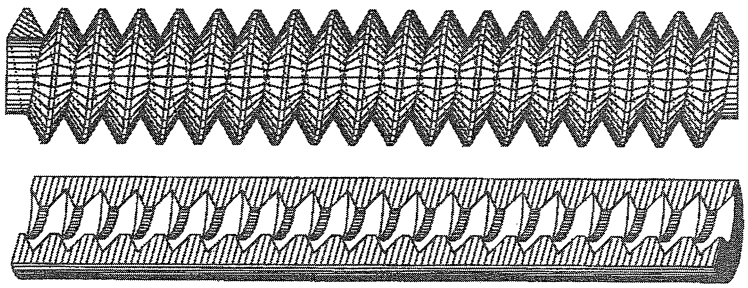
Product Screw Thread Elements & Characteristics

- LEAD
  - Long
  - Short
  - Includes helical deviation "drunk thread"
- FLANK ANGLE
  - Plus
  - Minus
- TAPER
  - Front
  - Back
- OUT OF ROUND
  - Even lobe
  - Odd lobe
- MAJOR DIAMETER
- PITCH DIAMETER
- MINOR DIAMETER



Screw Thread Designation

EXAMPLE: .3125 - 24 UNJF - 3A

.3125 = Nominal Diameter = Maximum Major Diameter

24 = Number of threads per inch

UN = Unified thread form (60°, V-thread)

