TECH SHEET

PEM® REF/ MINIATURE SCREW THREAD PROFILE

SUBJECT: THREAD PROFILE

The microPEM® line of fasteners from PennEngineering introduces some new thread designations which may not be familiar to many users. This technical sheet will present the differences between screw threads made to the more common M and UN profiles and threads made to the miniature profile of these fasteners. It will also explain why PennEngineering chooses to produce miniature screw threads to the ISO 1501 standard and review thread designations per that international standard.

First, we will review the thread designations for the more common M and UN profiles.

Figure 1 shows a unified thread designation and the five pieces of information it provides.
Figure 2 shows a metric thread designation and the four pieces of information it provides.
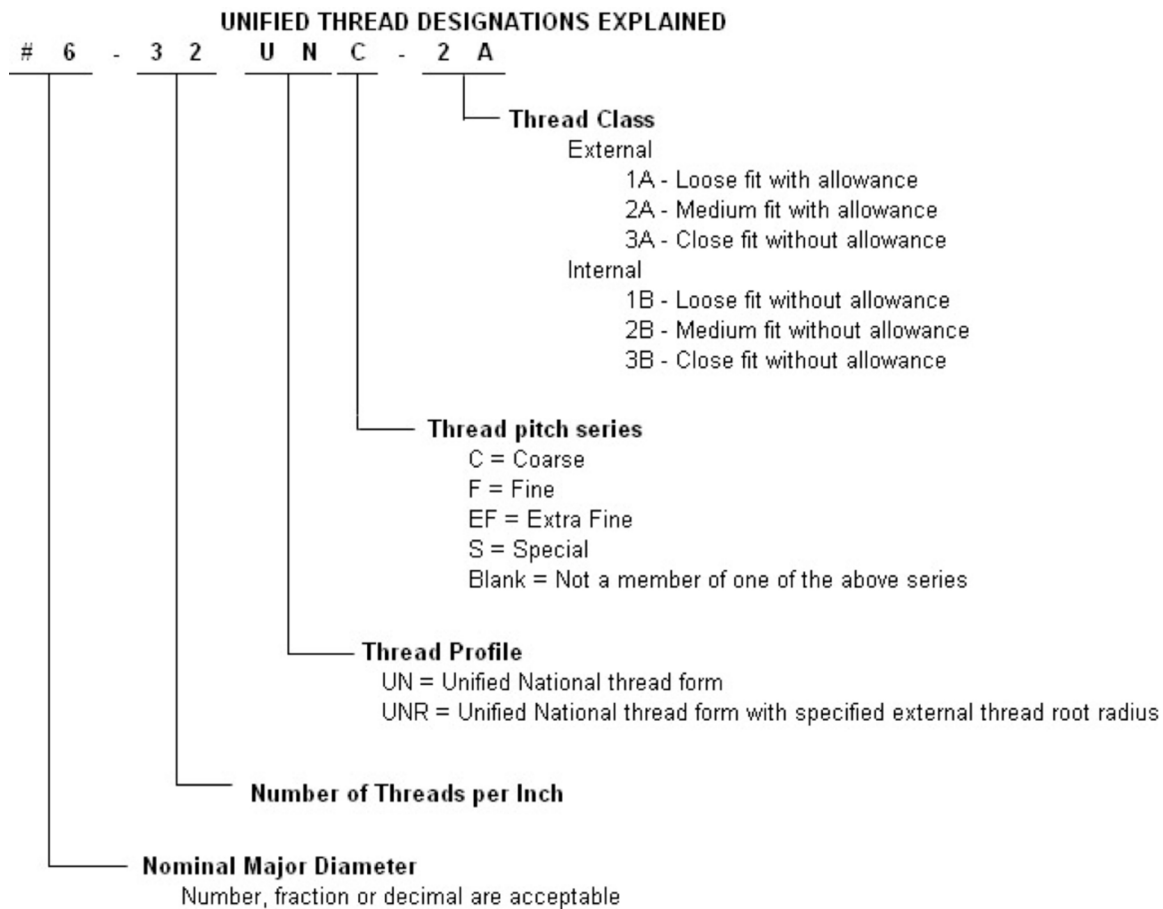

Figure 1 – Example of a unified thread designation

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METRIC THREAD DESIGNATIONS EXPLAINED

