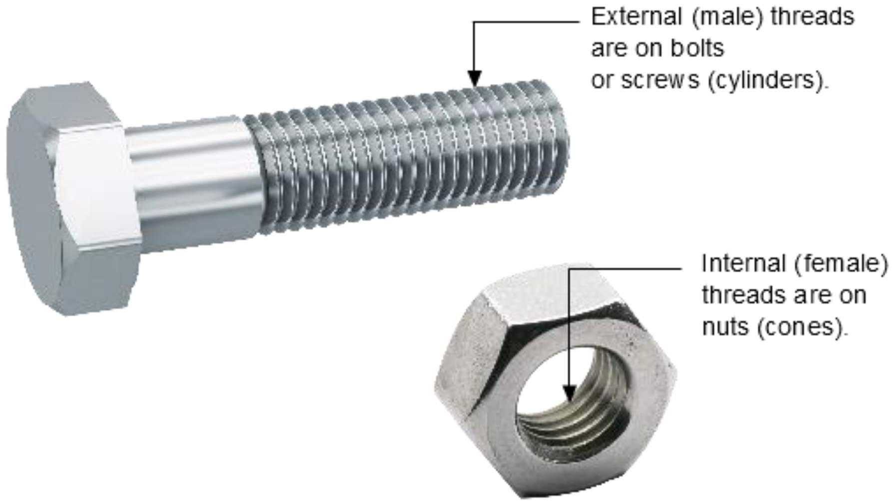
Screw Thread Nomenclature

A fastener is a hardware device used to create non-permanent joints. A screw thread is a feature of a type of fastener called a screw. Let's learn more about screw threads.

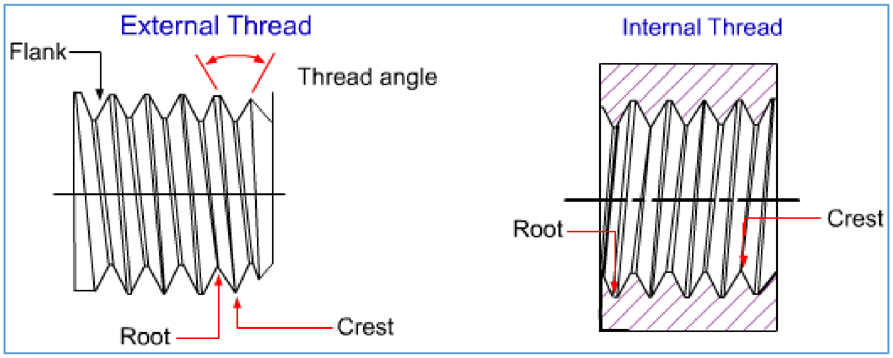
Screw Thread:

Definition
A screw thread is a continuous helical ridge of uniform section on the external or internal surface of a cylinder (screw) or cone (nut).



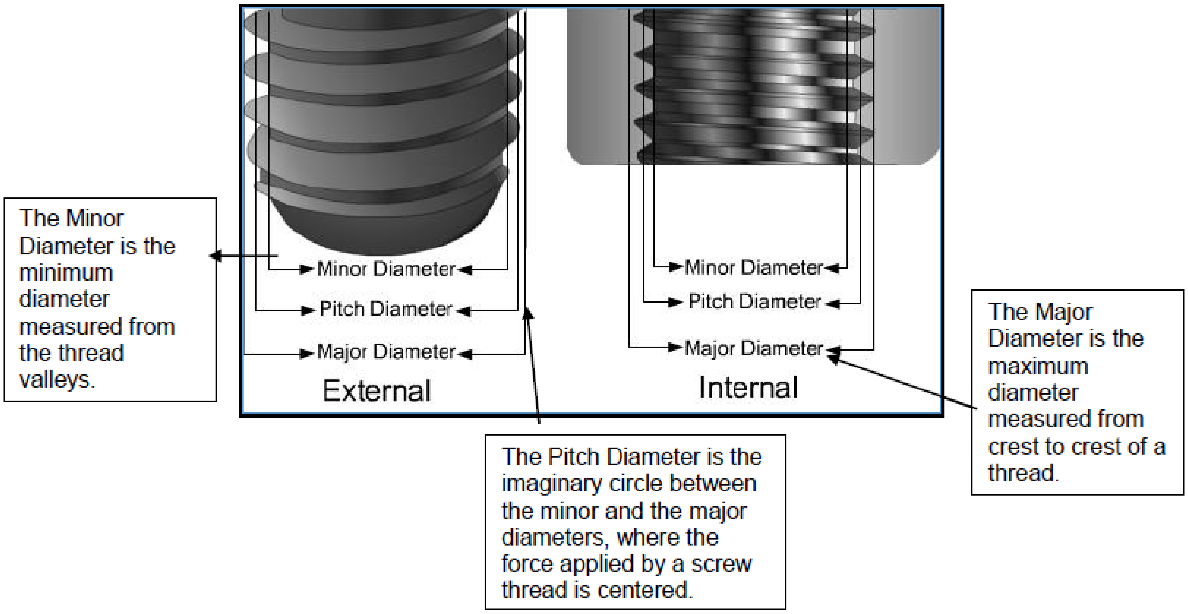
Profile
Here's the composition of a screw thread:

- **Crest**: The peak edge or the outermost surface of the thread
- **Root**: The bottom edge or the innermost surface of the thread
- **Flank**: The surface between the crest and the root
- **Thread angle**: The angle between two adjacent flanks



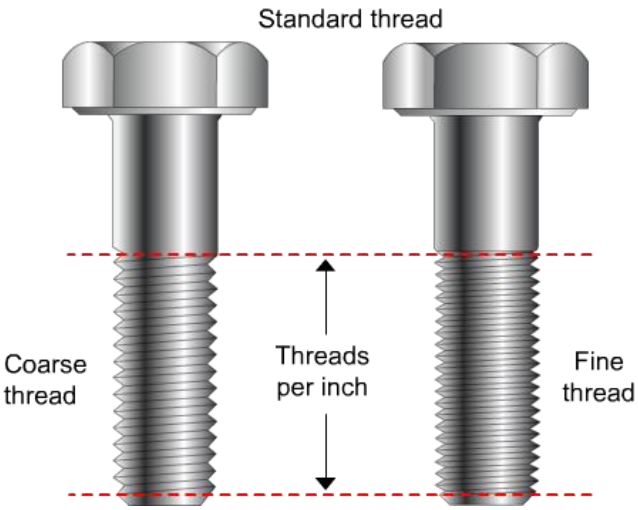
Basic Thread Terms

A thread has three characteristic diameters—major diameter, minor diameter, and pitch diameter:



Coarse, Fine, and Extra-Fine Threads

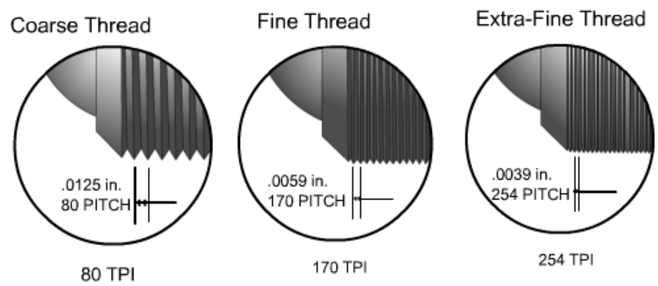
Threads are sometimes identified as “coarse” “fine,” or “extra fine.”



The following table compares the features of coarse threads and fine threads.

