(ISO)*

| SIZE mm | PITCH mm | RECOMMENDED TAP FOR CLASS OF THREAD 4H | 6H | PITCH DIAMETER LIMITS FOR CLASS OF THREAD MINIMUM (BASIC) | MAX. 4H | MAX. 6H |
|---|---|---|---|---|---|---|
| M1.5 | 0.35 | D1 | D2 | 1.273 | 1.326 | 1.358 |
| M1.6 | 0.35 | D1 | D3 | 1.373 | 1.426 | 1.458 |
| M1.8 | 0.35 | D1 | D3 | 1.573 | 1.626 | 1.658 |
| M2 | 0.45 | D1 | D2 | 1.708 | 1.768 | 1.803 |
| M2 | 0.40 | D1 | D3 | 1.740 | 1.796 | 1.830 |
| M2.2 | 0.45 | D1 | D3 | 1.908 | 1.968 | 2.003 |
| M2.3 | 0.40 | D1 | D2 | 2.040 | 2.096 | 2.130 |
| M2.5 | 0.45 | D1 | D3 | 2.208 | 2.268 | 2.303 |
| M2.6 | 0.45 | D1 | D2 | 2.308 | 2.368 | 2.403 |
| M3 | 0.60 | D1 | D2 | 2.610 | 2.681 | 2.722 |
| M3 | 0.50 | D1 | D3 | 2.675 | 2.738 | 2.775 |
| M3.5 | 0.60 | D1 | D4 | 3.110 | 3.181 | 3.222 |
| M4 | 0.75 | D2 | D3 | 3.513 | 3.588 | 3.631 |
| M4 | 0.70 | D2 | D4 | 3.545 | 3.620 | 3.663 |
| M4.5 | 0.75 | D2 | D4 | 4.013 | 4.088 | 4.131 |
| M5 | 1.00 | D2 | D3 | 4.350 | 4.440 | 4.490 |
| M5 | 0.90 | D2 | D3 | 4.415 | 4.501 | 4.549 |
| M5 | 0.80 | D2 | D4 | 4.480 | 4.560 | 4.605 |
| M5.5 | 0.90 | D2 | D3 | 4.915 | 5.002 | 5.050 |
| M6 | 1.00 | D3 | D5 | 5.350 | 5.445 | 5.500 |
| M6 | 0.75 | D3 | D4 | 5.513 | 5.598 | 5.645 |
| M7 | 1.00 | D3 | D5 | 6.350 | 6.445 | 6.500 |
| M7 | 0.75 | D2 | D4 | 6.513 | 6.598 | 6.645 |
| M8 | 1.25 | D3 | D5 | 7.188 | 7.288 | 7.348 |
| M8 | 1.00 | D3 | D5 | 7.350 | 7.445 | 7.500 |
| M9 | 1.25 | D3 | D5 | 8.188 | 8.288 | 8.348 |
| M9 | 1.00 | D3 | D5 | 8.350 | 8.445 | 8.500 |
| M10 | 1.50 | D3 | D6 | 9.026 | 9.138 | 9.206 |
| M10 | 1.25 | D3 | D5 | 9.188 | 9.288 | 9.348 |
| M10 | 1.00 | D3 | D5 | 9.350 | 9.445 | 9.500 |
| M11 | 1.50 | D3 | D5 | 10.026 | 10.138 | 10.206 |
| M12 | 1.75 | D3 | D6 | 10.863 | 10.988 | 11.063 |
| M12 | 1.50 | D3 | D5 | 11.026 | 11.144 | 11.216 |
| M12 | 1.25 | D3 | D5 | 11.188 | 11.300 | 11.368 |
| M14 | 2.00 | D3 | D7 | 12.701 | 12.833 | 12.913 |
| M14 | 1.50 | D3 | D6 | 13.026 | 13.144 | 13.216 |
| M14 | 1.25 | D3 | D5 | 13.188 | 13.300 | 13.368 |

cont.

These are general tap recommendations to produce the Class of Thread indicated in average materials when used with reasonable care. However, if the tap specified does not give a satisfactory gage fit in the work, please consult the factory.

## METRIC TAP RECOMMENDATIONS FOR CLASSES OF THREAD

*(ISO) cont.*

| SIZE mm | PITCH mm | RECOMMENDED TAP FOR CLASS OF THREAD 4H | 6H | PITCH DIAMETER LIMITS FOR CLASS OF THREAD MINIMUM (BASIC) | MAX. 4H | MAX. 6H |
|---|---|---|---|---|---|---|
| M16 | 2.00 | D4 | D7 | 14.701 | 14.833 | 14.913 |
| M16 | 1.50 | D3 | D6 | 15.026 | 15.144 | 15.216 |
| M17 | 1.50 | D3 | D5 | 16.026 | 16.144 | 16.216 |
| M18 | 2.50 | D4 | D7 | 16.376 | 16.516 | 16.600 |
| M18 | 2.00 | D4 | D6 | 16.701 | 16.833 | 16.913 |
| M18 | 1.50 | D3 | D6 | 17.026 | 17.144 | 17.216 |
| M19 | 2.50 | D4 | D6 | 17.376 | 17.516 | 17.600 |
| M20 | 2.50 | D4 | D7 | 18.376 | 18.516 | 18.600 |
| M20 | 2.00 | D4 | D6 | 18.701 | 18.833 | 18.913 |
| M20 | 1.50 | D3 | D6 | 19.026 | 19.144 | 19.216 |
| M22 | 2.50 | D4 | D7 | 20.376 | 20.516 | 20.600 |
| M22 | 2.00 | D4 | D6 | 20.701 | 20.833 | 20.913 |
| M22 | 1.50 | D3 | D6 | 21.026 | 21.144 | 21.216 |
| M24 | 3.00 | D4 | D8 | 22.051 | 22.221 | 22.316 |
| M24 | 2.00 | D4 | D7 | 22.701 | 22.841 | 22.925 |
| M24 | 1.50 | D3 | D5 | 23.026 | 23.151 | 23.226 |
| M25 | 2.00 | D4 | D7 | 23.701 | 23.841 | 23.925 |
| M25 | 1.50 | D3 | D5 | 24.026 | 24.151 | 24.226 |
| M26 | 3.00 | D5 | D8 | 24.051 | 24.221 | 24.316 |
| M27 | 3.00 | D5 | D8 | 25.051 | 25.221 | 25.316 |
| M27 | 2.00 | D5 | D7 | 25.701 | 25.841 | 25.925 |
| M28 | 3.00 | D5 | D8 | 26.051 | 26.221 | 26.316 |
| M28 | 2.00 | D5 | D7 | 26.701 | 26.841 | 26.925 |
| M30 | 3.50 | D5 | D9 | 27.727 | 27.907 | 28.007 |
| M30 | 3.00 | D5 | D8 | 28.051 | 28.221 | 28.316 |
| M30 | 2.00 | D5 | D7 | 28.701 | 28.841 | 28.925 |
| M32 | 3.50 | D5 | D9 | 29.727 | 29.907 | 30.007 |
| M32 | 2.00 | D5 | D7 | 30.701 | 30.841 | 30.925 |
| M33 | 3.50 | D5 | D9 | 30.727 | 30.907 | 31.007 |
| M33 | 3.00 | D5 | D8 | 31.051 | 31.221 | 31.316 |
| M33 | 2.00 | D5 | D7 | 31.701 | 31.841 | 31.925 |
| M34 | 3.50 | D5 | D9 | 31.727 | 31.907 | 32.007 |
| M36 | 4.00 | D5 | D9 | 33.402 | 33.592 | 33.702 |
| M36 | 3.00 | D5 | D8 | 34.051 | 34.221 | 34.316 |
| M36 | 2.00 | D5 | D7 | 34.701 | 34.841 | 34.925 |
| M38 | 4.00 | D5 | D9 | 35.402 | 35.592 | 35.702 |
| M39 | 4.00 | D6 | D9 | 36.402 | 36.592 | 36.702 |
| M39 | 3.00 | D6 | D8 | 37.051 | 37.221 | 37.316 |
| M39 | 2.00 | D6 | D7 | 37.701 | 37.841 | 37.925 |

These are general tap recommendations to produce the Class of Thread indicated in average materials when used with reasonable care. However, if the tap specified does not give a satisfactory gage fit in the work, please consult the factory.

# FORMULA FOR TAP/DRILL SIZES

*(INCH)*

METHOD 1

$$\text{Drilled Hole Size (in.)} = \text{Basic Major Dia. of Thread (in.)} - \frac{.013 \times \%\text{ of Full Thread*}}{\#\text{ of Threads per Inch (T.P.I.)}}$$

** Use whole number for % of thread...for 65%, use 65 (not .65).*

METHOD 2

Nominal O.D. - (Dbl. Thread Depth X % of Full Thread) = Drilled Hole Size

*EXAMPLE: To find the hole size for obtaining 75% of thread in a 1/4-20 tapped hole, follow first column down to 20 threads, then across to 75% of thread. This figure (.0485), when subtracted from the .250 diameter, is .2015, which is the required diameter of hole. See equation:*
*.250 - .0485 = .2015*

*To figure whether or not pitch is too coarse for diameter:*
*(Double thread depth) X 3 = x*
*x = the smallest diameter possible for that T.P.I.*

| Threads per Inch | Double Thread Depth | 50% Thread | 55% Thread | 60% Thread | 65% Thread | 70% Thread | 75% Thread | 80% Thread | 85% Thread |
|---|---|---|---|---|---|---|---|---|---|
| 6 | .21651 | .1083 | .1192 | .1300 | .1408 | .1517 | .1625 | .1733 | .1842 |
| 7 | .18558 | .0929 | .1021 | .1114 | .1207 | .1300 | .1393 | .1486 | .1579 |
| 8 | .16238 | .0813 | .0894 | .0975 | .1056 | .1138 | .1219 | .1300 | .1381 |
| 9 | .14434 | .0722 | .0794 | .0866 | .0939 | .1011 | .1083 | .1156 | .1228 |
| 10 | .12990 | .0649 | .0714 | .0779 | .0844 | .0909 | .0974 | .1039 | .1105 |
| 11 | .11809 | .0590 | .0649 | .0708 | .0767 | .0826 | .0885 | .0944 | .1005 |
| 12 | .10825 | .0541 | .0595 | .0649 | .0702 | .0755 | .0808 | .0861 | .0921 |
| 13 | .09992 | .0499 | .0549 | .0599 | .0649 | .0699 | .0749 | .0799 | .0850 |
| 14 | .09278 | .0464 | .0510 | .0556 | .0602 | .0648 | .0694 | .0740 | .0789 |
| 16 | .08119 | .0406 | .0446 | .0486 | .0526 | .0566 | .0606 | .0646 | .0691 |
| 18 | .07217 | .0361 | .0396 | .0431 | .0466 | .0501 | .0536 | .0571 | .0614 |
| 20 | .06495 | .0325 | .0357 | .0389 | .0421 | .0453 | .0485 | .0517 | .0553 |
| 24 | .05412 | .0270 | .0298 | .0326 | .0354 | .0382 | .0410 | .0438 | .0460 |
| 27 | .04811 | .0240 | .0264 | .0288 | .0312 | .0336 | .0360 | .0384 | .0409 |
| 28 | .04639 | .0232 | .0254 | .0276 | .0298 | .0324 | .0347 | .0370 | .0395 |
| 30 | .04330 | .0216 | .0238 | .0260 | .0282 | .0304 | .0326 | .0348 | .0368 |
| 32 | .04059 | .0203 | .0223 | .0243 | .0263 | .0283 | .0303 | .0323 | .0345 |
| 36 | .03608 | .0180 | .0198 | .0216 | .0234 | .0252 | .0270 | .0288 | .0307 |
| 40 | .03247 | .0162 | .0178 | .0194 | .0210 | .0226 | .0242 | .0258 | .0276 |
| 44 | .02952 | .0147 | .0162 | .0177 | .0192 | .0207 | .0222 | .0237 | .0251 |
| 48 | .02706 | .0135 | .0148 | .0161 | .0174 | .0187 | .0200 | .0213 | .0230 |
| 56 | .02319 | .0116 | .0127 | .0138 | .0149 | .0160 | .0171 | .0182 | .0197 |
| 64 | .02029 | .0101 | .0111 | .0121 | .0131 | .0141 | .0151 | .0161 | .0173 |
| 72 | .01804 | .0090 | .0099 | .0107 | .0115 | .0123 | .0131 | .0139 | .0153 |
| 80 | .01623 | .0081 | .0089 | .0097 | .0105 | .0113 | .0121 | .0129 | .0138 |

Figures in table show amount to subtract from O.D. of screw to obtain specific percentages of thread.
Select nearest size commercial stock drill.

