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The Tolerance of Position

Definition

The tolerance of position may be viewed in either of two ways:

- A *theoretical tolerance zone* of the toleranced feature located at true position within which the center point, axis, or center plane of the feature may vary from true position.
- A *virtual condition boundary* of the toleranced feature, when specified at MMC or LMC and located at true position, which may not be violated by the surface or surfaces of the considered feature.

The tolerance of position

A feature of size, such as the pin shown in Figure 7-1, has four geometric characteristics that must be controlled. These characteristics are size, form, orientation, and location. Both size and form are controlled by the limits of size. Rule #1 states that an individual regular feature of size may not exceed the boundary of perfect form at maximum material condition. If the actual local size of the pin is smaller than the MMC size, it may bow or be out of round by the amount that it departs from MMC. The sum of the actual local size and any form error equals the actual mating envelope.

The orientation and location of a feature are both controlled by the tolerance of position. The total positional tolerance is equal to the tolerance specified in the feature control frame plus any bonus tolerance. The pin in Figure 7-1 has a positional tolerance of .005 in diameter at MMC plus the bonus tolerance. Bonus tolerance is the difference between the maximum material condition and the actual mating envelope. Because the maximum material condition is a diameter of 1.020 and the actual mating envelope is a diameter of 1.012, the bonus tolerance is .008; the total positional tolerance is equal to the geometric tolerance, .005, plus the bonus tolerance, .008, or a total of .013. The combination of the form error and the total positional tolerance is equal to the difference between the virtual condition and the actual local size of the pin.

- **MMC – Actual Mating Envelope = Bonus**
- **Bonus + Geometric Tolerance = Total Positional Tolerance**

MMC	Actual Mating – Envelope	= Bonus	Geometric + Tolerance	Total Positional = Tolerance
1.020	1.012	.008	.005	.013

Table 7-1 The calculation of bonus tolerance for an external feature

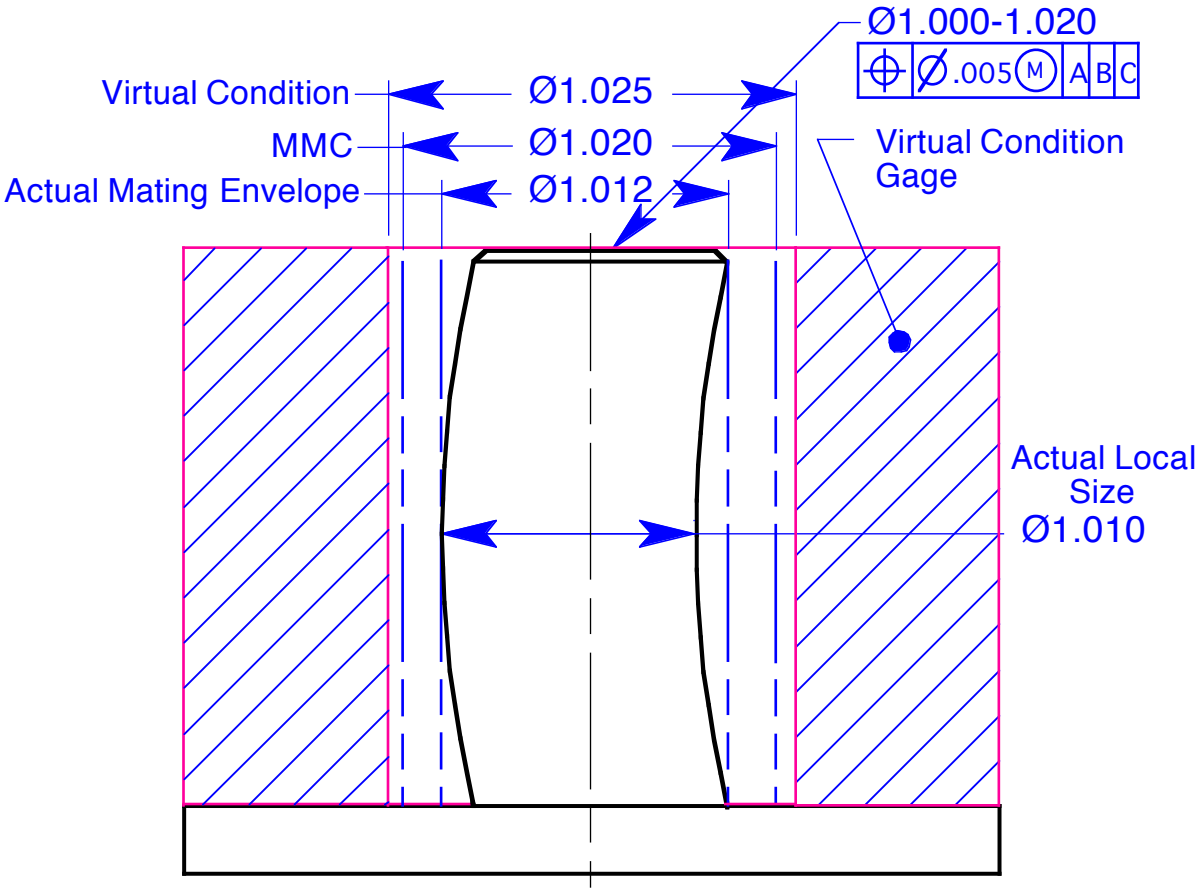

Figure 7-1 Both the limits of size and the tolerance of position control size, form, orientation, and location.