	Coarse Threads	Fine Threads
Pitch	A coarse thread has a relatively larger pitch (fewer threads per axial distance). The threads are farther apart than in a fine thread.	A fine thread has a relatively small pitch measurement. The threads are closer together.
Tensile Strength	In general, a coarse thread part may have lesser tensile strength than a fine thread part when both parts have the same hardness.	A fine thread part is stronger than a coarse thread part in tension and shear. Due to its larger stress area, it has higher tensile strength; the larger minor diameter contributes to its strength in shear.
Application	A coarse thread is specified for most applications. One exception is when thread adjustment is a critical feature in an application.	A fine thread allows finer adjustments in applications due to its smaller pitch. It can tap better into thin-walled sections.
Stripping	A coarse thread has greater resistance to stripping and cross-threading. It has a greater volume of material between each thread to resist stripping.	A fine thread is easier to strip because it has less depth than a coarse thread does.
Torque	A coarse thread is less efficient in transmitting torque (turning) into thread tension.	A fine thread requires less tightening torque to develop equivalent preloads to the corresponding coarse thread bolt sizes.
Galling	A coarse thread is less likely to gall than a fine thread.	A fine thread is more susceptible to galling than a coarse thread because of the closer fit between mating threads and more rotations that the threads have to undergo.
Ease of Assembly	Parts with coarse threads assemble faster than parts with fine threads.	Fine threads are less suitable for high-speed assembly because they are more likely to seize when being tightened.
Nicking	A coarse thread is less affected by thread nicking.	Since a fine thread is shallower than a coarse thread, it is proportionally more distorted by a nick of a given size.

Effect of Vibration	A coarse thread is more likely to loosen under vibration than a fine thread.	A fine thread has less of a tendency to become loose under vibration because its helix angle is smaller than that of a coarse thread. Fine thread locking insert grip coils are more flexible than the coils of coarse threads. By inserting a correct-sized grip coil, the vibration is reduced.



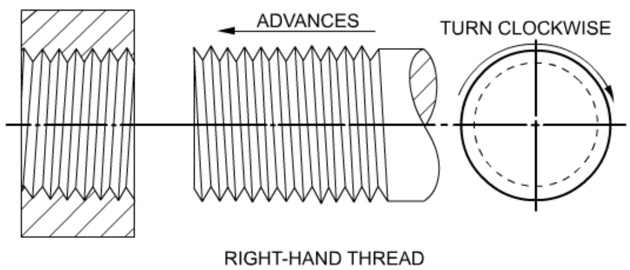
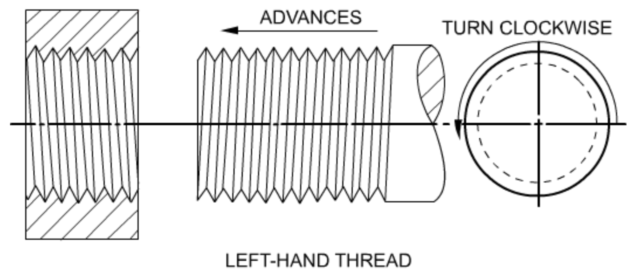
Extra-Fine Threads

In addition to coarse threads and fine threads, there are extra fine threads. An extra-fine thread series has a superfine pitch thread and is typically used when the length of engagement is smaller than that in the fine-thread series. The extra-fine thread series is particularly useful in the automotive and aircraft industries.

- The series having **8 threads** per inch for all sizes (1 to 6 inches) is used for high-pressure pipe flanges, cylinder head studs, or wherever an initial pressure-resisting tension is required in a fastening.
- The **12-thread** series is widely used for thin nuts on shafts and in boiler practice.
- The **16-thread** series is used for adjusting collars and bearing retaining nuts or other applications that require a very fine thread.

Right-Handed and Left-Handed Threads

A thread may be either right-handed or left-handed.

		
How it works	A right-handed thread on an external member advances into an internal thread when turned clockwise. Commonly, most threaded parts and fasteners have right-handed threads.	A left-handed thread on an external member advances into an internal thread when turned counterclockwise.
Rotation	Clockwise	Counterclockwise.
Labelling of screws	RH	LH

The major diameter of an external thread is typically smaller than the major diameter of an internal thread if the threads are designed to fit together. The amount of clearance between the male and female threads is established by the thread form standards. As the amount of clearance deceases, the ability of the male and female thread assembly to carry load increases.

Fastener Standards

Some of the organizations involved in developing technical standards for fasteners include the American National Standard Institute (ANSI), the American Society for Testing and Materials (ASTM), the Society of Automotive Engineers (SAE), and the Industrial Fasteners Institute (IFI).

