



# Metric Thread Classes

by Guy Avellon

Until a few decades ago, there was no agreement to standards regarding metric fasteners from France, Italy, Germany, England or Japan. The DIN (Deutsches Institut für Normung) devised the most complete standards of any country, but there was still a need for unification. Therefore, the ISO (International Standards Organization) was thus formed. The DIN standards have been modified to follow ISO recommendations. The United States coordinates their efforts with ISO through ANSI, the American National Standards Institute, although there are still some slight differences between standards.

**Fastener Designation:** When ordering or identifying the dimensions of a metric fastener, all metric fasteners are preceded by the capitalized letter 'M', which also designates a standard metric thread type. Then, similar to how inch series fasteners are identified, the diameter is listed with the thread pitch, length, property class and product description.

For example: M12 x 1.0 x 50, 10.9 Hex Cap Screw.

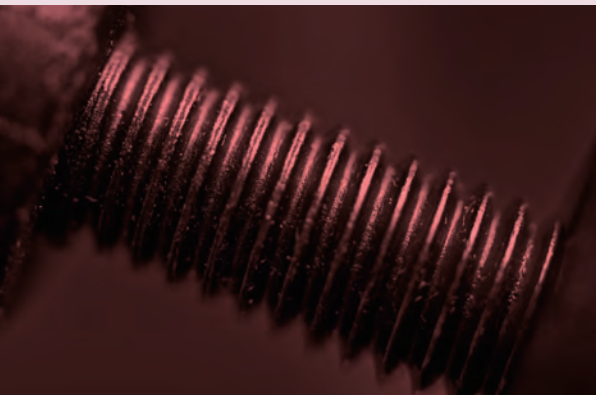
This tells us the diameter is 12mm, the thread pitch is 1.0mm and the length is 50mm. The property class is a 10.9 and the product is a hex head cap screw. Further information may indicate coating type or any other supplemental treatment.

**Thread Pitch:** Users must be aware that there are three types of thread pitches

available: the Standard thread, which is similar to the UNC; the Fine thread, similar to the UNF; and the Japanese thread which is in between the two, but is used only on the M10 and M12 fasteners. For example; an M10 fastener can have a thread pitch of 1.0mm, 1.25mm and 1.50mm.

Identification is extremely important because many metric sizes are very close to the inch series. The nut or fastener may be started but additional tightening could result in thread stripping. For example, a 1/4" -28 fastener has a diameter of 0.250" compared with an M6 which measures 0.236". The difference is 0.014". The thread pitch on the M6 is 1.0 which is roughly equivalent to 25.6 threads-per-inch vs. the 28 TPI for the inch fastener. These examples present a very close difference; visual confusion is easy, detection impossible and the threads are easy to strip.

The following chart cites other examples which illustrate the potential danger of mixing an inch threaded fastener with a metric threaded fastener. The resultant assembly will produce clamp loads from 25 to 60% less than expected, providing the threads haven't



## 公制螺纹等级

文 / Guy Avellon

几十年前，关于公制扣件的标准，从法国、意大利、德国到英国或日本，都没有一致的标准。虽然德国工业标准DIN的制定比任何国家都还完整，但仍然需要统一的标准。因此，国际标准组织ISO成立了。DIN标准也已做修改以追随ISO的建议。美国则透过美国国家标准机构ANSI与ISO调和，虽然两者标准之间仍然存在着些微的差异。

**扣件的称呼：**在订购或辨识公制扣件尺寸时，所有公制扣件都以一个大写M开始，这也订定了一种标准的公制螺纹形式。与英制扣件如何辨识很类似地，公制的直径也列出螺纹节径、长度、强度等级与产品描述。

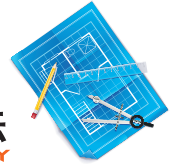
例如：M12x1.0x50, 10.9 Hex Cap Screw这告诉我们其直径是12mm，螺纹节径是1.0mm，长度是

50mm，强度等级是10.9级，其产品是六角头戴帽螺丝。也可以有进一步的资讯来显示涂层的形式或任何其他补充的处理。

**螺纹节径：**使用者必须清楚市面有三种形式的螺纹节径：(1)标准螺纹，(2)类似于UNC；细螺纹，类似UNF；(3)日本螺纹，介于两者之间，但只用于M10与M12扣件。例如：M10扣件可以有1.0mm、1.25mm与1.50mm的螺纹节径。

辨识是极为重要的，因为很多公制规格非常接近英制系列。螺帽或扣件可能可以开始旋入，但在锁紧时可能产生螺纹剥离。例如：一支1/4" -28的螺丝其直径为0.250"，相较于M6的则为0.236"，差别只有0.014"。M6的螺纹节径是1.0，大约相当于25.6螺纹/英寸，与英制扣件的28螺纹/英寸的对比。这些例子代表非常接近的差异。目视很容易搞混，检测的困难，螺纹则很容易剥离。

以下的图表举出其他的例子，显示出英制扣件与公制螺纹扣件混用的潜在危险。若螺纹没有剥离或尚未开始剥离的话，如此组装的结果会导致锁紧负荷比预期的少25%到60%；在此状况下，负荷减损将会接近100%。



stripped or have begun to strip, in which case the loads will be close to 100% lost.