J = Controlled root radius — High Strength

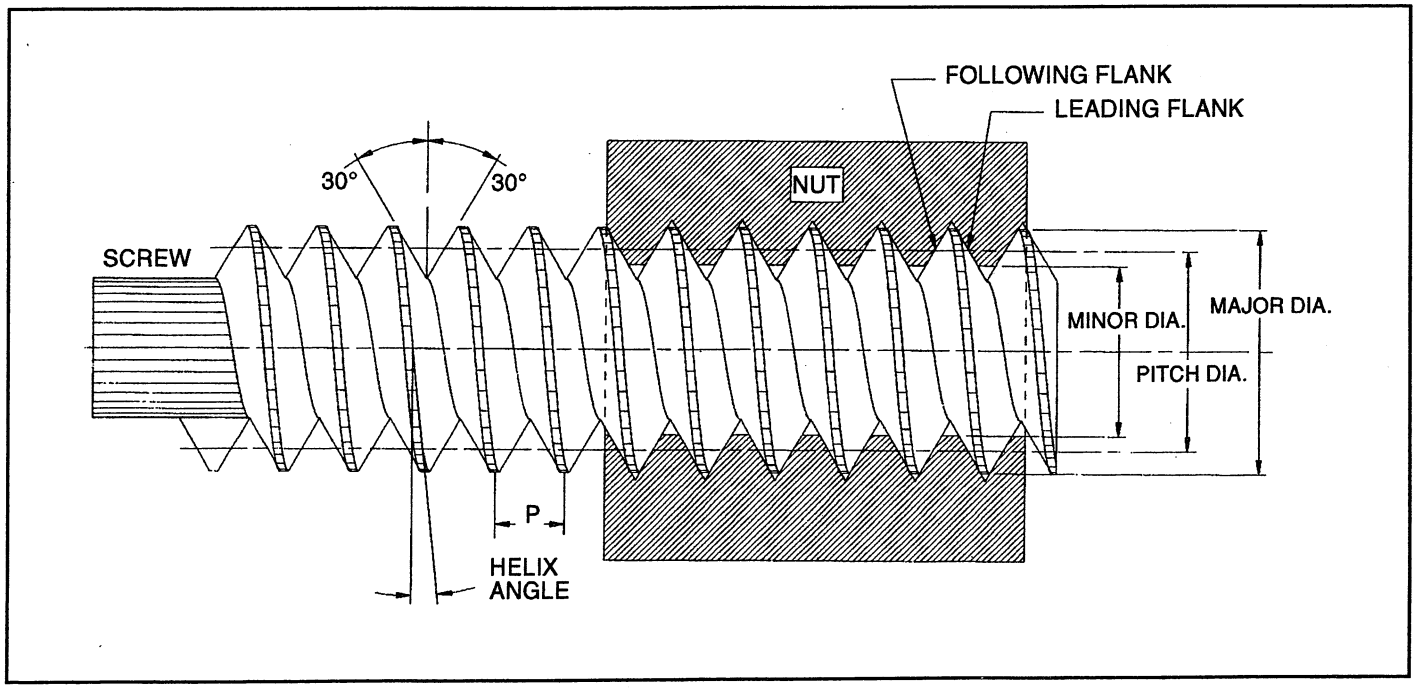
F = Fine thread series

3 = Thread class

A = External thread

B = Internal thread

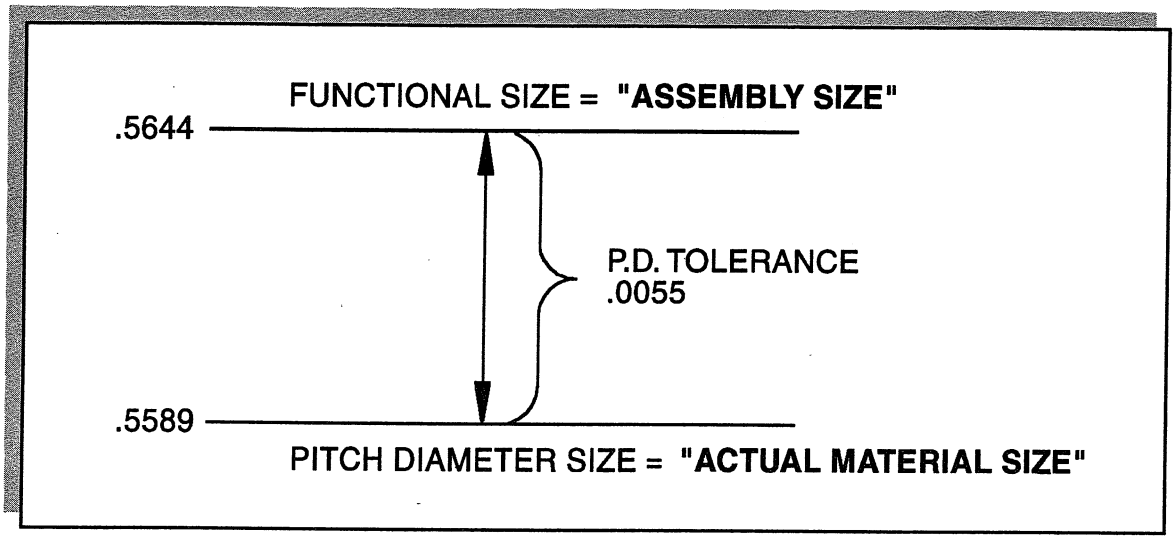
Unified Screw Thread Assembly



Product Screw Thread Limits of Size

EXAMPLE: .6250 - 11 UNC - 2A

Maximum P.D. = .5644
Minimum P.D. = .5589
Tolerance = .0055



- A product screw thread has two sizes:
  1) Functional Size
  2) Pitch Diameter Size

- Both sizes must be within specified tolerance limits to assure "dimensional conformance".

- Variables indicating type gaging will assure dimensional conformance to meet the most rigorous screw thread specifications.

Requirements of a Fastener or Threaded Component

1. Parts must ***assemble***.

2. Parts must ***stay together and perform*** for their application and specifications.

Functional Size

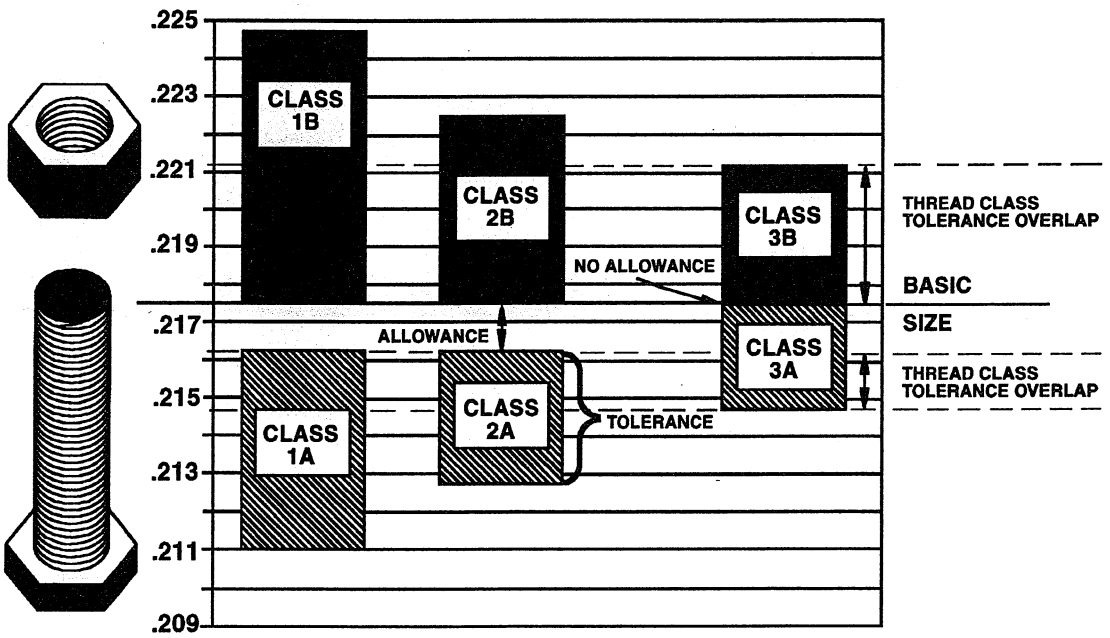
The Functional Size is the actual material size plus the cumulative diametral effect of variations in lead (including uniformity of helix), flank angle, taper, and roundness (see paper titled Functional Diameter Size: Understanding the Illusion). The functional size is a measured value. When it exceeds the maximum material pitch diameter tolerance limit, parts may not assemble. Functional size can be considered as the ***Virtual Material Size.***

Pitch Diameter Size

The Pitch Diameter Size is defined as the diameter of the cylinder that passes through the thread profile of either a product's internal or external screw thread to make the widths of thread ridge and thread groove equal on both sides of the thread and parallel to the axis. The pitch diameter is the measured value of the minimum material limit of size of either a product's internal or external screw thread known as the ***Actual Material Size.***

Thread Class

.250 - 20 UNC - ___



THREAD CLASS:
Shaded areas define the tolerance for different classes of threads. Tolerances are calculated from basic size. Classes 1A and 2A have an allowance added.

FIGURE 1

Screw Thread

The Screw Thread is a ridge, usually of uniform section and produced by forming a groove as a helix on the external or internal surface of a cylinder, or as a conical spiral on the external or internal surface of a cone. A screw thread formed on a cylinder is known as a straight or parallel thread, to distinguish it from a tapered thread that is formed on a cone.