## FORMULA FOR TAP/DRILL SIZES

*(METRIC)*

METHOD 1

Drilled Hole Size (mm) = Basic Major Dia. of Thread (mm) - $\frac{\text{\% of Full Thread* X mm Pitch}}{76.98}$

** Use whole number for % of thread...for 65%, use 65 (not .65).*

METHOD 2

Nominal O.D. - (Dbl. Thread Depth X % of Full Thread) = Drilled Hole Size

*EXAMPLE: To find the hole size for obtaining 75% of thread in a (M6) 6mm x 1.00 tapped hole, follow first column down to 1.00 threads, then across to 75% of thread. This figure (.9743), when subtracted from 6mm diameter, is 5.0257, which is the required diameter of hole. See equation:*
*M6 - (1.2990 X 75) = (6 - .9743) = 5.0257mm*

*To figure whether or not pitch is too coarse for diameter:*
*(Double thread depth) X 3 = x*
*x = the smallest diameter possible for that T.P.I.*

NOTE: All numbers are shown in millimeters (mm). To convert metric values to inches, divide by 25.4

| mm Pitch | Double Thread Depth | 50% Thread | 55% Thread | 60% Thread | 65% Thread | 70% Thread | 75% Thread | 80% Thread | 85% Thread |
|---|---|---|---|---|---|---|---|---|---|
| 4.0 | 5.1963 | 2.5982 | 2.8580 | 3.1178 | 3.3776 | 3.6374 | 3.8972 | 4.1570 | 4.4169 |
| 3.50 | 4.5466 | 2.2733 | 2.5006 | 2.7280 | 2.9553 | 3.1826 | 3.4100 | 3.6373 | 3.8646 |
| 3.00 | 3.8969 | 1.9485 | 2.1433 | 2.3381 | 2.5330 | 2.7278 | 2.9227 | 3.1175 | 3.3124 |
| 2.50 | 3.2476 | 1.6238 | 1.7862 | 1.9486 | 2.1109 | 2.2733 | 2.4357 | 2.5981 | 2.7605 |
| 2.00 | 2.5979 | 1.2990 | 1.4288 | 1.5587 | 1.6886 | 1.8185 | 1.9484 | 2.0783 | 2.2082 |
| 1.75 | 2.2733 | 1.1367 | 1.2503 | 1.3640 | 1.4776 | 1.5913 | 1.7050 | 1.8186 | 1.9323 |
| 1.50 | 1.9487 | .9744 | 1.0718 | 1.1692 | 1.2667 | 1.3641 | 1.4615 | 1.5590 | 1.6564 |
| 1.25 | 1.6236 | .8118 | .8930 | .9742 | 1.0553 | 1.1365 | 1.2177 | 1.2989 | 1.3801 |
| 1.00 | 1.2990 | .6495 | .7145 | .7794 | .8444 | .9093 | .9743 | 1.0392 | 1.1042 |
| .90 | 1.1687 | .5844 | .6428 | .7012 | .7597 | .8181 | .8765 | .9350 | .9934 |
| .80 | 1.0394 | .5197 | .5717 | .6236 | .6756 | .7276 | .7796 | .8315 | .8835 |
| .75 | .9743 | .4871 | .5359 | .5846 | .6333 | .6820 | .7307 | .7794 | .8282 |
| .70 | .9093 | .4547 | .5001 | .5456 | .5910 | .6365 | .6820 | .7274 | .7729 |
| .60 | .7793 | .3897 | .4286 | .4676 | .5065 | .5455 | .5845 | .6234 | .6624 |
| .50 | .6421 | .3211 | .3532 | .3853 | .4174 | .4495 | .4816 | .5137 | .5458 |
| .45 | .5847 | .2924 | .3216 | .3508 | .3801 | .4093 | .4385 | .4678 | .4970 |
| .40 | .5197 | .2599 | .2858 | .3118 | .3378 | .3638 | .3898 | .4158 | .4417 |
| .35 | .4547 | .2274 | .2501 | .2728 | .2956 | .3183 | .3410 | .3638 | .3865 |
| .30 | .3896 | .1948 | .2143 | .2338 | .2532 | .2727 | .2922 | .3117 | .3312 |
| .25 | .3246 | .1663 | .1785 | .1948 | .2110 | .2272 | .2434 | .2597 | .2759 |

Figures in table show amount to subtract from O.D. of screw to obtain specific percentages of thread.
Select nearest size commercial stock drill.

3638 E. Southern Ave. • P.M.B. 202 • Suite C105 • Mesa, AZ 85206
Phone: 800.528.7404 • 480.968.7937 • Fax: 480.731.9462
E-Mail: info@allenbenjamin.com • Web: www.allenbenjamin.com

## • Materials Listing • Suggested Surface Treatments • Cutting Fluids and Cutting Speeds

*(STARTING SFM RECOMMENDATIONS ONLY)*

| MATERIAL TO BE TAPPED | SUGGESTED SURFACE TREATMENT** | LUBRICANT/COOLANT | HSS SPEED / SFM | CARBIDE SPEED / SFM |
|---|---|---|---|---|
| ALUMINUM (WROUGHT) | TiN, TiCN | Soluble, Light Base, or Lard Oil | 90-150 | 100-250 |
| ALUMINUM DIE CASTING | TiCN, TiN, CrN, TiAlN+WC/C | Soluble or Lard Oil | 65-75 | 75-100 |
| ALUMINUM BRONZE | N, TiN | Mineral Oil w/Lard, or Light Oil | 20-60 | 40-80 |
| BAKELITE (HARD PLASTIC) | TiCN | Dry or Air Jet | 25-40 | 25-40 |
| BERYLLIUM COPPER | TiAlN+WC/C, CrN, N | Soluble Light Base Oil | 50-90 | 50-90 |
| BRASS | None, TiCN | Soluble Light Base Oil | 100-200 | 100-200 |
| BRONZE (FREE-MACHINE) | None, TiCN, N | Soluble Light Base Oil | 80-150 | 100-200 |
| CAST BRASS | N, TiCN | Soluble Light Base Oil | 100-200 | 125-250 |
| CAST IRON (GRAY) | N, TiCN | Dry or Soluble Oil | 20-80 | 40-100 |
| COPPER | TiAlN+WC/C, CrN | Soluble Light Base Oil | 80-150 | 100-200 |
| COPPER-NICKEL | N, TiCN | Soluble Light Base Oil | 10-20 | 20-50 |
| DELRIN | TiAlN+WC/C, TiN, N | Dry, Air Jet, or Water Soluble | 65-100 | 65-100 |
| DUCTILE IRON | N+O, TiN, TiCN | Soluble or Sulphur Based Oils | 30-50 | 40-80 |
| DURALUMIN | TiAlN+WC/C, CrN | Soluble or Lard Oil | 50-90 | 50-90 |
| FERRO-TIC | None | Anti-Seize Compound | 8-20 | 8-20 |
| FIBERGLASS | TiCN | Dry or Air Jet | 25-40 | 30-60 |
| HASTELLOY | CrN | Sulphur Based Oils | 8-20 | 8-20 |
| INCONEL | N, CrN | Sulphur Based Oils | 8-20 | 8-20 |
| MAGNESIUM | CrN | Soluble Light Base Oil | 100-150 | 100-150 |
| MALLEABLE IRON | N+O, TiN, TiCN | Soluble or Sulphur Based Oils | 30-50 | 30-50 |
| MANGANESE | TiCN | Sulphur Based Oils | 8-20 | 8-20 |
| MANGANESE BRONZE | N, TiCN | Soluble Light Base Oil | 20-60 | 40-80 |
| MOLYBDENUM | N, TiN, TiCN | Sulphur Based Oils | 20-45 | 30-60 |
| MONEL | N, TiCN | Sulphur Based Oils | 8-20 | 15-40 |
| NAVAL BRASS | N | Soluble Light Base Oil | 100-200 | 100-200 |
| NAVAL BRONZE | None, TiCN | Soluble Light Base Oil | 80-150 | 80-150 |
| NICKEL SILVER | N, TiCN | Sulphur Based Oils | 20-60 | 20-60 |
| NICKEL (PURE) | N, TiCN | Soluble Light Base Oil | 5-25 | 10-40 |
| NITRALLOY | N, TiCN | Sulphur Based Oils | 8-20 | 8-20 |
| NITRONIC (* NO GUARANTEE) | N, TiN, TiCN | Sulphur Based Oils | 8-20 | 8-20 |
| NYLON | N, TiN | Dry, Air Jet or Water Soluble | 65-100 | 65-100 |
| PLASTICS: | | | | |
| THERMOPLASTIC (SOFT) ABS, DELRIN, NYLON, PVC, ETC. | N, TiN | Dry, Air Jet or Water Soluble | 65-100 | 65-100 |
| THERMOSETTING (HARD) BAKELITE, LAMINATES, PHENOLIC, POLYESTERS, ETC. | TiCN | Dry or Air Jet | 25-40 | 25-40 |
| POWDERED METAL (Sintered) | TiCN | Soluble Light Based Oil | 25-80 | 25-80 |
| RUBBER, HARD | None | Dry | 50-200 | 50-200 |
| SILICON BRONZE | N, TiCN | Soluble Light Base Oil | 20-60 | 20-60 |
| STEEL: | | | | |
| CARBON STEEL | O, N, TiN | Sulphur Based Oils | 40-90 | 50-120 |
| COLD-ROLLED STEEL (1018, etc.) | O, N, TiN | Sulphur Based Oils | 40-90 | 50-120 |
| FORGED | O, N, TiN | Sulphur Based Oils | 20-50 | 30-75 |
| LEADED (12L14, etc.) | O, N, TiN | Sulphur Based Oils | 40-90 | 50-125 |
| STAINLESS: | | | | |
| FREE MACHINING | N, TiN, TiCN | Sulphur Based Oils | 20-40 | 40-80 |
| PRECIP. HARDENING | N, TiN, TiCN | Sulphur Based Oils | 8-20 | 10-30 |
| TOOL STEEL | N, TiN, TiCN | Sulphur Based Oils | 20-50 | 30-65 |
| TITANIUM | O, N, CrN | Sulphur Based Oils | 20-50 | 30-65 |
| TUNGSTEN | TiN | Sulphur Based Oils | 8-20 | 8-20 |
| TURCITE (SOFT PLASTIC) | N, TiN | Dry, Air Jet or Water Soluble | 65-100 | 65-100 |
| ZAMAK (ZINC DIE CAST) | TiCN, TiN, CrN, TiAlN+WC/C | Soluble Light Based Oil | 50-200 | 50-200 |
| ZINC | TiCN, TiN, CrN, TiAlN+WC/C | Soluble Light Based Oil | 50-200 | 50-200 |

* If problems are encountered when tapping nitronic, or any other material (listed or not), please consult the factory.
** See page 79 for definitions of surface treatment abbreviations.
Note: The SFM cutting speeds listed are starting SFM recommendations only and depending on specific tapping conditions, may have to be altered. Allen Benjamin assumes no responsibility or liability of any kind as a result of the above listed SFM recommendations.

