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Specifying the Position Tolerance at MMC[1]

Where the maximum material condition (MMC) symbol is specified to modify the tolerance of a feature of size in a feature control frame, the following two requirements apply:

- The specified tolerance applies at the MMC size of the feature. The MMC of a feature of size is the largest shaft and the smallest hole. The MMC size of a feature is not to be confused with the MMC modifier, circle M.
- As the actual mating envelope size of the feature departs from MMC toward LMC, a bonus tolerance is achieved in the exact amount of such departure.

Bonus tolerance equals the difference between the actual mating envelope and the MMC sizes of a feature. The bonus tolerance is added to the geometric tolerance specified in the feature control frame. Of the three material condition modifiers, the MMC modifier is the most common and is typically used for features on parts that are to be fastened together in a static assembly.

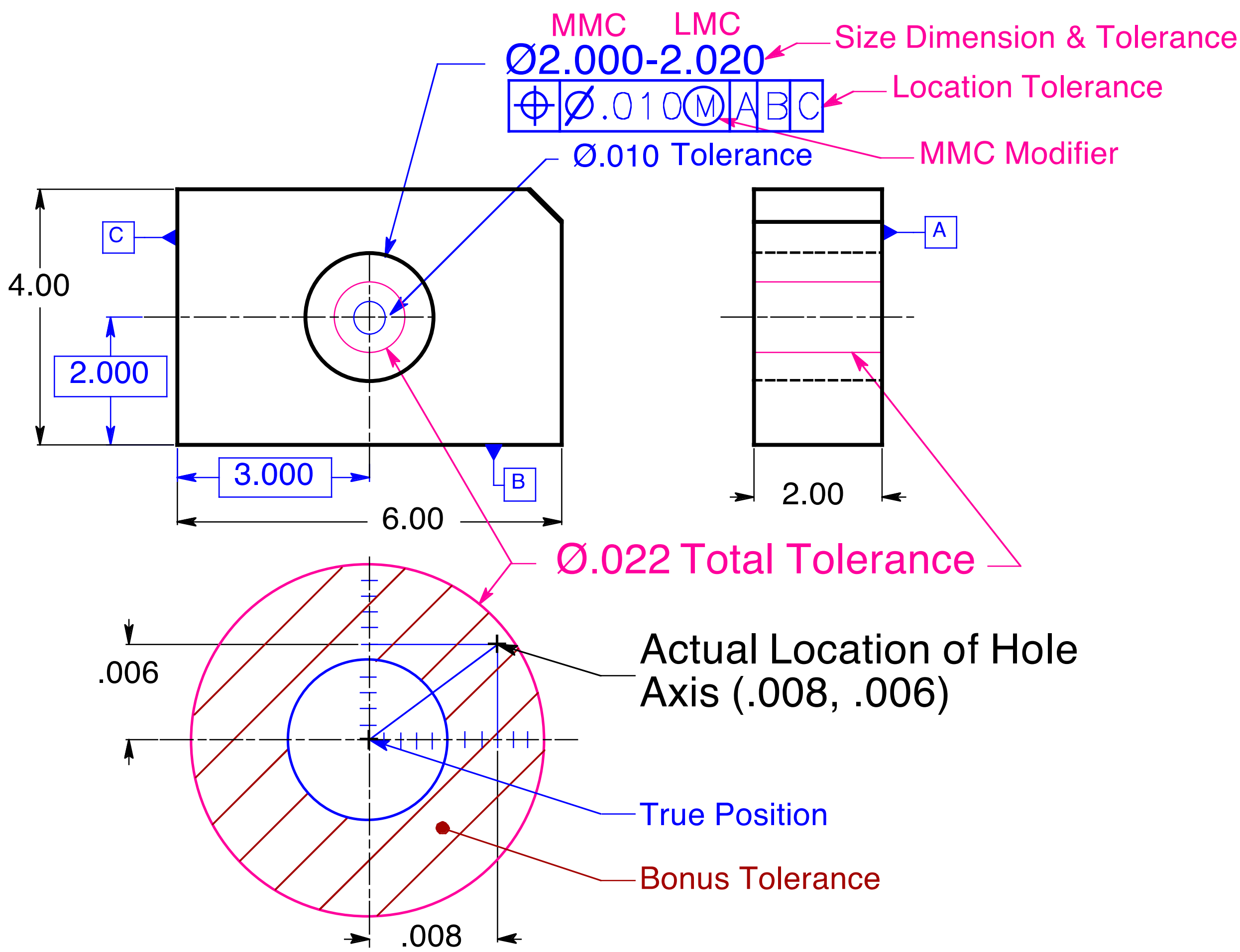

Figure 7-5 Analysis of the hole location using a theoretical tolerance zone specified at MMC.

