HYDAC

Compact Hydraulics / Cartridge Valve Design

Olaf Pippel

GEOMETRIC DIMENSIONING & TOLERANCING

2019

GEOMETRIC DIMENSIONING & TOLERANCING

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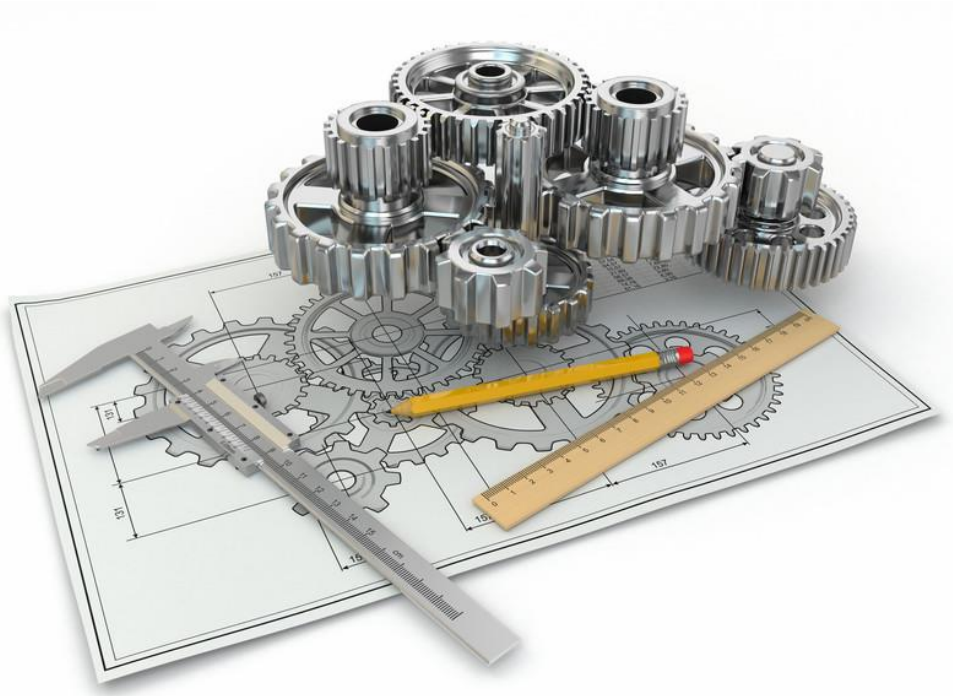


Image courtesy of Automotive Engineering HQ:
http://www.automotiveengineeringhq.com/gdt-geometric-dimensioning-tolerancing/

GEOMETRIC DIMENSIONING & TOLERANCING

1. INTRODUCTION

Drawing → dimensional tolerances

→ geometric tolerances

→ surface roughness

-Dimensional tolerances not sufficient enough

-Room for too many degrees of freedom

→Boundaries need to be set

→Feature shape within limits

GEOMETRIC DIMENSIONING & TOLERANCING

2. STANDARDS

American

ASME Y14.5 (2009)

International

ISO 1101 (2017)

Image courtesy of ASME

Image courtesy of ISO

GEOMETRIC DIMENSIONING & TOLERANCING

3. DEFINITIONS

MMC – Maximum Material Condition

> "The condition in which a feature of size contains the **maximum amount of material** within the stated limits of size" (ASME Y14.5)

LMC – Least Material Condition

> "The condition in which a feature of size contains the **least amount of material** within the stated limits of size" (ASME Y14.5)

Envelope principal

> envelope → boundary = perfect geometric form at MMC (virtual condition)

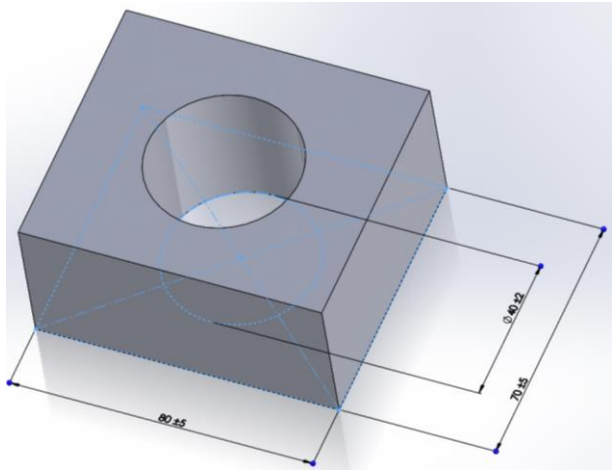
RFS – Regardless of Feature Size

> indicates that a geometric tolerance applies at any increment of size of the feature