Allen Benjamin

# TABLE OF SPEEDS FOR TAPS

*(USE ONLY AS SUGGESTED STARTING R.P.M.)*

MACHINE SCREW AND FRACTIONAL SIZES

| Tap Size (UNC/UNF) | Taper Pipe Taps (NPT/NPTF) | Surface Feet per Minute (SFM) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 5' | 10' | 15' | 20' | 25' | 30' | 40' | 50' | 60' | 70' | 80' | 90' | 100' | 110' | 120' | 130' | 140' | 150' |
| | | Revolutions per Minute (RPM) | | | | | | | | | | | | | | | | | |
| 0 (.060) | | 318 | 637 | 955 | 1273 | 1592 | 1910 | 2546 | 3183 | 3820 | 4456 | 5093 | 5729 | 6366 | 7003 | 7639 | 8276 | 8913 | 9549 |
| 1 (.073) | | 273 | 546 | 819 | 1046 | 1308 | 1570 | 2093 | 2617 | 3140 | 3663 | 4186 | 4710 | 5233 | 5756 | 6279 | 6805 | 7326 | 7849 |
| 2 (.086) | | 212 | 424 | 637 | 888 | 1110 | 1333 | 1777 | 2221 | 2665 | 3109 | 3554 | 3999 | 4442 | 4886 | 5330 | 5774 | 6218 | 6662 |
| 3 (.099) | | 191 | 382 | 573 | 772 | 964 | 1157 | 1543 | 1929 | 2315 | 2701 | 3086 | 3472 | 3858 | 4244 | 4629 | 5015 | 5401 | 5787 |
| 4 (.112) | | 174 | 347 | 521 | 682 | 853 | 1023 | 1364 | 1705 | 2046 | 2387 | 2728 | 3069 | 3411 | 3751 | 4092 | 4434 | 4775 | 5116 |
| 5 (.125) | | 147 | 294 | 441 | 611 | 764 | 917 | 1222 | 1528 | 1833 | 2139 | 2445 | 2750 | 3056 | 3361 | 3667 | 3973 | 4278 | 4584 |
| 6 (.138) | | 136 | 273 | 409 | 553 | 691 | 829 | 1106 | 1382 | 1659 | 1935 | 2212 | 2488 | 2766 | 3042 | 3318 | 3595 | 3871 | 4148 |
| 8 (.164) | | 119 | 239 | 358 | 466 | 583 | 699 | 932 | 1165 | 1398 | 1631 | 1864 | 2097 | 2330 | 2563 | 2796 | 3029 | 3262 | 3495 |
| 10 (.190) | | 101 | 201 | 302 | 402 | 502 | 603 | 804 | 1005 | 1205 | 1406 | 1607 | 1808 | 2009 | 2210 | 2411 | 2612 | 2813 | 3014 |
| 12 (.216) | | 87 | 174 | 260 | 354 | 442 | 531 | 707 | 884 | 1061 | 1238 | 1415 | 1592 | 1769 | 1945 | 2122 | 2300 | 2476 | 2653 |
| 14 (.242) | | 79 | 158 | 237 | 316 | 395 | 474 | 631 | 789 | 947 | 1105 | 1263 | 1421 | 1579 | 1736 | 1894 | 2052 | 2210 | 2368 |
| 1/4 | | 76 | 153 | 229 | 306 | 382 | 458 | 611 | 764 | 917 | 1070 | 1222 | 1375 | 1528 | 1681 | 1833 | 1986 | 2139 | 2292 |
| 5/16 | 1/16 | 62 | 123 | 185 | 245 | 306 | 367 | 489 | 611 | 733 | 856 | 978 | 1100 | 1222 | 1345 | 1467 | 1589 | 1711 | 1833 |
| 3/8 | | 50 | 101 | 151 | 204 | 255 | 305 | 407 | 509 | 611 | 713 | 815 | 917 | 1019 | 1120 | 1222 | 1324 | 1426 | 1528 |
| 7/16 | 1/8 | 43 | 87 | 130 | 175 | 219 | 262 | 349 | 437 | 524 | 611 | 698 | 786 | 873 | 960 | 1048 | 1135 | 1222 | 1310 |
| 1/2 | | 38 | 76 | 115 | 153 | 191 | 229 | 305 | 382 | 458 | 535 | 611 | 688 | 764 | 840 | 917 | 993 | 1070 | 1146 |
| 9/16 | 1/4 | 34 | 68 | 102 | 137 | 172 | 206 | 274 | 342 | 410 | 478 | 547 | 616 | 683 | 752 | 820 | 888 | 952 | 1020 |
| 5/8 | | 32 | 64 | 96 | 122 | 153 | 183 | 244 | 306 | 367 | 428 | 489 | 550 | 611 | 672 | 733 | 794 | 856 | 917 |
| 11/16 | 3/8 | 28 | 55 | 83 | 111 | 138 | 167 | 222 | 278 | 333 | 389 | 444 | 500 | 556 | 611 | 667 | 722 | 778 | 833 |
| 3/4 | | 25 | 51 | 76 | 102 | 128 | 153 | 203 | 255 | 305 | 357 | 407 | 458 | 509 | 560 | 611 | 662 | 713 | 764 |
| 7/8 | 1/2 | 22 | 43 | 65 | 87 | 109 | 131 | 175 | 218 | 262 | 306 | 350 | 392 | 437 | 480 | 524 | 568 | 611 | 655 |
| 1" | | 19 | 38 | 57 | 76 | 96 | 115 | 153 | 191 | 230 | 268 | 305 | 344 | 382 | 420 | 458 | 497 | 535 | 573 |
| 1 1/8 | 3/4 | 17 | 34 | 51 | 68 | 84 | 102 | 136 | 170 | 204 | 238 | 272 | 306 | 340 | 373 | 407 | 441 | 475 | 509 |
| 1 1/4 | | 15 | 31 | 46 | 61 | 76 | 92 | 122 | 153 | 183 | 214 | 244 | 275 | 305 | 336 | 367 | 397 | 428 | 458 |
| 1 3/8 | 1 | 14 | 28 | 42 | 56 | 69 | 83 | 111 | 139 | 167 | 194 | 222 | 250 | 278 | 306 | 333 | 361 | 389 | 417 |
| 1 1/2 | | 13 | 25 | 38 | 51 | 63 | 76 | 102 | 127 | 153 | 178 | 204 | 229 | 255 | 280 | 305 | 331 | 356 | 382 |
| 1 5/8 | | 12 | 23 | 35 | 47 | 59 | 71 | 94 | 118 | 141 | 165 | 188 | 212 | 235 | 259 | 282 | 306 | 329 | 353 |
| 1 3/4 | 1 1/4 | 11 | 22 | 33 | 44 | 55 | 65 | 87 | 109 | 131 | 153 | 175 | 196 | 218 | 240 | 262 | 284 | 306 | 327 |
| 1 7/8 | 1 1/2 | 10 | 20 | 30 | 41 | 51 | 61 | 81 | 102 | 122 | 143 | 163 | 183 | 204 | 224 | 244 | 265 | 285 | 306 |
| 2" | | 9 | 19 | 29 | 38 | 48 | 57 | 76 | 96 | 115 | 134 | 153 | 172 | 191 | 210 | 229 | 248 | 267 | 287 |

METRIC SIZES

| Metric Tap Size | Dec. Equiv. Size | Surface Feet per Minute (SFM) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 5' | 10' | 15' | 20' | 25' | 30' | 40' | 50' | 60' | 70' | 80' | 90' | 100' | 110' | 120' | 130' | 140' | 150' |
| | | Revolutions per Minute (RPM) | | | | | | | | | | | | | | | | | |
| M1 | .0394 | 490 | 979 | 1469 | 1959 | 2449 | 2938 | 3918 | 4897 | 5877 | 6856 | 7836 | 8815 | 9795 | 10774 | 11754 | 12733 | 13713 | 14692 |
| M2 | .0787 | 242 | 484 | 725 | 967 | 1209 | 1451 | 1934 | 2418 | 2901 | 3385 | 3868 | 4352 | 4835 | 5319 | 5803 | 6286 | 6770 | 7253 |
| M3 | .1181 | 162 | 324 | 486 | 647 | 809 | 971 | 1295 | 1619 | 1942 | 2266 | 2590 | 2914 | 3237 | 3561 | 3885 | 4208 | 4532 | 4856 |
| M3.5 | .1378 | 138 | 277 | 415 | 554 | 692 | 830 | 1107 | 1384 | 1661 | 1938 | 2214 | 2491 | 2768 | 3045 | 3322 | 3599 | 3875 | 4152 |
| M4 | .1575 | 122 | 243 | 365 | 487 | 608 | 730 | 973 | 1217 | 1460 | 1703 | 1946 | 2190 | 2433 | 2676 | 2920 | 3163 | 3406 | 3650 |
| M5 | .1969 | 97 | 194 | 291 | 388 | 485 | 582 | 776 | 970 | 1163 | 1357 | 1551 | 1745 | 1939 | 2133 | 2327 | 2521 | 2715 | 2909 |
| M6 | .2362 | 81 | 162 | 243 | 324 | 405 | 486 | 647 | 809 | 971 | 1133 | 1295 | 1457 | 1619 | 1781 | 1942 | 2104 | 2266 | 2428 |
| M7 | .2756 | 69 | 138 | 208 | 277 | 346 | 415 | 554 | 692 | 830 | 969 | 1107 | 1246 | 1384 | 1522 | 1661 | 1799 | 1938 | 2076 |
| M8 | .3150 | 61 | 121 | 182 | 243 | 303 | 364 | 485 | 606 | 728 | 849 | 970 | 1091 | 1213 | 1334 | 1455 | 1577 | 1698 | 1819 |
| M10 | .3937 | 48 | 97 | 145 | 194 | 242 | 291 | 388 | 485 | 582 | 679 | 776 | 873 | 970 | 1067 | 1163 | 1260 | 1357 | 1454 |
| M12 | .4724 | 40 | 81 | 121 | 162 | 202 | 243 | 324 | 405 | 486 | 567 | 647 | 728 | 809 | 890 | 971 | 1052 | 1133 | 1214 |
| M14 | .5512 | 35 | 69 | 104 | 139 | 173 | 208 | 277 | 347 | 416 | 485 | 555 | 624 | 693 | 763 | 832 | 901 | 971 | 1040 |
| M16 | .6299 | 30 | 61 | 91 | 121 | 152 | 182 | 243 | 303 | 364 | 424 | 485 | 546 | 606 | 667 | 728 | 788 | 849 | 910 |
| M18 | .7087 | 27 | 54 | 81 | 108 | 135 | 162 | 216 | 269 | 323 | 377 | 431 | 485 | 539 | 593 | 647 | 700 | 754 | 808 |
| M20 | .7874 | 24 | 49 | 73 | 97 | 121 | 146 | 194 | 243 | 291 | 340 | 388 | 437 | 485 | 534 | 582 | 631 | 680 | 728 |
| M22 | .8661 | 22 | 44 | 66 | 88 | 110 | 132 | 176 | 221 | 265 | 309 | 353 | 397 | 441 | 485 | 529 | 573 | 618 | 662 |
| M24 | .9449 | 20 | 40 | 61 | 81 | 101 | 121 | 162 | 202 | 243 | 283 | 323 | 364 | 404 | 445 | 485 | 526 | 566 | 606 |
| M27 | 1.0630 | 18 | 36 | 54 | 72 | 90 | 108 | 144 | 180 | 216 | 252 | 287 | 323 | 359 | 395 | 431 | 467 | 503 | 539 |
| M30 | 1.1811 | 16 | 32 | 49 | 65 | 81 | 97 | 129 | 162 | 194 | 226 | 259 | 291 | 323 | 356 | 388 | 420 | 453 | 485 |

Factors to be considered when determining tapping speeds:

- Material to be tapped
- Depth of hole
- Length of chamfer on tap
- Pitch of thread
- Percentage of full thread to be cut
- Lubrication
- Machine equipment and rigidity
- Horizontal or vertical tapping

**Speed / Feed Equations:**

***INCH:*** S.F.M. = 0.26 X R.P.M. X TOOL DIA. R.P.M. = $\frac{3.82 \text{ X S.F.M.}}{\text{TOOL DIA.}}$

***METRIC:*** S m/m = $\frac{\pi \text{ X TOOL DIA. X R.P.M.}}{1000}$ R.P.M. = $\frac{\text{m/m X 1000}}{\pi \text{ X TOOL DIA.}}$

# ROCKWELL - BRINELL HARDNESS DATA

**ROCKWELL C to BRINELL 3000 KG.**
**For Hardened Steel and Alloys**

| ROCKWELL C 150 Kg. Load "Brale" | BRINELL 3000 Kg. Load 10mm Ball |
|---|---|
| 60 | 614 |
| 59 | 600 |
| 58 | 587 |
| 57 | 573 |
| 56 | 560 |
| 55 | 547 |
| 54 | 534 |
| 53 | 522 |
| 52 | 509 |
| 51 | 496 |
| 50 | 484 |
| 49 | 472 |
| 48 | 460 |
| 47 | 448 |
| 46 | 437 |
| 45 | 426 |
| 44 | 415 |
| 42 | 393 |
| 40 | 372 |
| 38 | 352 |
| 36 | 332 |
| 34 | 313 |
| 32 | 297 |
| 30 | 283 |
| 28 | 270 |
| 26 | 260 |
| 24 | 250 |
| 22 | 240 |
| 20 | 230 |

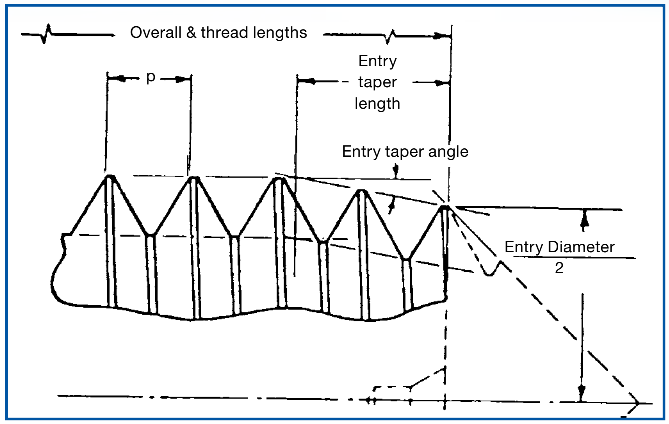
**BRINELL 3000 KG. TO ULTIMATE TENSILE STRENGTH FOR STEELS**

| BRINELL 3000 Kg. Load 10mm Ball | ULTIMATE TENSILE STRENGTH, psi |
|---|---|
| 200 | 100,000 |
| 225 | 108,000 |
| 250 | 122,000 |
| 275 | 141,000 |
| 300 | 158,000 |
| 325 | 174,000 |
| 350 | 188,000 |
| 375 | 202,000 |
| 400 | 215,000 |
| 425 | 227,000 |
| 450 | 238,000 |
| 475 | 249,000 |
| 500 | 258,000 |
| 525 | 267,000 |
| 550 | 282,000 |
| 575 | 295,000 |
| 600 | 308,000 |