M 3 x 0.5 6 H

- **Tolerance Class**
  - External
    - 8g - Loose fit with allowance
    - 6g - Medium fit with allowance
    - 4h - Close fit without allowance
  - Internal
    - 7H - Loose fit without allowance
    - 6H - Medium fit without allowance
    - 5H - Close fit without allowance
- **Pitch (in millimeters)**
- **Nominal Major Diameter (in millimeters)**
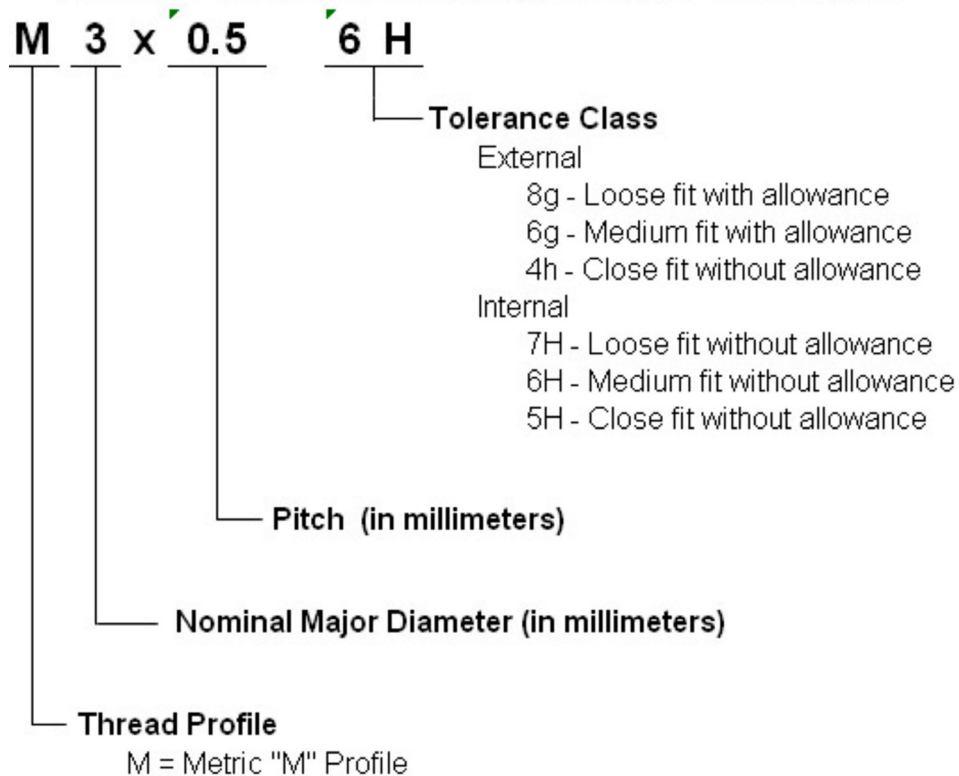- **Thread Profile**
  - M = Metric "M" Profile

Figure 2 – Example of a metric thread designation

Notice that most of the information including Nominal Major Diameter, Pitch, Thread Profile and Thread (Tolerance) Class are common to both unified and metric designations. The Thread Pitch Series information is not applicable to metric because there is only one preferred pitch for each basic major diameter. Of the four common pieces of information, Nominal Major Diameter and Pitch are rather straight forward. Thread Profile and Thread (Tolerance) Class deserve further discussion.

Figure 3 explains the unified and metric thread tolerance designations. The metric system is more logical and gives the flexibility of applying different tolerances to different thread diameters, such as pitch diameter and internal thread minor diameter.

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UNIFIED SYSTEM

Number: Inversely related to magnitude of the tolerance
Class 3 tolerance is less than Class 2 tolerance

Letter:
A = External thread
B = Internal thread

METRIC SYSTEM

Number represents tolerance grade:
Related to the magnitude of the tolerance
Class 6 tolerance is greater than Class 4 tolerance

Letter represents tolerance position:
h or H = No allowance exists, tolerance touches basic
g or G = A small allowance exists
f = A medium allowance exists
e = A large allowance exists

Lowercase = External thread
Uppercase = Internal thread

Four Character Tolerance Symbols:

External thread: (example 4g6g)
First two characters = tolerance grade and position for pitch diameter
Second two characters = tolerance grade and position for major diameter

Internal thread: (example 5H6H)
First two characters = tolerance grade and position for pitch diameter
Second two characters = tolerance grade and position for minor diameter