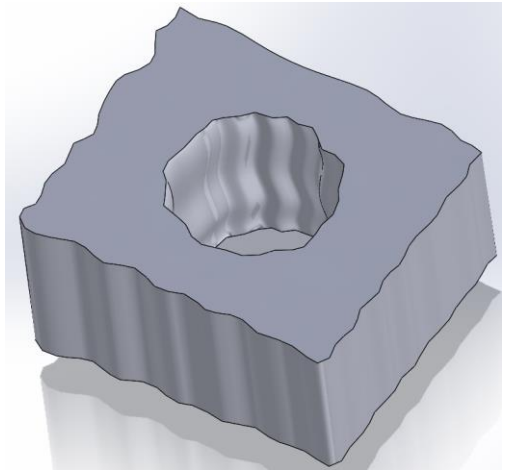
GEOMETRIC DIMENSIONING & TOLERANCING

3. DEFINITIONS

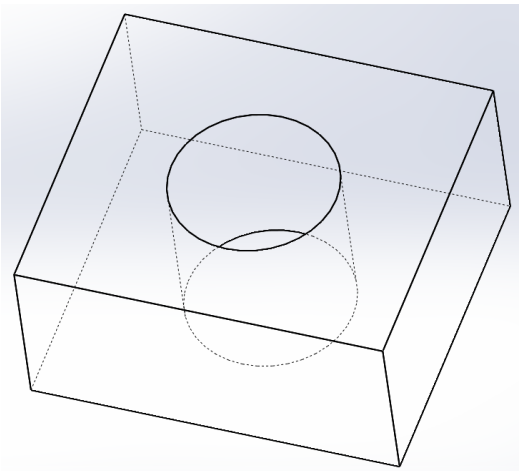
Specification



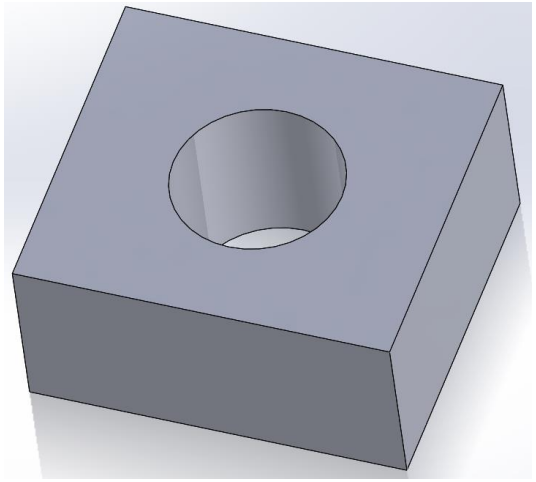
Reality



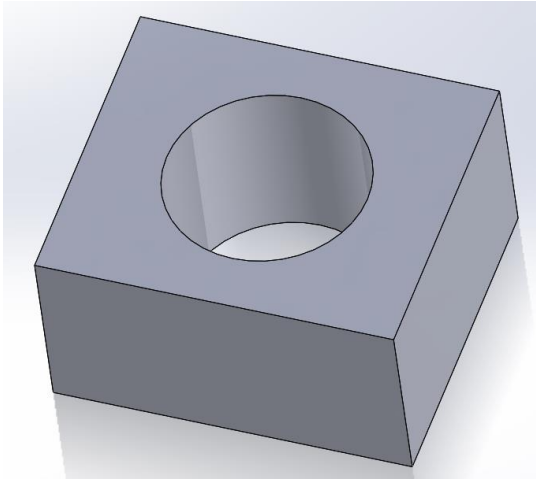
Envelope



MMC



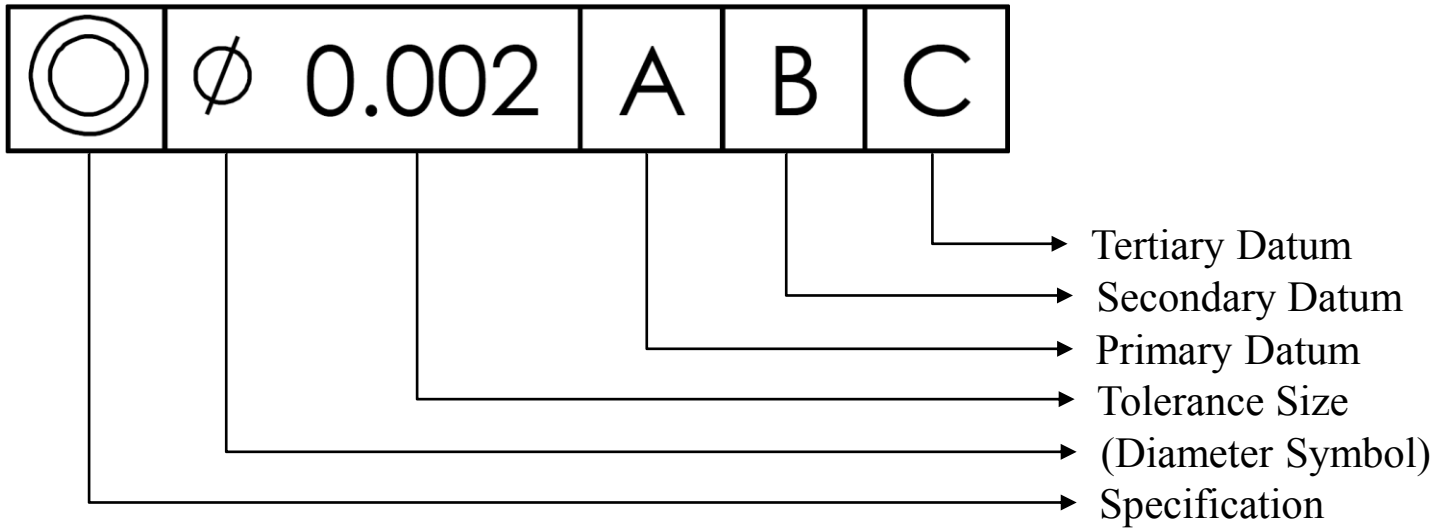
LMC



GEOMETRIC DIMENSIONING & TOLERANCING

3. DEFINITIONS

Geometric tolerance displayed on the drawing

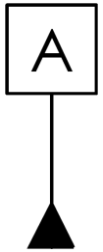


GEOMETRIC DIMENSIONING & TOLERANCING

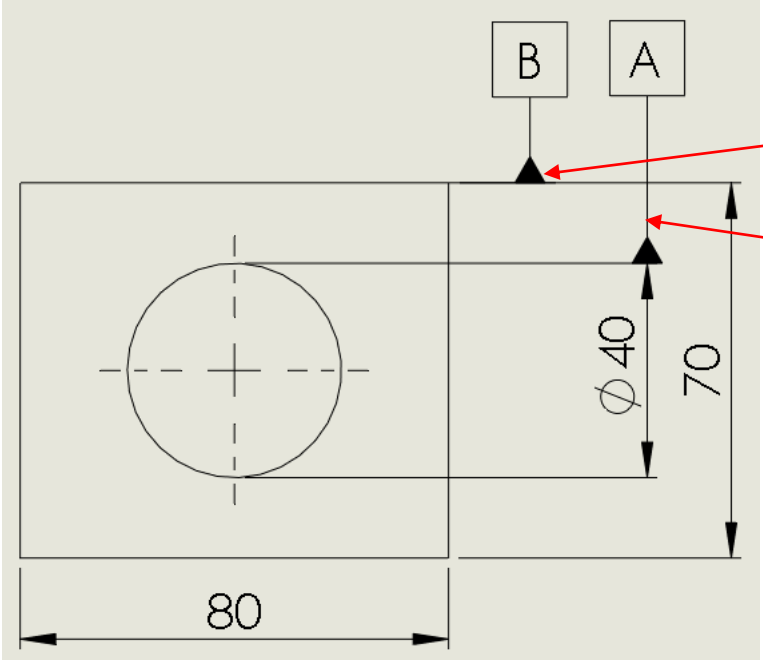
3. DEFINITIONS

Datum

Display as 1982



Datum location determines reference
- In line with the dimension line → axis
- On the surface or extension line → surface



Datum placed on the extension line

Datum placed as an extension of dimension line

GEOMETRIC DIMENSIONING & TOLERANCING

4. SYMBOLS AND THEIR MEANINGS

1. Limit

definition

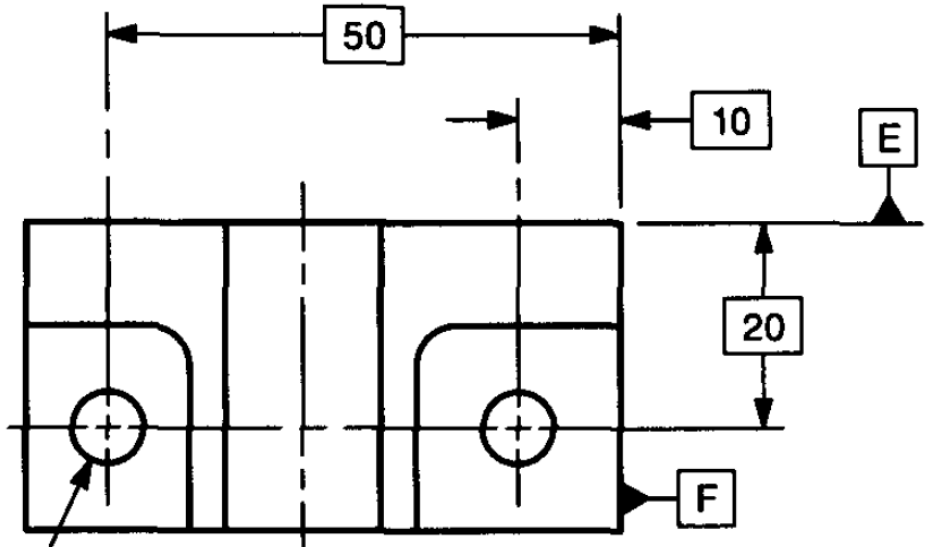
- Describes the dimensional boundaries (dimensional tolerances) of
  - Size
  - Distance

tolerance zone

- Two parallel lines
- Two parallel planes
- Spherical
- cylindrical

application

- All features on drawings



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GEOMETRIC DIMENSIONING & TOLERANCING

4. SYMBOLS AND THEIR MEANINGS

2. Form

Straightness

definition

Straightness is a condition where an element of a surface, or an axis, is a straight line.

symbol

tolerance zone

- Two parallel lines

application

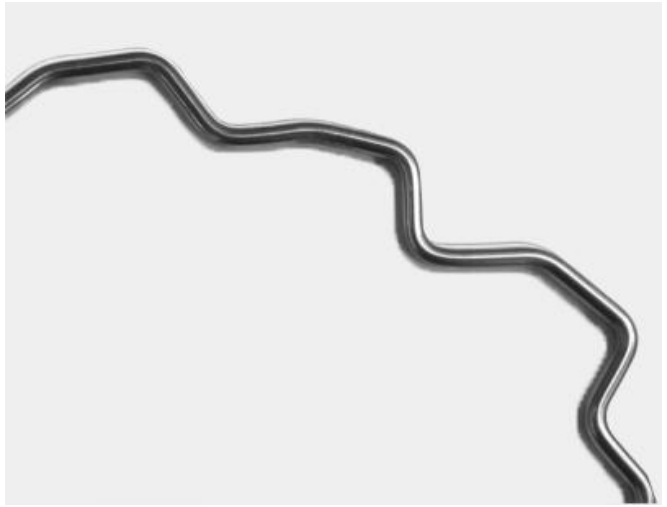
- Feature displayed as a straight line on the drawing

GEOMETRIC DIMENSIONING & TOLERANCING

4. SYMBOLS AND THEIR MEANINGS

2. Form

Straightness



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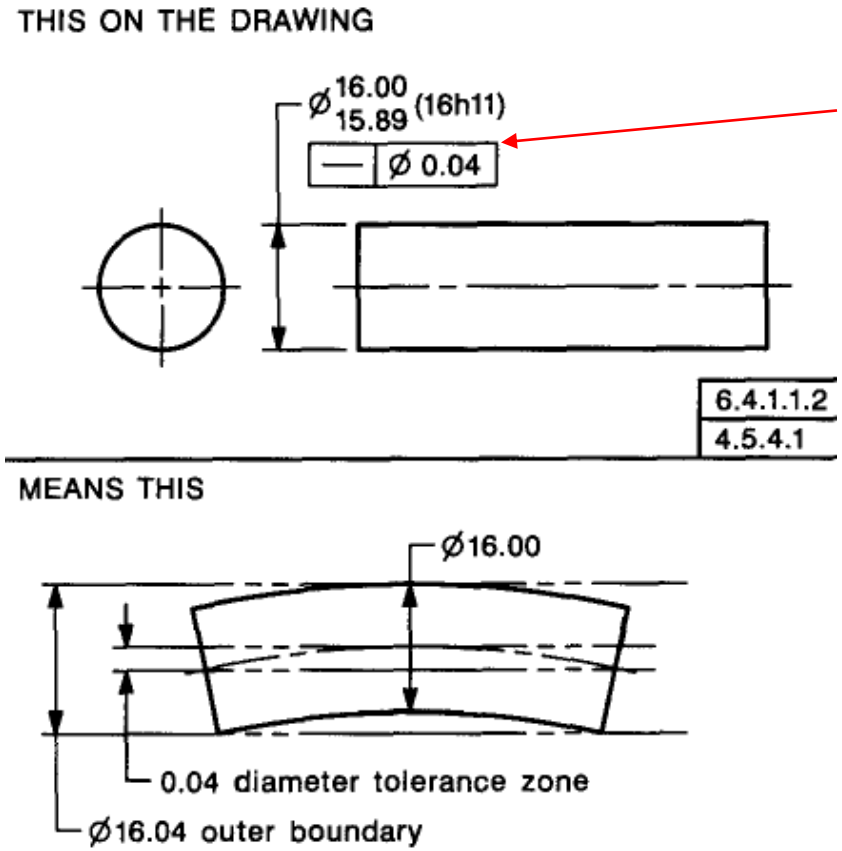