**ROCKWELL B to BRINELL 500 and 3000 KG.**
**For Unhardened Steel, Steel of Soft Temper, Gray and Malleable Cast Iron and Most Nonferrous Metal**

| ROCKWELL B 100 Kg. Load 1/16" Dia. Ball | BRINELL 500 Kg. Load 10mm Ball | BRINELL 3000 Kg. Load 10mm Ball |
|---|---|---|
| 100 | 201 | 240 |
| 99 | 195 | 234 |
| 98 | 189 | 228 |
| 97 | 184 | 222 |
| 96 | 179 | 216 |
| 95 | 175 | 210 |
| 94 | 171 | 205 |
| 93 | 167 | 200 |
| 92 | 163 | 195 |
| 91 | 160 | 190 |
| 90 | 157 | 185 |
| 89 | 154 | 180 |
| 88 | 151 | 176 |
| 87 | 148 | 172 |
| 86 | 145 | 169 |
| 85 | 142 | 165 |
| 84 | 140 | 162 |
| 83 | 137 | 159 |
| 82 | 135 | 156 |
| 81 | 133 | 153 |
| 80 | 130 | 150 |
| 79 | 128 | 147 |
| 78 | 126 | 144 |
| 77 | 124 | 141 |
| 76 | 122 | 139 |
| 75 | 120 | 137 |
| 74 | 118 | 135 |
| 72 | 114 | 130 |
| 70 | 110 | 125 |
| 68 | 107 | 121 |
| 66 | 104 | 117 |
| 64 | 101 | 114 |
| 62 | 98 | 110 |
| 60 | 95 | 107 |
| 58 | 92 | 104 |
| 56 | 90 | 101 |
| 54 | 87 | |
| 52 | 85 | |
| 50 | 83 | |
| 48 | 81 | |
| 46 | 79 | |
| 44 | 78 | |
| 42 | 76 | |
| 40 | 74 | |
| 38 | 73 | |
| 36 | 71 | |
| 34 | 70 | |
| 32 | 68 | |
| 30 | 67 | |
| 28 | 66 | |
| 24 | 64 | |
| 20 | 62 | |
| 16 | 60 | |
| 12 | 58 | |
| 8 | 56 | |
| 4 | 55 | |
| 0 | 53 | |

**THREAD FORMING TAP ENTRY LENGTHS:**
Entry taper length is measured on the full diameter of the thread forming lobes and is the axial distance from the entry diameter position to the theoretical intersection of tap major diameter and entry taper angle. Whenever entry taper length is specified in terms of number of threads, this length is measured in number of pitches (p).
*BOTTOMING LENGTH = 1-1/2 to 2-1/2 PITCHES*
*PLUG LENGTH = 3 to 5 PITCHES*
The chamfer on BOTTOM style form taps is approximately 2 threads long and requires a drilled hole depth 3-4 pitches beyond the full thread required. When a controlled maximum chamfer shorter than 2 threads is required, an additional charge will apply. *We will not guarantee the performance of taps with the shorter chamfer.*
Entry diameter, measured at the thread crest nearest the front of the tap, is an appropriate amount smaller than the diameter of the hole drilled for tapping. See below for tap/drill size formulas, and formulas to determine maximum and minimum drill hole sizes for appropriate percent of thread.
**TAPPING SPEEDS:** Form taps operate most efficiently at spindle speeds 1-1/2 to 2 times faster than those recommended for conventional cutting taps, especially in softer materials and/or with fine pitch forming taps.




As higher speeds are attained, adequate lubrication is essential for prolonged tap life and thread quality.
**LUBRICATION:** Since it is more important to 'lubricate' the cold-forming tap than to 'cool' the tap, these taps should be used with conventional lubricating cutting oils or EP (extreme pressure) rated oil...soluble oils and similar coolants are not recommended.
**PRE-TAPPED HOLE SIZE:** Forming taps require a larger pre-tapped hole size than conventional cutting taps. To insure a properly tapped (cold formed) hole, adhere to the following:

## *FORMULA FOR TAP/DRILL SIZES FOR DECIMAL/INCH FORM TAPS:*

$$\text{HOLE SIZE} = \text{Basic Tap O.D.} - \left(\frac{.0068 \text{ X \% of Thread*}}{\text{Threads per Inch}}\right)$$

For example:
To determine drill size for a 1/4-20 thread forming tap at 65% of thread: $.250 - \left(\frac{.0068 \text{ X } 65}{20}\right) = .2279$
* Use <u>whole</u> number for % of thread...for 65%, use 65 (not .65).

## *FORMULA FOR TAP/DRILL SIZES FOR METRIC FORM TAPS:*

$$\text{HOLE SIZE (mm)} = \text{Basic Tap O.D.(mm)} - \left(\frac{\text{\% of Thread X mm Pitch}}{147.06}\right)$$

* Use <u>whole</u> number for % of thread...for 65%, use 65 (not .65).

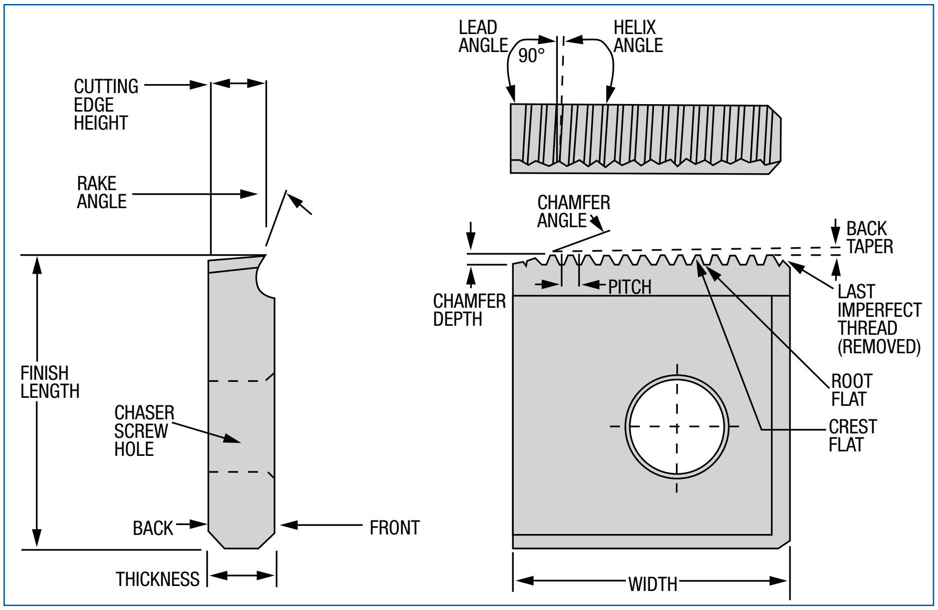
There is no true method of predicting percent of thread that will be obtained when tapping with forming taps due to the many variables involved. As a starting point, however, 55% for maximum drill size and 75% for minimum drill size can be used as a guide. Any desired percent of thread can be approximated by using drill sizes in between. To determine theoretical maximum and minimum drill sizes (for average operating conditions), see formulas below.

For UNIFIED INCH Threads:
**Max. Drill Size** = Basic Major Diameter - $\frac{3}{8N}$
**Min. Drill Size** = Basic Major Diameter - $\frac{1}{2N}$
N = T.P.I. (Threads per Inch)

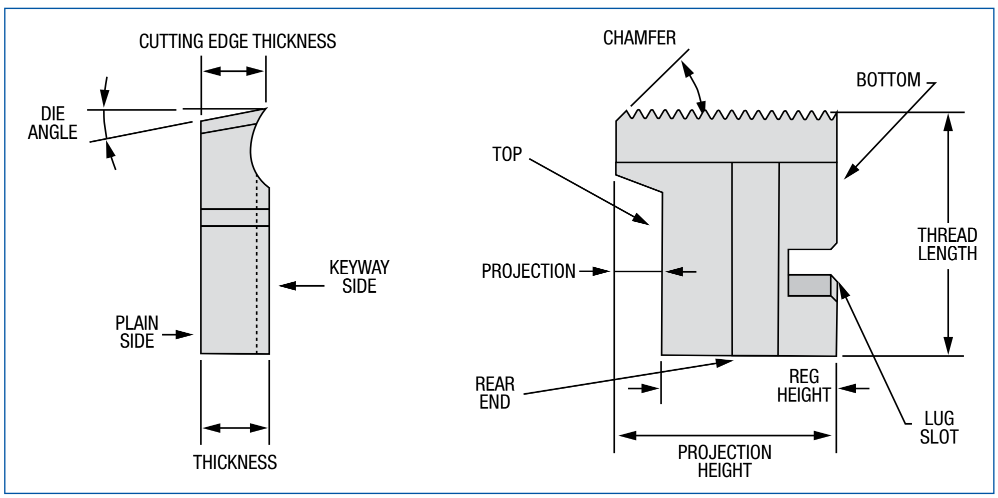
For 60° Metric Threads:
**Max. Drill Size** = Basic Major Diameter - 0.375P
**Min. Drill Size** = Basic Major Diameter - 0.5P
P = Pitch
Note: For Basic Major Diameter and Pitch, use millimeter value to obtain drill size in mm. To convert mm to inch value, divide by 25.4:
$\frac{\text{mm Value}}{25.4} = \text{Inch Value}$

# Engineering Data

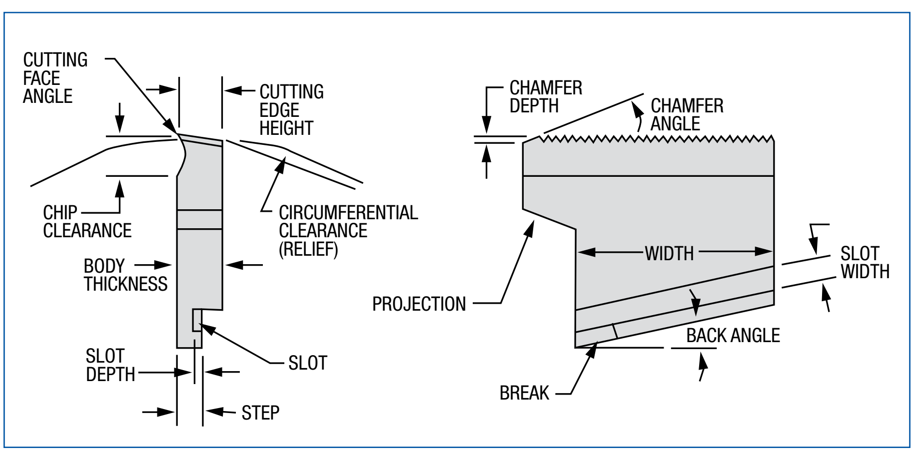
## Illustration of Terms Applying to Chasers




***Solid Carbide H & G Style 100 Series***




***Carbide Insert Geometric Style / "D" Style (Projection Style)***




***Carbide Insert Geometric Style / "S-SJ" Style (Projection Style)***

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## Recommended Cutting Face Angles for Chasers Based On Material To Be Threaded

| Material To Be Threaded | Straight Threads | Tapered Threads |
|---|---|---|
| **ALUMINUM** | | |
| Cast | 10° Rake | 10° Rake |
| Die Cast | 10° Rake | 10° Rake |
| Rod | 10° Rake | 10° Rake |
| Stamping | 10° Rake | 10° Rake |
| Bronze Cast | 5° Rake | 5° Rake |
| **BRASS** | | |
| Bar | -5° Rake | Neutral |
| Yellow | -5° Rake | Neutral |
| Cast | 5° Snub | 5° Snub |
| Forging | 5° Rake | 5° Rake |
| Naval | 5° Rake | 5° Rake |
| Red | 5° Rake | 5° Rake |
| Stamping | 5° Rake | 5° Rake |
| Tubing | 5° Rake | 5° Rake |
| **BRONZE** | | |
| Bar | 5° Rake | 5° Rake |
| Cast | Neutral | Neutral |
| Cast Aluminum | 5° Rake | 5° Rake |
| Manganese | 5° Rake | 5° Rake |
| Naval | 5° Rake | 5° Rake |
| Phosphor | 5° Rake | 5° Rake |
| Silicone | 5° Rake | Neutral |
| Tubing | 5° Rake | 5° Rake |
| **IRON** | | |
| Black Pipe | 5° Rake | 5° Rake |
| Cast | Neutral | Neutral |
| Ductile | Neutral | Neutral |
| Gray | Neutral | Neutral |
| Malleable | 5° Rake | 5° Rake |
| Wrought | 5° Rake | 5° Rake |
| **STEELS** | | |
| 1010-1035 Carbon Steel | 5° Rake | 5° Rake |
| 1040-1095 Carbon Steel | 10° Rake | 5° Rake |
| 1112-X1340 Carbon Steel | 5° Rake | 5° Rake |
| T1330-T1350 Manganese | 10° Rake | 5° Rake |
| 2015-2515 Nickel Alloy | 10° Rake | 5° Rake |
| 3115-3450 Ni-Chrome | 10° Rake | 5° Rake |
| 4130-4820 Molybdenum | 10° Rake | 5° Rake |
| 5120-52100 Chrome Alloy | 10° Rake | 5° Rake |
| 6115-6195 Chrome Vanadium | 10° Rake | 5° Rake |
| Bessemer Screw | 5° Rake | 5° Rake |
| Bolt, grade 2 & 3 | 5° Rake | 5° Rake |
| Bolt, grade 5 & 8 | 10° Rake | 10° Rake |
| Cast Steel | 5° Rake | 5° Rake |
| Rolled (Hot/Cold) | 5° Rake | 5° Rake |
| Semi-Casting | Neutral | Neutral |
| Stainless Steel 300 Series | 10° Rake | 10° Rake |
| Stainless Steel 400 Series | 5° Rake | 5° Rake |
| Stamping | 10° Rake | 5° Rake |
| Stress & Fatigue Proof | 5° Rake | 5° Rake |
| Stress Proof 8620 | 10° Rake | 5° Rake |
| Tool Steel | 10° Rake | 5° Rake |
| Tubing | 5° Rake | 5° Rake |

*For materials not listed or for special applications, contact Allen Benjamin.*

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## Carbide Standard Straight Flute Taps

Straight flute carbide taps are for general purposes and are listed in sub-micron carbide up to and including 5/8 inch diameter. All inserted carbide taps, 3/4 inch and larger, are manufactured by brazing sub-micron carbide onto high speed steel bodies, thus providing the ultimate in strength and wear. Upon ordering any carbide or carbide inserted tap, it is advisable and highly recommended to specify the material to be tapped, and the condition that the material is in at the time of tapping.