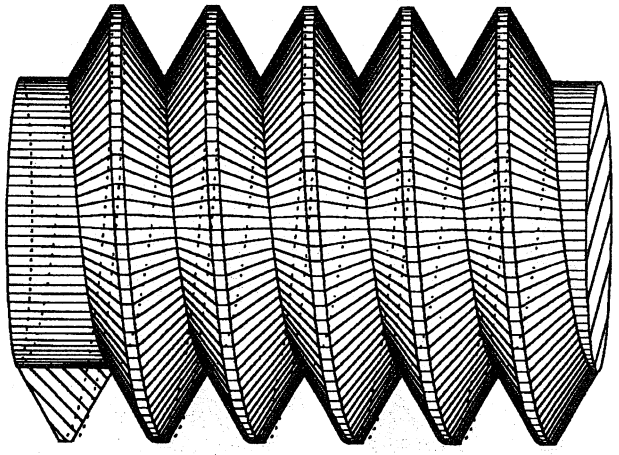


FIGURE 2

Thread

A thread is a portion of a screw thread encompassed by one ridge wrapped around a cylinder or cone for one complete turn.

Single Start Thread

A single start thread is one having ***one ridge*** wrapped around a cylinder or cone for the total length.

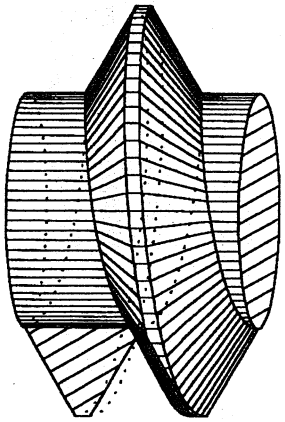


FIGURE 3

Multiple-Start Thread

A multiple-start thread is one that has ***two or more ridges*** wrapped around a cylinder or cone for the total length.

External Thread

An external thread is on a cylindrical or conical external surface (reference Figures 1, 2 and 3).

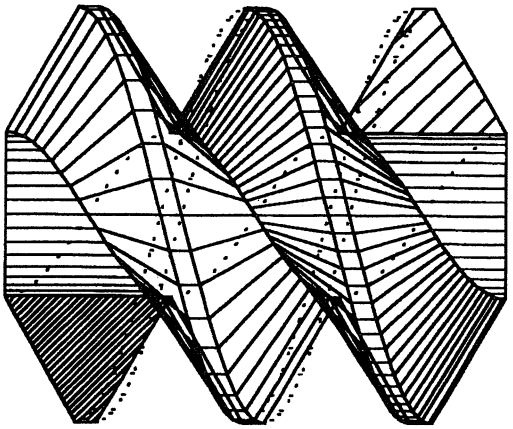


FIGURE 4

Internal Thread
An internal thread is on a cylindrical or conical internal surface.

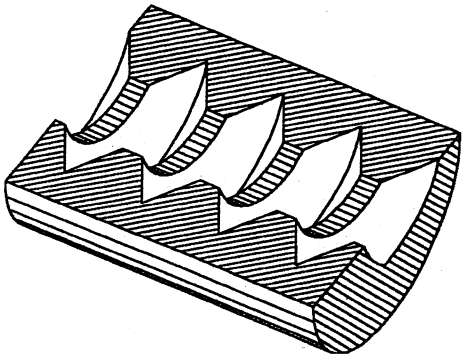


FIGURE 5

Right-Hand Thread
A thread is a right-hand thread if, when viewed axially, it winds in a clockwise and receding direction. A thread is considered right-hand unless specifically shown otherwise.

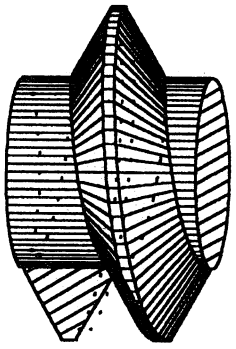


FIGURE 6

Left-Hand Thread
A thread is a left-hand thread if, when viewed axially, it winds in a counterclockwise and receding direction. All left-hand threads are designated LH.

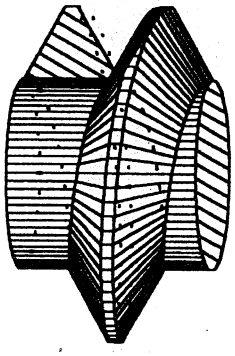
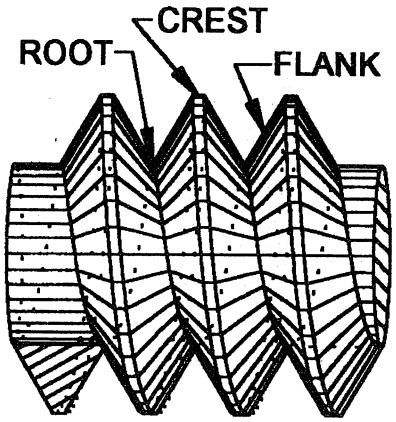


FIGURE 7

Flank of Thread
The flank (or side) of the ridge. The flank surface intersection with an axial plane is theoretically a straight line.

Crest of Thread
The crest is that surface of the thread that joins the flank of the thread and is farthest from the cylinder or cone from which the thread projects.

Root of Thread
The root is that surface of the thread that joins the flanks of adjacent thread forms and is identical with or immediately next to the cylinder or cone from which the thread projects.



Definitions & Terminology

Maximum Material Condition
The condition where the product screw thread contains the maximum amount of material.

Minimum Material Condition
The condition where the product screw thread contains the minimum amount of material.

Tolerance
The total amount of variation permitted for the size of a dimension. It is the difference between the maximum limit of size and the minimum limit of size for a given thread size.

Allowance
The difference between the design (maximum material) size and the basic size.

Basic Size
The basic size is that size from which the limits of size are derived by the application of allowances and tolerances.

Design Size
The design size is the basic size with allowance applied, from which the limits of size are derived by the application of tolerance. If there is no allowance, the design size is the same as the basic size.

Nominal Size
The nominal size is the designation that is used for general identifical of the diameter.

Thread series
Thread series are groups of diameters/pitch combinations distinguished from each other by the number of threads per inch applied to specific diameters.

Classes of Thread
Classes of threads are distinguished from each other by the amount of tolerance or tolerance and allowance specified.