Tolerance connected to diameter callout or extension of dimension line

→ Tolerance applied to rotational axis

→ Tolerance has to include diameter sign

GEOMETRIC DIMENSIONING & TOLERANCING

4. SYMBOLS AND THEIR MEANINGS

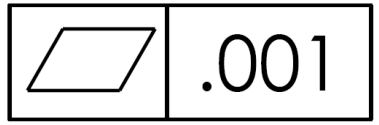
2. Form

Flatness

definition

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

symbol



tolerance zone

- Two parallel planes

application

- Flat surface

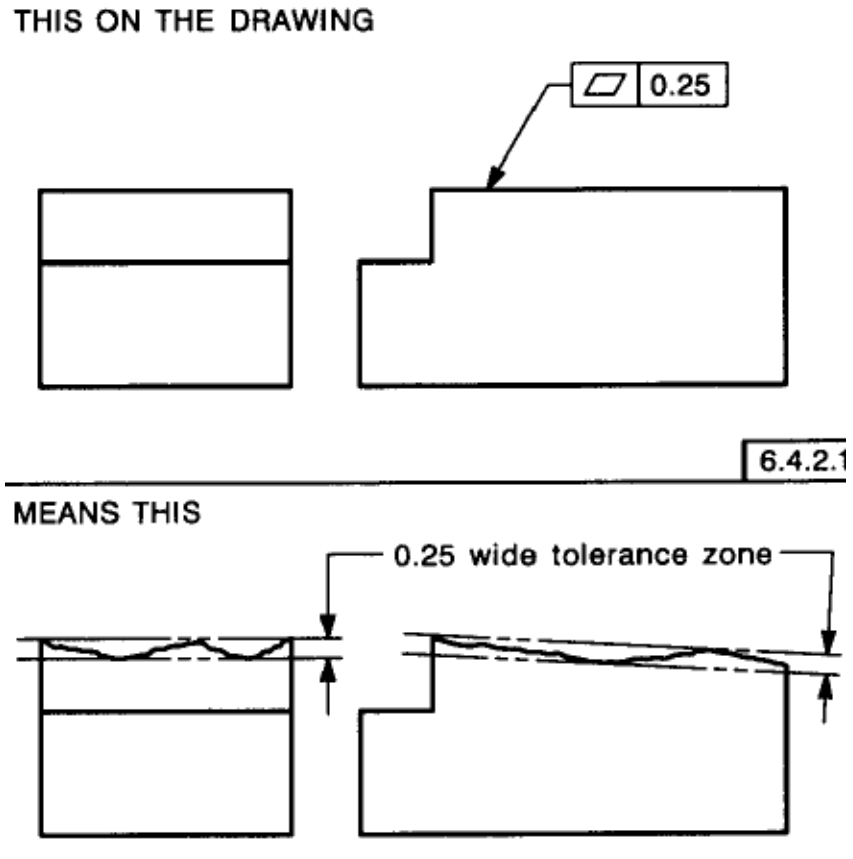
GEOMETRIC DIMENSIONING & TOLERANCING

4. SYMBOLS AND THEIR MEANINGS

2. Form

Flatness

Image source:
https://www.google.com/url?sa=i&source=images&cd=&ved=2ahUKEwiG_vCXoZ3nAhWIiOAKHRWzCEAQjRx6BAgBEAQ&url=https%3A%2F%2Fleonlogothetis.com%2Fwhat-road-is-your-life-on%2F&psig=AOvVaw2rSJ5ZZw5to1w3s0y27_d4&ust=1579990432821474



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GEOMETRIC DIMENSIONING & TOLERANCING

4. SYMBOLS AND THEIR MEANINGS

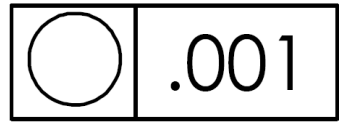
2. Form

Roundness

definition

Circularity is a condition where all points of the surface intersected by any plane perpendicular to an axis/passing through a common center are equidistant from the axis/common center.

symbol

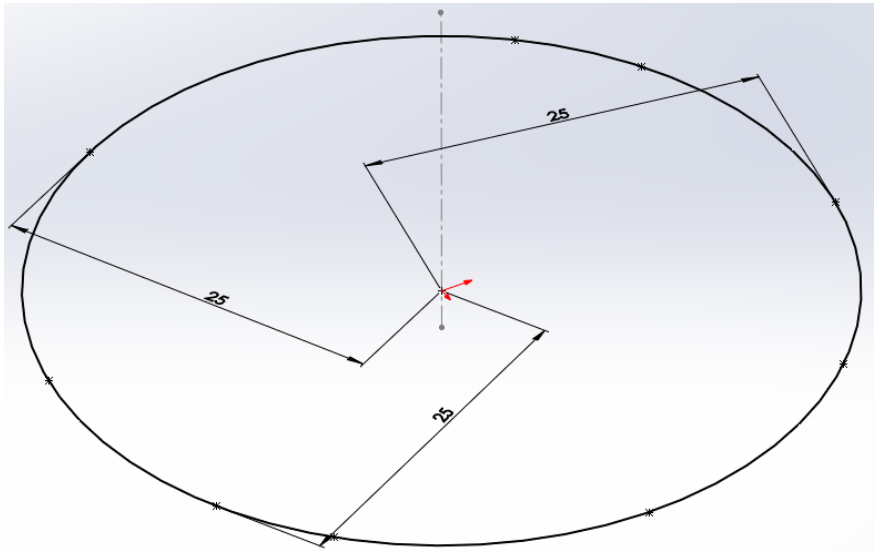


tolerance zone

- Two concentric circles

application

- Sphere, cylinder, round feature



GEOMETRIC DIMENSIONING & TOLERANCING

4. SYMBOLS AND THEIR MEANINGS

2. Form

Roundness

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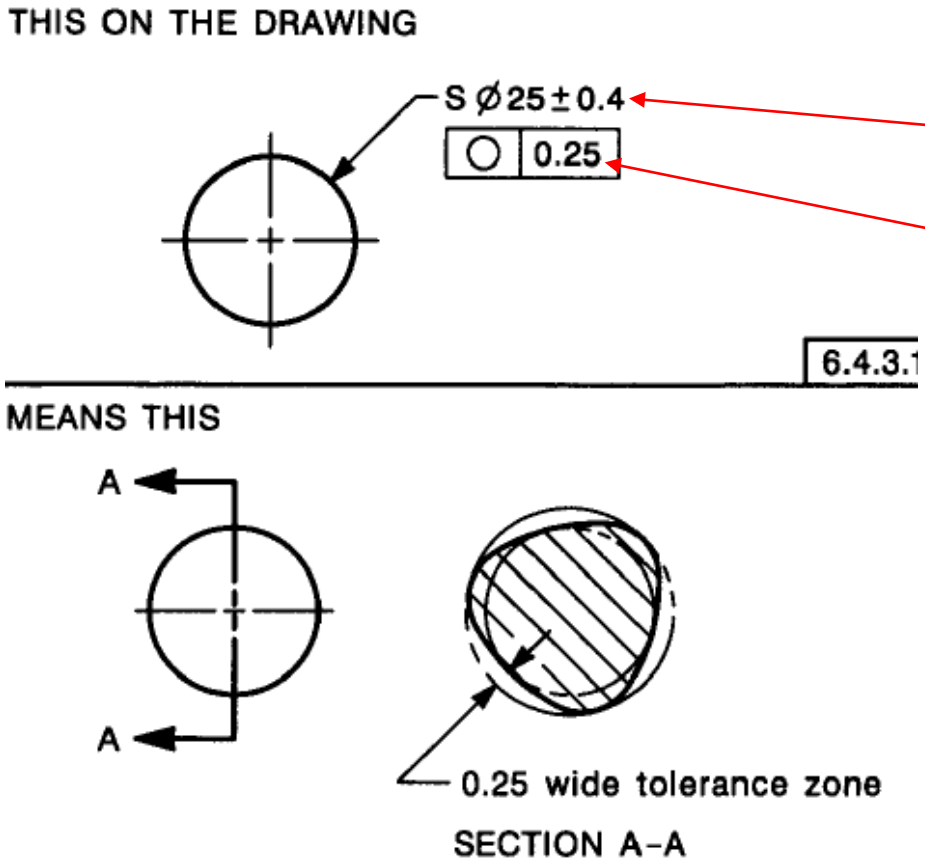

size tolerance
>
Geometric tolerance

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GEOMETRIC DIMENSIONING & TOLERANCING