## Carbide Standard Spiral Point Taps

Spiral point taps, also known as gun taps, are so named because they drive the chip ahead of the tap. These taps are stronger than other straight flute taps and are most efficient when used for tapping through holes.

Spiral point carbide taps are highly recommended for cast iron, ferrous and extremely abrasive applications.

All spiral point taps listed are offered in sub-micron carbide to be used under conditions of high metallurgical strength and hardness. These taps are an economical means of tapping the current high temperature alloy materials. Upon ordering any carbide spiral point tap, it is advisable and highly recommended to specify the material to be tapped, and the condition that the material is in at the time of tapping.

## Carbide Standard Screw Thread Insert (S.T.I.) Taps

Screw thread insert taps are primarily used in soft abrasive materials. It is most advisable to use sub-micron carbide taps. Carbide taps generally wear longer and maintain accurate thread forms, which is essential to proper gaging. The taps listed are available as factory standards. When ordering S.T.I. taps, it is highly recommended to specify the material to be tapped, and the condition that the material is in at the time of tapping.

## Carbide Standard Metric (ISO) Taps

All carbide metric taps are manufactured the same as the American standard straight flute and spiral point taps. The ISO metric tap is used as commonly as the American standard tap in all threading applications. All sizes larger than M16 are available as carbide inserted specials and are priced upon application.

## 'PRX' Series Carbide Taps for Stellite, Inconel, etc.

The 'PRX' tap was first developed in 1984 by Allen Benjamin Inc. as a tap for a local aerospace company to tap inconel, and was the first truly high performance carbide tap. This tap has evolved through changes in carbide composition, geometry and surface treatment. As the basis of the Allen Benjamin line of high performance taps, the 'PRX' tap remains basically a tap for inconel and stellite, and is available in many variations. It has been used to chase threads in materials with a high hardness on the Rockwell C scale and has proven successful in tapping pure tungsten and cast aluminum.

'PRX' taps are manufactured from a special grade of sub-micron carbide engineered specifically for tapping high cobalt chrome materials and are widely used in demanding aerospace applications.

## 'PRC' Series Carbide Taps for Titanium and Beryllium

The 'PRC' tap for titanium is a specialized version of the Allen Benjamin line of high performance carbide taps. The original specialized line was the 'PRX' tap for inconel and stellite introduced in 1984. Allen Benjamin 'PRC' high performance taps are based on the 'PRX' tap design and have benefited from continuing improvements.

The 'PRC' tap, with its unique characteristics and geometry, was engineered for threading titanium, beryllium and related materials in aerospace and medical applications.

## Carbide Multi-Flute Taps (for Plastic)

Multi-flute taps, manufactured with thin lands, were developed specifically for the tapping of resins, plastics, fiberglass circuit boards, ceramics, metal oxides and like materials. The life of the carbide multi-flute tap is remarkable, compared to high speed steel. Carbide tap life, in the above materials, will outperform HSS taps in the majority of applications under favorable tapping conditions. The multi-flute, thin land design permits better chip clearance and less heat generation, thereby reducing tap breakage. Note the larger pitch diameter sizes (H#) that are carried as catalog items. Most of the above materials have memory and tend to close in after tapping, hence the extra size allowance built into the stock taps. These taps are manufactured with the full thread length, as specified in Table 302, instead of the high performance style of our standard line of general purpose taps made to Table 302-A standards.

## Carbide Pipe Taps - NPT / NPTF / NPS / NPSF

Carbide pipe taps prove the most profitable when used for threading cast iron, aluminum, bronze, brass or plastic pipe fittings. Tap life is higher than that of high speed steel pipe taps depending upon the application. Contact Allen Benjamin for specific pipe thread forms required.

## Carbide Thread Forming Taps

Carbide thread forming taps will outperform HSS thread form taps in most instances by producing a higher number of consistent threaded holes. These taps are fluteless and are typically designed with one or more lubrication grooves. The thread form is lobed so there is a finite number of points contacting the work. The thread forming tap is not a general purpose tool, as threads are formed by displacing the metal without removing it. Therefore, the difficulties of chip removal in blind holes is eliminated. No loading of chips means oversize or damaged threads is not a problem as well. Allen Benjamin form taps are well suited to threading many materials.

## Carbide Insert Taps

Carbide insert taps provide an economical approach to carbide taps where only the cutting portion of the tap is comprised of carbide. This tap features a HSS tap body with brazed micrograin carbide cutting faces. The HSS tap body is better suited to absorb vibration and handle lack of rigidity in the cut over conventional solid carbide taps.

## Solid Carbide and Ceramic Thread Plug Gages

*Features & Benefits*

Allen Benjamin offers precision, high hardness thread plug gages manufactured from:

- ***Micro-grain tungsten carbide***
- ***Zirconia ceramic***

These thread gages are manufactured to precise tolerances and are available in:

- ***Inch and Metric sizes;***
- ***Go and No-Go double-end assemblies;***
- ***Taperlock or Reversible styles;***
- ***NC/UNC, NF/UNF and NEF/UNEF thread forms;***
- ***Pitch diameters for 2B, 3B (Inch); and 6H (Metric) class of fit.***
- ***Special gages to your specifications are also available.***
- ***Single gage members and gage handles are available upon request.***

These meticulously crafted gages from Allen Benjamin feature attributes that are sought after in any quality control program which involves mechanical gaging. High hardness equates to prolonged wear life of the gage and results in better, longer lasting quality.

The greatest cost in production thread gaging is not the original cost of the thread plug members, but rather the constant and continual inspection of the gaging member to detect wear, scratching, or distortion. Most procedures are to inspect a gage every time it is returned to the gage crib for all the above possible points of trouble, creating an increase in gaging costs.

Using carbide or ceramic thread plug gages saves almost all of the inspection costs. High hardness gages will not distort or scratch. By actual tests during use, the wear of tool steel gages is over 100 times the wear of carbide and/ or ceramic gages. So, for a higher initial cost, it is possible to gage accurately and reliably over longer periods.

Accurate thread measurements lead to fewer scrapped parts, fewer reworks, and cost savings in the parts production cycle.

In addition, when a high volume of parts require continuous gaging, the hardness factor of these gages greatly reduces wearing and premature out-of-tolerance failure. This will allow extended periods between inspections and calibrations.

All gages are traceable to the National Institute of Standards and Technology (NIST), with adherence to ANSI and Mil specs.

# Carbide Tooling

*Technical Data*

Many cutting tool applications are well suited to the use of carbide tooling to achieve maximum performance and productivity.

Compared to high speed steel, carbide taps can offer the following advantages:
- Higher hardness and wear resistance;
- Greater performance at high temperatures through maximum heat resistance;
- Sharper cutting edges over the life of the tap.

*Special taps made to your specifications are available upon request. Inquiries concerning specials and non-standard tools can be directed to our Customer Service Dept.*

## *TAPPING RECOMMENDATIONS FOR CARBIDE TAPS*

- Always follow good tapping procedures.

- If possible, use a torque-limiting tapping head or an axial/radial tension-compression holder unless performing rigid tapping.

- Set torque to minimum to cut full thread with new tap plus 5-8%. When a tap will not cut at this setting, the tap is dull and should be sharpened. Increasing torque will cause the tap to break.

- If horizontal tapping is required, reduce overhang to a minimum and use direct drive rather than a tapping head.

- Use full flood coolant directed into the hole. Flooding the surface is not sufficient in most applications. If possible, use coolant-feeding (coolant-through) taps.

- Contact Customer Service about availability of additional tap geometries.

## *WARNING*

### CEMENTED CARBIDE PRODUCT WITH COBALT BINDER (ALL CARBIDE GRADES)

The above grades contain Tungsten Carbide and Cobalt, with some grades containing one or more of the following: Tantalum Carbide, Vanadium Carbide, Molybdenum and Nickel.

Tungsten Carbide products are prone to fracture under some conditions. Because cutting tools may shatter or break, goverment regulations require the use of safety glasses with side shields and other safety equipment at all times in the vicinity of use. Grinding of solid carbide and brazed carbide tools may produce dust and fumes with potentially hazardous ingredients. To avoid adverse health effects utilize adequate ventilation and dust collection procedures and read the Material Safety Data Sheet for carbides as well as for any cutting fluids and other material coming into contact with this product.

Dust from grinding this product can cause nose, throat, skin and eye irritation and temporary or permanent respiratory disease in a small percentage of exposed individuals. Permanent respiratory disease can lead to disability or death. Coolant mist from wet grinding or machining may contain dust.
- Avoid breathing dust or mist.
- Avoid prolonged skin contact with dust or mist.
- Use adequate ventilation when grinding.
- Maintain dust level below OSHA and ACGIH levels.
- Use protective devices as specified in MSDS for this product.
- Wash hands thoroughly after handling, before eating or smoking.
- Dispose of materials according to local, state and/or federal regulations.

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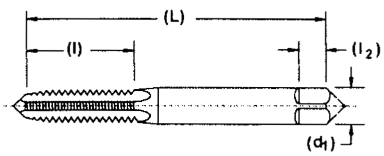
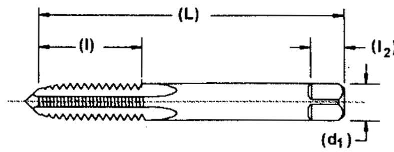
## STANDARD TAP DIMENSIONS • GROUND THREAD

