Metric System & Specifications

Throughout history, people have been trying to limit the number of measurement systems. Today, only two systems, inch-pound and metric, are predominate in most industrial nations. As with any system, the metric system has also been changing and several modifications have been devised to match the progress of technology.

All nations, including the U.S., are unified under one version of metric: the International System of Units, or SI. Currently, the U.S. is using both SI and inch-pound standards. Most countries have converted from the inch-pound system and now use SI as the standard measurement system. In these nations, the use of inch-pound products is limited to maintenance parts for older machinery and equipment. Many U.S. industries, such as the automotive and agricultural industries, have implemented the metric system into their operations.

The Metric System

One problem with standardizing the metric system is the initiative to fully convert metric specifications to an ISO standard. Although the process has begun, most industries are unenthusiastic about converting from DIN or metric ANSI.

For example, metric hex cap screws are generally manufactured to one of the three standards:

Product Type	Metric Specification			Scope
	Din	ISO	ANSI/ASME	
HCS	931	4014	B18.2.3.1M	Partially Threaded
	933	4017		Fully Threaded
	960	8676		Partially Threaded (Fine)
	961	8765		Fully Threaded (Fine)
Hex Nuts	934	4032	B18.2.4.1M (style 1)	classes 6, 8, & 10
SHCS	912	4762	B18.3.1M	
BH SHCS	N/A	7380	B18.3.4M	
FHSCS	N/A	7991	B18.3.5M	

- DIN 931 (DIN 933 fully-threaded)
- ISO 4014 (ISO 4017 fully-threaded)
- ANSI/ASME B18.2.3.1M

Although the various standards may have different dimensional properties, products made to these three standards are interchangeable. Hex cap screws manufactured to the dimensional specifications of any one of the listed standards are compatible with nuts manufactured to the metric specification of any of the respective organizations. The main difference between each of the hex cap screw standards is the width across the flats dimensions for the M10, M12, and M14.

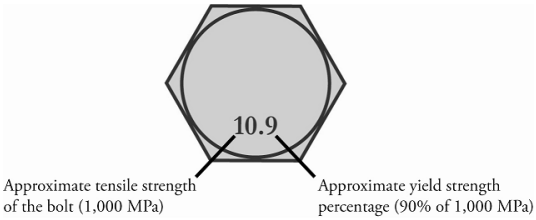
Each metric standard is product specific. For example DIN 931 is for partially threaded coarse thread metric hex cap screws. DIN 960 is the specification for partially threaded fine thread metric hex cap screws. The specification used to produce the corresponding inch series fastener is ANSI B 18.2.1. However, the ANSI B 18.2.1 specification encompasses eight product types under the broad heading of "Square and Hex Bolts and Screws." Therefore, one must state the pattern of the desired product; in this

case, hex cap screw. Under the metric system, each of the eight product types would have its own individual standard.

Fastener Property Classes

The metric system designates strength capabilities via **property classes** rather than **grades**. The numbering system is very simple; the number that appears before the decimal, when multiplied by 100, will provide the approximate minimum tensile strength of the bolt. In this example the 10 in 10.9 multiplied by 100 tells the user that this bolt has an approximate minimum tensile strength of 1,000 **MPa** (Mega Pascals).

The number which appears after the decimal, when multiplied by 10, will provide the approximate yield strength percentage in relation to the minimum tensile strength. For the 10.9 bolt, the 9 tells the user that the yield strength of the bolt is approximately 90% of the first number: 1,000 MPa. Thus, the 10.9 bolt has an approximate yield strength of 900 MPa (940 MPa by specification).



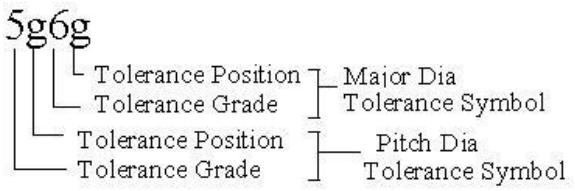
Two other common symbols that are included on metric parts are the "S" and the 3 designations. When a letter "S" is included after the first number of the property class (tensile strength number) it indicates a high-strength, heavy hex structural bolt.