Definitions & Terminology

Pitch

Pitch is not pitch diameter, threads per inch (TPI), nor is it LEAD, but it is the axial distance defined in (x,y) between any point on a thread to the corresponding point on the adjacent thread.

$$\text{Pitch} = \frac{\text{Number of thread starts}}{\text{Number of threads per inch}}$$

Lead

Lead is the axial advance per unit rotation for a given pitch distance. Pitch will equal lead only on a perfect thread.

Major Cylinder

The major cylinder bounds the crest of an external straight thread or the root of an internal straight thread.

Minor Cylinder

The minor cylinder bounds the root of an external straight thread or the crest of an internal thread.

Pitch Cylinder

The pitch cylinder is one of such diameter and location of its axis that its surface would pass through a straight thread in such a manner as to make the width of the thread ridge and the thread groove equal.

Pitch Line

The pitch line is linear and parallel to the center line of the pitch cylinder. Defined where thread width and thread groove are equal along the length of the thread.

Thread Axis

The thread axis is the axis of its pitch cylinder.

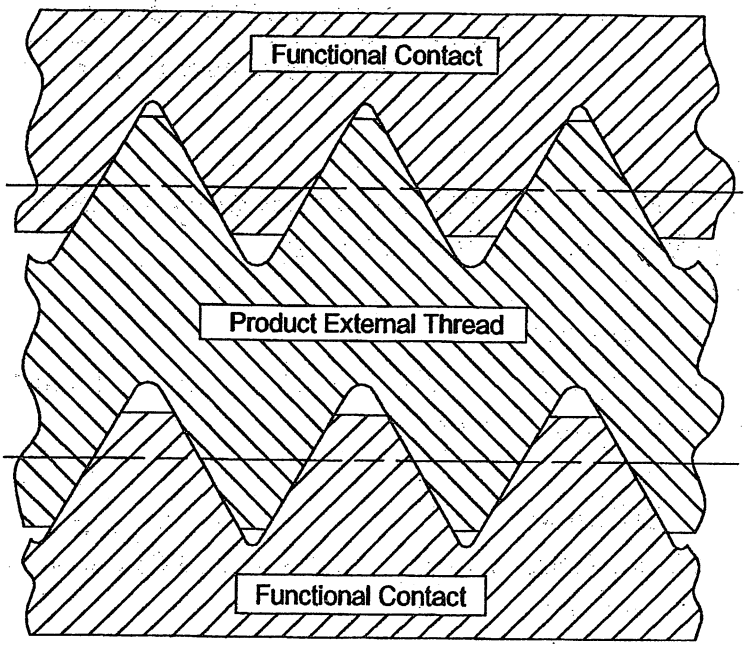
Actual Size

An actual size is a measured size.

