Profile Controls

• Profile of a Line
• Profile of a Surface
Profile Tolerances:

- Are usually used for irregular, curved or complex geometry*
- Can control form, orientation and location*
- Can be difficult to inspect ($)
- Always applied to a feature (Not a Feature of Size) and are RFS*
  - Are not able to make use of the LMC or MMC Modifiers*
- May or may not reference datums*
  - Only When controlling orientation or location
- The more datums, the more restriction. Generally:*  
  No Datum, Form  
  Primary Datum, Orientation  
  Tertiary and Basic Dimensions, Position/Location
- Often, the CAD Model sets true profile reference then the profile tolerance is inspected with a CMM.
- When controlling orientation and/or location, all related feature dimensions are made Basic*
Profile Types

- There are two types of Profile controls:
  - Profile of a Line
  - Profile of a Surface
Profile of a Line

– Inspection of individual line elements*
– Independent checks (Indicator/CMM is Reset)
– Inspection motion is parallel to the drawing view
– 2-D Zone: Two parallel “lines” (Curves)*
  • That follow the surface contour
  • Dial indicator is always perpendicular to the surface
  • FIM should not be greater than the tolerance value
  • Unless otherwise specified, the zone is bilateral (equally disposed about the basic profile)
  • Unless otherwise indicated, the profile generally extends to the first abrupt (non-tangent) change or sharp corner*
– Often used as a refinement of Profile of a Surface*
– Like Straightness applied to a curved feature*
Line Profile (Basics)

Overview

Profile of a line

Relative to Datum:

Optional
May be specified with or without a datum reference

MMC or LMC: No

- This control specifies how far from the true profile the cross sectional surface is allowed to deviate. Unless otherwise specified, the tolerance zone is a uniform (or equally disposed) boundary about the true profile.

- The tolerance zone for Line Profile extends the length of the part (2D) at any given cross section (not the entire surface) and applies normal (perpendicular) to the true profile.

- All line elements of the referenced feature must lie entirely within the tolerance zone.

Always Uses a Leader and Arrow – Applied to Feature
Can be Simple as Straightness

Line Profile

Tolerance Zone

- The simplest form of Line Profile is when no datums are used. With no datums, the control only acts as a form control.
- The resulting tolerance zone is two parallel lines equally disposed about the true profile at any given cross section.
Indirect/Embedded Controls

**Line Profile**

*Control of Other Geometric Symbols*

2D Cross-Section Controls *(Straightness, Circularity and Circular Runout)* – When applied to planar surfaces, Line Profile is able to indirectly* control the relative Straightness of line elements. When applied to a circular feature, Line Profile is able to control Circularity and Circular Runout. It does this by limiting the amount of “out of round” in a circular section and along the length, in addition to controlling the Straightness of line elements.

*CAUTION* – These instances are indirect controls. Indirect controls are not inspected. In instances where inspection of an indirect control is required, it should be specified on the drawing with that specific control.

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If you want to control Straightness, Circularity or Runout, Use the Specific Control
Profile of a Line

- Default bilateral zone
- Unless Otherwise Indicated the Zone ends at end an Abrupt Change to the Contour of a surface*
- All related feature dimensions are made basic

(A) DRAWING CALLOUT

(B) BILATERAL TOLERANCE ZONE
Specifying the Extent of the Controlled Profile

This zone extends from point A to point B only
Generally used as a Refinement to Profile of a Surface Control

**Line Profile**

*Tolerance Zone - Refinement*

- Next we consider Profile of a Line applied to a surface as a refinement of a Surface Profile control (This is most common).
- The tolerance zone is two parallel lines equally disposed about the true profile of the part (2D tolerance zone).

In this example only the form is controlled for the Line Profile control.

Controls: Form, Orientation and Location

The feature may be located anywhere within this zone (0.8) and is basically related to AB.

Controls: Form Only

(Does Not Call Out to a Datum)*

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Line Profile

When is it Used?

Use Profile of a Line when you want to:
- Refine an existing control for Surface Profile (This is its most common use.)
- Control the shape of the line elements where surface control is unnecessary or difficult.
- Refine the orientation of line elements in one direction.

Consistent Cross sections with curves can sometimes be measured with Line Profile.

It is difficult and unnecessary to control the Surface Profile of long extruded shapes. Profile of a Line can be used instead for routine checks on the profile shape.

Common applications for Line Profile are:
- Instances where there is linear motion relative to the two parts.
- Parts with either a constant or varying cross section that do not require a tolerance zone applied to the entire surface.
- Extruded parts where a quick check will suffice for quality verification.
Profile of a Surface

- Inspection of entire surface
  - All directions
  - All at once
- 3-D Zone:* Two parallel “planes” (3-D Envelope)
  - That surrounds the feature contour
  - Inspects the entire surface in all directions*
  - Is perpendicular to the profile surface (Dial indicator Is always perpendicular to the surface)*
  - FIM should not be greater that the tolerance value
  - Unless otherwise specified, the zones are bilateral (equally disposed about the basic profile)
- Like Flatness applied to irregular, curved or complex geometry*
Surface Profile (Basics) (Profile of a Surface)

**Overview**

On the GD&T Symbols Chart Row #12:

- This control specifies how far from the true profile the individual feature is allowed to deviate. Unless otherwise specified, the tolerance zone is a uniform (or equally disposed) boundary about the true profile.

