

ADVANCED GEOMETRIC DIMENSIONING AND TOLERANCING

Presented by

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Advanced G D & T

Course Outline



1. Introduction

2. Datums

- a. Implied
- b. Features of Size
- c. Inclined Datum features
- d. Multiple Datum Features
- e. Coplanar Datums
- f. Partial Surface as a Datum Feature

3. Graphic Analysis

- a. Composite Positional Tolerancing
- b. Pattern of Features Located to a Common Datum of Size Controlled by a Geometric Tolerance

- 4. Pattern of Features Located to a Common Datum of Size Controlled by a Geometric Tolerance**
 - a. Shift Tolerance from Size Datums at MMC
 - b. Inspection Requirements for VC Rule

- 5. Multiple Patterns of Features Located to Common Datums**
 - a. Datum–To–Pattern Relationship
 - b. Feature–to–Feature Relationship
 - c. Inspection Requirements
 - d. Separate and Simultaneous Requirements

- 6. Composite Positional Tolerancing**
 - a. Primary Datum Repeated
 - b. Primary and Secondary Datums Repeated
 - c. Two Single–Segment Feature Control Frames

7. **Fasteners**
 - a. Floating Fasteners
 - b. Fixed Fasteners
 - c. Fasteners at “0” Positional Tolerance
 - d. Pin Location

8. **Bidirectional Positional Tolerance**
 - a. Rectangular Coordinate Method
 - b. Polar Coordinate Method
 - c. Noncircular Features

9. **Coaxial Positional Tolerancing**
 - a. Coaxial Plug and Socket
 - b. Coaxial Holes the Same Size Parallel
 - c. Coaxial Holes of Different Size

10. **Profile**
 - a. Profile Control
 - b. Profile and Orientation Control
 - c. Profile Control of Coplanar Surfaces
 - d. Profile, Orientation, and Location Control
 - e. Profile and Size Datums
 - f. Profile for Sheet Metal Parts

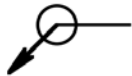














Course Objectives

Participants will be able to:










1. Demonstrate a thorough understanding of GD&T fundamentals
 - A. Symbols
 - B. Terms
 - C. Rules
2. Properly apply frequently used tolerancing schemes
3. Locate the proper GD&T applications in reference materials

Pertains to	Type of Tolerance	Geometric Characteristics	Symbol
Individual Feature Only	Form	STRAIGHTNESS	—
		FLATNESS	▭
		CIRCULARITY	○
		CYLINDRICITY	⊘
Individual Feature or Related Features	Profile	PROFILE OF A LINE	⌒
		PROFILE OF A SURFACE	⊔
Related Features	Orientation	ANGULARITY	∠
		PERPENDICULARITY	⊥
		PARALLELISM	//
	Location	POSITION	⊕
		CONCENTRICITY	◎
		SYMMETRY	≡
	Runout	CIRCULAR RUNOUT	↗
		TOTAL RUNOUT	↗↗