4. SYMBOLS AND THEIR MEANINGS

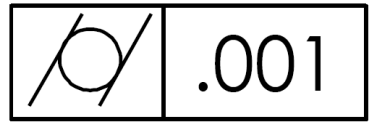
2. Form

Cylindricity

definition

Cylindricity is a condition of a surface of revolution in which all points of the surface are equidistant from a common axis.

symbol



tolerance zone

- Two concentric cylinders

application

- cylinders

GEOMETRIC DIMENSIONING & TOLERANCING

4. SYMBOLS AND THEIR MEANINGS

2. Form

Cylindricity

Image source:

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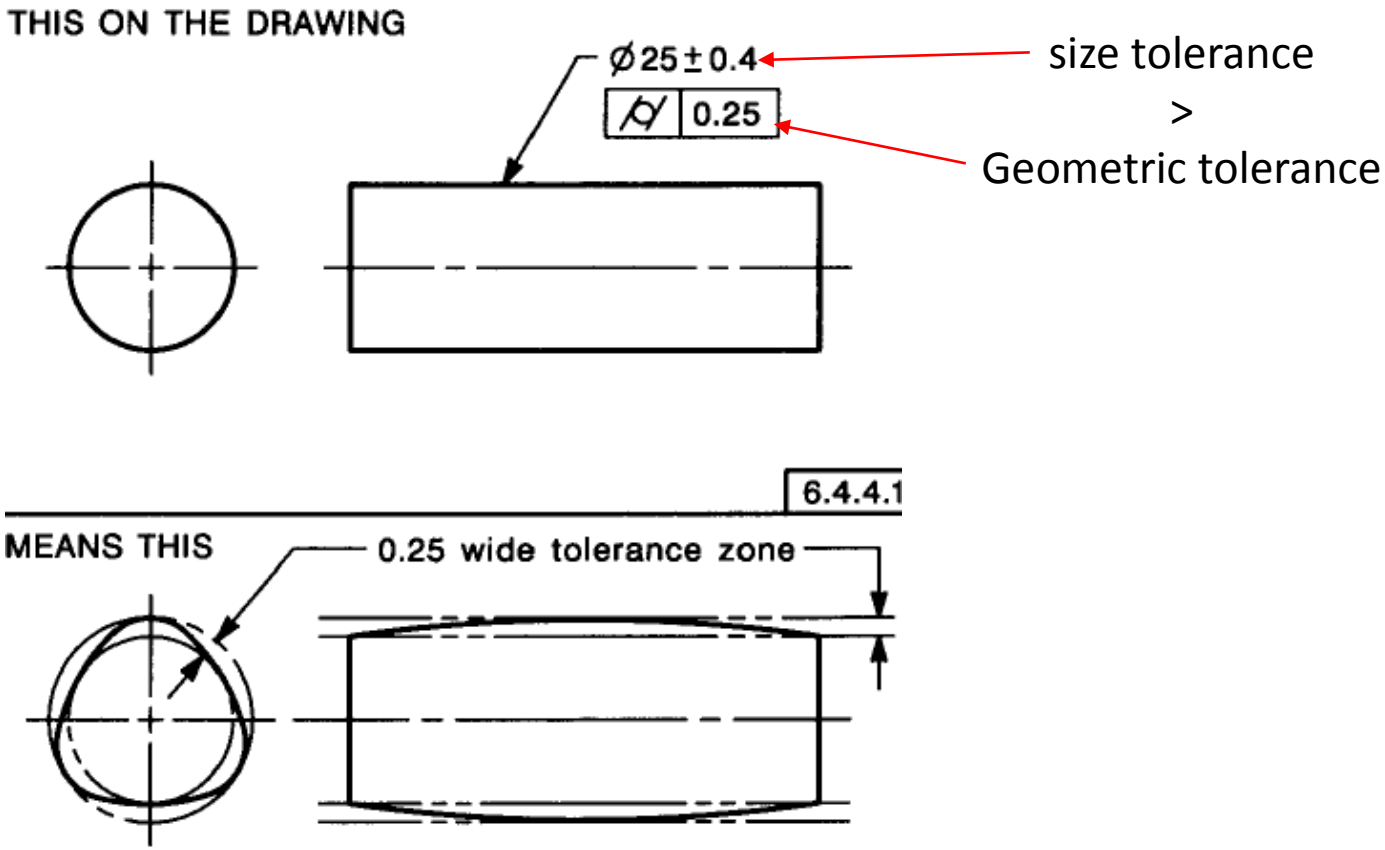


GEOMETRIC DIMENSIONING & TOLERANCING

4. SYMBOLS AND THEIR MEANINGS

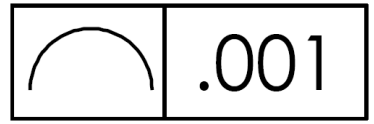
2. Form

Profile of line

definition

Profile is the outline of an object in a given plane. It can consist of straight lines, arcs and curved lines.

symbol



tolerance zone

- Two profile lines
- Boundary (virtual condition)

application

- Feature profile displayed as a line on the drawing

GEOMETRIC DIMENSIONING & TOLERANCING

4. SYMBOLS AND THEIR MEANINGS

2. Form

Profile of line

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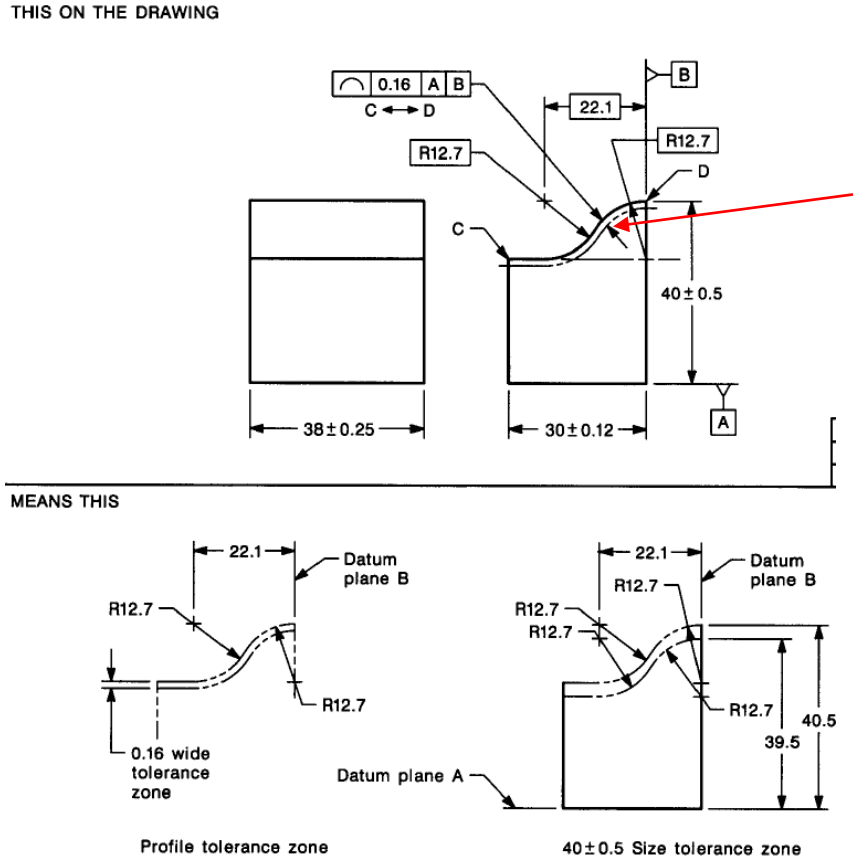


Definition of tolerance field

→ True profile equals outer boundary

→ Other boundary drawn inside

GEOMETRIC DIMENSIONING & TOLERANCING

4. SYMBOLS AND THEIR MEANINGS

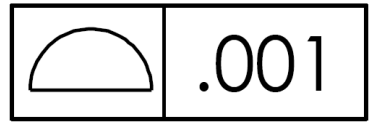
2. Form

Profile of surface

definition

Profile is the outline of an object in a given plane. It can consist of straight lines, arcs and curved lines. This one includes a whole surface.