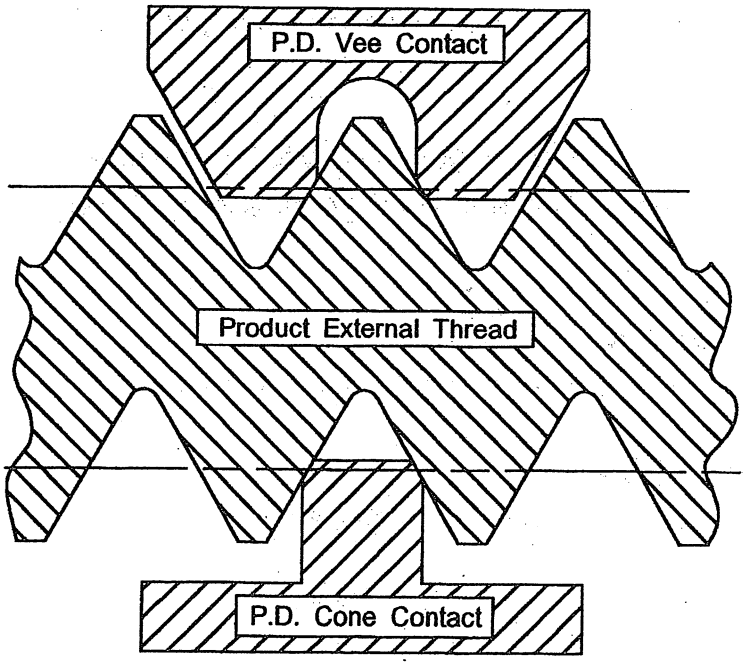
REFERENCE: ANSI B1.7M

UN GAGE PROFILE CONTACTS

Functional Size

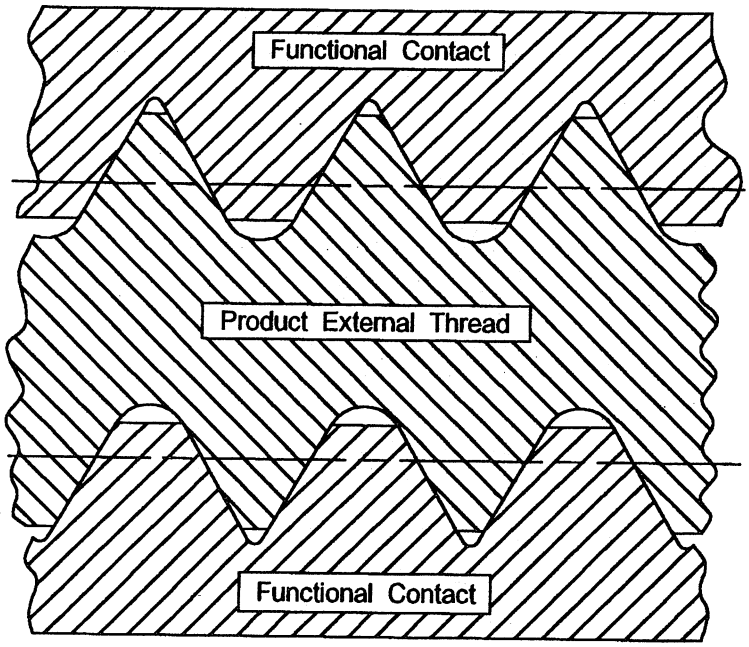


Pitch Diameter Size

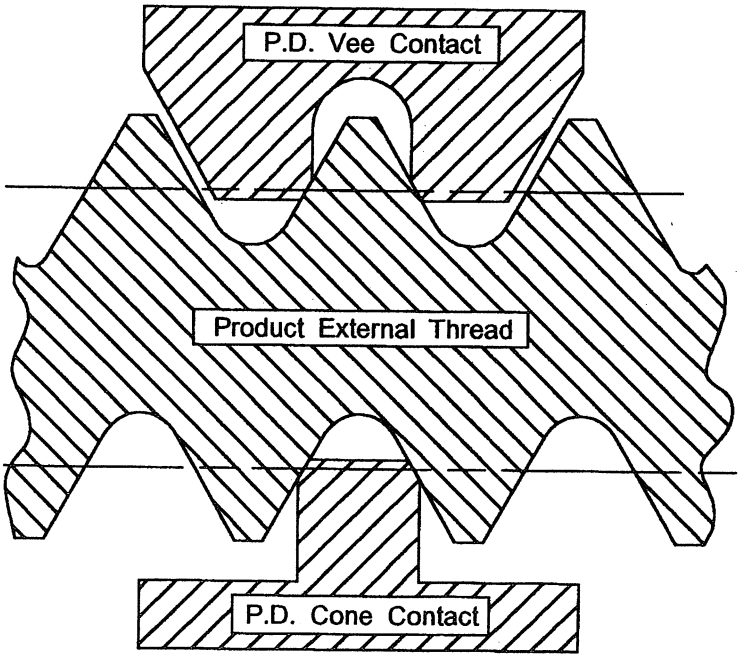


UNJ GAGE PROFILE CONTACTS

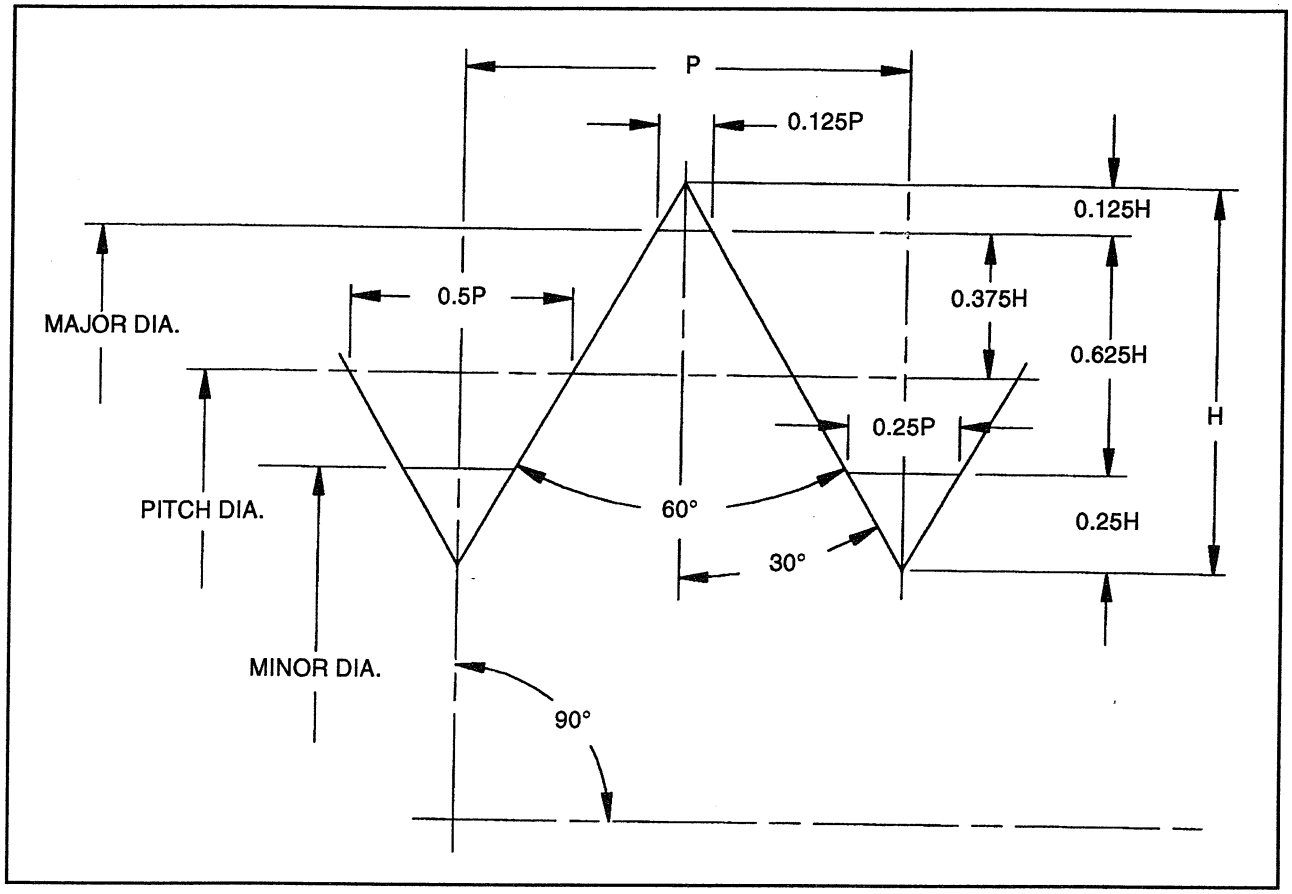
Functional Size



Pitch Diameter Size

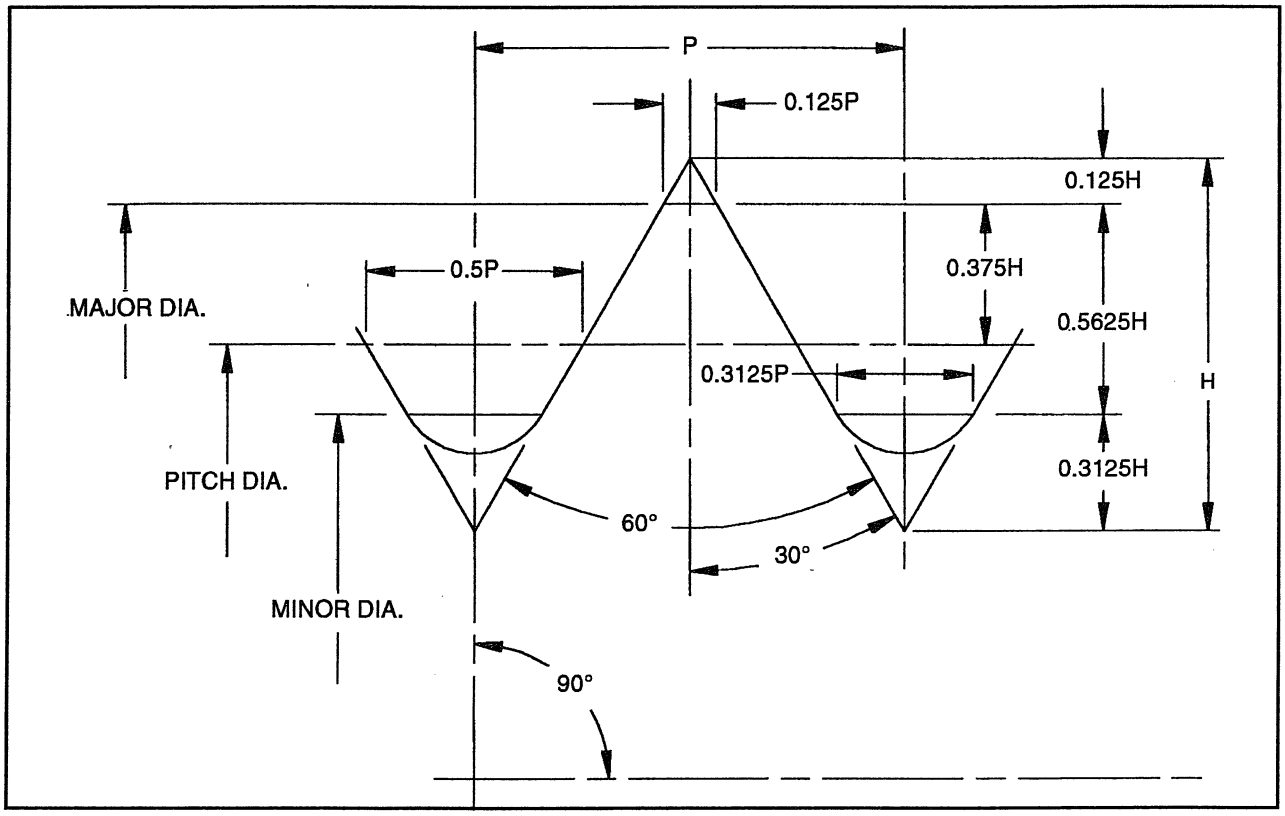


Anatomy of a UN Screw Thread