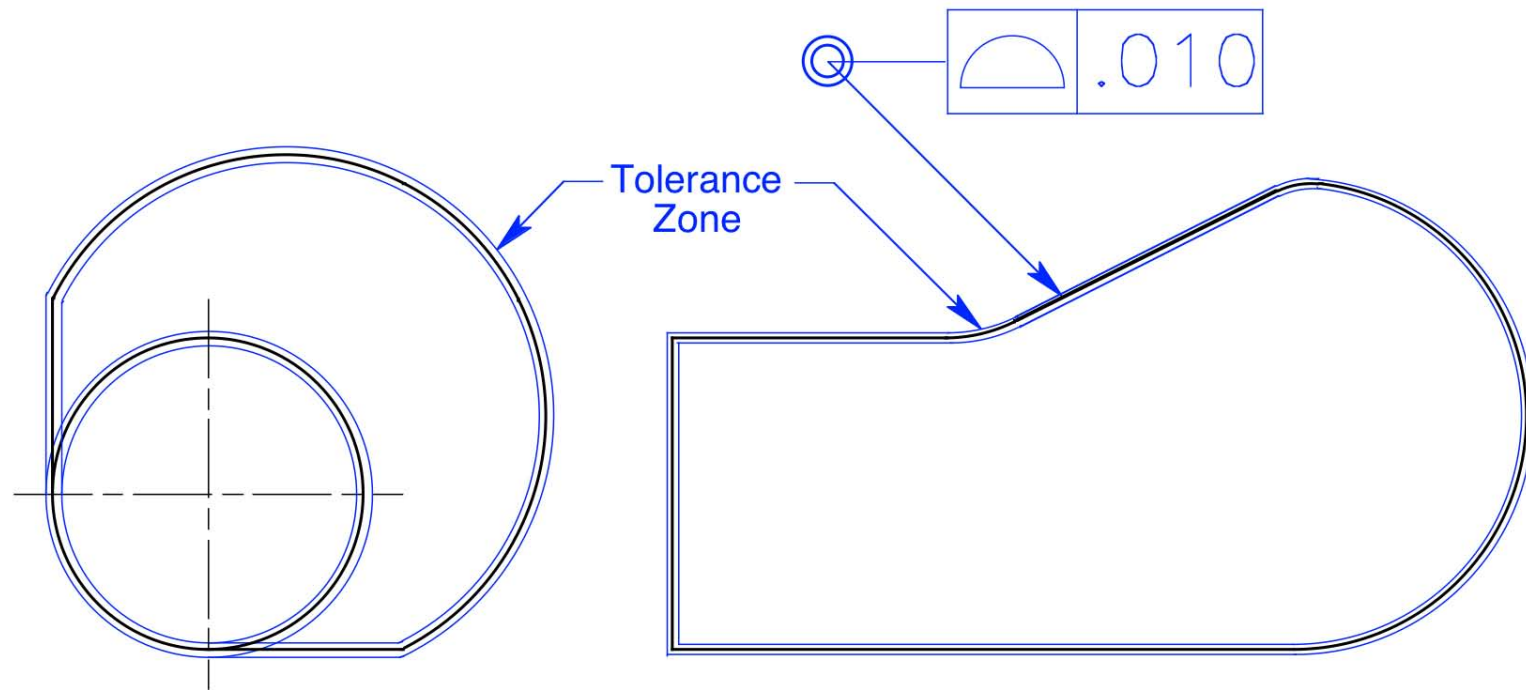
Geometric Characteristic Symbols

All Around		Free State	
Between		Projected Tolerance Zone	
Number of Places	X	Tangent Plane	
Counterbore/Spotface		Radius	R
Countersink		Radius, Controlled	CR
Depth/Deep		Spherical Radius	SR
Diameter	∅	Spherical Diameter	S∅
Dimension, Basic	1.000	Square	□
Dimension, Reference	(60)	Statistical Tolerance	
Dimension Origin		Datum Target	
Arc Length		Target Point	
Conical Taper		Slope	

Other symbols used on prints

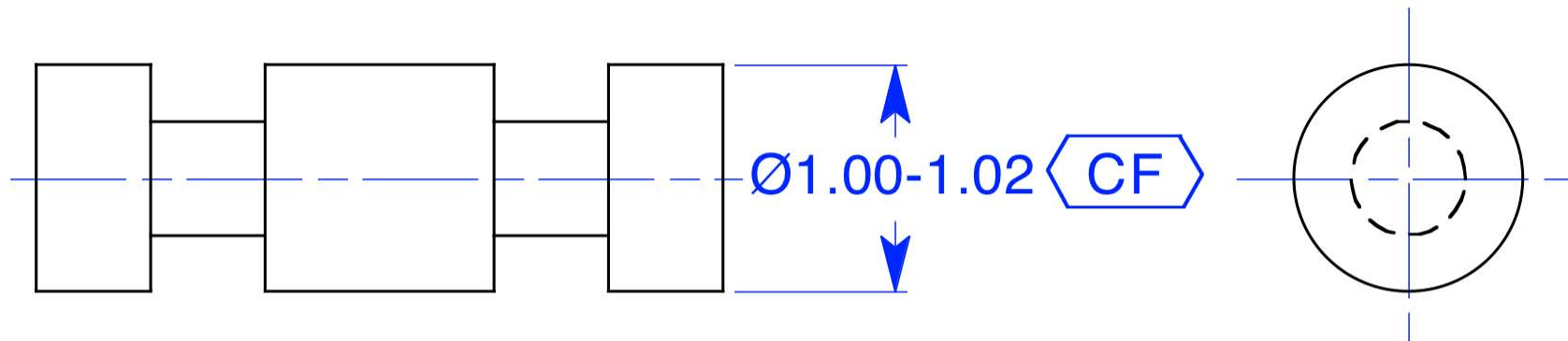
<p>AT MAXIMUM MATERIAL CONDITION (When applied to a tolerance value)</p> <p>AT MAXIMUM MATERIAL BOUNDARY (When applied to a datum reference)</p>	
<p>AT LEAST MATERIAL CONDITION (When applied to a tolerance value)</p> <p>AT LEAST MATERIAL BOUNDARY (When applied to a datum reference)</p>	
<p>ALL OVER</p>	
<p>CONTINUOUS FEATURE</p>	
<p>SPOT FACE</p>	
<p>INDEPENDENCY</p>	
<p>UNEQUALLY DISPOSED PROFILE</p>	
<p>DATUM TRANSLATION</p>	
<p>MOVABLE DATUM TARGET SYMBOL</p>	