Suppose that the 2-inch hole in Fig. 7-5 is inspected; the actual mating envelope diameter of the hole is found to be 2.012, and the actual axis is found to be .006 up and .008 over from true position. By applying the Pythagorean theorem to these coordinates, it is easily determined that the actual axis is .010 away from true position. To be acceptable, this part requires a cylindrical tolerance zone centered on true position of at least .020 in diameter. The tolerance is only .010 in diameter, but it is specified with an MMC modifier; consequently, bonus tolerance is available. The following formulas are used to calculate the bonus tolerance and total positional tolerance:

Actual Mating Envelope Size – MMC Size = Bonus Tolerance

Bonus Tolerance + Geometric Tolerance = Total Positional Tolerance

When the calculations in Table 7-2 are completed, the total positional tolerance zone is .022 in diameter, sufficient tolerance to make the hole in the part in Fig. 7-5 acceptable. Bonus tolerance is the positive difference or the absolute value between the actual mating envelope and MMC.

Actual Mating Envelope	– MMC	= Bonus	+ Geometric Tolerance	= Total Positional Tolerance
2.012	2.000	.012	.010	.022

Table 7-2 Calculation of Bonus Tolerance for an Internal Feature

Inspection with a Functional Gage

Another way of inspecting the hole specified at MMC is with a functional gage like the one shown in Fig. 7-6. A functional gage for this part is a datum reference frame with a virtual condition pin positioned perpendicular to datum feature A and located a basic 2.000 inches up from datum feature B and a basic 3.000 inches over from datum feature C. If the part can be set over the pin and placed against the datum reference frame in the proper order of precedence, the hole is in tolerance.

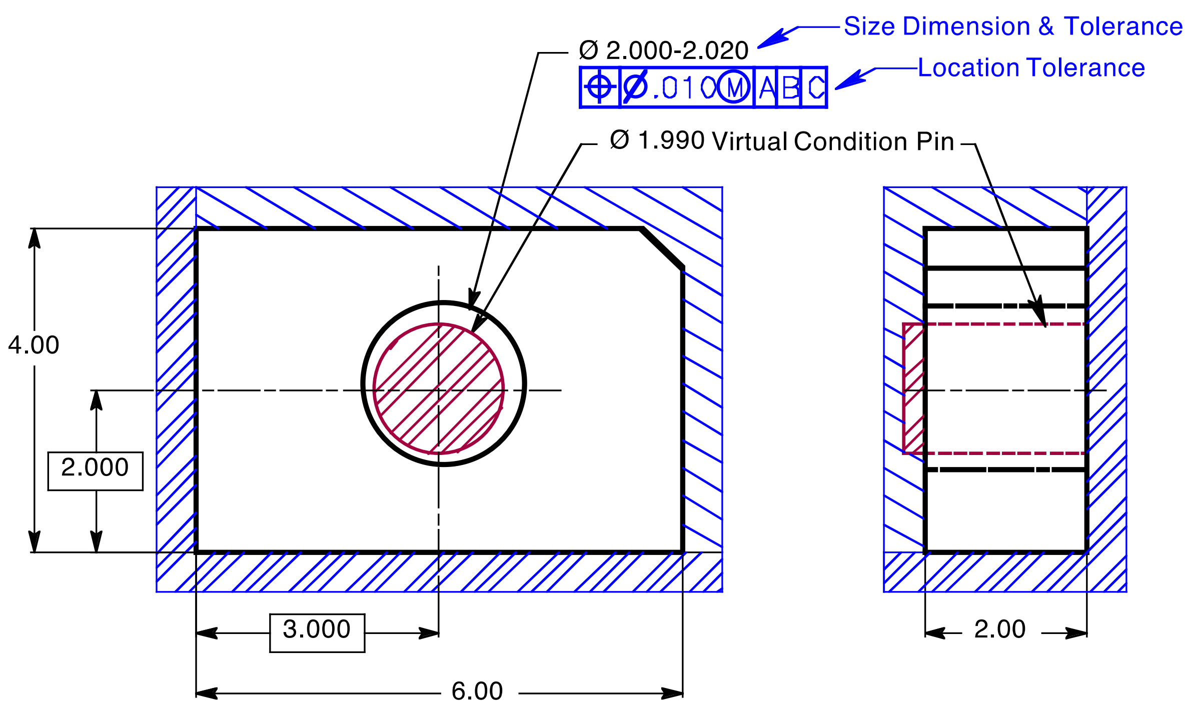

Figure 7-6 Inspection of a feature of size with a position tolerance at MMC using a functional gage.

Although features toleranced with GD&T may be inspected using any appropriate inspection technique, functional gages are very convenient for checking large numbers of parts or when inexperienced operators are required to inspect parts. A functional gage represents the worst-case mating part. Dimensions on gage drawings may be either toleranced or dimensioned with basic dimensions. Tolerances for basic dimensions on gage drawings are gage-makers' tolerances. Gage-makers' tolerances are usually no more than 10% of the tolerance of the part. All the tolerance for the gage comes from the tolerance for the part. In other words, a gage may not accept a bad part, but it can reject a marginally good part. If a part is inspected with a gage and also with some other inspection method and the two methods yield contradictory results, the gage is the more reliable inspection method because the gage more closely simulates the mating part.

[1]Cogorno, Gene R., ***Geometric Dimensioning and Tolerancing for Mechanical Design, Second Edition***, McGraw-Hill, New York, 2011, p. 109.