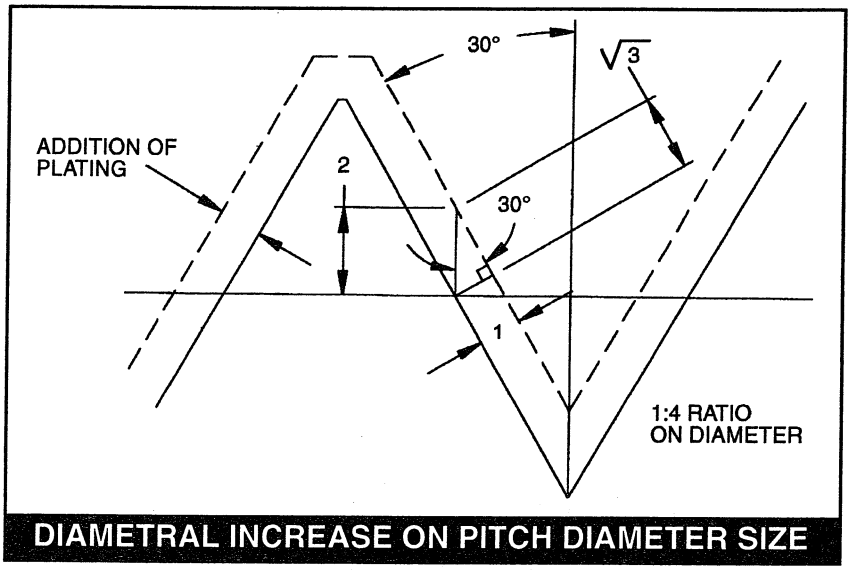
- H = Height of the Fundamental Triangle: (Cos 30 / TPI) or (Cos 30 x P)
- FLANK ANGLES are made up of the two half angles of 30° each for the 60° included angle.
- MAJOR DIAMETER is at P/8 *or* 0.125P
- PITCH DIAMETER is at P/2 *or* 0.500P
- MINOR DIAMETER is at P/4 *or* 0.250P
- TPI = Number of Threads per Inch
- N = Number of Thread Starts
- P = Pitch P = N/TPI