New symbols in the 2009 standard



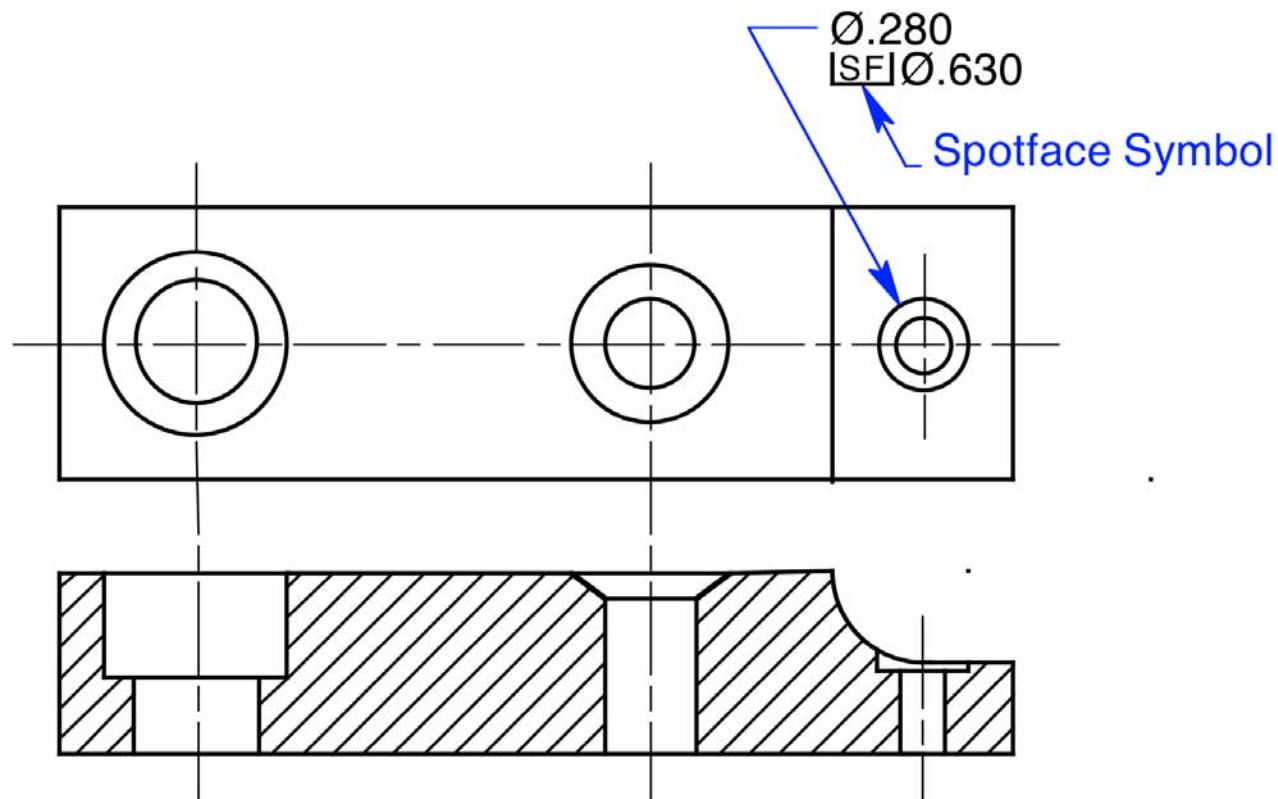
All over symbol

The **All Over** symbol indicates that the specified tolerance applies in all views, all over the three-dimensional profile of the part.