symbol



tolerance zone

- Two surfaces
- Boundary (virtual condition)

application

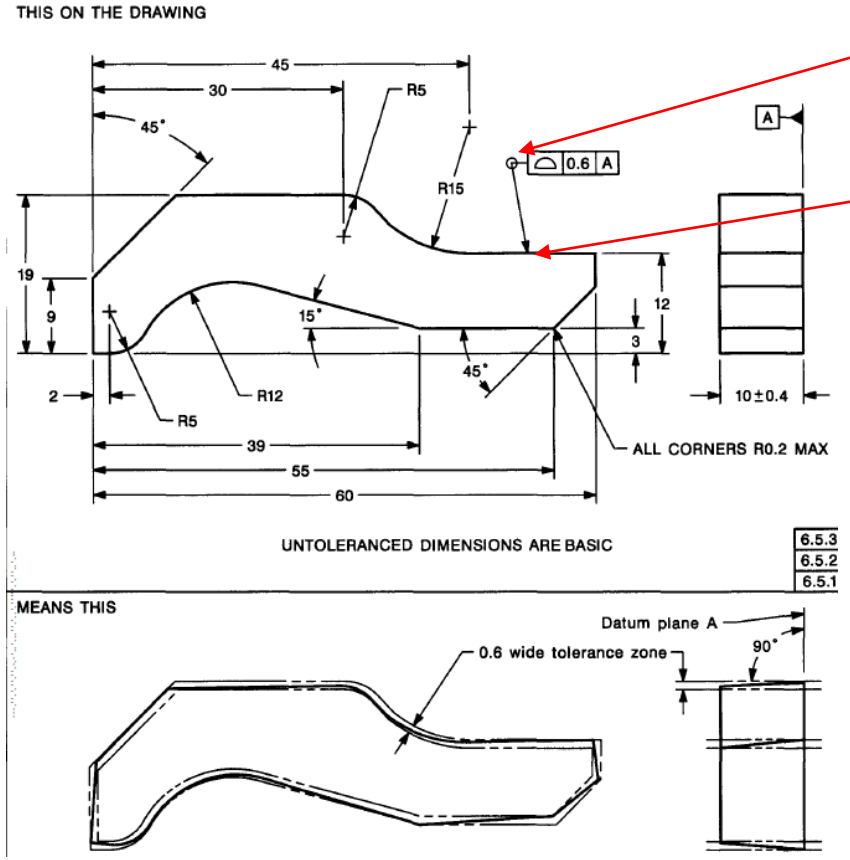
- Surface profile displayed as a line on the drawing

GEOMETRIC DIMENSIONING & TOLERANCING

4. SYMBOLS AND THEIR MEANINGS

2. Form

Profile of surface



Sign for ‘all around’

Definition of tolerance field

→ Equally disposed limits

GEOMETRIC DIMENSIONING & TOLERANCING

4. SYMBOLS AND THEIR MEANINGS

3. Orientation

Parallelism

definition

Parallelism is the condition of a surface or center plane, equidistant at all points from a datum plane.

symbol

tolerance zone

- Two parallel planes
- Two parallel lines
- One cylinder

application

- Two parallel surfaces
- Two parallel axes

GEOMETRIC DIMENSIONING & TOLERANCING

4. SYMBOLS AND THEIR MEANINGS

3. Orientation

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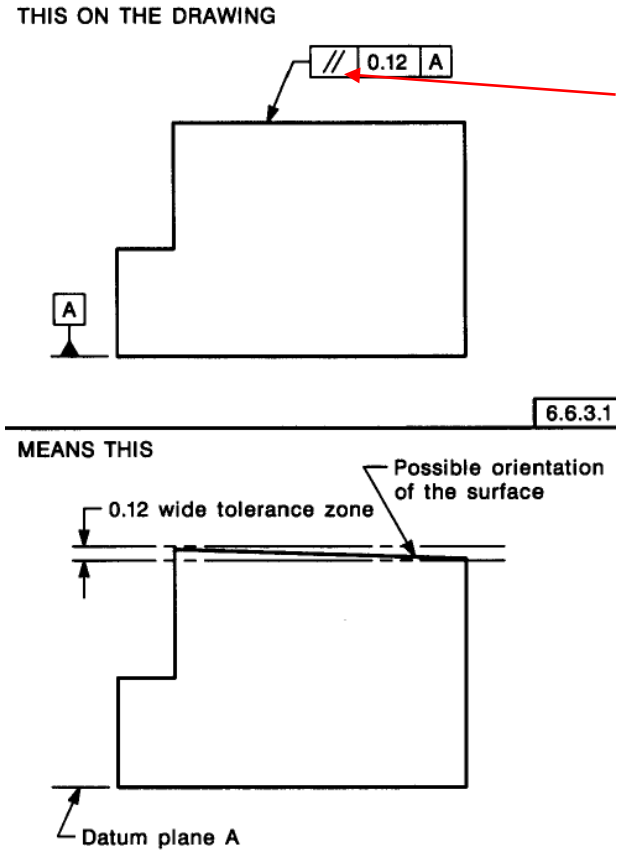
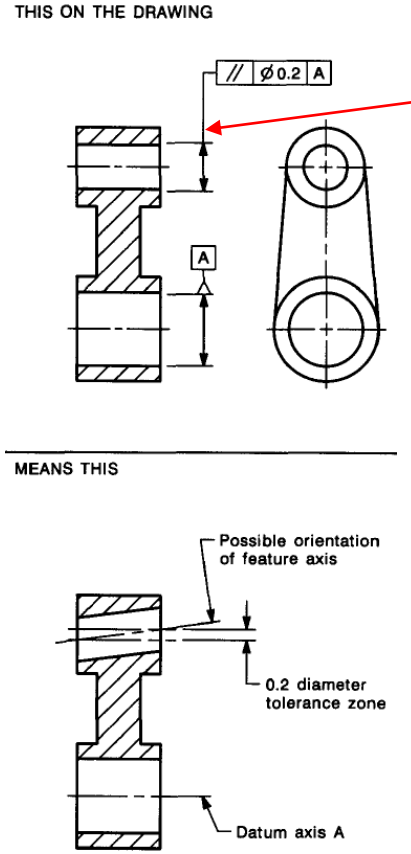
Parallelism



Two planes tolerance zone



Cylindrical tolerance zone

GEOMETRIC DIMENSIONING & TOLERANCING

4. SYMBOLS AND THEIR MEANINGS

3. Orientation

Perpendicularity

definition

Perpendicularity is the condition of a surface, center plane, or axis at a right angle to a datum plane or axis.

symbol

tolerance zone

- Two parallel planes
- Two parallel lines
- One cylinder

application

- Two surfaces perpendicular to each other
- A hole/cylinder perpendicular to a surface

GEOMETRIC DIMENSIONING & TOLERANCING

4. SYMBOLS AND THEIR MEANINGS

3. Orientation

Image soruce:
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Perpendicularity

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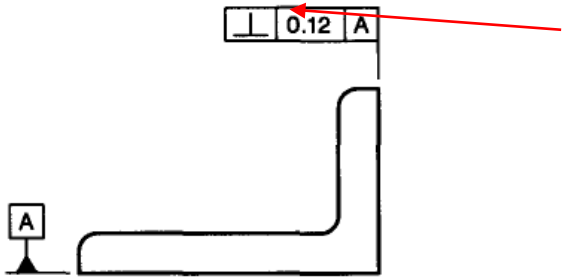
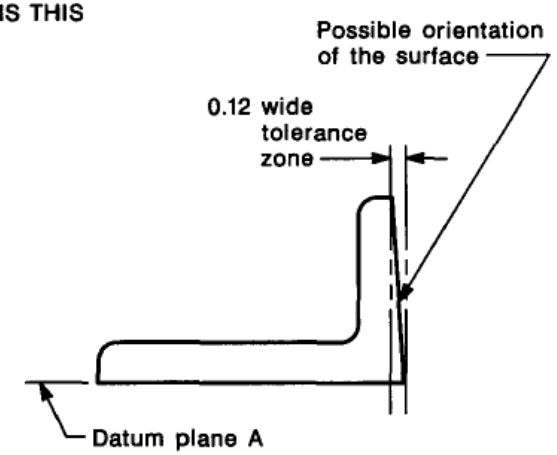
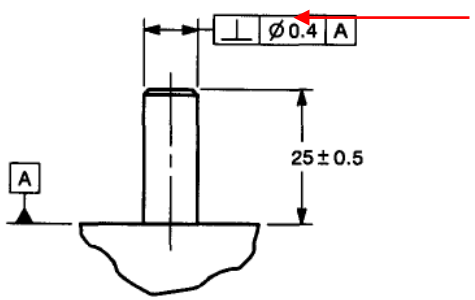


Two planes tolerance zone

MEANS THIS

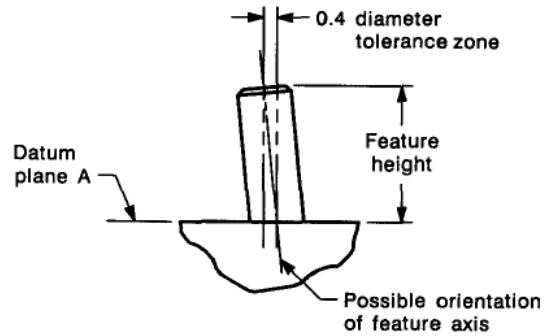


THIS ON THE DRAWING



Cylindrical tolerance zone

MEANS THIS



GEOMETRIC DIMENSIONING & TOLERANCING

4. SYMBOLS AND THEIR MEANINGS

3. Orientation

Angularity

definition

Angularity is the condition of a surface, center plane, or axis at a specified angle (other than 90) from a datum plane or axis.