Anatomy of a UNJ Screw Thread



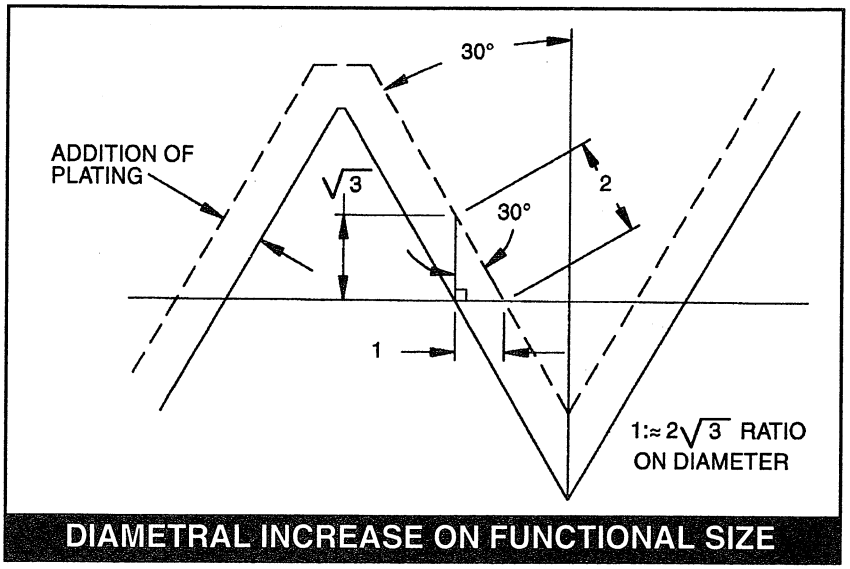
- H = Height of the Fundamental Triangle: (Cos 30 / TPI) or (Cos 30 x P)
- FLANK ANGLES are made up of the two half angles of 30° each for the 60° included angle.
- MAJOR DIAMETER is at P/8 *or* 0.125P
- PITCH DIAMETER is at P/2 *or* 0.500P
- MINOR DIAMETER is at P/4 *or* 0.3125P
- TPI = Number of Threads per Inch
- N = Number of Thread Starts
- P = Pitch P = N/TPI

Effect on Pitch Diameter with respect to the addition of Plating and Coating Normal to Surface



DIAMETRAL INCREASE ON PITCH DIAMETER SIZE

Effect on Functional Size with respect to the addition of Plating and Coating on Lead Variation

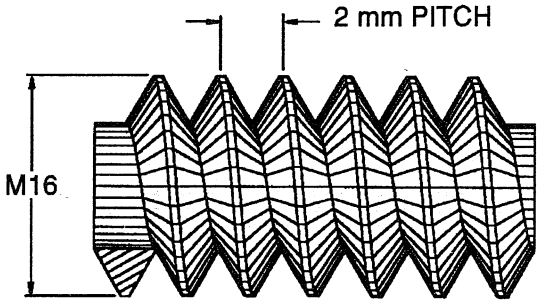


DIAMETRAL INCREASE ON FUNCTIONAL SIZE

ISO Metric Threads
ISO Basic Designations

SIZE is designated by letter M
followed by NOMINAL SIZE & PITCH (both in mm)
separated by sign X.