*(Ref. USCTI Table 302)*

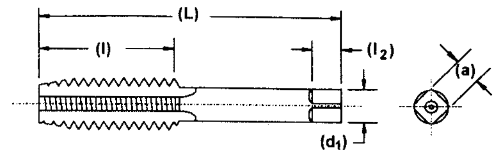
General Dimensions



BLANK DESIGN 1



BLANK DESIGN 2



BLANK DESIGN 3

| Nominal Diameter Range - Inches | | Machine Screw Size No. | Nominal Fractional Diameter Inches | Nominal Metric Diameter Millimeters, (Inches) | Blank Design No. | Tap Dimensions----Inches | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Over | To (Inc.) | | | | | Overall Length L | Thread Length l | Square Length $l_2$ | Shank Diameter $d_1$ | Size of Square a |
| .052 | .065 | 0 (.0600) | | M 1.6 (.0630) | 1 | 1.63 | .31 | .19 | .1410 | .110 |
| .065 | .078 | 1 (.0730) | | M1.8 (.0709) | 1 | 1.69 | .38 | .19 | .1410 | .110 |
| .078 | .091 | 2 (.0860) | | M2 (0787), M2.2 (.0866) | 1 | 1.75 | .44 | .19 | .1410 | .110 |
| .091 | .104 | 3 (.0990) | | M2.5 (.0984) | 1 | 1.81 | .50 | .19 | .1410 | .110 |
| .104 | .117 | 4 (.1120) | | | 1 | 1.88 | .56 | .19 | .1410 | .110 |
| .117 | .130 | 5 (.1250) | | M3 (.1181) | 1 | 1.94 | .63 | .19 | .1410 | .110 |
| .130 | .145 | 6 (.1380) | | M3.5 (.1378) | 1 | 2.00 | .69 | .19 | .1410 | .110 |
| .145 | .171 | 8 (.1640) | | M4 (.1575) | 1 | 2.13 | .75 | .25 | .1680 | .131 |
| .171 | .197 | 10 (.1900) | | M4.5 (.1772), M5 (.1969) | 1 | 2.38 | .88 | .25 | .1940 | .152 |
| .197 | .223 | 12 (.2160) | | | 1 | 2.38 | .94 | .28 | .2200 | .165 |
| .223 | .260 | | 1/4 (.2500) | M6 (.2362) | 2 | 2.50 | 1.00 | .31 | .2550 | .191 |
| .260 | .323 | | 5/16 (.3125) | M7 (.2756), M8 (.3150) | 2 | 2.72 | 1.13 | .38 | .3180 | .238 |
| .323 | .395 | | 3/8 (.3750) | M10 (.3937) | 2 | 2.94 | 1.25 | .44 | .3810 | .286 |
| .395 | .448 | | 7/16 (.4375) | | 3 | 3.16 | 1.44 | .41 | .3230 | .242 |
| .448 | .510 | | 1/2 (.5000) | M12 (.4724) | 3 | 3.38 | 1.66 | .44 | .3670 | .275 |
| .510 | .573 | | 9/16 (.5625) | M14 (.5512) | 3 | 3.59 | 1.66 | .50 | .4290 | .322 |
| .573 | .635 | | 5/8 (.6250) | M16 (.6299) | 3 | 3.81 | 1.81 | .56 | .4800 | .360 |
| .635 | .709 | | 11/16 (.6875) | M18 (.7087) | 3 | 4.03 | 1.81 | .63 | .5420 | .406 |
| .709 | .760 | | 3/4 (.7500) | | 3 | 4.25 | 2.00 | .69 | .5900 | .442 |
| .760 | .823 | | 13/16 (.8125) | M20 (.7874) | 3 | 4.47 | 2.00 | .69 | .6520 | .489 |
| .823 | .885 | | 7/8 (.8750) | M22 (.8661) | 3 | 4.69 | 2.22 | .75 | .6970 | .523 |
| .885 | .948 | | 15/16 (.9375) | M24 (.9449) | 3 | 4.91 | 2.22 | .75 | .7600 | .570 |
| .948 | 1.010 | | 1 (1.0000) | M25 (.9843) | 3 | 5.13 | 2.50 | .81 | .8000 | .600 |
| 1.010 | 1.073 | | 1-1/16 (1.0625) | M27 (1.0630) | 3 | 5.13 | 2.50 | .88 | .8960 | .672 |
| 1.073 | 1.135 | | 1-1/8 (1.1250) | | 3 | 5.44 | 2.56 | .88 | .8960 | .672 |
| 1.135 | 1.198 | | 1-3/16 (1.1875) | M30 (1.1811) | 3 | 5.44 | 2.56 | 1.00 | 1.0210 | .766 |
| 1.198 | 1.260 | | 1-1/4 (1.2500) | | 3 | 5.75 | 2.56 | 1.00 | 1.0210 | .766 |
| 1.260 | 1.323 | | 1-5/16 (1.3125) | M33 (1.2992) | 3 | 5.75 | 2.56 | 1.06 | 1.1080 | .831 |
| 1.323 | 1.385 | | 1-3/8 (1.3750) | | 3 | 6.06 | 3.00 | 1.06 | 1.1080 | .831 |
| 1.358 | 1.448 | | 1-7/16 (1.4375) | M36 (1.4173) | 3 | 6.06 | 3.00 | 1.13 | 1.2330 | .925 |
| 1.448 | 1.510 | | 1-1/2 (1.5000) | | 3 | 6.38 | 3.00 | 1.13 | 1.2330 | .925 |
| 1.510 | 1.635 | | 1-5/8 (1.6250) | M39 (1.5354) | 3 | 6.69 | 3.19 | 1.13 | 1.3050 | .979 |
| 1.635 | 1.760 | | 1-3/4 (1.7500) | M42 (1.6535) | 3 | 7.00 | 3.19 | 1.25 | 1.4300 | 1.072 |
| 1.760 | 1.885 | | 1-7/8 (1.8750) | | 3 | 7.31 | 3.56 | 1.25 | 1.5190 | 1.139 |
| 1.885 | 2.010 | | 2 (2.0000) | M48 (1.8898) | 3 | 7.63 | 3.56 | 1.38 | 1.6440 | 1.233 |

(Continued)

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## STANDARD TAP DIMENSIONS • GROUND THREAD (cont.)

*(Ref. USCTI Table 302)*

General Dimensions

| Nominal Diameter Range - Inches | | Machine Screw Size No. | Nominal Fractional Diameter Inches | Nominal Metric Diameter Millimeters, (Inches) | Blank Design No. | Tap Dimensions----Inches | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Over | To (Inc.) | | | | | Overall Length L | Thread Length l | Square Length $l_2$ | Shank Diameter $d_1$ | Size of Square a |
| 2.010 | 2.135 | | 2 1/8 (2.1250) | | 3 | 8.00 | 3.56 | 1.38 | 1.7690 | 1.327 |
| 2.135 | 2.260 | | 2 1/4 (2.2500) | M56 (2.2047) | 3 | 8.25 | 3.56 | 1.44 | 1.8940 | 1.420 |
| 2.260 | 2.385 | | 2 3/8 (2.3750) | | 3 | 8.50 | 4.00 | 1.44 | 2.0190 | 1.514 |
| 2.385 | 2.510 | | 2 1/2 (2.5000) | | 3 | 8.75 | 4.00 | 1.50 | 2.1000 | 1.575 |
| 2.510 | 2.635 | | 2 5/8 (2.6250) | M64 (2.5197) | 3 | 8.75 | 4.00 | 1.50 | 2.2250 | 1.669 |
| 2.635 | 2.760 | | 2 3/4 (2.7500) | | 3 | 9.25 | 4.00 | 1.56 | 2.3500 | 1.762 |
| 2.760 | 2.885 | | 2 7/8 (2.8750) | M72 (2.8346) | 3 | 9.25 | 4.00 | 1.56 | 2.4750 | 1.856 |
| 2.885 | 3.010 | | 3 (3.0000) | | 3 | 9.75 | 4.56 | 1.63 | 2.5430 | 1.907 |
| 3.010 | 3.135 | | 3 1/8 (3.1250) | | 3 | 9.75 | 4.56 | 1.63 | 2.6680 | 2.001 |
| 3.135 | 3.260 | | 3 1/4 (3.2500) | M80 (3.1496) | 3 | 10.00 | 4.56 | 1.75 | 2.7930 | 2.095 |
| 3.260 | 3.385 | | 3 3/8 (3.3750) | | 3 | 10.00 | 4.56 | 1.75 | 2.8830 | 2.162 |
| 3.385 | 3.510 | | 3 1/2 (3.5000) | | 3 | 10.25 | 4.94 | 2.00 | 3.0080 | 2.256 |
| 3.510 | 3.635 | | 3 5/8 (3.6250) | M90 (3.5433) | 3 | 10.25 | 4.94 | 2.00 | 3.1330 | 2.350 |
| 3.635 | 3.760 | | 3 3/4 (3.7500) | | 3 | 10.50 | 5.31 | 2.13 | 3.2170 | 2.413 |
| 3.760 | 3.885 | | 3 7/8 (3.8750) | | 3 | 10.50 | 5.31 | 2.13 | 3.3420 | 2.506 |
| 3.885 | 4.010 | | 4 (4.0000) | M100 (3.9370) | 3 | 10.75 | 5.31 | 2.25 | 3.4670 | 2.600 |

**SPECIAL TAPS**
Unless otherwise specified:
Special taps over 1.010” to 1.510” diameter inclusive, having 14 or more threads per inch or 1.75 millimeter pitch and finer, and sizes over 1.510” diameter with 10 or more threads per inch or 2.5 millimeter pitch and finer, are made to general dimensions shown in Table 303.

Special tap thread limits are determined by using the formulas shown in Table 331 for Unified Inch Screw Threads and Table 341 for Metric M-Profile Screw Threads.

**NOTES**
Tap sizes .395” and smaller have an external center on the thread end (may be removed on bottoming taps). Sizes .223” and smaller have an external center on the shank end. Sizes .224” thru .395” have truncated partial cone centers on the shank end (length of cone approx. 1/4 of diameter of shank). Sizes over .395” have internal centers on both the thread and shank ends.

For standard thread limits and tolerances for Unified Inch Screw Threads see table 327 and for Metric Threads see Table 337.

For eccentricity tolerances of tap elements see Table 317.

**Tolerances**

| Element | Nominal Diameter Range in Inches | | Direction | Tolerance (Inches) |
|---|---|---|---|---|
| | Over | To (Inc.) | | |
| Length Overall - L | .0520 | 1.0100 | Plus or Minus | .031 |
| | 1.0100 | 4.0100 | Plus or Minus | .063 |
| Length of Thread - l | .0520 | .2230 | Plus or Minus | .047 |
| | .2230 | .5100 | Plus or Minus | .063 |
| | .5100 | 1.5100 | Plus or Minus | .094 |
| | 1.5100 | 4.0100 | Plus or Minus | .125 |
| Length of square - $l_2$ | .0520 | 1.0100 | Plus or Minus | .031 |
| | 1.0100 | 4.0100 | Plus or Minus | .063 |
| Diameter of shank - $d_1$ | .0520 | .2230 | Minus | .0015 |
| | .2230 | .6350 | Minus | .0015 |
| | .6350 | 1.0100 | Minus | .0020 |
| | 1.0100 | 1.5100 | Minus | .0020 |
| | 1.5100 | 2.0100 | Minus | .0030 |
| | 2.0100 | 4.0100 | Minus | .0030 |
| Size of square - a | .0520 | .5100 | Minus | .004 |
| | .5100 | 1.0100 | Minus | .006 |
| | 1.0100 | 2.0100 | Minus | .008 |
| | 2.0100 | 4.0100 | Minus | .010 |

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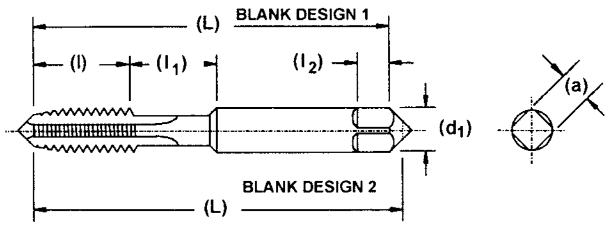
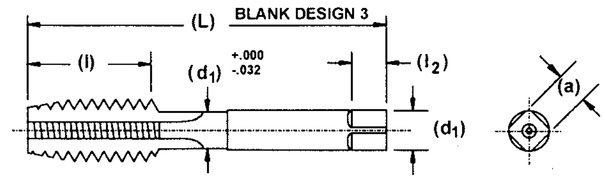
# OPTIONAL NECK AND OPTIONAL SHORTENED THREAD LENGTH TAP DIMENSIONS, GROUND THREAD

*(Ref. USCTI Table 302-A)*




## General Dimensions

| Nominal Diameter Range-Inches | | Machine Screw Size No. | Nominal Fractional Diameter Inches | Nominal Metric Diameter Millimeters, (Inches) | Blank Design No. | Tap Dimensions----Inches | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Over | To (Inc.) | | | | | Overall Length L | Thread Length l | Neck Length l1 | Square Length l2 | Shank Diameter d1 | Size of Square a |
| .104 | .117 | 4 (.1120) | | | 1 | 1.88 | .31 | .25 | .19 | .1410 | .110 |
| .117 | .130 | 5 (.1250) | | M3 (.1181) | 1 | 1.94 | .31 | .31 | .19 | .1410 | .110 |
| .130 | .145 | 6 (.1380) | | M3.5 (.1378) | 1 | 2.00 | .38 | .31 | .19 | .1410 | .110 |
| .145 | .171 | 8 (.1640) | | M4 (.1575) | 1 | 2.13 | .38 | .38 | .25 | .1680 | .131 |
| .171 | .197 | 10 (.1900) | | M4.5 (.1772), M5 (.1969) | 1 | 2.38 | .50 | .38 | .25 | .1940 | .152 |
| .197 | .223 | 12 (.2160) | | | 1 | 2.38 | .50 | .44 | .28 | .2200 | .165 |
| .223 | .260 | | 1/4 (.2500) | M6 (.2362) | 2 | 2.50 | .63 | .38 | .31 | .2550 | .191 |
| .260 | .323 | | 5/16 (.3125) | M7 (.2756), M8 (.3150) | 2 | 2.72 | .69 | .44 | .38 | .3180 | .238 |
| .323 | .395 | | 3/8 (.3750) | M10 (.3937) | 2 | 2.94 | .75 | .50 | .44 | .3810 | .286 |
| .395 | .448 | | 7/16 (.4375) | | 3 | 3.16 | .88 | - | .41 | .3230 | .242 |
| .448 | .510 | | 1/2 (.5000) | M12 (.4724) | 3 | 3.38 | .94 | - | .44 | .3670 | .275 |
| .510 | .573 | | 9/16 (.5625) | M14 (.5512) | 3 | 3.59 | 1.00 | - | .50 | .4290 | .322 |
| .573 | .635 | | 5/8 (.6250) | M16 (.6299) | 3 | 3.81 | 1.09 | - | .56 | .4800 | .360 |
| .635 | .709 | | 11/16 (.6875) | M18 (.7087) | 3 | 4.03 | 1.09 | - | .63 | .5420 | .406 |
| .709 | .760 | | 3/4 (.7500) | | 3 | 4.25 | 1.22 | - | .69 | .5900 | .442 |
| .760 | .823 | | 13/16 (.8125) | M20 (.7874) | 3 | 4.47 | 1.22 | - | .69 | .6520 | .489 |
| .823 | .885 | | 7/8 (.8750) | M22 (.8661) | 3 | 4.69 | 1.34 | - | .75 | .6970 | .523 |
| .885 | .948 | | 15/16 (.9375) | M24 (.9449) | 3 | 4.91 | 1.34 | - | .75 | .7600 | .570 |
| .948 | 1.010 | | 1 (1.0000) | M25 (.9843) | 3 | 5.13 | 1.50 | - | .81 | .8000 | .600 |

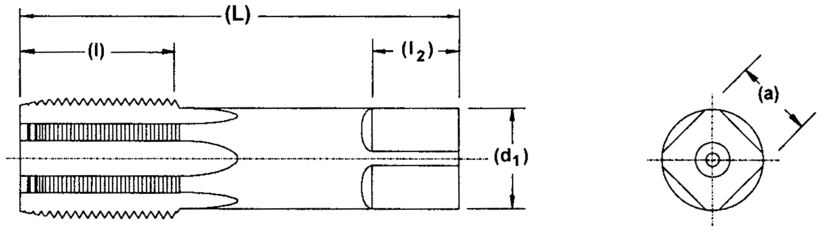
**NOTES**

1. Thread Length "l" is based on a length of 12 pitches of the UNC thread series.
2. Thread Length "l" is a minimum value and has no tolerance.
3. When Thread Length "l" is added to Neck Length "$l_1$," the total shall be no less than the minumum Table 302 Thread Length "l".
4. Unless otherwise specified, all tolerances are in accordance with Table 302.
5. For eccentricity tolerances, see Table 317.

