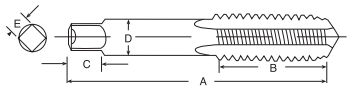
INTRODUCTION TO TAPS

Enco Introduction to Taps

A tap removes material from a pre-drilled or punched hole. The result produces threads within the drilled hole. The cutting edges at the front of a tap remove material from the workpiece. The chips are stored in the flutes, or pushed forward in front of the tap, or are drawn up along the flutes, removing the chips and cutting fluids from the hole.

TERMINOLOGY

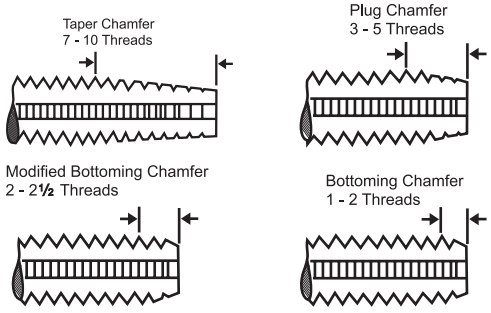
Tap Legend:A = Overall Length
B = Thread Length Including Chamfer
C = Square Length
D = Shank Diameter
E = Size of Square



Overall Length - Length of body and the shank
Thread Length - Part of the body containing the threads
Chamfer - Tapered portion at the front end of the tap. Both the chamfered portion and the first full thread beyond the chamfer produce the finished thread of the part
Square (Flats) - The squared end of the tap shank
Square Length - Length of the square
Size of Square - Thickness of the square
Shank - Part of the tap that fits into the tap holder. The end is made square for driving and rotating the tap. The square surface is known as flats
Body - Made up of the flutes, land, core, diameter, thread length and chamfer. These elements produce the threaded hole
Flutes - Grooves or valleys that run along a body of a tap. They provide a path for the removal of chips and carry cutting fluid to the front of the tap. Increasing the number of flutes, increases the strength of the tap and reduces the amount of space for chip flow
Land - The area of the tap between the flutes that contains the threads
Core - Center portion of the tap that separates the flutes and provides strength to the tap. As the number of flutes increases, the core becomes larger, increasing the strength of the tap
Diameter - The diameters of the threads of a tap are largest at the front, behind the chamfer. The thread diameter decreases slightly toward the shank, known as the back taper. The back taper creates clearance between the workpiece and the tap
Crest - The top surface joining two sides of a thread. In an internal thread the crest is at its minor diameter. In an external thread the crest is at the major diameter
Base of Thread - The bottom section of the thread
Through Hole - Hole that goes all the way through the part
Blind Hole - Hole that does not go all the way through the part, but the threads must come as close as possible to the bottom of the drilled hole
Major Diameter - The largest diameter of the thread. Also known as the outside diameter
Minor Diameter - The smallest diameter of the thread. Also known as the root diameter
Thread Height - The radial distance between the crest and the base of thread
Length of Engagement - The length of contact between two mating threaded parts
Percentage of Thread - Calculated by determining one-half the difference between the major diameter and the minor diameter of an internal thread and dividing it by the thread height
Pitch - The distance between a point on a screw thread and a corresponding point on the next thread. The pitch is equivalent to one divided by the number of threads per inch
Ground Thread - More accurate threads than "cut" taps. Held to much closer limits and tolerances

HAND TAP CHAMFERS

A chamfer is the tapered portion at the front end of the tap. Both the chamfered portion and the first full thread beyond the chamfer produce the finished thread of the part.



Taper (7-10 Threads) - Also known as a starter tap, a taper tap has the longest standard chamfer and requires less tapping torque.
Plug (3-5 Threads) - The most common chamfer for use by hand or machine in through or blind holes. The most efficient chamfer available.
Modified Bottoming (2-2½ Threads) - Allows for threading close to the bottom of blind holes. Due to the slightly longer chamfer and more working teeth, this chamfer is more efficient than a bottoming chamfer.
Bottoming (1-2 Threads) - Use for threading close to the bottom of blind holes. The least efficient standard chamfer available.