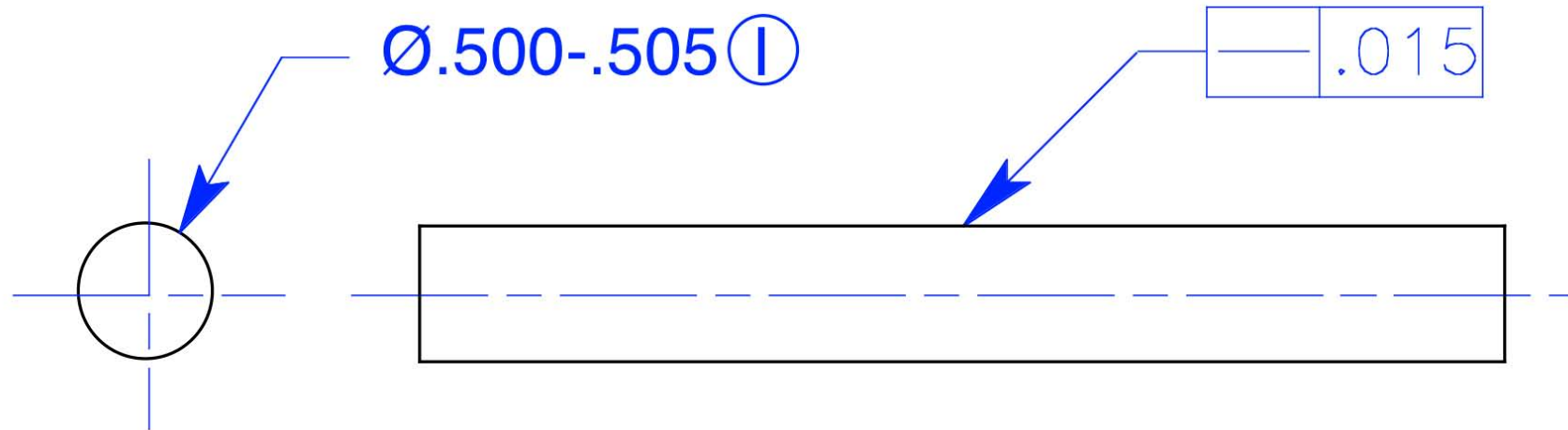
Continuous feature symbol

The **Continuous Feature** symbol specifies that a group of two or more interrupted features of size be considered as one single feature of size.



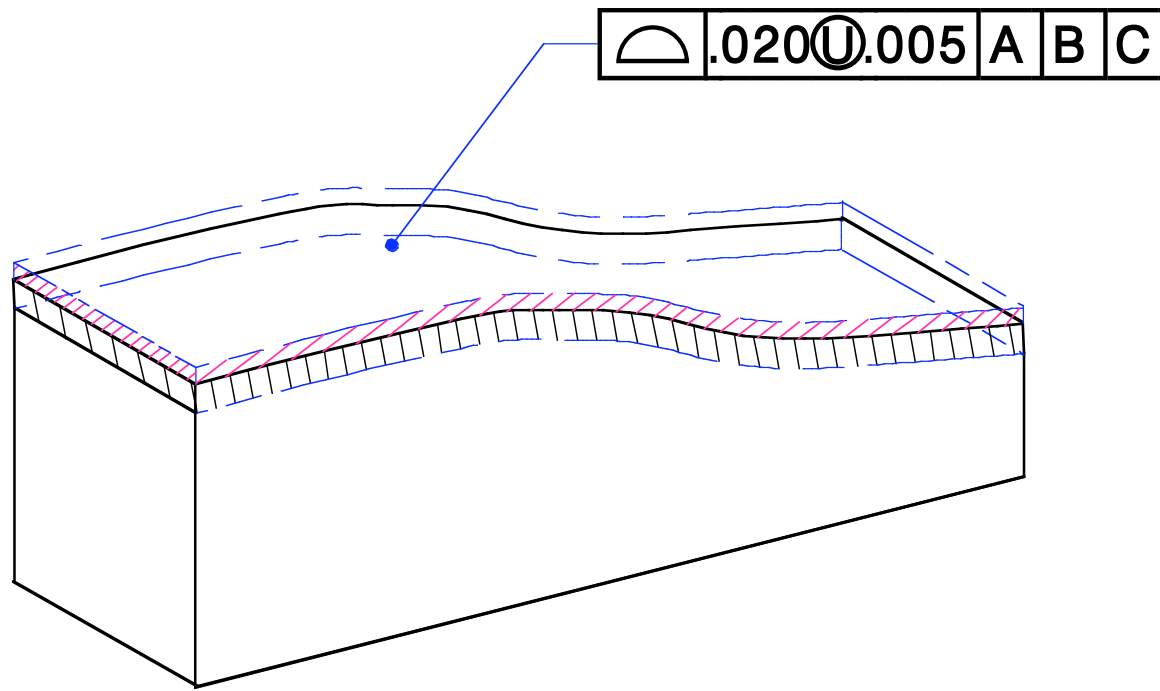
Spotface

Where a **Spotface** is indicated, either the depth or the remaining thickness of the material may be specified. If no depth or remaining thickness is specified, the spotface is the minimum depth necessary to clean up the surface of the specified diameter.



Independence Symbol

The **Independency** symbol, circle I, indicates that perfect form of a feature of size at MMC or LMC is not required.



