

Hex Head Cap Screws Have Five Length Dimensions That Must Be Inspected

By Joe Greenslade

In recent years I have been asked several times to explain the correct way of measuring the various lengths that are specified on hex head cap screws. Hopefully, this article will help to make these length requirements easier to understand and inspect.

The standard governing the dimensional characteristics of hex head cap screws is ANSI/ASME B18.2.1. Note in the illustration (Figure 1) from this standard that there are five dimensions designated as different lengths. They are:

- "L" overall length
- "L_B" body length
- "L_G" grip gaging length
- "L_T" thread length
- "Y" transition thread length

Of these, L_T and Y are reference dimensions; the other three are dimensions having tolerances.

Reference Dimension

A reference dimension is one that provides an approximate dimension to use for general information relative to a complete part configuration. It does not have a tolerance and it is not a characteristic on which a product can be rejected. Also, these characteristics are never critical to the proper fit or function of the final product.

The L_T on cap screws that are 6 inches and shorter is equal to two times the basic diameter plus 1/4 inch. Therefore, a 1/2-13 X 2-1/4" cap screw is to have thread length of approximately 1-1/4 inch ($[1/2" \times 2] + 1/4"$).

The L_T for cap screws over 6 inches is

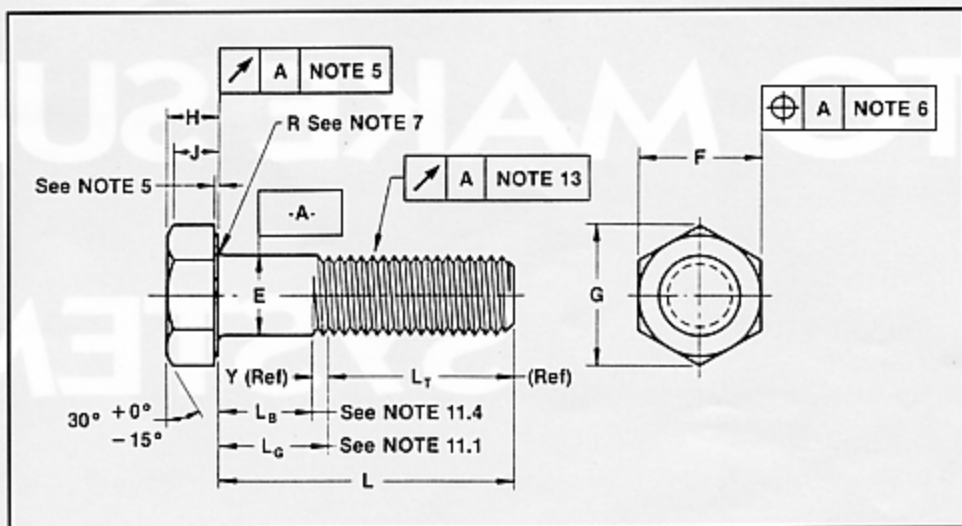


Figure 1.

1/2 inch. Therefore, the thread length of a 1/2-13 X 8" cap screw is to be approximately 1-1/2 inches ($[1/2" \times 2] + 1/2"$). These reference lengths are listed as L_T in Table 4 of the standard.

The Y dimension is defined in paragraph 11.5 as follows:

"Transition thread length Y, is a reference dimension equal to five coarse (UNC) pitches intended for calculation purposes only, which includes the length of incomplete threads, the extrusion angle on rolled threads, and tolerances on grip length."

This means that since the pitch length of a 1/2-13 thread is .077 inches (1.00" divided by 13), the Y on 1/2 inch cap screws is .385 inch ($5 \times .077"$). The transition thread length is the same whether the thread is coarse or fine. The Y dimension is also listed in Table 4.

Dimensions Having Tolerances

The dimensions that have tolerances are L, L_G, and L_B. The tolerances for cap screw L dimensions are found in Table 7 of the standard under "Pointed Products". All L dimension tolerances are plus nothing, minus .030 inches up to minus .240 inches, depending on the cap screw's basic diameter and nominal length. This dimension from the bearing surface to the extreme end of the cap screw. This can be measured with a scale, caliper, or fastener length gage. This is a relatively easy-to-measure, seldom disputed, characteristic.

The L_G is defined in paragraph 11.2. It is determined by screwing a non-countersunk Go ring gage on the thread until it stops and then measuring from the gage's face to the cap screw's bearing surface. Making this mea-

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He is an Associate Member of the Industrial Fastener Institute and a member of the American Society of Mechanical Engineers B1 Thread Specification Committee. In 1992, Joe was recognized for his technical and innovative contributions to the fastener industry when, at age 44, he became the youngest person to be inducted into the National Industrial Fastener Show "Hall of Fame."

Hex Head Cap Screws

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surement (see Figure 2) is not difficult. The problem with this procedure is that "non-counterbored or non-countersunk" Go ring gages are not standard. All sizes are special order and cost approximately two to three times the standard Go ring gage. In the past fifteen years our firm has never taken an order for one of these gages. That leads me to believe that not many companies are actually making this

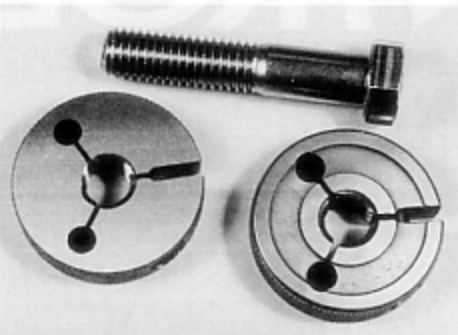


Figure 2. Special non-counterbored Go ring gage (left) and standard Go ring gage (right).

measurement. The L_G is acceptable as long as it does not exceed its calculated length as explained below. Parts can only be rejected if the L_G is too long since there is no minimum requirement.

The specifications for L_G , referred to as L_G max in Table 4B, are tabulated for "Full Threaded" cap screws within a designated range of nominal lengths. For other nominal lengths, the L_G is to be calculated by subtracting the specified L_T from the nominal length. In the case of a 1/2-13 X 2 1/4" cap screw, the L_G max is 1.00 inches (2.25" - 1.25"). Notice that the cap screw in Figure 3 is out of tolerance by being 0.052 inches too long.

The L_B , referred to as L_B min in Table 4B, is defined in paragraph 11.4 as the distance from the "last scratch of thread or top of the extrusion angle" to the cap screw's bearing surface. Table 4B lists the requirements for "Full Threaded" cap screws. Other cap screw L_B min. requirements are calculated by subtracting the Y listed in Table 4 from the measured L_G of the cap screw being measured. Following our 1/2-13 X 2-1/4" cap screw example, this pictured part would be rejectable if its L_B was

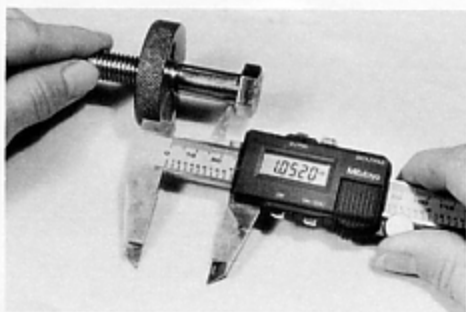


Figure 3. Measuring " L_G max" with non-counterbored Go ring gage and caliper.

shorter than .667 inches (1.052" - .385"). □

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