Allen Benjamin

# SPECIAL FINE PITCH TAPS, SHORT SERIES, GROUND THREAD

*(Ref. USCTI Table 303)*




Unless otherwise specified, special taps 1.010" to 1.510" diameter inclusive, having 14 or more threads per inch or 1.75 millimeter pitch and finer, and sizes over 1.510" diameter with 10 or more threads per inch, or 2.5 millimeter pitch and finer, will be made to the general dimensions shown below:

## General Dimensions

| Nominal Diameter Range - Inches | | Nominal Fractional Diameter Inches | Nominal Metric Diameter Millimeters | Tap Dimensions - Inches | | | | |
|---|---|---|---|---|---|---|---|---|
| Over | To (Incl.) | | | Overall Length L | Thread Length l | Square Length $l_2$ | Shank Diameter $d_1$ | Size of Square a |
| 1.010 | 1.073 | 1 1/16 | M27 | 4.00 | 1.50 | .88 | .8960 | .672 |
| 1.073 | 1.135 | 1 1/8 | | 4.00 | 1.50 | .88 | .8960 | .672 |
| 1.135 | 1.198 | 1 3/16 | M30 | 4.00 | 1.50 | 1.00 | 1.0210 | .766 |
| 1.198 | 1.260 | 1 1/4 | | 4.00 | 1.50 | 1.00 | 1.0210 | .766 |
| 1.260 | 1.323 | 1 5/16 | M33 | 4.00 | 1.50 | 1.00 | 1.1080 | .831 |
| 1.323 | 1.385 | 1 3/8 | | 4.00 | 1.50 | 1.00 | 1.1080 | .831 |
| 1.385 | 1.448 | 1 7/16 | M36 | 4.00 | 1.50 | 1.00 | 1.2330 | .925 |
| 1.448 | 1.510 | 1 1/2 | | 4.00 | 1.50 | 1.00 | 1.2330 | .925 |
| 1.510 | 1.635 | 1 5/8 | M39 | 5.00 | 2.00 | 1.13 | 1.3050 | .979 |
| 1.635 | 1.760 | 1 3/4 | M42 | 5.00 | 2.00 | 1.25 | 1.4300 | 1.072 |
| 1.760 | 1.885 | 1 7/8 | | 5.00 | 2.00 | 1.25 | 1.5190 | 1.139 |
| 1.885 | 2.010 | 2 | M48 | 5.00 | 2.00 | 1.38 | 1.6440 | 1.233 |
| 2.010 | 2.135 | 2 1/8 | | 5.25 | 2.00 | 1.38 | 1.7690 | 1.327 |
| 2.135 | 2.260 | 2 1/4 | M56 | 5.25 | 2.00 | 1.44 | 1.8940 | 1.420 |
| 2.260 | 2.385 | 2 3/8 | | 5.25 | 2.00 | 1.44 | 2.0190 | 1.514 |
| 2.385 | 2.510 | 2 1/2 | | 5.25 | 2.00 | 1.50 | 2.1000 | 1.575 |
| 2.510 | 2.635 | 2 5/8 | M64 | 5.50 | 2.00 | 1.50 | 2.1000 | 1.575 |
| 2.635 | 2.760 | 2 3/4 | | 5.50 | 2.00 | 1.50 | 2.1000 | 1.575 |
| 2.760 | 2.885 | 2 7/8 | M72 | 5.50 | 2.00 | 1.50 | 2.1000 | 1.575 |
| 2.885 | 3.010 | 3 | | 5.50 | 2.00 | 1.50 | 2.1000 | 1.575 |
| 3.010 | 3.135 | 3 1/8 | | 5.75 | 2.00 | 1.50 | 2.1000 | 1.575 |
| 3.135 | 3.260 | 3 1/4 | M80 | 5.75 | 2.00 | 1.50 | 2.1000 | 1.575 |
| 3.260 | 3.385 | 3 3/8 | | 5.75 | 2.00 | 1.50 | 2.1000 | 1.575 |
| 3.385 | 3.510 | 3 1/2 | | 5.75 | 2.00 | 1.50 | 2.1000 | 1.575 |
| 3.510 | 3.635 | 3 5/8 | M90 | 6.00 | 2.00 | 1.75 | 2.1000 | 1.575 |
| 3.635 | 3.760 | 3 3/4 | | 6.00 | 2.00 | 1.75 | 2.1000 | 1.575 |
| 3.760 | 3.885 | 3 7/8 | | 6.00 | 2.00 | 1.75 | 2.1000 | 1.575 |
| 3.885 | 4.010 | 4 | M100 | 6.00 | 2.00 | 1.75 | 2.1000 | 1.575 |

**NOTES**
For tolerances see Table 302.
For standard thread limits and tolerances for Unified Inch Screw Threads see Table 327A.
For standard thread limits and tolerances for Metric Threads see Tables 337 and 341.
For eccentricity tolerances of tap elements see Table 317.

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Phone: 800.528.7404 • 480.968.7937 • Fax: 480.731.9462
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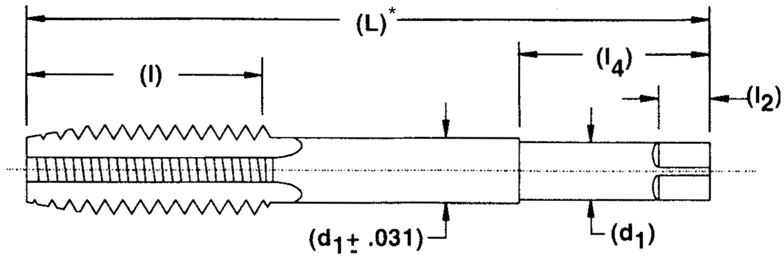
# SPECIAL EXTENSION TAPS, GROUND THREAD

*(Ref. USCTI Table 303-A)*




Unless otherwise specified, special extension taps will be furnished with dimensions and tolerances as shown for Machine Screw and Fractional taps in Tables 302 and 303, and for Pipe taps in Table 311.
Exceptions:
1. Types of centers are optional with manufacturer.
2. Tolerances on shank diameter $d_1$ for $l_4$ lengh as shown in the following table.
3. Shank eccentricity tolerance in Table 317 applies only to the $l_4$ length shown in the following table.
4. Length of Close Tolerance Shank, ($L_4$) is minimum.

| Nominal Tap Size | | l | $d_1$ | $l_2$ | | "$l_4$" |
|---|---|---|---|---|---|---|
| Fractional | Machine Screw | Thread Length | Shank Diameter | Square Length | Square Size | Ground Shank Length |
| | 6 | .688 | .141 | .188 | .110 | 1.13 |
| | 8 | .750 | .168 | .250 | .131 | 1.25 |
| | 10 - 12 | .875 | .194 | .250 | .152 | 1.38 |
| 1/4 | 14 | 1.00 | .255 | .313 | .191 | 1.50 |
| 1/4* | | 1.00 | .185 | .250 | .138 | Full Length |
| 5/16 | | 1.13 | .318 | .375 | .238 | 1.56 |
| 5/16* | | 1.13 | .240 | .281 | .180 | Full Length |
| 3/8 | | 1.25 | .381 | .438 | .286 | 1.63 |
| 3/8* | | 1.25 | .275 | .375 | .206 | Full Length |
| 7/16 | | 1.44 | .323 | .406 | .242 | 1.69 |
| 1/2 | | 1.66 | .367 | .438 | .275 | 1.69 |
| 9/16 | | 1.66 | .429 | .500 | .322 | 1.88 |
| 5/8 | | 1.81 | .480 | .563 | .360 | 2.00 |
| 3/4 | | 2.00 | .590 | .688 | .442 | 2.25 |
| 7/8 | | 2.22 | .697 | .750 | .523 | 2.50 |
| 1" | | 2.50 | .800 | .813 | .600 | 2.63 |
| 1-1/8 | | 2.56 | .896 | .875 | .672 | 2.75 |
| 1-1/4 | | 2.56 | 1.021 | 1.00 | .766 | 2.88 |
| 1-3/8 | | 3.00 | 1.108 | 1.063 | .831 | 3.00 |
| 1-1/2 | | 3.00 | 1.233 | 1.125 | .925 | 3.00 |

*NOTE: The overall length ('L' Dimension) is determined by customer requirements. Stocked sizes are 4", 6", 8" 10" and 12" OAL depending on diameter.

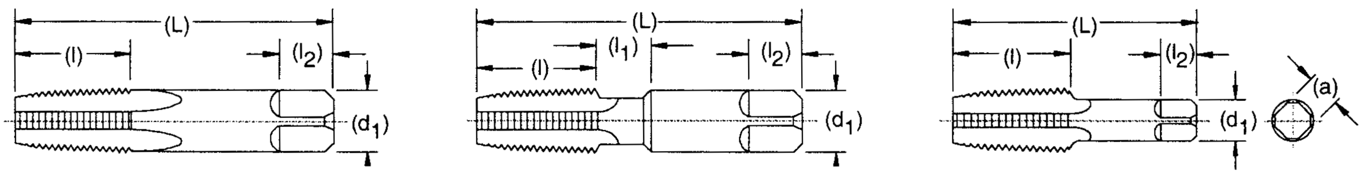
Tolerances

For Shank Diameter, $d_1$ and $l_4$ length

| Size Range | | | |
|---|---|---|---|
| Fractional | Machine Screw | Direction | Tolerance |
| 1/4 to 5/8 incl. | 0 - 14 incl. | Minus | .003 |
| 11/16 to 1-1/2 incl. | | Minus | .004 |

# STANDARD PIPE TAP DIMENSIONS
# STRAIGHT AND TAPER, GROUND THREAD

*(Ref. USCTI Table 311)*




## General Dimensions

| Nominal Size Inches | Length Overall L | Length of Thread l | Length of Square $l_2$ | Dia. of Shank $d_1$ | Size of Square a | Length Optional Neck $l_1$ |
|---|---|---|---|---|---|---|
| | Dimensions - Inches | | | | | |
| 1/16 | 2.13 | .69 | .38 | .3125 | .234 | .375 |
| 1/8 | 2.13 | .75 | .38 | .3125 | .234 | ... |
| 1/8 | 2.13 | .75 | .38 | .4375 | .328 | .375 |
| 1/4 | 2.44 | 1.06 | .44 | .5625 | .421 | .375 |
| 3/8 | 2.56 | 1.06 | .50 | .7000 | .531 | .375 |
| 1/2 | 3.13 | 1.38 | .63 | .6875 | .515 | ... |
| 3/4 | 3.25 | 1.38 | .69 | .9063 | .679 | ... |
| 1" | 3.75 | 1.75 | .81 | 1.1250 | .843 | ... |
| 1-1/4 | 4.00 | 1.75 | .94 | 1.3125 | .984 | ... |
| 1-1/2 | 4.25 | 1.75 | 1.00 | 1.5000 | 1.125 | ... |
| 2" | 4.50 | 1.75 | 1.13 | 1.8750 | 1.406 | ... |
| 2-1/2 | 5.50 | 2.56 | 1.25 | 2.2500 | 1.687 | ... |
| 3" | 6.00 | 2.63 | 1.38 | 2.6250 | 1.968 | ... |
| 3-1/2 | 6.50 | 2.69 | 1.50 | 2.8125 | 2.108 | ... |
| 4" | 6.75 | 2.75 | 1.56 | 3.0000 | 2.250 | ... |

## Tolerances

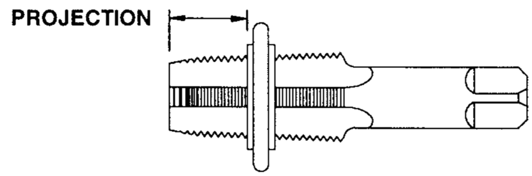
| Element | Range | Direction | Tolerance |
|---|---|---|---|
| Length Overall - L | 1/16 to 3/4 inc. | Plus or Minus | .031 |
| | 1" to 4" inc. | Plus or Minus | .063 |
| Length of Thread - l | 1/16 to 3/4 inc. | Plus or Minus | .063 |
| | 1" to 1-1/4 inc. | Plus or Minus | .094 |
| | 1-1/2 to 4" | Plus or Minus | .125 |
| Length of Square - $l_2$ | 1/16 to 3/4 inc. | Plus or Minus | .031 |
| | 1" to 4" inc. | Plus or Minus | .063 |
| Diameter of Shank - | 1/16 to 1/8 | Minus | .0015 |
| | 1/4 to 1" inc. | Minus | .0020 |
| | 1-1/4 to 4" inc. | Minus | .0030 |
| Size of Square - a | 1/16 to 1/8 | Minus | .004 |
| | 1/4 to 3/4 inc. | Minus | .006 |
| | 1" to 4" inc. | Minus | .008 |

**NOTE:** For thread limits and tolerances see USCTI Tables 335, 335A and 338. For eccentricity tolerances of taps see Table 317.