Figure 3 – Explanation of tolerance designations for unified and metric threads

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The basic profile for both the metric M profile and the unified UN profile is shown in **Figure 4**. Notice that the thread profile gives the following four pieces of information

1. Thread is symmetric with same flank angle on both sides
2. Included angle is 60 degrees
3. Truncation at the major diameter is P/8 or .125 * P
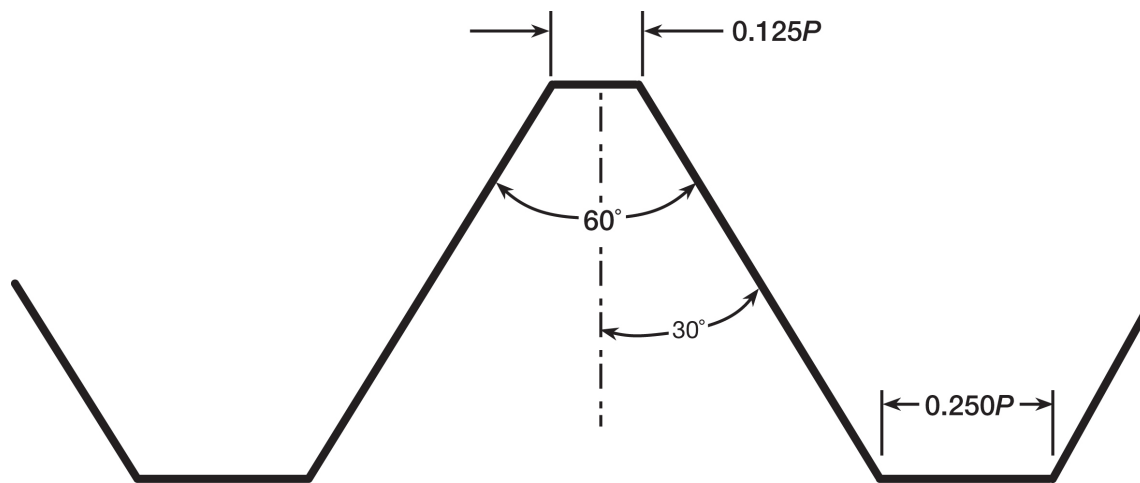4. Truncation at the minor diameter is P/4 or .25 * P

0.125P

60°

30°

0.250P

Figure 4 – Basic thread profile for the metric M and Unified national screw threads

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The basic profile for the miniature screw thread profile is shown in **Figure 5**. Notice that the thread profile gives the following four pieces of information and the fourth is the only one that is different from the M and UN profile.

1. Thread is symmetric with same flank angle on both sides
2. Included angle is 60 degrees
3. Truncation at the major diameter is P/8 or .125 * P
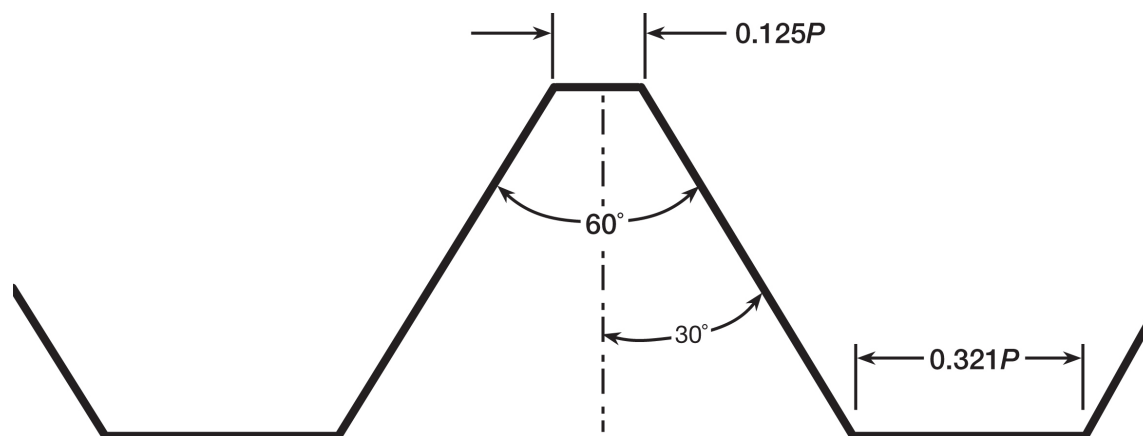4. Truncation at the minor diameter is .321 * P

Figure 5 – Basic thread profile for miniature screw threads per ISO 1501

The larger minor diameter truncation makes the miniature thread depth slightly less, resulting in a larger minor diameter. The purpose is to reduce tap breakage when tapping internal miniature threads. The increased minor diameter allows a larger root diameter on taps which increases their torsional strength. The larger minor diameter also reduces the amount of material that must be removed (cut tapping) or displaced (form tapping) thus reducing the required tapping torque.

