

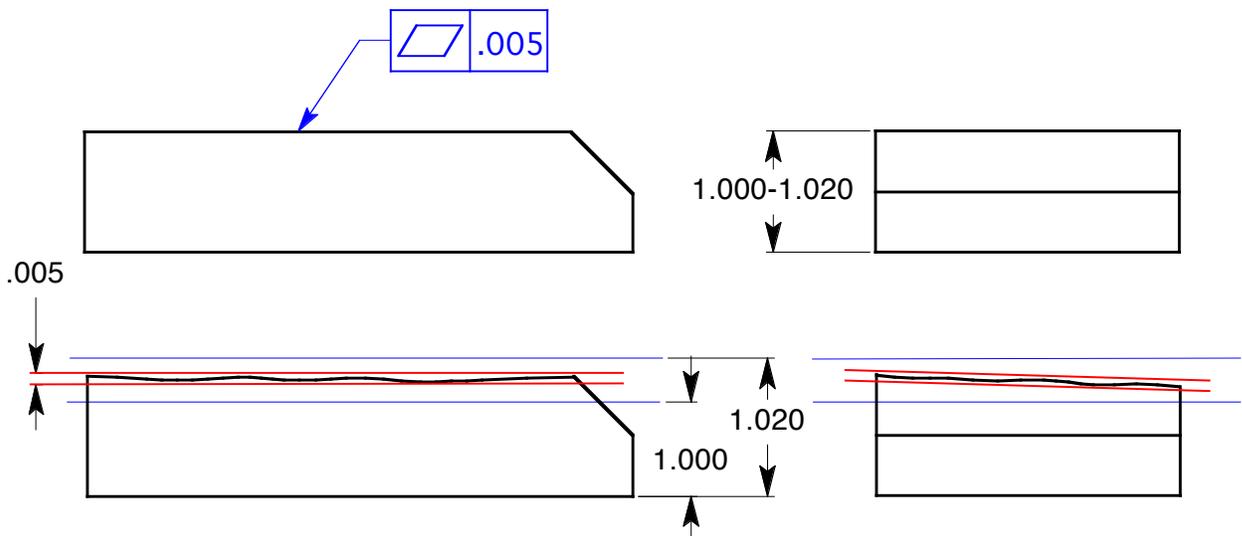
# Flatness<sup>1</sup>

## Definition

Flatness is the condition of a surface or derived median plane having all elements in one plane.

## Specifying Flatness Tolerance

In a view where the surface to be controlled appears as a line, a feature control frame is attached to the surface with a leader or extension line, as shown in Fig. 5-1. The feature control frame contains a flatness symbol and a numerical tolerance. Normally, nothing else appears in a feature control frame controlling flatness of a surface, except possibly the free-state symbol or unit flatness. Flatness tolerance is a refinement of the size tolerance, rule #1, and must be less than the size tolerance. The thickness at each local size must fall within the limits of size; the feature of size may not exceed the boundary of perfect form at maximum material condition.

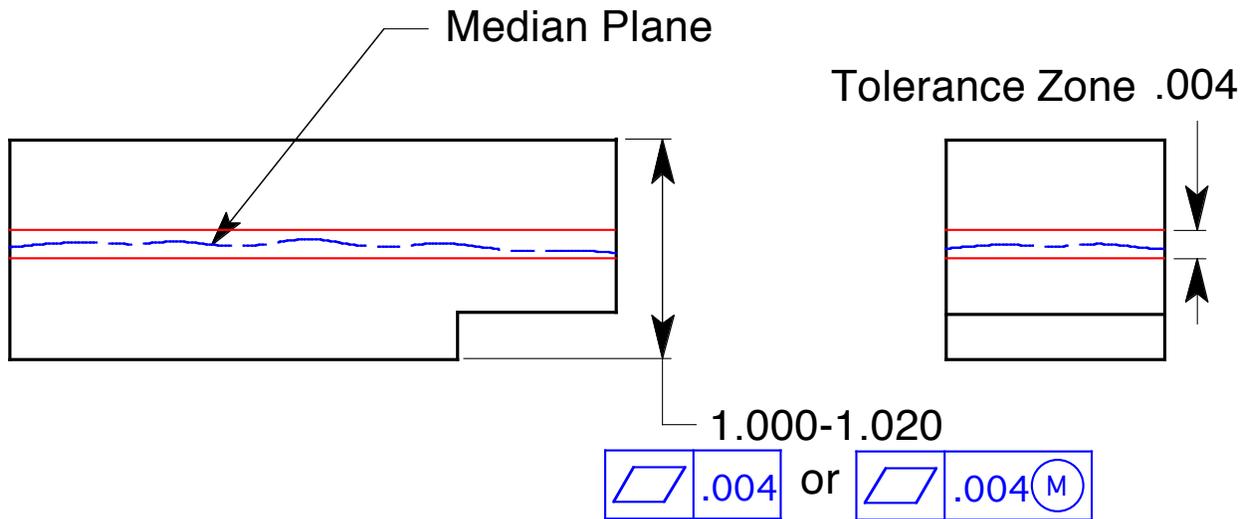


**Figure 5-1 A flatness tolerance applied to a plane surface**

## Interpretation

The surface being controlled in Fig. 5-1 must lie between two parallel planes separated by the flatness tolerance of .005 specified in the feature control frame. In addition, the surface must fall within the size tolerance, the two parallel planes .020 apart. The flatness tolerance zone does not need to be parallel to any other surface, as indicated in the right side view. The standard states that the flatness tolerance must be less than the size tolerance, but the size tolerance applies to both top and bottom surfaces of the part. The manufacturer probably will make the part in Fig. 5-1 about 1.010 thick using only half the size tolerance. Since the maximum material condition of 1.020 minus the actual size of 1.010 is an automatic rule #1 form tolerance of .010, a flatness tolerance refinement of .005, as specified in the feature control frame, seems appropriate. The entire part in Fig. 5-1 must fit between two parallel planes 1.020 apart. If the thickness of the part is produced anywhere between 1.015 and 1.020, the flatness of the part is controlled by rule #1.

If the thickness of the part is between 1.000 and 1.014, the geometric tolerance ensures that the top surface of the part does not exceed a flatness of .005.



**Figure 5-3 The flatness tolerance of a median plane is associated with the size dimension.**

### Specifying Flatness of a Median Plane

When a feature control frame with a flatness tolerance is associated with a size dimension, the flatness tolerance applies to the median plane for a noncylindrical feature (Fig. 5-3). The median plane derived from the surfaces of the noncylindrical feature may bend, warp, or twist in any direction away from a perfectly flat plane but must not exceed the flatness tolerance zone boundaries.

<sup>1</sup>Cogorno, Gene R., *Geometric Dimensioning and Tolerancing for Mechanical Design, Second Edition*, McGraw-Hill, New York, 2011, p. 69.