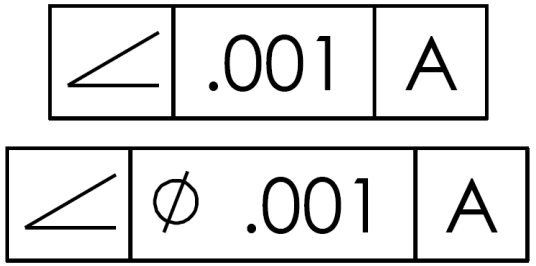
tolerance zone

- Two parallel planes
- Two parallel lines
- One cylinder

application

- Two surfaces in an angle to each other
- A hole/cylinder in an angle to a surface

symbol



GEOMETRIC DIMENSIONING & TOLERANCING

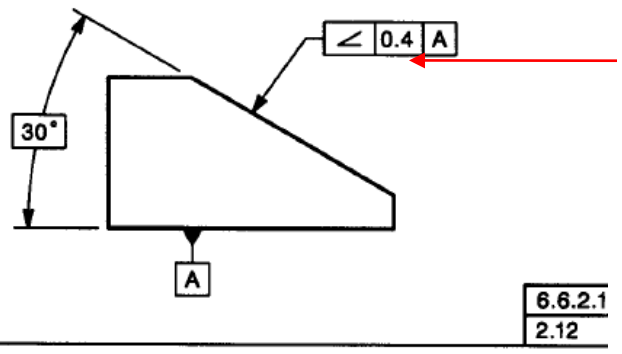
4. SYMBOLS AND THEIR MEANINGS

3. Orientation

Angularity

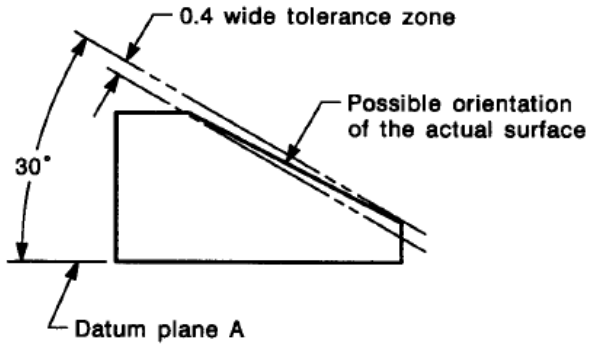
Image source:
https://www.google.com/url?sa=i&source=images&cd=&ved=2ahUKEwj335ydpp3nAhUkmuAKHTKcAVAQjRx6BAgBEAQ&url=https%3A%2F%2Fwww.hoelleinshop.com%2FRitzel-13-Zaehne-PFEILGEZAHNT-Modul-1-fuer-6mm-Motorwelle.htm%3Fshop%3Dhoellein_e%26SessionId%3D%26a%3Darticle%26ProdNr%3DMH04413%26t%3D49301%26c%3D76185%26p%3D76185&psig=AOvVaw0fdra1Alh2BDcKfX-jh3H8&ust=1579991780497842

THIS ON THE DRAWING



Two planes tolerance zone

MEANS THIS



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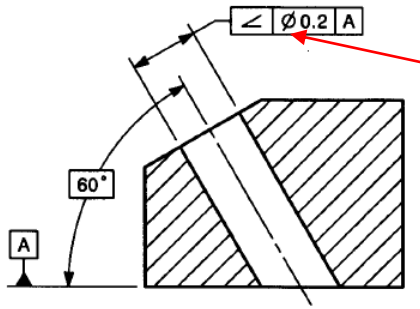
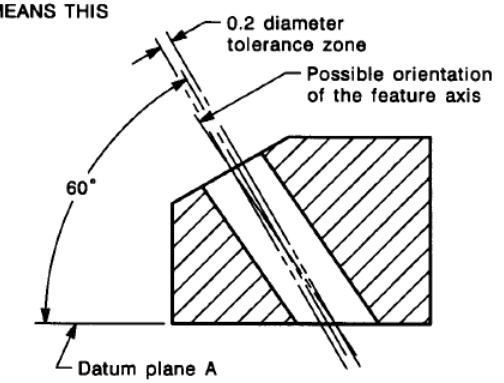


Cylindrical tolerance zone

6.6.2.1

MEANS THIS



GEOMETRIC DIMENSIONING & TOLERANCING

4. SYMBOLS AND THEIR MEANINGS

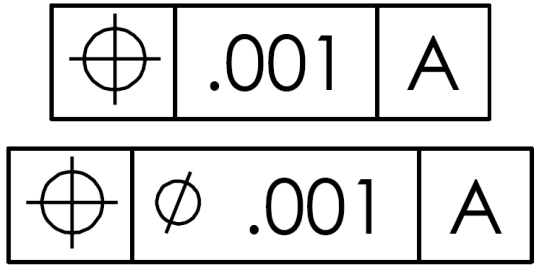
4. Location

Position

definition

Position is the condition of the location of a feature relative to another feature.

symbol



tolerance zone

- Two parallel planes
- One cylinder
- One sphere
- Boundary

application

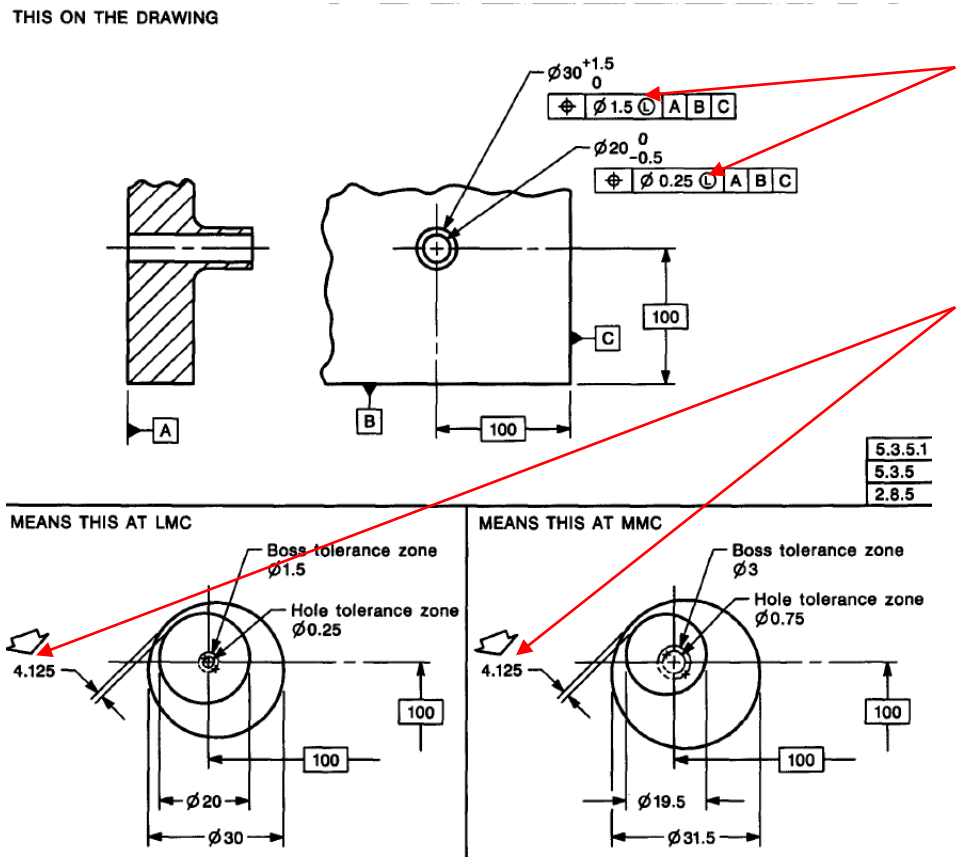
- Position of holes, slots, bosses and tabs