Because the miniature screw thread profile shown in Figure 5 is different from the M and UN profile, it must be designated differently. ISO 1501 and several other miniature screw thread standards designate this profile as "S." Examples of miniature screw thread designations for an internal and an external thread per ISO 1501 are shown in Figure 6. It is important to note that only three pieces of information about the thread are provided in a miniature screw thread designation. Comparison of Figure 6 and Figure 2 shows that pitch is not designated for miniature threads. This is because the standards do not allow any choice of pitch for a given nominal major diameter.
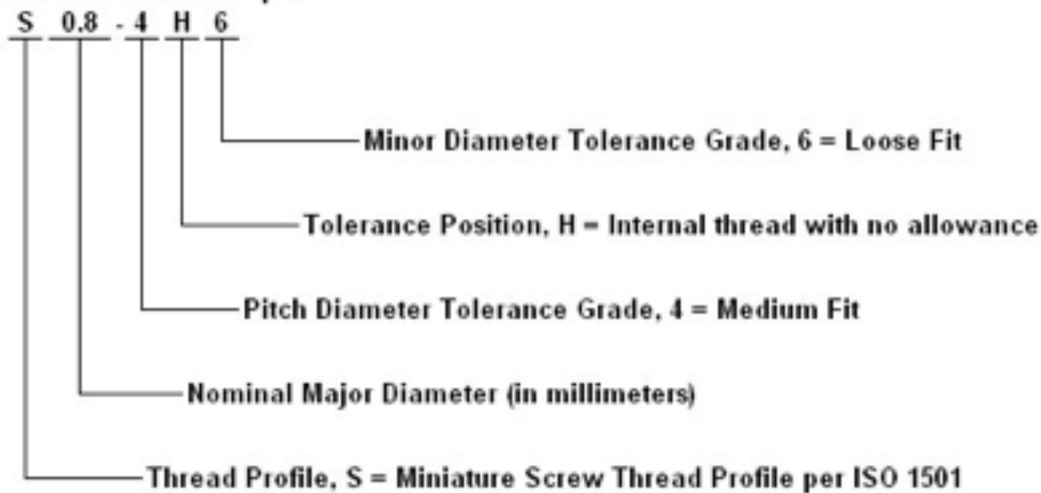
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MINIATURE SCREW THREAD DESIGNATIONS PER ISO 1501 EXPLAINED

Internal Thread Example

S 0.8 - 4 H 6

- Minor Diameter Tolerance Grade, 6 = Loose Fit
- Tolerance Position, H = Internal thread with no allowance
- Pitch Diameter Tolerance Grade, 4 = Medium Fit
- Nominal Major Diameter (in millimeters)
- Thread Profile, S = Miniature Screw Thread Profile per ISO 1501

External Thread Example

S 1.4 - 5 h 3

- Major Diameter Tolerance Grade, 3 = Close Fit
- Tolerance Position, h = External thread with no allowance
- Pitch Diameter Tolerance Grade, 5 = Medium Fit
- Nominal Major Diameter (in millimeters)
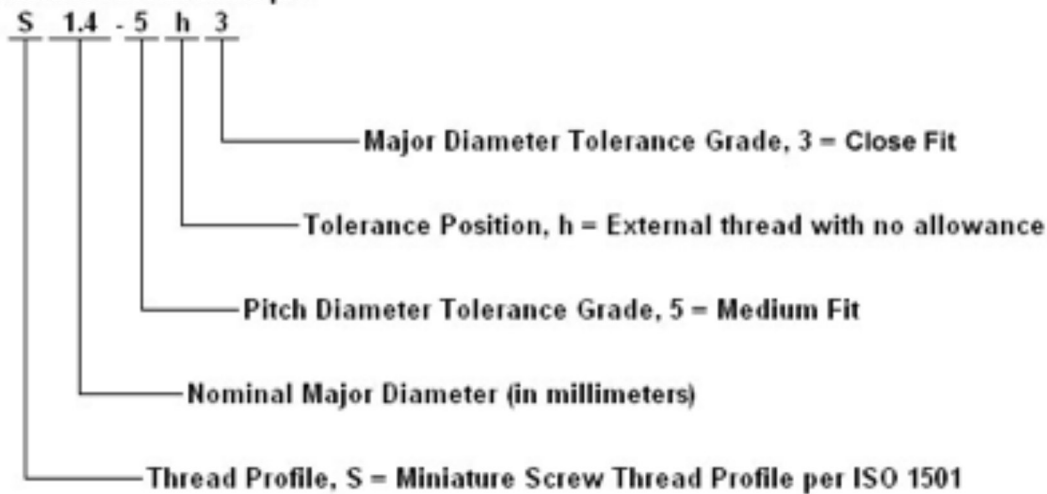- Thread Profile, S = Miniature Screw Thread Profile per ISO 1501