Inch Threads Vs. Metric Threads 英制螺纹对公制螺纹	
Inch Bolts 英制螺栓	Metric Nuts 公制螺帽
10-32	M5 x 0.8
1/4"-28	M7 x 1.0
5/16"-18	M8 x 1.0
3/8"-16	M10 x 1.5
7/16"-14	M12 x 1.75
1/2"-13	M14 x 2
3/4"-10	M20 x 2.5
3/4"-16	M20 x 1.5
Metric Bolts 公制螺栓	Inch Nuts 英制螺帽
M12 x 1.25	1/2"-20
M18 x 2.5	3/4"-10
M18 x 1.5	3/4"-16
M24 x 3	1"-8
M24 x 2	1"-12

**Thread Tolerances:** Threads are designed with tolerance ranges for different applications. Some applications, such as allowing for heavy coating thicknesses, require more fundamental deviation (gap allowance) than a tapped hole. This allowance must be made before the coating is applied so the thickness of the coating can fit with a mating thread form without causing any interference. Therefore, the external threads (male) and internal threads (female) must have specific tolerances to be able to function smoothly together.

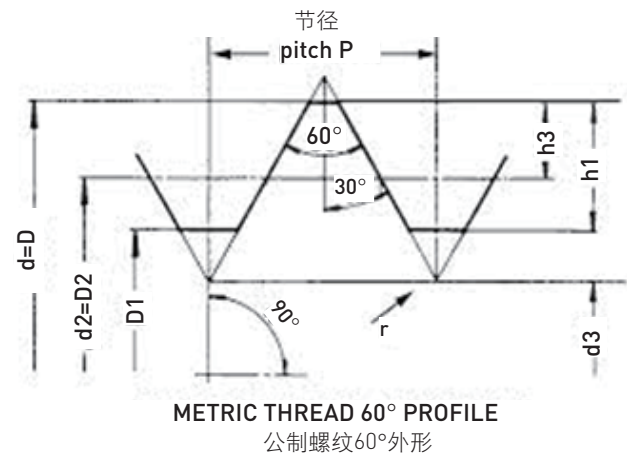
When first explaining how to order a metric fastener, the diameter, thread pitch, length and property class were written in this order. The full designation for metric threads also includes information for the thread tolerance class for the pitch diameter and the major diameter. Using the previous example for a hex head cap screw, it is now written as; M12 x 1 – 5g6g. Here, the 5g represents the tolerance class for the thread pitch diameter, while the major diameter tolerance class is represented by the 6g.

When indicating a thread fit between the male and female fasteners, the nut thread tolerance designation is given first, followed with a slash, then the bolt thread tolerance designation. The complete thread information is now written: M12 x 1 – 6H/5g6g. The female thread tolerance class is written with a capitalized letter (6H or 6G); while the male threads are designated with lower case letters (4g, 5g, 6g, or 4h, 6h).

**螺纹公差:** 针对不同的使用场合, 螺纹的设计是有公差范围的。某些使用, 譬如要容纳较厚的涂层厚度, 则需要比公制的孔洞还大的基本差异(间隙裕量)。此裕量必须在涂层施加上去之前做好, 如此涂层的厚度才能与搭配的螺纹外形相配, 不会造成干涉。因此, 外螺纹(公螺纹)与内螺纹(母螺纹)必须有明确的公差, 才能顺利地一起发挥功能。

首先解释如何订购公制扣件, 在订单上要写明直径、螺纹节径、长度与强度等级。公制螺纹的全部名称也包含节径直径与大径的螺纹公差等级之资讯。现在用之前的六角头戴帽螺丝的例子来说, 现在则会写成M12X1—5g6g。在此5g代表螺纹节径直径的公差等级, 6g则代表大径的公差等级。

要指出公母扣件之间的螺纹之松紧配合, 首先给的是螺帽螺纹公差的称呼, 接着是一斜线, 之后是螺栓螺纹公差的称呼。完整的螺纹资讯写成M12X1—6H/5g6g。母螺纹公差等级是用大写字母(6H或6G), 公螺纹是用小写字母(4g, 5g, 6g或4h, 6h)。



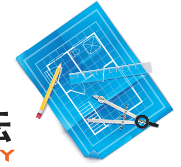
上图为一支6g螺栓, 下页图示为一个6H螺帽, 锁着一个外螺纹扣件。

完整的公差称呼包括: 内螺纹的G, H; 外螺纹的e, f, g, h。

公差等级则编以号码, 数字愈小, 公差愈小。例如: 螺帽螺纹的小径与节径直径是从4级到8级。

螺栓螺纹的大径有4级, 6级和8级。节径直径从3级到9级。

螺帽螺纹有两个公差位置, 是从基本尺寸到公差位置的距离。H是零基本偏差, G为正值的基本偏差。



The diagram above represents a 6g bolt while the following diagram represents a 6H nut being engaged with an externally threaded fastener.