Unequally disposed profile symbol

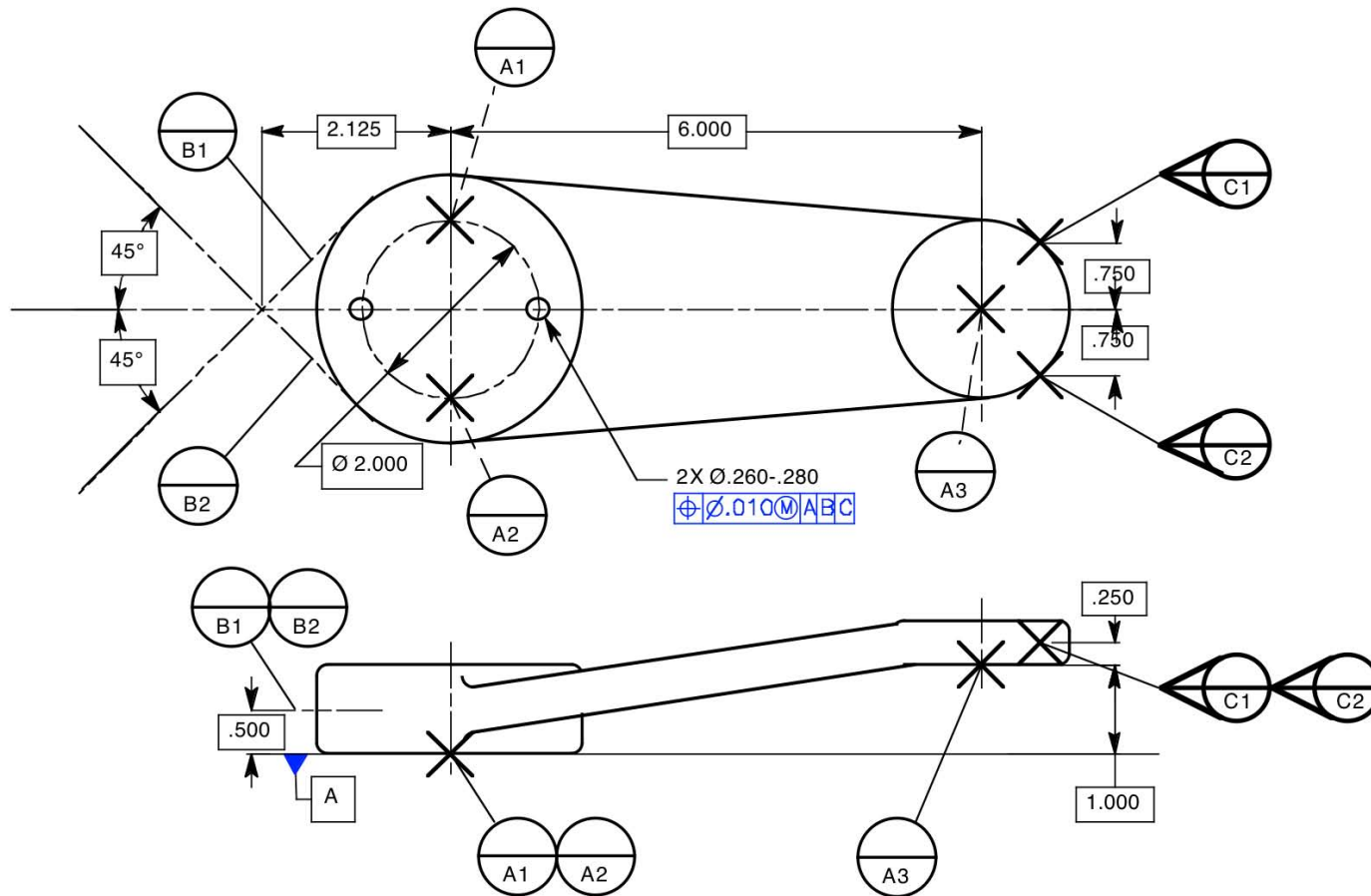
The **Unequally Disposed Profile** symbol, circle U, indicates a unilateral tolerance or a tolerance unequally disposed about the true profile.

Datum Translation Symbol



Datum Translation symbol

The **Datum Translation** symbol indicates that a datum feature simulator is not fixed and is free to translate within the specified geometric tolerance to fully engage the feature.



Movable Datum targets for step and equalizing datums

The **Movable Datum Target** symbol indicates that a datum target is not fixed at its basic location and is free to translate.