Figure 6 – Example thread designations for miniature threads per ISO 1501

Another common miniature screw thread standard, ASME B1.10M uses the profile designation "UNM" for Unified National Miniature and does not offer any choice of tolerance. Therefore a thread designation per ASME B1.10M only gives two pieces of information; nominal major diameter and profile. The 1.4 mm size, both internal and external, is designated "1.40 UNM" if following ASME B1.10M rules.

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PennEngineering has chosen to follow ISO 1501, and not ASME B1.10M. This was done because for internal threads ISO 1501 gives a choice of four different tolerance grades. In the case of minor diameter, the grade 6 tolerance per ISO 1501 is essentially the same as the ASME B1.10M minor diameter tolerance so for minor diameter there is no advantage to using ISO 1501. However, the ISO 1501 grade 4 pitch diameter tolerance is roughly twice the ASME B1.10M pitch diameter tolerance which is a significant benefit, especially for plated parts because any variation in plating thickness causes a four-fold variation in pitch diameter. Larger internal thread pitch diameter tolerances are not a significant strength concern for miniature screw threads because, with the limited external thread strength of these small diameters, it is not difficult to get internal thread stripping strength above external thread tensile strength.

Unless otherwise specified by a particular customer for a special part, PennEngineering will use ISO 1501 for thread diameters of 0.3 mm through 1.4 mm. Internal threads will be produced to the class 4H6 tolerances and external threads will be produced to the class 3h5 tolerances. Metric thread sizes M1.6 and larger will be produced to ASME B1.13 M. Unified thread sizes #0 and larger will be produced to ASME B1.1. Although there has been some usage of unified sizes below #0 designated as #00 for .047 diameter, #000 for .034 diameter and even #0000 for .021 inch diameter these sizes are not recommended for new designs. New designs should use miniature screw threads from the first choice columns of ISO 1501 or ASME B1.10M. Both standards offer the same range of diameter and pitch combinations and all nominal major diameters are based on .05 or .1 mm or .2 mm increments. The first choice diameter and pitch combinations from ISO 1501 are shown in Table I along with #0 through #0000 sizes for comparison.

Table 1

Miniature Screw Thread Size Chart

Designation	Nominal Major Dia.		Thread Pitch			Comment
	mm	inch	mm	inch	threads/in.	
S0.3	0.3	0.0118	0.8	0.00315	317.5	Size not currently available
S0.4	0.4	0.0157	0.1	0.00394	254.0	Size not currently available
S0.5	0.5	0.0197	0.125	0.00492	203.2	Size not currently available
#0000-160	0.53	0.0210	0.159	0.00625	160	Not recommend for new designs
S0.6	0.6	0.0236	0.15	0.00591	169.3	Size not currently available
S0.8	0.8	0.0315	0.2	0.00787	127.0	Available
#000-120	0.86	0.0340	0.212	0.00833	120	Not recommend for new designs
S1	1	0.0394	0.25	0.00984	101.6	Available
S1.1	1.1	0.0433	0.25	0.00984	101.6	Available
#00-90	1.19	0.0470	0.282	0.01111	90	Not recommend for new designs
S1.2	1.2	0.0472	0.25	0.00984	101.6	Available
S1.4	1.4	0.0551	0.3	0.01181	84.7	Available
#0-80	1.52	0.0600	0.318	0.01250	80	Smallest recommended unified size
M1.6	1.6	0.0630	0.35	0.01378	72.6	Smallest metric M profile size