GEOMETRIC DIMENSIONING & TOLERANCING

4. SYMBOLS AND THEIR MEANINGS

4. Location

Position



LMC = Least Material Condition

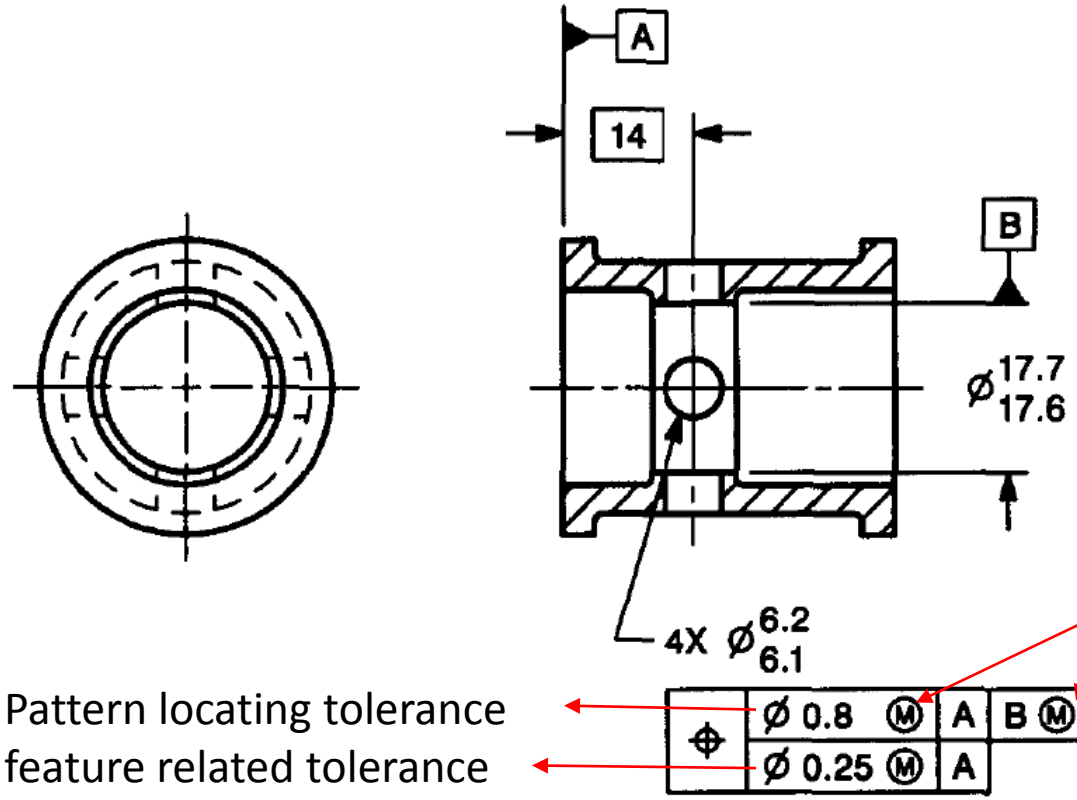
→ Ensure sufficient wall thickness

GEOMETRIC DIMENSIONING & TOLERANCING

4. SYMBOLS AND THEIR MEANINGS

4. Location

Position



MMC = Maximum Material Condition

Pattern locating tolerance

feature related tolerance

GEOMETRIC DIMENSIONING & TOLERANCING

4. SYMBOLS AND THEIR MEANINGS

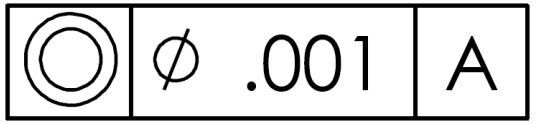
4. Location

Concentricity

definition

Concentricity is the condition where the median points of all diametrically opposed elements of a figure of revolution are congruent with the axis of a datum feature.

symbol



tolerance zone

- One cylinder
- One sphere

application

- Cylinder
- Sphere

GEOMETRIC DIMENSIONING & TOLERANCING

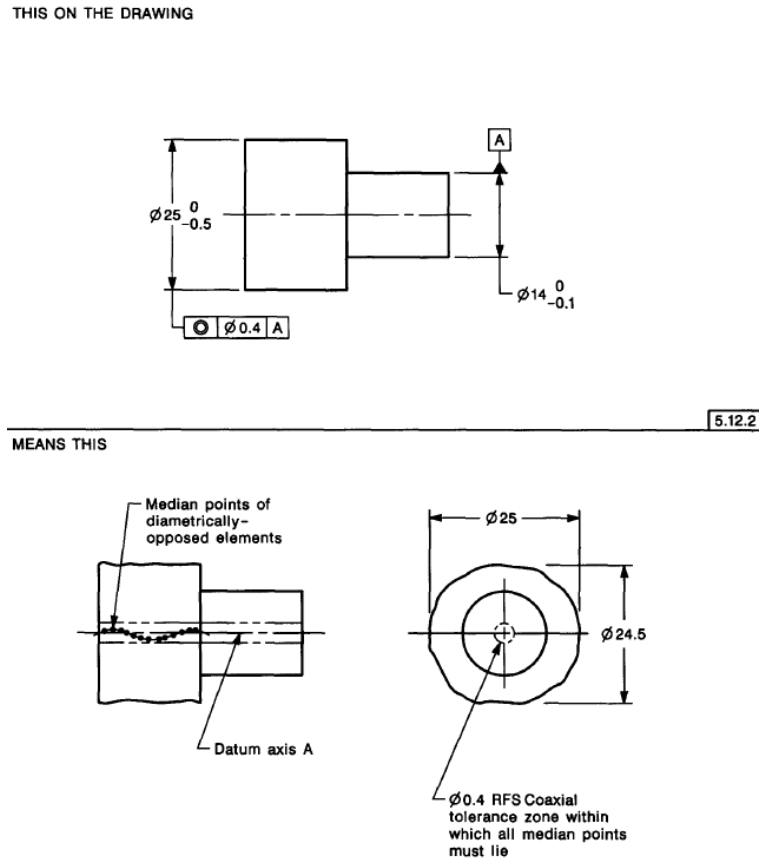
4. SYMBOLS AND THEIR MEANINGS

4. Orientation

Image source:

https://www.google.com/imgres?imgurl=https%3A%2F%2Fcdn5.vectorstock.com%2Fi%2F1000x1000%2F11%2F39%2Fcar-wheel-rims-vector-26961139.jpg&imgrefurl=https%3A%2F%2Fwww.vectorstock.com%2Froyalty-free-vector%2Fcar-wheel-rims-vector-26961139&docid=uB4qwr6vDpUj5M&tbnid=YPCS-Y6dyaa0MM%3A&vet=10ahUKEwiV3PrErZ3nAhXyUt8KHSoDCOQQMwimAigNMA0..i&w=1000&h=1080&bih=811&biw=1222&q=rims&ved=0ahUKEwiV3PrErZ3nAhXyUt8KHSoDCOQQMwimAigNMA0&iact=mrc&uact=8

Concentricity



GEOMETRIC DIMENSIONING & TOLERANCING

4. SYMBOLS AND THEIR MEANINGS

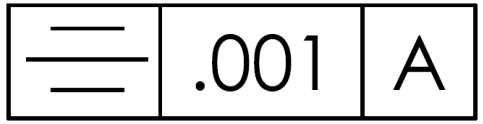
4. Location

Symmetry

definition

Symmetry is the condition where the median points of all opposed located elements are congruent with the axis or center plane of a datum feature.