EXAMPLE: M16X2

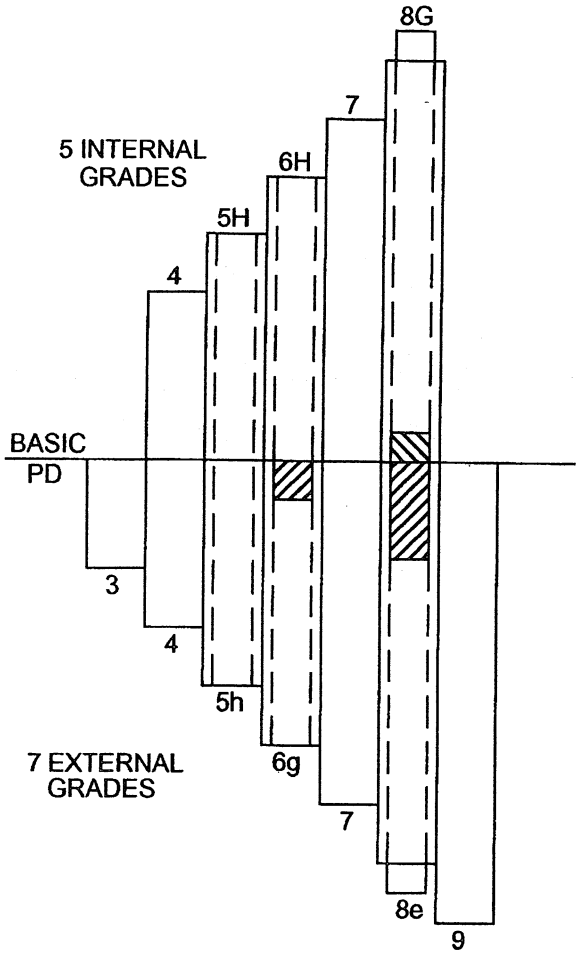


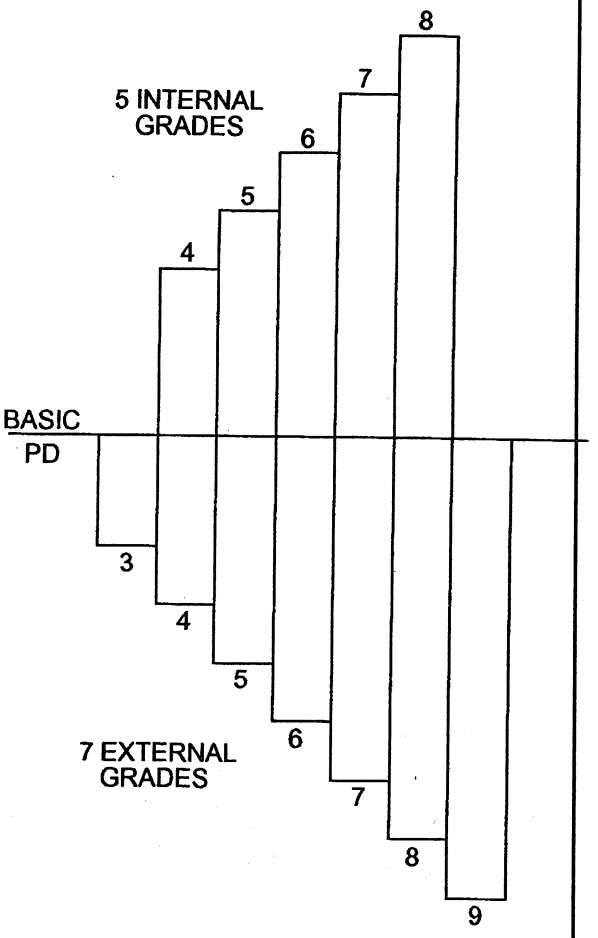
METRIC THREAD SIZE	
M1.6X0.35	
M1.8X0.35	
M2X0.4	
M2.2X0.45	
M6X1	
M7X1	
M8X1.25	Coarse
M8X1	Fine
M16X2	Coarse
M16X1.5	Fine
M18X2.5	Coarse
M18X1.5	Fine

To convert MM Pitch to TPI
25.4/Pitch = TPI
EXAMPLES:
2 mm = 12.70 TPI
.35 mm = 72.57 TPI

ISO Metric Threads
ISO Product Tolerance Symbols

GRADES - DESIGNATED BY
NOS. 3 4 5 [6] 7 8 9
NO.6 MEDIUM GRADE





POSITION - DESIGNATED BY
LETTERS e G [g] [H] h
LOWER CASE = EXTERNAL
ALLOWANCES (EXTERNAL)
e = LARGE
g = SMALL
h = NONE

EXAMPLES

M6X1-5H	M6X1-6H	M6X1-8G
M6X1-5h	M6X1-6g	M6X1-8e

Reference: MIL-S-8879C

4.42 Application category verification inspections.
Screw threads shall be inspected to ensure their ability to assemble with mating parts and shall be measured to ensure dimensional compliance with characteristics that are selected based on application category.

4.4.2.1 When characteristics are not specified on the drawing, product specification, or specification sheet, parts shall be inspected for the following characteristics based on application category:

Application Category	Inspection
Safety Critical Thread Thread	"GO" functional diameter size ❶ Pitch diameter size ❶ Major diameter size (external threads only) Minor diameter size Root radius (external threads only) Flank angle ❶ Lead (including helix variations) ❶ Circularity Taper Runout Surface roughness
Other Thread ❸	"GO" functional diameter ❷ Pitch diameter size Major diameter size (external threads only) Minor diameter size ❷ Root radius (external threads only)

❶ If the differential between "GO" functional size and pitch diameter size does not exceed 0.4 of the pitch diameter tolerance, inspection of flank angle and lead (including helix variations) is not necessary.

❷ For tapped holes with internal threads of nominal size less than 0.190 inches, only the functional diameter limit and the minor diameter limit inspections are to be performed.

❸ Includes threads for which the application category has not been specified or cannot be feasibly determined.

Reference: FEDERAL STANDARD H28/20B

5.1.3. System 21 – Go / No Go Gaging

5.1.3.1 System 21 provides for interchangeable assembly with functional size control at the maximum material limits within the length of standard gaging elements; and also control of characteristics identified as NOT-GO functional diameters or as HI (Internal) and LO (External) functional diameters. These functional gages provide some control at the minimum material limit when there is little variation in thread form characteristics such as lead, flank angle, taper and roundness.

5.1.3.2a System 21 is suggested for use under *any one* (or more) of the following conditions: a) Where the threads of the product do not need specific mechanical strength properties, or where mechanical strength requirements are not specified for the product threads by either material strength and dimensional limits or be testing strength of the threads.

5.1.4. System 22 – Variables Indicating Type Gaging

5.1.4.1 System 22 provides for interchangeable assembly with *functional size* control at the maximum material limits within the length of standard gaging elements; and also control of the minimum material size limits over the length of the full thread. Other thread characteristics such as lead, flank angle, taper and roundness variations are confined within these limits with no specific control of their magnitudes. For UNJ and MJ external threads, control is also provided for the thread root radius and rounded root minor diameter.

5.1.4.2 System 22 is suggested when none of the conditions specified in paragraphs **5.1.3.2** or **5.1.5.2** are applicable.

5.2 Acceptability

Screw thread acceptability criteria are in accordance with Section 6 of ANSI/ASME B1.3M

Screw Thread Gages and Measuring Equipment

Thread Gages and Measuring Equipment	Maximum Material Go Functional Size A_2	Minimum Material Pitch Diameter Size C_2
EXTERNAL PRODUCT THREAD CHARACTERISTICS		
GO segments @ 120° contact	■	
GO segments @ 180° contact	■	
GO rolls @ 120° contact	■	
GO rolls @ 180° contact	■	
Minimum material, pitch diameter type, cone & vee @ 120° contact		■
Minimum material, pitch diameter type, cone & vee @ 180° contact		■
INTERNAL PRODUCT THREAD CHARACTERISTICS		
GO segments @ 120° contact	■	
GO segments @ 180° contact	■	
GO rolls @ 120° contact	■	
GO rolls @ 180° contact	■	
Minimum material, pitch diameter type, cone & vee @ 120° contact		■
Minimum material, pitch diameter type, cone & vee @ 180° contact		■