Most ASTM specifications allow for the production of metric series and inch series fasteners from the same specification. For example, ASTM A490 allows for the production of ASTM A490M. The ASTM A490M is the metric A490 structural bolt (not to be confused with the DIN 6914: 10.9 structural bolt.

Metric Thread

The metric screw thread is identified by the capital letter M, followed by the nominal diameter. Metric threads are measured by the distance between two adjacent threads in millimeters (pitch). Threads on a standard (inch based) fastener are measured by counting the number of threads per inch.

The tolerance system for metric threads is composed of a two sets of a number followed by a letter. The first set indicates the pitch diameter tolerance, and the second set indicates the major diameter tolerance. Numbers indicate the range of tolerance or tolerance grade. Capital letters indicate internal thread (nut) tolerance. Lowercase letters indicate external thread (bolt) tolerance. It is customer to not repeat the set if the second set repeats the first set. For example, 6g6g would just be 6g.

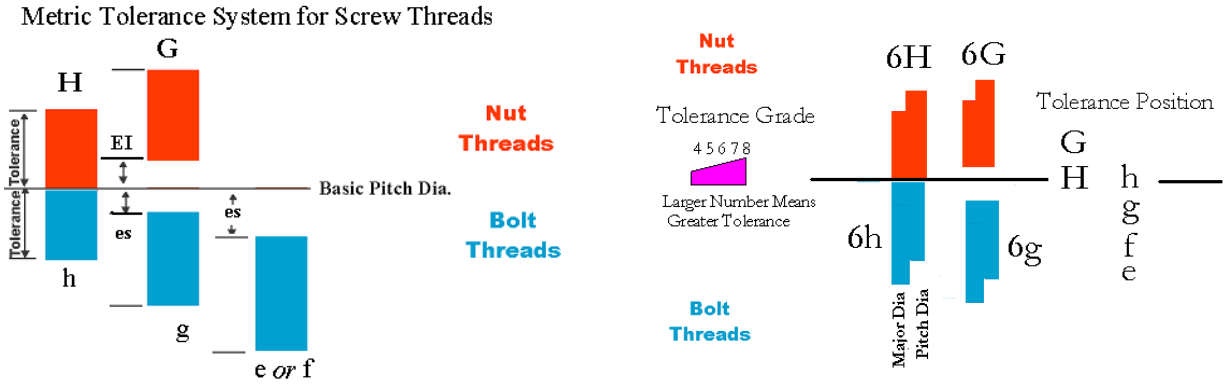


The 6g thread tolerance is comparable to a 2A Unified thread tolerance. The 6g tolerance allows room for plating. The 6h tolerance is comparable with the 3A Unified thread tolerance. The 6H tolerance is comparable to a 2B Unified thread tolerance. Like the inch series, internal threads with allowance are not standard practice. The illustration below show the tolerance of the metric screw threads.

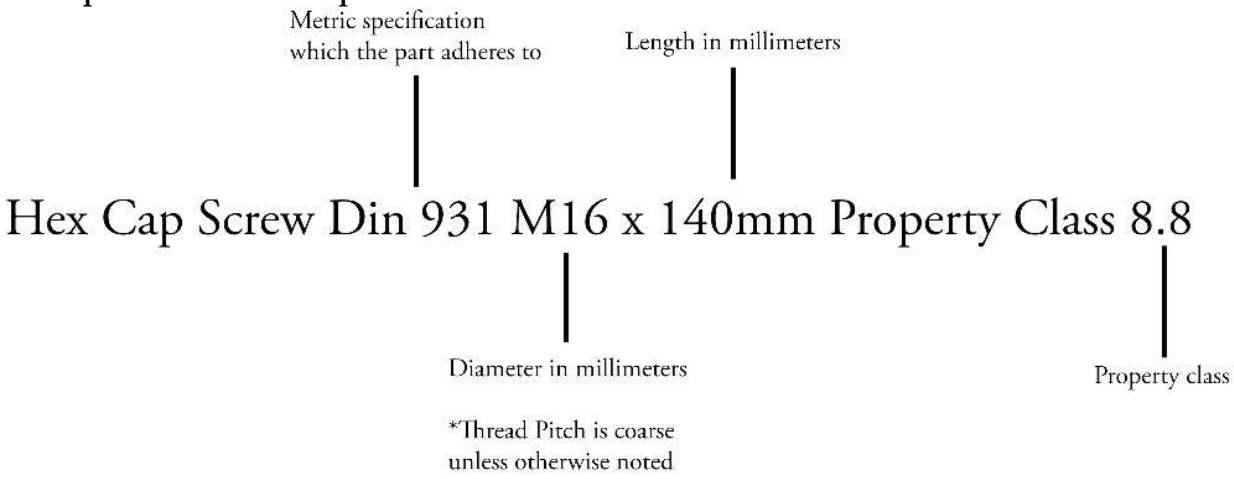
Other available thread tolerances:

5g6g: For DIN 912 or ISO 4762 Property class 12.9 socket head cap screws (class 8.8 and stainless steel socket head cap screws have 6g tolerance).

ANSI B18.3.1M uses 4g6g for all socket products regardless of strength class and material.



Example of Metric Description

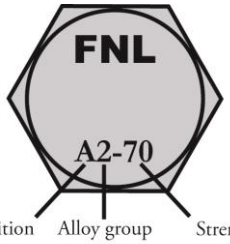


- Din 931; indicates partially threaded hex head cap screw – The DIN 931 standard will specify the thread tolerance.
- M16; diameter in mm (16 mm)
- In the metric system, all fasteners are assumed coarse thread unless another thread pitch is stated.
- Length listed in mm (140 mm)
- Property Class must be stated

ISO Stainless Steel

The metric system has its own unique way of marking and designating stainless steel fasteners. As with unified fasteners, metric bolts will be stamped to designate the type of stainless steel that they are made of.

Rather than being stamped with F593C/D or F593G/H (ASTM specifications for inch series stainless bolts), metric bolts will have a metric property class designation stamped on the head. This property class designation conveys most of the relevant necessary information about the fastener due to the design of the metric marking system.



Steel composition type (austenitic) | Alloy group designation (18-8) | Strength properties (700 MPa)

The first two characters in the marking indicate the steel grade. The letter denotes the composition of the steel's microstructure. The first number before the dash gives the specific alloy group which the steel belongs to. The final two characters convey the strength properties of the steel. This number is 10% of the minimum tensile strength of the bolt (10% of proof strength for nuts). Thus, multiplying this number by 10 will produce the minimum tensile strength of the fastener in MPa.

Metric Stainless Steel Fasteners

Steel Composition		Alloy Group		Property Class	
		#	Steel Type	#	Minimum Tensile Strength in MPa[1]
A	Austenitic	**1** **2** **4**	18-8[2] 18-8[3] 316	**50** **70** **80**	500 (soft) 700 (cold-worked) 800 (high strength)
F	Ferritic	**1**	430	**45** **60**	450 (soft) 600 (cold-worked)
C	Martensitic	**1** **4**	410 416, 416Se	**50** **70** **110**[4]	500 (soft) 700 (hardened and tempered) 1100 (hardened and tempered)
		3	431	**80** **120**[5]	800 (hardened and tempered) 1200 (hardened and tempered)
P[6]	Precipitation-Hardening	**1**	630 (17-4)	**90**	900

[1] If it is a stainless nut, then this number will indicate the Nut Proof Stress rather than the Minimum Tensile Strength.
[2] Specifics vary based on specification used. ISO alloy group 1 for austenitic indicates 18-8 with sulfur added for machining. ASTM alloy group 1 austenitic may indicate 304, 304L, 305, 384, or XM7. At customer request, 303, 303Se, or XM1 may be used.
[3] Specifics vary based on specification used. ISO alloy group 2 for austenitic indicates 18-8. ASTM alloy group 2 austenitic will consist of 321 or 347,
[4] C1-110 & C4-110 apply to ASTM metric only.
[5] C3-120 applies to ASTM metric only.
[6] Precipitation-Hardening stainless steel applies to ASTM metric only.