## TAPER PIPE TAP, THREAD LIMITS, GROUND THREAD

*(Ref. USCTI Table 338)*

• American National Standard Taper Pipe Thread Form (NPT)
• Aeronautical National Taper Pipe Thread Form (ANPT)
• Dryseal American National Standard Taper Pipe Thread Form (NPTF)




| Tap Thread Limits | | | | | | Reference Dimensions | |
|---|---|---|---|---|---|---|---|
| Nominal Size Inches | Threads per Inch | Projection* Inches | Projection Tolerance + or - | Taper Per Foot Limits | | $L_1$ Length | Tap Drill Size ** NPT,ANPT,NPTF |
| | | | | Minimum | Maximum | | |
| 1/16 | 27 | .312 | .063 | .719 | .781 | .160 | C |
| 1/8 | 27 | .312 | .063 | .719 | .781 | .1615 | Q |
| 1/4 | 18 | .459 | .063 | .719 | .781 | .2278 | 7/16 |
| 3/8 | 18 | .454 | .063 | .719 | .781 | .240 | 9/16 |
| 1/2 | 14 | .579 | .063 | .719 | .781 | .320 | 45/64 |
| 3/4 | 14 | .565 | .063 | .719 | .781 | .339 | 29/32 |
| 1" | 11-1/2 | .678 | .094 | .719 | .781 | .400 | 1-9/64 |
| 1-1/4 | 11-1/2 | .686 | .094 | .719 | .781 | .420 | 1-31/64 |
| 1-1/2 | 11-1/2 | .699 | .094 | .719 | .781 | .420 | 1-23/32 |
| 2" | 11-1/2 | .667 | .094 | .719 | .781 | .436 | 2-3/16 |
| 2-1/2 | 8 | .925 | .094 | .734 | .781 | .682 | 2-39/64 |
| 3" | 8 | .925 | .094 | .734 | .781 | .766 | 3-15/64 |
| 3-1/2 | 8 | .938 | .125 | .734 | .781 | .821 | ...... |
| 4 | 8 | .950 | .125 | .734 | .781 | .844 | ...... |

**NOTES**
* Distance small end of tap projects throught $L_1$ Taper Thread Ring Gage.
** Recommended size given permit direct tapping without reaming the hole, but only give a full thread for approx. the $L_1$ length.

**LEAD TOLERANCE**
A maximum lead deviation of plus or minus .0005” within any two threads not farther than 1” is permitted.

# ECCENTRICITY TOLERANCES OF TAP ELEMENTS WHEN TESTED ON DEAD CENTERS

*(Ref. USCTI Table 317)*

**Applicable to Tables 302,303,303A,and 311**

| Element | Range | | | Ground Thread | |
|---|---|---|---|---|---|
| | Inch & Mach. Screw | Pipe | Metric | Eccen- tricity | t.i.v.* |
| Square (at central point) | #0 - 1/2" | 1/16 - 1/8" | M1.6 - M12 | .0030 | .0060 |
| | Over 1/2" thru 4" | 1/4 - 4" | Over M12 Thru M100 | .0040 | .0080 |
| Shank | #0 - 5/16" | 1/16" | M1.6 - M8 | .0005 | .0010 |
| | Over 5/16" thru 4" | 1/8 - 4" | Over M8 thru M100 | .0008 | .0016 |
| Major Diameter | #0 - 5/16" | 1/16" | M1.6 - M8 | .0005 | .0010 |
| | Over 5/16" thru 4" | 1/8 - 4" | Over M8 thru M100 | .0008 | .0016 |
| Pitch Diameter (at first full thread) | #0 - 1/2" | 1/16" | M1.6 - M8 | .0005 | .0010 |
| | Over 1/2" thru 4" | 1/8 - 4" | Over M8 thru M100 | .0008 | .0016 |
| Chamfer** | #0 - 1/2" | 1/16 - 1/8" | M1.6 - M12 | .0010 | .0020 |
| | Over 1/2" thru 4" | 1/4 - 4" | Over M12 Thru M100 | .0015 | .0030 |

* t.i.v. = Total indicator variation. Figures are given for both eccentricity and total indicator variation to avoid misunderstanding.

**Chamfer should preferably be inspected by light projection to avoid errors due to indicator contact points dropping into the thread grooves.

## SURFACE TREATMENT ABBREVIATIONS

*See page 62 for surface treatment recommendations.*

| | |
|---|---|
| AlCrN: | Aluminum Chromium Nitride |
| CrC: | Chromium Carbide |
| CrN: | Chromium Nitride |
| DLC: | Diamond-like Carbon |
| N: | Nitride |
| N + Ox: | Nitride + Oxide* **Oxide (Ox) may also be shown as ‘O’* |
| Ox: | Steam Oxide* |
| TiAlN: | Titanium Aluminum Nitride |
| TiAlN+WC/C: | ‘*Hardlube*’ - Titanium Aluminum Nitride +Tungsten Carbide/Carbon |
| TiCN: | Titanium Carbonitride |
| TiN: | Titanium Nitride |
| WC/C: | Tungsten Carbide/Carbon |
| WS2: | Tungsten Disulfide |
| ZrN: | Zirconium Nitride |

In many applications, a tap that is properly designed and used under recommended conditions will produce acceptable results without the use of surface treatments. However, under some conditions, such as tapping excessively hard, abrasive or challenging materials, the use of performance enhancing surface treatments will be beneficial to the overall results of your tapping operation in terms of improved tool life and internal thread quality. Coolant-through taps may also be a consideration.

*Contact Allen Benjamin for tapping recommendations.*

# Taps Test Application Data Sheet

Fill-out and fax to: 480.731.9462
or copy and send to Allen Benjamin.
Be sure to include pertinent comments, blueprints or sketches.

Allen Benjamin Rep.: ______________________________

Customer Name: ________________________________ Date: _____ / _____ / _____

City/State/Zip: ____________________________________ Distributor: ________________

Phone: __________________ Fax: __________________ E-Mail: _____________________

Contact: _________________ Title: _______________ Extn.: ________________________

## GENERAL INFORMATION

(Application) B/P or Job # ________________________________________________

Tool Description __________________________________________________________

Tap Style ____________ Class of Fit ______ H-Limit ________ Thread Form ______________

Surface Treatment __________ Cutting/Forming ___________ Blind/Thru Hole ____________

Hole Depth ______ Thread Length ________ Tap Drill Size ____ % of Thread _____________

Machine Tool ______________ Condition ____________ Horiz./Vert. ____________________

Coolant ________ Mix ______ Speed (SFM) _________ # Taps/Set-Up __________________

Holder: Tension/Compression ___________ Rigid Collet __________ Floating _____________

Material _____________ Hardness ____________ Characteristics _______________________

Feed: ☐ CNC control ☐ NC control ☐ Synchronous Spindle ☐ Manual

☐ Cam Followed ☐ Lead Screw

Unique job details: ________________________________________________________

## COMPETITIVE BRAND:

Name _________________________ Tool Description _________________________________

Current Performance ____________________________ # Holes/Tap ____________________

Competitive Price ($) _______________________ Est. Annual Usage ____________________

Comments ___________________________________________________________________

## RECOMMENDATIONS:

Tap Style ____________ H-Limit ____ Surface Treatment __________ Speed (SFM) __________

Tap/Drill Size _________ Coolant ________ Comments ___________________________________

## TEST EVALUATION

Allen Benjamin P.O. # ____________ Dist. P.O. # _______________ # Holes Tapped _______

Quality of Thread ___________ Gaging O.K. __________ On-Hand for Test _________________

Comments ___________________________________________________________________

____________________________________________________________________________

____________________________________________________________________________

Allen Benjamin

*METRIC SIZE X .03937 = DECIMAL EQUIVALENT*
*DECIMAL SIZE X 25.4 = METRIC (mm) EQUIVALENT*

**FRACTIONAL, DECIMAL AND METRIC EQUIVALENTS**

| Fraction Of Inch | Decimal Of Inch | Millimeters | Fraction Of Inch | Decimal of Inch | Millimeters |
|---|---|---|---|---|---|
| 1/64 | .015625 | 0.3969 | 33/64 | .515625 | 13.0969 |
| 1/32 | .03125 | 0.7938 | 17/32 | .53125 | 13.4938 |
| 3/64 | .046875 | 1.1906 | 35/64 | .546875 | 13.8906 |
| 1/16 | .0625 | 1.5875 | 9/16 | .5625 | 14.2875 |
| 5/64 | .078125 | 1.9844 | 37/64 | .578125 | 14.6844 |
| 3/32 | .09375 | 2.3812 | 19/32 | .59375 | 15.0812 |
| 7/64 | .109375 | 2.7781 | 39/64 | .609375 | 15.4781 |
| 1/8 | .125 | 3.1750 | 5/8 | .625 | 15.8750 |
| 9/64 | .140625 | 3.5719 | 41/64 | .640625 | 16.2719 |
| 5/32 | .15625 | 3.9688 | 21/32 | .65625 | 16.6688 |
| 11/64 | .171875 | 4.3656 | 43/64 | .671875 | 17.0656 |
| 3/16 | .1875 | 4.7625 | 11/16 | .6875 | 17.4625 |
| 13/64 | .203125 | 5.1594 | 45/64 | .703125 | 17.8594 |
| 7/32 | .21875 | 5.5562 | 23/32 | .71875 | 18.2562 |
| 15/64 | .234375 | 5.9531 | 47/64 | .734375 | 18.6531 |
| 1/4 | .250 | 6.3500 | 3/4 | .750 | 19.0500 |
| 17/64 | .265625 | 6.7469 | 49/64 | .765625 | 19.4469 |
| 9/32 | .28125 | 7.1438 | 25/32 | .78125 | 19.8438 |
| 19/64 | .296875 | 7.5406 | 51/64 | .796875 | 20.2406 |
| 5/16 | .3125 | 7.9375 | 13/16 | .8125 | 20.6375 |
| 21/64 | .328125 | 8.3344 | 53/64 | .828125 | 21.0344 |
| 11/32 | .34375 | 8.7312 | 27/32 | .843750 | 21.4312 |
| 23/64 | .359375 | 9.1281 | 55/64 | .859375 | 21.8281 |
| 3/8 | .375 | 9.5250 | 7/8 | .875 | 22.2250 |
| 25/64 | .390625 | 9.9219 | 57/64 | .890625 | 22.6219 |
| 13/32 | .40625 | 10.3188 | 29/32 | .90625 | 23.0188 |
| 27/64 | .421875 | 10.7156 | 59/64 | .921875 | 23.4156 |
| 7/16 | .4375 | 11.1125 | 15/16 | .9375 | 23.8125 |
| 29/64 | .453125 | 11.5094 | 61/64 | .953125 | 24.2094 |
| 15/32 | .46875 | 11.9062 | 31/32 | .96875 | 24.6062 |
| 31/64 | .484375 | 12.3031 | 63/64 | .984375 | 25.0031 |
| 1/2 | .500 | 12.7000 | 1.000 | 1.0000 | 25.4000 |

**MILLIMETER PITCH TO THREADS PER INCH**
**METRIC PITCH CONVERSIONS**

| Pitch In Millimeters | Pitch In Inches | Threads Per In. | Basic Height |
|---|---|---|---|
| .25 | .00984 | 101.6000 | .00639 |
| .30 | .01181 | 84.6668 | .00767 |
| .35 | .01378 | 72.5689 | .00895 |
| .40 | .01575 | 63.4921 | .01023 |
| .45 | .01772 | 56.4334 | .01151 |
| .50 | .01969 | 50.8000 | .01279 |
| .60 | .02362 | 42.3370 | .01534 |
| .70 | .02756 | 36.2845 | .01790 |
| .75 | .02953 | 33.8639 | .01918 |
| .80 | .03150 | 31.7460 | .02046 |
| .90 | .03543 | 28.2247 | .02301 |
| 1.00 | .03937 | 25.4000 | .02557 |

| Pitch In Millimeters | Pitch In Inches | Threads Per In. | Basic Height |
|---|---|---|---|
| 1.25 | .04921 | 20.3211 | .03196 |
| 1.50 | .05906 | 16.9316 | .03836 |
| 1.75 | .06890 | 14.5138 | .04475 |
| 2.00 | .07874 | 12.7000 | .05114 |
| 2.50 | .09843 | 10.1595 | .06393 |
| 3.00 | .11811 | 8.4667 | .07671 |
| 3.50 | .13780 | 7.2569 | .08950 |
| 4.00 | .15748 | 6.3500 | .10229 |
| 4.50 | .17717 | 5.6443 | .11508 |
| 5.00 | .19685 | 5.0800 | .12785 |
| 6.00 | .23622 | 4.2333 | .15344 |