Definitions[1]

1. **Actual local size**
   The measured value of any individual distance at any cross section of a feature of size.

[1]Cogorno, Gene R., ***Geometric Dimensioning and Tolerancing for Mechanical Design***, McGraw-Hill, New York, 2006, p. 30.

2. **Actual Mating Envelope**
   The actual mating envelope is a similar, perfect, feature(s) counterpart of smallest size that can be contracted about an external feature(s) or largest size that can be expanded within an internal feature(s) so that it coincides with the surface(s) at the highest points. Two types of actual mating envelopes are described below

   - **Unrelated Actual Mating Envelope**

     An unrelated actual mating envelope is a similar perfect feature(s) counterpart contracted about an external feature(s) or expanded within an internal feature(s), and not constrained to any datum feature(s).

   - **Related Actual Mating Envelope**

     A related actual mating envelope is a similar perfect feature(s) counterpart contracted about an external feature(s) or expanded within an internal feature(s) while constrained either in orientation or location or both to the applicable datum feature(s).

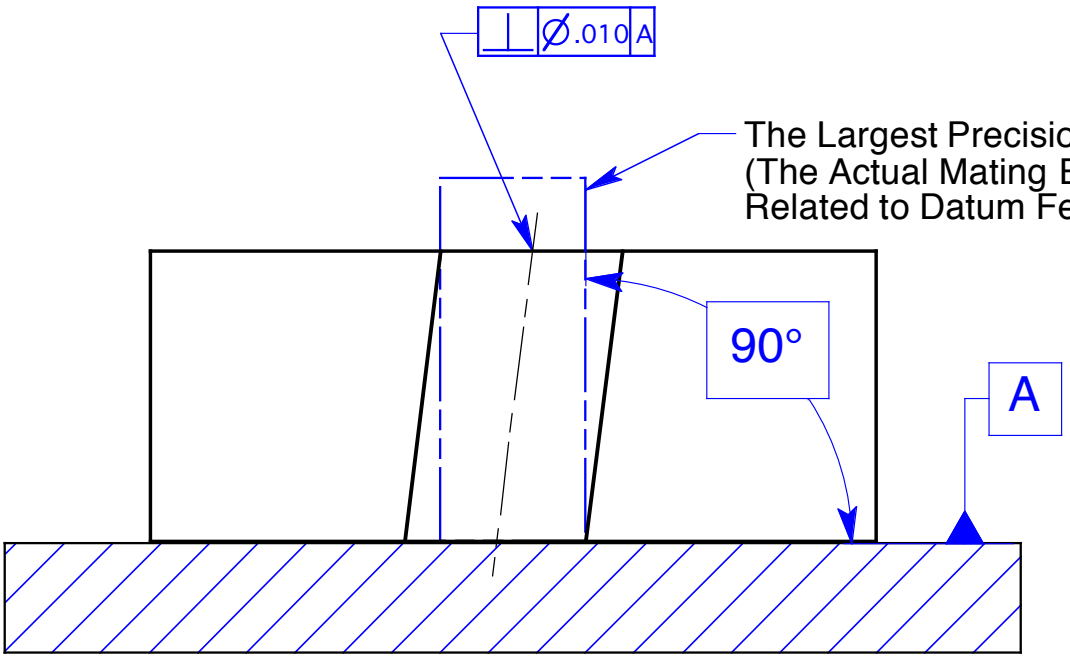

Figure 3-25 The actual related mating envelope is the largest precision pin, perpendicular to datum plane A that will fit inside the hole

3. **Maximum Material Condition (MMC)**
   The MMC of a feature of size is the maximum amount of material within the stated limits of size. For example, the maximum shaft diameter or the minimum hole diameter.

4. Virtual Condition

The virtual condition of a feature of size specified at MMC is a constant boundary generated by the collective effects of the MMC limit of size of the feature and the specified geometric tolerance. Features specified with a least material condition modifier also have a virtual condition.

Virtual condition calculations:

External Features (Pins)

	MMC
Plus	Geo. Tol. @ MMC
Equals	Virtual Condition

Internal Features (Holes)

	MMC
Minus	Geo. Tol. @ MMC
Equals	Virtual Condition