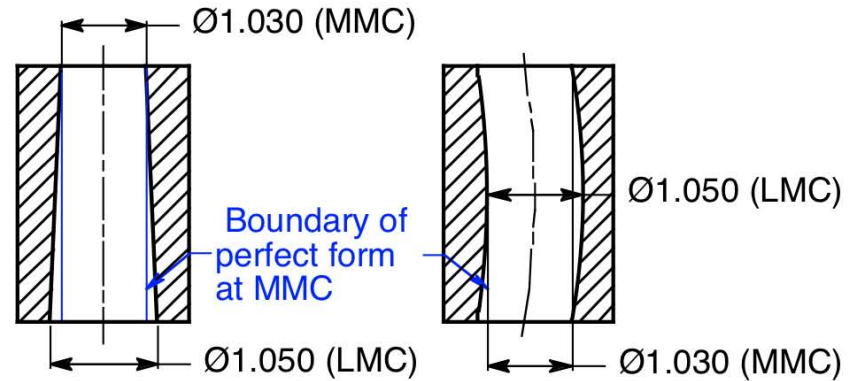
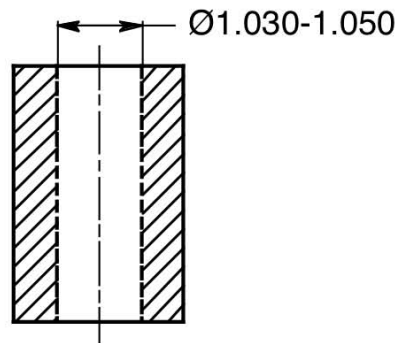
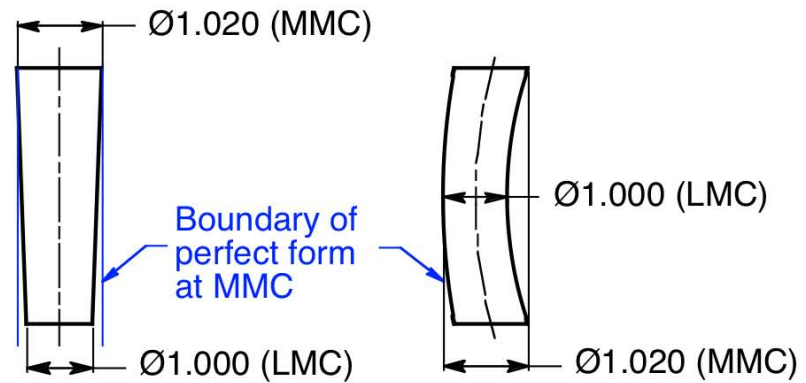
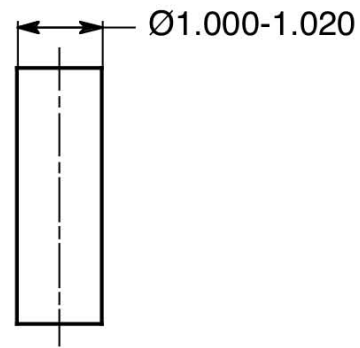
Rules

Rule #1

Rule #1 states that where only a tolerance of size is specified, the limits of size of an individual feature prescribe the extent to which variations in its **geometric form**, as well as its **size**, are allowed.

No element of a feature shall extend beyond the maximum material condition boundary of perfect form.

The form tolerance increases as the actual size of the feature departs from MMC toward LMC. There is no perfect form boundary requirement at LMC.