SURFACE TREATMENTS

Oxide (Blue/Black): Prevents galling, welding and loading during the threading operation. Increases lubricity and works well in low carbon steels, stainless steels and ferrous (iron based) metals.
TiN (Titanium Nitride): Provides extreme hardness and heat resistance allowing tools to run at higher speeds. Excellent for general-purpose use. Provides higher lubricity for improved chip flow, reduced buildup, edge formation and chipping. Recommended for use in free machining steels and irons, high tensile steels, tough machining steels and plastics.
Chrome: A bright chrome-plating process developed to increase tap life an impart and anti-galling surface. Considered a heavy metal and produces hazardous dust when ground. Breathing protection is recommended when regrinding chromed tools. Recommended for use in all non-chromium materials.

HOW TO READ A TAP SIZE

Example - ¼-20NC
The ¼ represents the diameter of the thread in inches. The 20 represents the number of threads per inch or TPI. Standard taps are either standard coarse series threads NC (¼-20), fine series threads NF (¼-28) or extra fine series NEF (¼-32). There are other standard tap designations such as NPT or NPTF for tapered pipe threads. Special taps are usually designated NS indicating a special thread size.

STYLES OF TAPS

Hand - Hand taps are popular in hand use, in general machine tapping, or CNC tapping. They are also appropriate for tapping the vast majority of materials in through or blind hole conditions
Spiral Point - Shoot chips ahead of the cutting action, thus reducing loading and clogging in the flutes. Sometimes referred to as a Gun® tap which is a registered trademark of Greenfield Tap & Die
Spiral Flute - Draw chips out of a tapped hole where chip disposal is a problem
Thread Forming- Do not cut threads, rather they form threads, eliminating the problem of chip disposal
Pipe - General purpose pipe taps are appropriate for threading a wide variety of materials both ferrous and non-ferrous. Ground thread pipe taps are standard in American Standard Pipe Form (NPT) and American Standard Dryseal Pipe Form (NPTF). NPT threads require the use of a "sealer" like Teflon® tape or pipe compound. Dryseal taps are used to tap fittings, which will give a pressure tight joint without the use of a sealer. American National Standard Straight Pipe Thread (NPS) is used when tapping pipe couplings
Acme - Produce transvering motions on machine tools and are extensively used to manufacture valves, jacks and other mechanisms. Have 29° angles
Pulley - Have longer length shanks to tap pulley hubs and set screw holes
Screw Thread Insert (STI) - For use in tapping holes according to screw thread standards

Enco Introduction to Taps - Cont'd

TAP STANDARDS

ANSI - American National Standards Institute
Sets industry standards and product guidelines to ensure conformity and to maintain the highest product standards
DIN - Deutsche Industries Norm
German standards organization responsible for setting industrial standards of products. European equivalent of ANSI

EXPLANATION of H & D LIMITS

Example - ¼-20 NC H3
In addition to the nominal size and pitch of a tap, there is another important dimensional factor to be considered in selecting a ground thread tap. This is the H limit of the pitch diameter of a tap. H means (high) above basic pitch diameter. These tap limits have been established to provide a choice in the selection of the tap size best suited to produce the class of thread desired. The difference in size from one H limit to the next is 0.0005" increments for taps through 1" diameter. Sizes over 1" diameter are separated by .001" diameter increments. If the threads in the part are too loose, smaller numbers such as H1 or H2 are used. If the threads are too tight, the H limit number is increased. Proper selection of the H limit number ensures that the threads are within the tolerance required by the part print. Best rule of thumb: always select the largest "H" limit possible to achieve proper class of fit and maximum tool life.
H1 basic to basic plus .0005"
H2 basic plus .0005" - .0010"
H3 basic plus .0010" - .0015"
H4 basic plus .0015" - .0020"
H5 basic plus .0020" - .0025"
H6 basic plus .0025" - .0030"

D limits for metric threads function in the same manner as H limits except the values are calculated in millimeters. Each D limit increment is 0.013mm, which is slightly larger than 0.0005".

CLASS of FIT

Unified system that relates standard screw thread classes to specific tap tolerance limits.
Class A - External
Class B - Internal
Class 1A & 1B - For frequent quick assembly, loose assembly
Class 2A & 2B - Fit is medium loose to eliminate seizure in assembly. Used for screws, bolts and nuts.
Class 3A & 3B - Accuracy of thread is required, gages are used to ensure a tight fit.