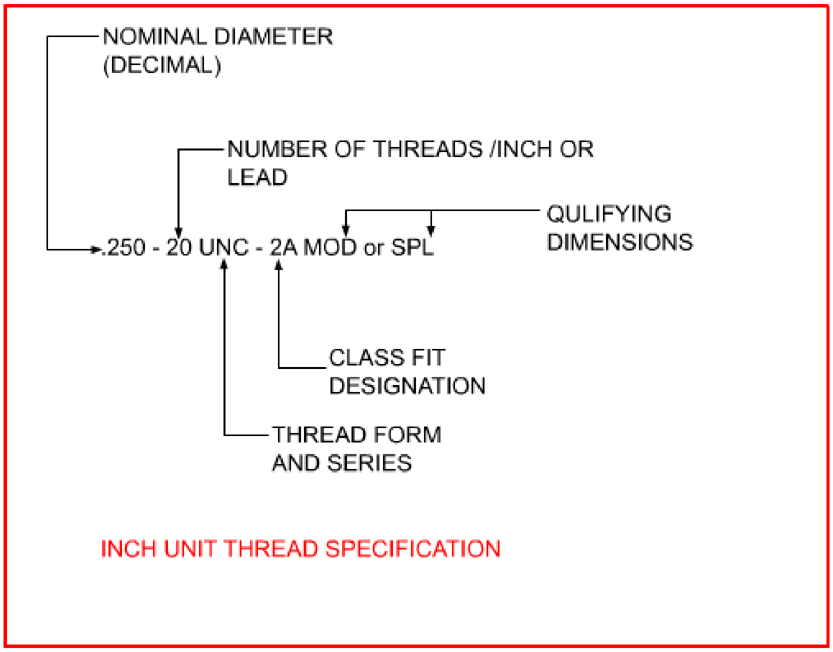
Thread Systems

Let's learn about the two major screw thread systems that are used today:

- Unified (UN) system—standard thread form for inch unit threads in the U.S.
- Metric system—given through ISO standards

Unified (UN) Thread Designation

An example of a standard inch unit thread specification is shown here, and the details of the various components are provided below:



A typical thread with UN designation has the following components:

- **Nominal diameter** of the thread in decimal
- **Threads per inch** (TPI) or lead; simply a count of the number of threads per inch measured along the length of fastener
- **Thread form and series**
  - UNC: thread diameter with **coarse** pitch
  - UNF: thread diameter with **fine** pitch
  - UNEF: thread diameter with **extra-fine** pitch
  - UN: thread diameter with **constant** pitch
- **Class fit** is a specific combination of tolerances and allowances applied to male and female threads. It is a measure of tightness or looseness, a specification of how tightly mating external and internal threads will mesh. UN screw threads have six standard classes of fit:
  - External threads: 1A, 2A, and 3A
  - Internal threads: 1B, 2B, and 3B

The details of these classes are as follows:

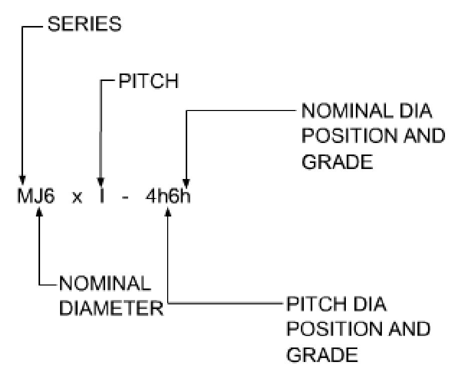
Class	**Type of Fit**	**Description**	**Application**
1A and 1B	Loose fit	• Assembles easily by hand • Used when quick and easy assembly/disassembly is required • Requires use of locking devices such as lock	Bolts and nuts

		washers, locking nuts, and jam nuts	
2A and 2B	Standard fit	• May be assembled partly by hand • Offers optimum thread fit that balances fastener performance, manufacturing, economy, and convenience • Used in semi-permanent assemblies	Most commercial and industrial fasteners
3A and 3B	Tight fit	• Has restrictive tolerance and no allowance • Suited for close tolerance fasteners • Intended for service where safety is critical	Socket products and aerospace applications

- Qualifying information, if any.

