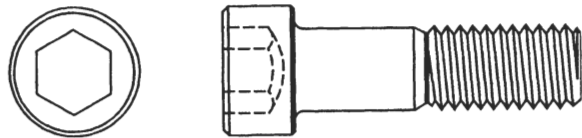


Inspecting Hex Socket Recesses

By Joe Greenslade



Joe Greenslade is President of Greenslade and Company, Inc. His company specializes in providing manufacturing tooling and inspection equipment to suppliers of screws, bolts, rivets, and nuts throughout the world. Greenslade is an associate member of the Industrial Fastener Institute (IFI), a member of the American Society of Mechanical Engineers B1 Thread Specification Committee, and a member of the Public Law 101-592 Task Force.



Hex recessed socket head cap screws are the highest performance standard commercial screws in both the inch and metric series. The inch socket head cap screws have strength levels between 170,000 and 180,000 PSI, which is 20% stronger than Grade 8 bolts. Metric socket head cap screws come in three property classes; 8.8, 10.9, and 12.9 with the 12.9, which is comparable to the inch strength level, being the most common.

Unlike most bolts that are designed to be tightened by rotating the nut on the bolt, hex socket head cap screws are specifically designed to be tightened to very high stress levels by rotating the

screw by means of the internal hex drive. The proper hex recess size and depth in the screw heads are critical in making sure that the hex driver bit or hex keys will fit snugly in the recess so the high torque values can be achieved without having recess of driver wear and rounding.

If the screw's hex recess is too small across corners or across flats, the driver may not enter the recess at all or not deeply enough to achieve the required high torque values without damaging the recess or driver. If the screw's hex recess is too shallow or the recess is too large across the flats, the driver has less engagement than necessary and in this case recess or driver reaming may result. If any of these undesirable driver to recess fit conditions exist the hex recess screws will not be adequately tightened. Inadequately tightened assembly joints can lead to many different kinds of product failures as a result of screw loosening or screw fatigue failures.

The only way a hex socket screw supplier or user knows if the screw's recesses have the correct hex size and socket depth is by inspecting the recesses with the hex recess gages specified in the various inch and metric hex socket screw standards. These standards include:

*** Inch**

- **ASME B18.3 (strength level: 170,000 - 180,000 PSI)**

*** Metric**

- **ASME B18.3.1M (Property class: 12.9)**
- **ISO 4762 (Property classes: 8.8, 10.9, and 12.9)**
- **DIN 912 (Property classes: 8.8, 10.9, and 12.9)**
- **JIS B 1176 (Property classes: 10.9 and 12.9)**

The proper inspection of hex sockets is extremely important to assure the screws will be able to be tighten properly. The hex socket recess must be inspected for proper size using Go and NOGO plug gages and socket penetration using a GO size element connected to an indicator.

Below are charts for the required sizes of hex socket gages for both inch and metric hex socket recesses. These charts only cover the most popular range of screw sizes. Those interested in smaller or larger sizes should review the specifications I have listed above.

There is only one series of hex socket gage sizes for inch screws. In the case of metric screws, the GO (minimum) size is the same size for all of the various standards: ASME, ISO, DIN, and JIS. For reasons I do not understand, none of these four standards agree completely on all of the NOGO (maximum) gage sizes. Those inspecting metric hex socket recess products must be careful to make sure

they are using the correct NOGO gaging element to properly evaluate screws to the appropriate standard. I have added a column to the metric chart for the NOGO gage sizes I recommend to screw manufacturers. It is difficult to use several different standards in one manufacturing facility. If the manufacturers will use the NOGO sizes I recommend the recesses which conform to these gage sizes will meet the requirements of all of the metric standards.

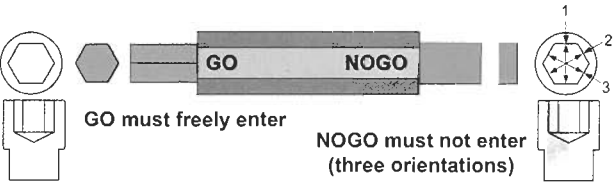
Inch Screw Size	Nominal Hex Size	ASME	
		Min. GO	Max. NOGO
#4	3/32	0.9370	0.0952
#5	3/32	0.0937	0.0952
#6	7/64	0.1094	0.1111
#8	9/64	0.1406	0.1426
#10	5/32	0.1562	0.1587
1/4	3/16	0.1875	0.1900
5/16	1/4	0.2500	0.2530
3/8	5/16	0.3125	0.3160
7/16	3/8	0.3750	0.3790
1/2	3/8	0.3750	0.3790
5/8	1/2	0.5000	0.5050
3/4	5/8	0.6250	0.6310
7/8	3/4	0.7500	0.7570
1	3/4	0.7500	0.7570

Note: Gage tolerance is GO + .0002" and NOGO - .0002"

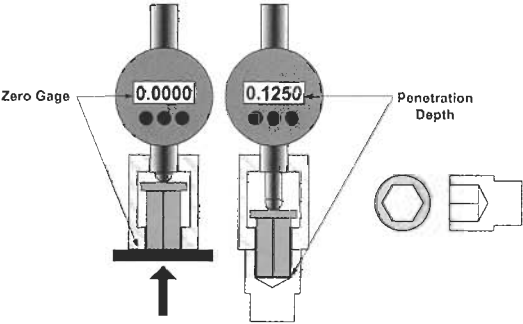
The use of the GO and NOGO plug gages to inspect hex socket recesses is simple. The hex shaped GO element must enter the full socket depth without interference. The rectangular shaped NOGO element must not enter the socket in any of its three across flats orientations.

Metric Screw Size	Nominal Hex Size mm	ASME ISO, DIN, JIS	ASME	JIS	DIN	ISO		Suggested Mfg NOGO Size
		Min. GO	Max. NOGO	Max. NOGO	Max. NOGO	Max. NOGO (12.9)	Max. NOGO (8.8,10.9)	Max. NOGO
M3	2.5	2.520	2.560	2.580	2.580	2.560	2.580	2.560
M4	3	3.020	3.071	3.080	3.080	3.071	3.080	3.071
M5	4	4.020	4.084	4.105	4.095	4.084	4.095	4.084
M6	5	5.020	5.840	5.105	5.140	5.840	5.140	5.840
M8	6	6.020	6.095	6.105	6.140	6.095	6.140	6.095
M10	8	8.025	8.115	8.130	8.175	8.115	8.175	8.115
M12	10	10.025	10.127	10.130	10.175	10.115	10.175	10.115
M16	14	14.032	14.159	14.230	14.212	14.142	14.212	14.212
M20	17	17.050	17.216	17.230	17.230	17.230	17.230	17.230
M24	19	19.065	19.243	19.275	19.275	19.275	19.275	19.275

Note: Gage tolerance is GO +.005 mm and NOGO -.005 mm.



What some standards refer to as "key engagement" is the minimum penetration depth of the socket recess. The GO size hex element must enter the screw's recess at least the minimum depth freely to be acceptable.



I have based my comments on hex socket head cap screws only. The same requirements and related gages and gaging techniques apply to hex socket button heads, flat heads, set screws, and shoulder screws.

Hex socket products are designed to be the highest performing commercial grade of externally threaded products. The quality of the hex recess in these parts is critical to their proper performance. The gages and techniques explained above should always be used to thoroughly inspect the recesses in these products thus assuring they meet the specification requirements.