Complete tolerance designations include: G, H for internal threads; e, f, g, h for external threads.

Tolerance grades are numbered, with the lower the number having the smaller the tolerance. For instance; the minor diameter and the pitch diameter of the nut thread includes grades 4 through 8.

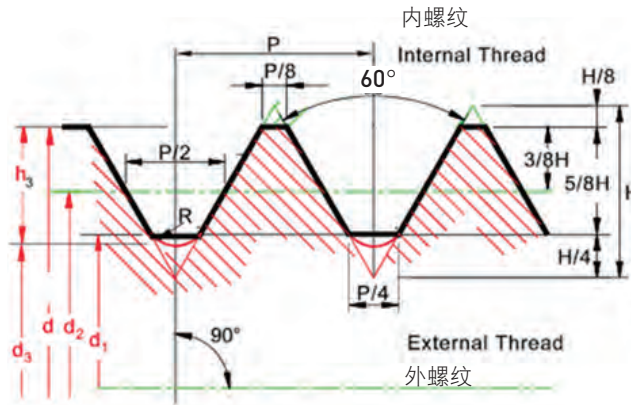
The major diameter of the bolt threads includes grade numbers 4, 6 and 8, while the pitch diameter includes grades 3 through 9.

Nut threads have two tolerance positions, which is the distance of the tolerance position from the basic dimension; H is a zero fundamental deviation and G has a positive fundamental deviation.

Bolt threads have four tolerance positions; h, which is also a zero fundamental deviation; e, f and g are negative. A negative fundamental deviation indicates that the thread element is smaller, whereas a positive fundamental deviation would indicate that the thread element is larger than nominal dimensions. However, for simplification, standard industrial and commercial fasteners will use only two thread fit classes: 6H/4g6g and class 6H/6g.

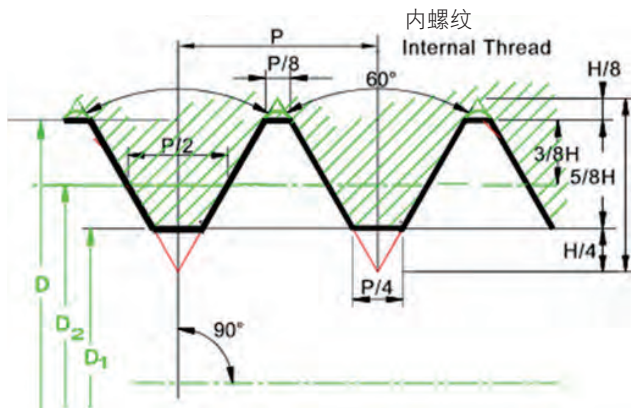
An internal thread (tapped hole) tolerance class with no allowance is; 6H6H or 4H5H. A 4H5H/4h6h is approximately equivalent to a 3B/3A inch thread with no allowance.

For a bolt with a looser fit, or a bolt tolerance to accept a coating,



$$\begin{aligned}
 H &= 0.86603 P \\
 H/4 &= 0.21651 P \\
 H/8 &= 0.10825 P \\
 3/8 H &= 0.32476 P \\
 5/8 H &= 0.54127 P \\
 H/6 &= 0.14434 P = R \\
 0.61343 P &= H_3
 \end{aligned}$$

- h = Full height of external thread (外螺纹全高)
- d = Major dia (Ext') 大径(Ext')
- $d_2$  = Effective(Pitch) Dia(Ext') 有效径(Pitch)(Ext')
- $d_3$  = Minor Dia (Ext') 小径(Ext')
- $d_1$  = Basic Minor Dia (Ext') 基本小径(Ext')



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 0.61343 P &= H_3
 \end{aligned}$$

- D = Major diameter (Int') 大径(Int')
- $D_2$  = Effective(Pitch) Dia(Int') 有效径(Pitch)(Int')
- $D_1$  = Minor Dia (Int') 小径(Int')
- $h_3$  = Full height of external thread (外螺纹全高)

螺栓螺纹有四个公差位置，h是零基本偏差，e，f，g，h是负值的基本偏差。负值的基本偏差表示螺纹尺寸较小，正值的基本偏差则表示螺纹尺寸比公称尺寸还大。可是为了简单化，标准的工业用与商业用的扣件只采用两种螺纹松紧配合等级：6H/4g6g与6H/6g。

无裕量的内螺纹(攻制的孔)公差等级是6H6H或4H5H。4H5H/4h6h大约等于英制螺纹无裕量的3B/3A。

一支螺栓若有较松的配合，或者一支螺栓要接受一个涂层，其基本偏差会是6H/6g等级，这是相当于英制的2B/2A级。较紧的外螺纹等级大约是3A，而有裕量的是4g6g。

节径直径与大径的公差是相同的，它可能写做6H，6H/6g或6H/4g6g。



the fundamental deviations would be class 6H/6g, which is similar to the inch 2B/2A. A tighter external thread class that is approximate to a 3A, but with an allowance, is 4g6g.

Where the pitch diameter and major diameter tolerances are identical, it may be written as: 6H, 6H/6g or 6H/4g6g.