symbol



tolerance zone

- Two parallel planes

application

- Symmetric features

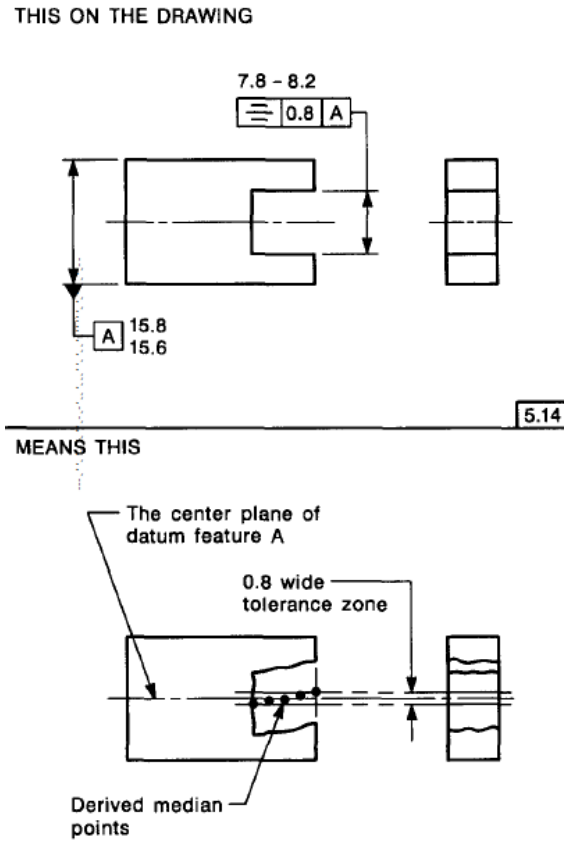
GEOMETRIC DIMENSIONING & TOLERANCING

4. SYMBOLS AND THEIR MEANINGS

4. Location

Symmetry

Image source:
https://www.google.com/imgres?imgurl=https%3A%2F%2Fwww.distrelec.biz%2FWeb%2FWebShopImages%2Flandscape_large%2F_t%2Fif%2Fteleskopschienen-dreiteilig-55.jpg&imgrefurl=https%3A%2F%2Fwww.distrelec.biz%2Fen%2Faluminium-profile-length-alcoa-inc-en-aw-6060-t66-20x20x2mm-pro%2Fp%2F14846251&docid=U0JNQ0kJM8plwM&tbnid=KAr196lxjn7wsM%3A&vet=10ahUKEwiKy624p53nAhUIh-AKHRTXAd4QMwjfASgNMA0..i&w=600&h=336&bih=811&biw=1222&q=U-profile&ved=0ahUKEwiKy624p53nAhUIh-AKHRTXAd4QMwjfASgNMA0&iact=mrc&uact=8



GEOMETRIC DIMENSIONING & TOLERANCING

4. SYMBOLS AND THEIR MEANINGS

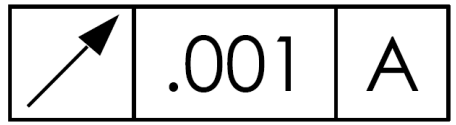
5. Runout

Circular Runout

definition

Runout is a composite tolerance used to control the functional relationship of one or more features to a datum axis.

symbol



tolerance zone

- Two concentric circles

application

- Cylindrical features around a datum axis
- Plane surfaces perpendicular to a datum axis

GEOMETRIC DIMENSIONING & TOLERANCING

4. SYMBOLS AND THEIR MEANINGS

5. Runout

Circular Runout

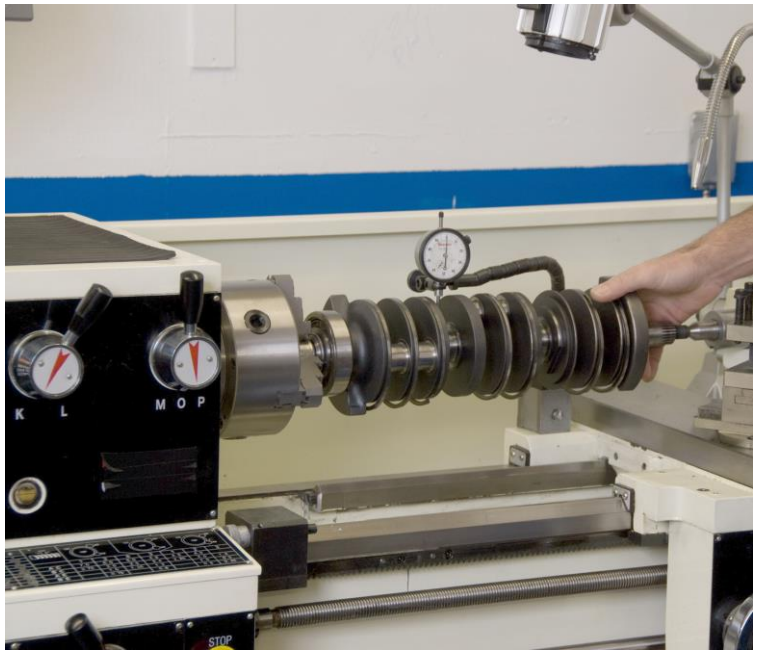
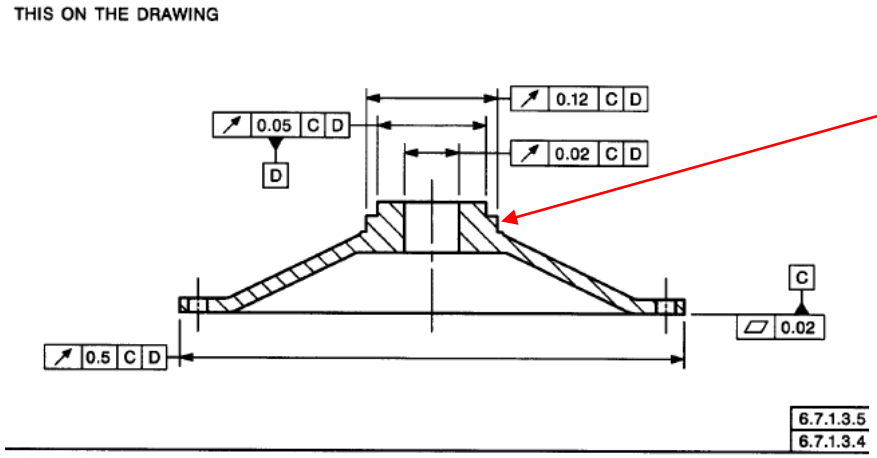
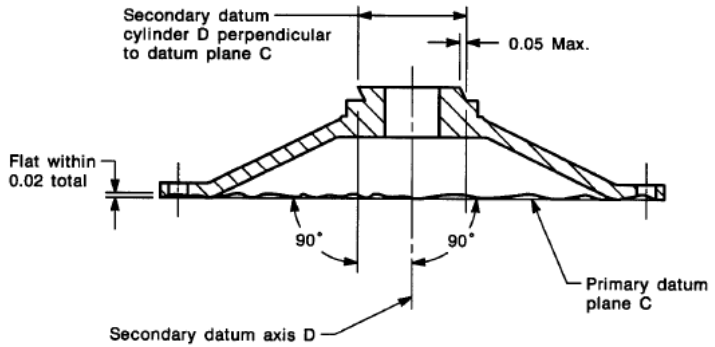


Image courtesy of Toni Marine Inc:
http://www.tonimarine.com/_DSC2152%20Gamma%20Adj.jpg





One revolution and one indicator position only

Runout = Full Indicator Movement

GEOMETRIC DIMENSIONING & TOLERANCING

4. SYMBOLS AND THEIR MEANINGS

5. Runout

Total Runout

definition

Runout is composite tolerance used to control the functional relationship of one or more features to a datum axis.

symbol

tolerance zone

- Two concentric cylinders

application

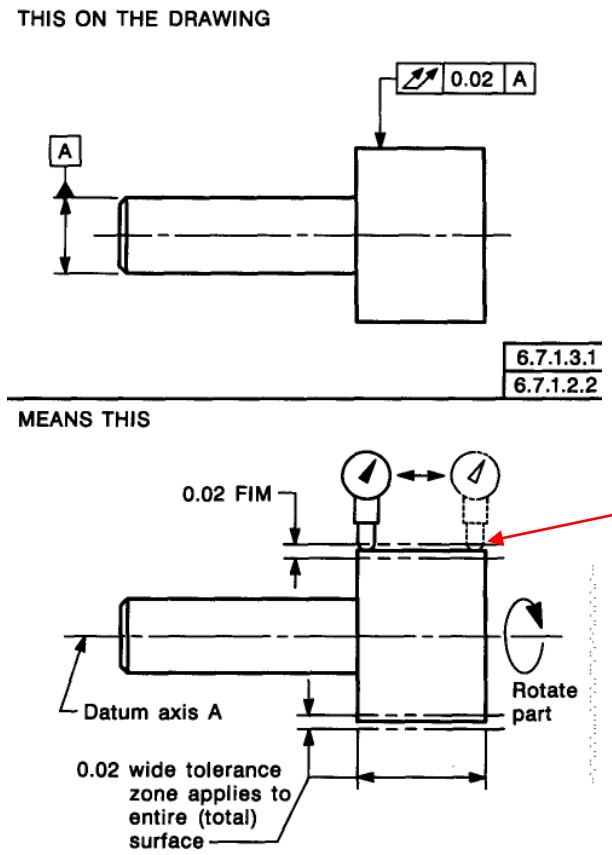
- Cylindrical features around a datum axis
- Plane surfaces perpendicular to a datum axis

GEOMETRIC DIMENSIONING & TOLERANCING

4. SYMBOLS AND THEIR MEANINGS

5. Runout

Total Runout



Multiple revolutions and indicator positions

GEOMETRIC DIMENSIONING & TOLERANCING

5. Q & A

Questions?

GEOMETRIC DIMENSIONING & TOLERANCING

Thank you for your attention!

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