ISO Metric Thread Designation

Metric threads are defined in the standard document ISO 965-1. An example of a metric thread specification is shown here, and the details of the various components are provided below:



METRIC THREAD SPECIFICATION

A typical thread with metric designation has the following components:

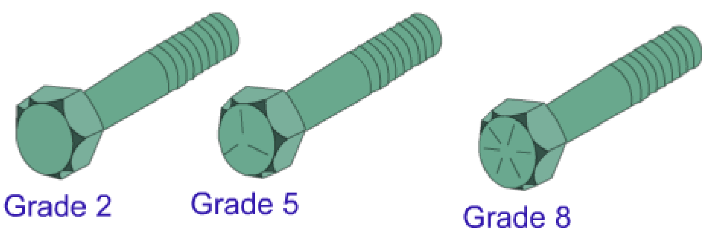
- A metric thread specification always begins with **thread series designation,** for example,
  - M: Standard metric thread profile,
  - MJ: Modified series in which crest and root radii are specified.
- **Nominal diameter** and **thread pitch** (both in millimeters) are separated by the multiplication sign, ×.
  - Metric fasteners are specified with a thread pitch instead of a thread count. The thread pitch is the distance between threads measured along the length of fasteners. For example, a thread pitch of 1.5 mm means that the distance between one thread and the next is 1.5 mm.
- **Tolerance classes** defined in ISO 965-1 may be included. The tolerance is indicated by a number for the tolerance grade and a letter for the tolerance position. External threads are designated by lowercase letter g or h. Internal threads are designated by capital letters G or H.

Grade/Class and Fastener Strength

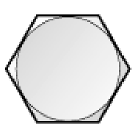
Fastener grade (US) or class (metric) refers to the mechanical properties of the fastener material.

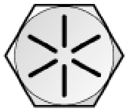
Inch Fasteners

These type of fasteners are commonly used in North America. They have a grade or ASTM rating. Special marking on screw heads and nuts identify the fastener's grade.



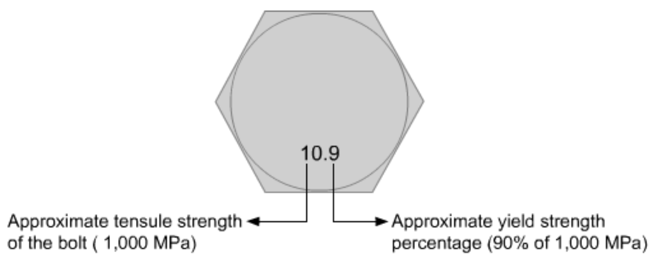
The table presents the properties of the different grades of US bolts and screws.

<table>
<tr><th rowspan="2">Grade</th><th rowspan="2">Head Marking</th><th rowspan="2">Material</th><th rowspan="2">Nominal Size Range (inches)</th><th colspan="3">Mechanical Properties</th></tr>
<tr><th>Proof Load (psi)</th><th>Min. Yield Strength (psi)</th><th>Min. Tensile Strength (psi)</th></tr>
<tr><td rowspan="2">Grade 2
(No radial lines)</td><td rowspan="2"></td><td rowspan="2">Low or medium carbon steel</td><td>1/4" thru 3/4"</td><td>55,000</td><td>57,000</td><td>74,000</td></tr>
<tr><td>Over 3/4" thru 1 1/2"</td><td>33,000</td><td>36,000</td><td>60,000</td></tr>
</table>

Grade 5 (Three radial lines)		Medium carbon steel	1/4" thru 1"	85,000	92,000	120,000
			Over 1" thru 1 1/2"	74,000	81,000	105,000
Grade 8 (Six radial lines)		Medium carbon alloy steel	1/4" thru 1 1/2"	120,000	130,000	150,000

Metric Fasteners
The metric system designates strength capabilities via **property classes** rather than grades.

An example of the numbering system is explained below.



Number before the decimal × 100 = Approximate minimum tensile strength of the bolt.
For example:
10 × 100 = 1,000 **MPa** (Mega Pascal's).