Dimensions on the drawing

Allowed extremes of size and form

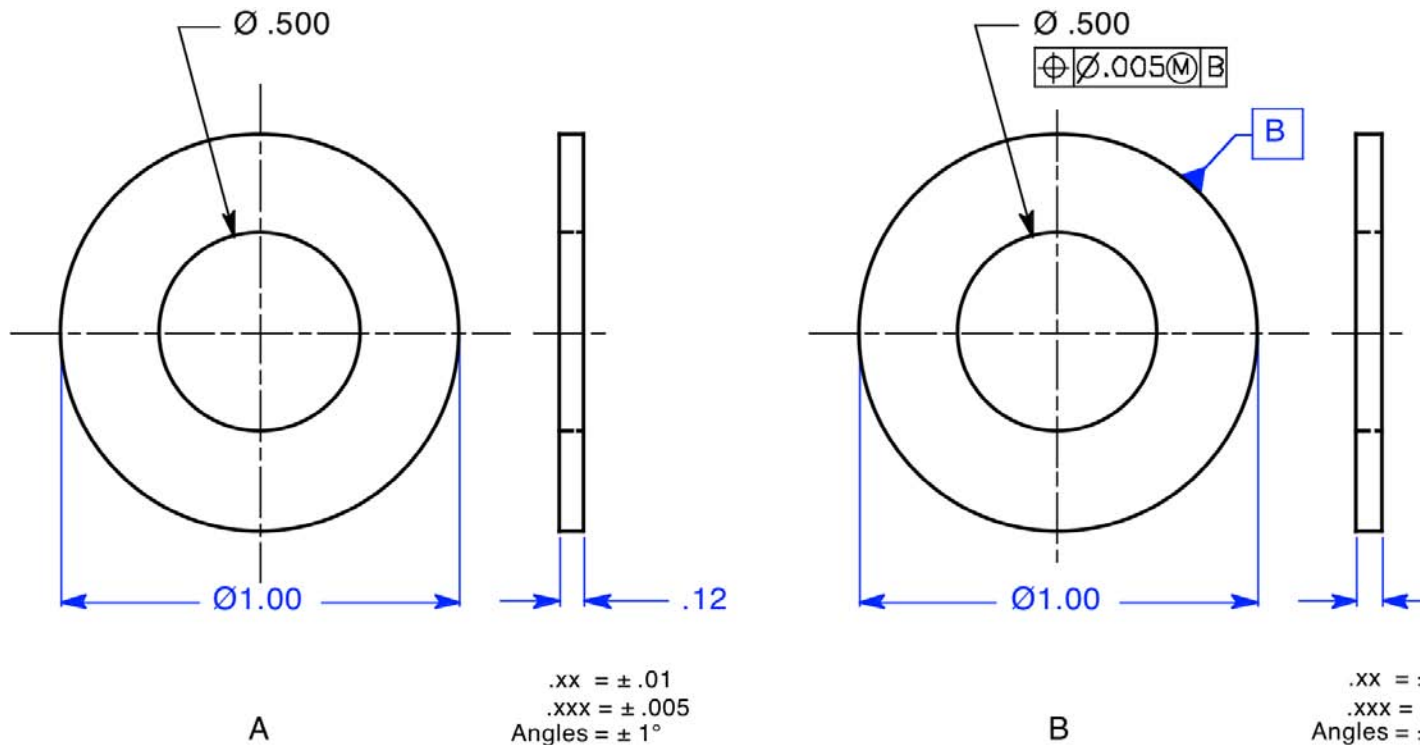
Rule #1 – examples of size and form variations allowed by the size tolerance

Rule #1 does not apply to stock or to features subject to **free state variation** in the un-restrained condition.

Stock items are manufactured to industry or government standards and are not controlled by Rule #1. Stock is used as is.

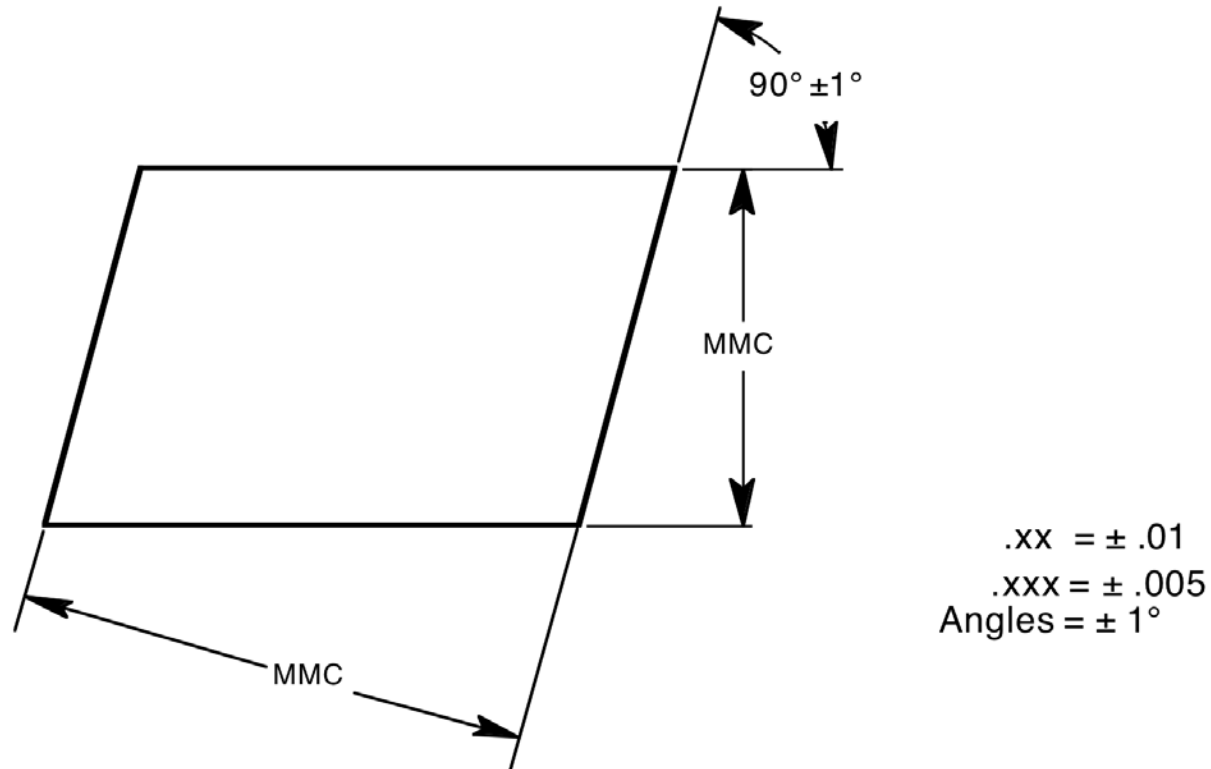
Rule #1 does not apply to parts that are flexible and are to be measured in their **free state**.