- The tolerance zone for Surface Profile extends the entire length, width, and height of the indicated surface (3D) and applies normal (perpendicular) to the true profile. This may be refined using Profile of a Line (next lesson).

- All elements of the surface must lie entirely within the Profile tolerance zone.

Relative to Datum:
- **Optional**
  - May be specified with or without a datum reference

MMC or LMC: **No**

Always Uses a Leader and Arrow – Applied to Feature*

Profile is considered the universal GD&T symbol as it can control size, location, orientation, and form depending on the datums used.

*If you cannot control it with anything else – use Profile.
Can be as Simple as Controlling Flatness

Surface Profile

Tolerance Zone - No Datums

First we will consider Profile of a Surface applied to a single surface (simplest example) without any datum reference - In this example only the form is controlled.

The tolerance zone is two parallel surfaces equally disposed about the true profile of the part (3D tolerance zone).

When applied to a flat surface – this is the same as a Flatness callout.

Applies to the full width, length, and depth of the indicated surface. All measurements are to be taken normal to the true profile.
**Surface Profile Indirect/Embedded Controls**

**Surface Profile**

**Control of Other Geometric Symbols**

- **Form (Straightness, Flatness, Circularity, Cylindricity)** – When applied to planar surfaces, Surface Profile is able to indirectly* control the relative Straightness of line elements and the overall Flatn of the surface. When applied to a circular feature, Surface Profile is able to control Circularity and Cylindricity by specifying the form of any shape.

- **Orientation (Parallelism, Perpendicularity, Angularity)** – When applied to planar surfaces, Surface Profile is able to indirectly* control the overall Parallelism, Perpendicularity and Angularity of a considered feature as they relate to a specified datum (when applicable).

- **Runout** – If Profile of a Surface is applied to a circular or cylindrical feature, the Runout on the considered feature can also be indirectly* controlled, as basic dimensions can be used to exactly specify the location, form and orientation of a cylindrical feature.

*Indirect control means that the surface profile is not directly specified on the part, but rather implied by the control symbol.
(A) DRAWING CALLOUT

R1.500

(B) BILATERAL TOLERANCE ZONE

.006 TOLERANCE ZONE (3D)*

R 1.500
Profile of a Surface

Controlling Form and Orientation

Controlling Form, Orientation and Location

The Zone ends at end an Abrupt Change to the Contour of a surface*
Surface Profile (Profile of a Surface)

Example (continued)

The best way to achieve all of these goals is by using a Surface Profile control.

- The basic dimensions, along with the Profile tolerance restricts the size and the form of the part.
- Datum A sets up the orientation of the tolerance zone and thus, the relative angle of the part surface.
- Datum B accurately locates the feature to the hole so it functions properly in the assembly.
Surface Profile (Profile of a Surface)

Example

As a designer, you have a cam with a follower. The top of the cam must be closely controlled to achieve precise placement of the connecting rod. Additionally, the surface must be smooth to avoid undesirable vibrations.

Design Goals:

- Precise control over the size of the feature to make sure the cam functions properly.
- Accurate location of the feature relative the hole in the cam so that it functions within an assembly.
- Control over the orientation of the feature to the back surface for even wear.
Surface Profile (Profile of a Surface)

Example (continued)

The best way to achieve all of these goals is by using a Surface Profile control.

- The basic dimensions, along with the Profile tolerance restricts the size and the form of the part.
- Datum A sets up the orientation of the tolerance zone and thus, the relative angle of the part surface.
- Datum B accurately locates the feature to the hole so it functions properly in the assembly.

Benefits of this design:
- Clear intent for repeatable measurements with a CMM.
- The surface is now fully defined to control Size, Location, Orientation and Form.
Surface Profile (Profile of a Surface)

When is it Used?

- Contoured surfaces that can be mathematically defined.
- Surfaces of complex geometry that can’t be controlled by any other controls (e.g., ergonomic/aesthetic surfaces involving lofts and sweeps).
- A general need to provide a loose control over the outline of a typical or complex part.
- Control of curved, complex, irregular surfaces.

Curved parts that are used for aerodynamics may have their outer surface defined by Profile.

Common applications for Surface Profile are:

- Defining the surface of a car hood or body panels.
- Castings or plastic moldings that have geometric or CAD defined profiles.
- Airfoils, ribs and other complex geometry.
- Non-rigid parts that may not hold their shape in a free state (such as stamped metals, plastics rubber, etc.).

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