COMMON TROUBLE SOURCES in TAPPING

- Using wrong style or designated tap for the job
- Using dull tap
- Workpiece material too hard or soft for the tap being used
- Over-packing of chips in the flutes
- Improper pre-tapped hole conditions (Size, depth, straightness, roundness, glazed or work-hardened surface, chips in the bottom)
- Misalignment of the tap and the prepared hole
- Lack of/or improper lubrication and application

Signs that the above are occurring may be: welding of materials being tapped, loading, chipping and breakage of taps, poor thread finish and low tap wear life.

CALCULATING PERCENTAGE of THREAD

% of Full Thread = Threads per Inch x (Major Dia. / Selected Drill Dia.) / .01299

CALCULATING TAP DRILL SIZES

For Cutting Taps
Tap Drill Size = Tap Basic Major Diameter - Pitch
Drill Size = Major Diameter - [(.01299 x desired % of thread) / Threads per Inch]
Drill Size (mm) = Major Diameter / (desired % of thread x pitch (mm) / 76.98)
For Forming Taps
Tap Drill Size = Major Diameter / (Pitch / 2)
Drill Size = Major Diameter - [(0.0068 x desired % of thread) / Threads per Inch]
Drill Size (mm) = Major Diameter / (desired % of thread x pitch (mm) / 147.06)

TECHNICAL INFO

Inch - Tap & Drill Chart 75% Thread

Thread Size	Drill Size
0-80	3/64
1-64	53
1-72	53
2-56	50
2-64	50
3-48	47
3-56	46
4-40	43
4-48	42
5-40	39

Thread Size	Drill Size
5-44	38
6-32	36
6-40	33
8-32	29
8-36	29
10-24	25
10-32	21
12-24	17
12-28	15
¼-20	7

Thread Size	Drill Size
¼-28	3
5/16-18	F
5/16-24	I
3/8-16	5/16
3/8-24	Q
7/16-14	U
7/16-20	W
½-13	27/64
½-20	29/64
9/16-12	31/64

Thread Size	Drill Size
9/16-18	33/64
5/8-11	17/32
5/8-18	37/64
¾-10	21/32
¾-16	11/16
7/8-9	49/64
7/8-14	13/16
1-8	7/8
1-12	59/64
1-14	15/16

Metric - Tap & Drill Size 70-75% Thread

Thread Size	Drill Size
M1.6 x .35	1.25
M2 x 0.4	1.6
M2.5 x .45	2.05
M3 x .5	2.5
M3 x .6	2.9
M4 x .7	3.3

Thread Size	Drill Size
M4.5 x .75	3.75
M5 x .8	4.2
M6 x 1	5
M7 x 1	6
M8 x 1.25	6.75
M10 x 1.5	8.5

Thread Size	Drill Size
M12 x 1.75	Y
M14 x 2	12
M16 x 2	14
M18 x 2.5	15.5
M20 x 2.5	17.5

Inch - Tap Thread Length

Thread Size	Thread Length
0	5/16
1	3/8
2	7/16
3	½
4	9/16
5	5/8
6	11/16
8	¾
10	7/8

Thread Size	Thread Length
12	15/16
¼	1
5/16	1 1/8
3/8	1 ¼
7/16	1 7/16
½	1 21/32
9/16	1 21/32
5/8	1 13/16
11/16	1 13/16

Thread Size	Thread Length
¾	2
7/8	2 7/32
1	2 ½
1 1/8	2 9/16
1 ¼	2 9/16
1 3/8	3
1 ½	3

Metric - Tap Thread Length

Thread Size	Thread Length
M1.6 x .35	5/16
M2 x 0.4	7/16
M2.5 x .45	½
M3 x .5	5/8
M3.5 x .6	11/16
M4 x .7	¾
M4.5 x .75	7/8

Thread Size	Thread Length
M5 x .8	7/8
M6 x 1	1
M7 x 1	1 1/8
M8 x 1.25	1 1/8
M10 x 1.5	1 ¼
M12 x 1.75	1 21/32
M14 x 2	1 21/32

Thread Size	Thread Length
M16 x 2	1 13/16
M18 x 2.5	1 13/16
M20 x 2.5	2
M24 x 3	2 7/32
M30 x 3.5	2 9/16
M36 x 4	3