Perfect form at MMC is not required if it is desired to allow the surface(s) of a feature to exceed the boundary of perfect form at MMC. In such cases, the note, PERFECT FORM AT MMC NOT REQD, may be specified on the drawing.



The limits of size do not control coaxiality.

The relationship between individual features is not controlled by the limits of size. If features on a drawing are shown coaxial, or symmetrical to each other and not controlled for location, the drawing is incomplete. Figure A is incomplete.

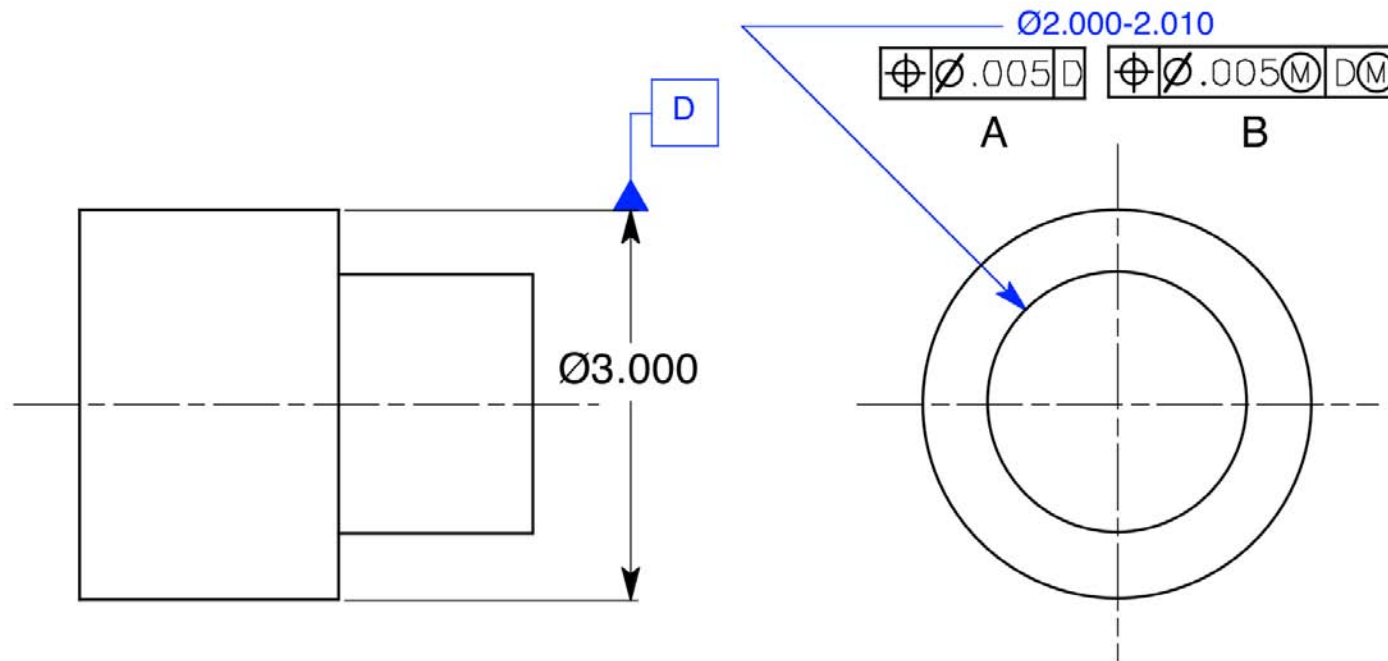


Angularity tolerance controls the angularity between individual features

If no orientation tolerance is specified, perpendicularity is controlled, not by the size tolerance, but by the angularity tolerance.

Rule #2

Rule #2 states that **Regardless of Feature Size (RFS)**, in a feature control frame, automatically applies to individual tolerances of size features and to datum features of size. **MMC** and **LMC** must be specified when required.



Feature control frames specified with RFS and MMC.

Common Tolerancing Schemes