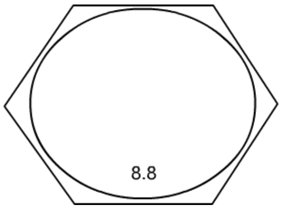
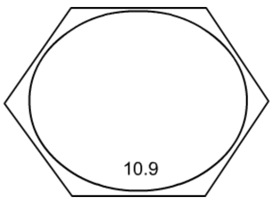
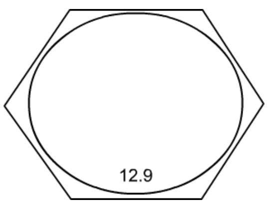
Approximate minimum tensile strength of bolt

Number after the decimal × 10 = Approximate yield strength percentage (in relation to the minimum tensile strength)

For example, in the 10.9 bolt, the yield strength of the bolt is approximately 90% of the first number: 1,000 MPa, or 900 MPa (940 MPa by specification).

Another common symbol included on metric parts is the "S" designation. When "S" is included after the first number of the property class (tensile strength number), it indicates a high-strength, heavy hex structural bolt.

The table presents the properties of the property classes 8.8, 10.9, and 12.9.

Head Marking	Class and Metal	Size Range (mm)	Mechanical Properties		
			Proof Load (MPa)	**Min Yield Strength (MPa)**	**Min Tensile Strength (MPa)**
	Class 8.8 Medium carbon, steel, quenched and tempered	All sizes below 16 mm	580	640	800
		16 mm–72 mm	600	660	830
	Class 10.9 Alloy steel, quenched and tempered	5 mm–100 mm	830	940	1040
	Class 12.9 Alloy steel, quenched and tempered	1.6 mm–100 mm	970	1100	1220

For inch as well as metric fasteners, a higher number typically indicates a stronger, more hardened (but also more brittle) fastener.

The chart here shows the recommended torque for metric bolts in nanometers.

Metric Bolt Torque Chart			
Recommended Torque in Nm			
Bolt Diameter	**Property Class 4.8**	**Property Class 8.8**	**Property Class 10.9**
M5	3	7	9
M6	6	12	16
M8	15	30	40
M10	25	55	75

M12	50	100	135
M14	80	160	215
M16	125	245	335
M20	240	480	650
M24	410	825	1125
M30	820	1640	2240
M36	1435	2870	3910

The following chart shows the recommended torque for English bolts.

Size	English Bolt Torque Chart											
	Recommended Torque Sizes from #4 to #10 are in lb-in. Sizes from 1/4" up are in lb-ft.											
	Grade 2		**Grade 5**		**Grade 8**		**18-8 S/S**		**Bronze**		**Brass**	
	Coarse	**Fine**	**Coarse**	**Fine**	**Coarse**	**Fine**	**Coarse**	**Fine**	**Coarse**	**Fine**	**Coarse**	**Fine**
#4*	-	-	-	-	-	-	5.2	-	4.8	-	4.3	-
#6*	-	-	-	-	-	-	9.6	-	8.9	-	7.9	-
#8*	-	-	-	-	-	-	19.8	-	18.4	-	16.2	-
#10*	-	-	-	-	-	-	22.8	31.7	21.2	29.3	18.6	25.9
1/4"	4	4.7	6.3	7.3	9	10	6.3	7.8	5.7	7.3	5.1	6.4
5/16"	8	9	13	14	18	20	11	11.8	10.3	10.9	8.9	9.7
3/8"	15	17	23	26	33	37	20	22	18	20	16	18
7/16"	24	27	37	41	52	58	31	33	29	31	26	27
1/2"	37	41	57	64	80	90	43	45	40	42	35	37
9/16"	53	59	82	91	115	129	57	63	53	58	47	51
5/8"	73	83	112	128	159	180	93	104	86	96	76	85
3/4"	125	138	200	223	282	315	128	124	104	102	118	115
7/8"	129	144	322	355	454	501	194	193	178	178	159	158
1"†	188	210	483	541	682	764	287	289	265	240	235	212
† Fine thread figures are for 1"-14. Grade 2, 5, and 8 values are for slightly lubricated bolts.												