Concentricity and Symmetry Controls

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Concentricity and Symmetry Controls

Sections:
1. Concentricity Control
2. Symmetry Control
3. Summary
4. References
Concentricity Control

**Concentricity** is the condition where the median points of all diametrically opposed elements of a cylinder (or a surface of revolution) are congruent with the axis of a datum feature. A median point is the midpoint of a two-point measurement.

A **concentricity control** is a geometric tolerance that limits the concentricity error of a part feature. The tolerance zone for a concentricity control is three-dimensional; it is a cylinder that is coaxial with the datum axis. The diameter of the cylinder is equal to the concentricity control tolerance value. The median points of correspondingly located elements of the feature being controlled, regardless of feature size, must lie within the cylindrical tolerance zone. When using a concentricity control, the specified tolerance and the datum references always apply on an RFS basis.
Concentricity Control

FIGURE 10-2 Example of a Concentricity Control Tolerance Zone
Concentricity Control

Concentricity Application
In industry concentricity controls are only used in a few unique applications. Concentricity is used when a primary consideration is precise balance of the part, equal wall thickness, or another functional requirement that calls for equal distribution of mass. The tolerated FOS may contain flats or be lobed and still be perfectly concentric.

When concentricity is applied to a diameter, the following conditions apply:
- The diameter must meet its size and Rule #1 requirements.
- The concentricity control tolerance zone is a cylinder that is coaxial with a datum axis.
- The tolerance value defines the diameter of the tolerance zone.
- All median points of the tolerated diameter must be within the tolerance zone.
Concentricity Control

FIGURE 10-3 Concentricity Application
# Concentricity Control

<table>
<thead>
<tr>
<th>CONCEPT</th>
<th>GEOMETRIC CONTROL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CONCENTRICITY</td>
</tr>
<tr>
<td>Tolerance zone</td>
<td>Cylinder</td>
</tr>
<tr>
<td>Tolerance zone applies to . . .</td>
<td>Median points of tolerated diameter</td>
</tr>
<tr>
<td>Relative cost to produce</td>
<td>$$</td>
</tr>
<tr>
<td>Relative cost to inspect</td>
<td>$$$</td>
</tr>
<tr>
<td>Part characteristics being controlled</td>
<td>Location and orientation</td>
</tr>
</tbody>
</table>

FIGURE 10-4 Differences Between Concentricity, Runout, and TOP
Concentricity Control

**QUESTIONS**

1. Is the feature control frame applied to a surface of revolution that is coaxial to the datum axis?
   - Yes
   - No

2. Do the datum(s) referenced specify one of the three types of datum axes shown below?
   - Yes
   - No
   - 1. Single dia. of sufficient length
   - 2. Two diameters spaced apart
   - 3. A surface primary; dia. secondary

3. Is the Ø symbol shown in the tolerance portion of the feature control frame?
   - Yes
   - No

4. Are any modifiers specified? (M, L, T, P)
   - Yes
   - No

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FIGURE 10-5 Legal Specification Flowchart for a Concentricity Control
Concentricity Control

FIGURE 10-6 Inspecting Concentricity

- Distance from datum axis to part surface: $X$
- Distance from datum axis to part surface: $Y$
- Distance of two-point measurement: $X + Y$
- Midpoint: $W = \frac{X + Y}{2}$
- Distance between midpoint and datum axis: $Z = X - W$

Median points of the tolerated diameter must be within the tolerance zone.

Each distance $Z$ must be within the cylindrical tolerance zone.
Symmetry Control

**Symmetry** is the condition where the median points of all opposed elements of two or more feature surfaces are congruent with the axis or centerplane of a datum feature. A symmetry control is a geometric tolerance that limits the symmetry error of a part feature. A symmetry control may only be applied to part features that are shown symmetrical to the datum centerplane. The tolerance zone is centered about the datum centerplane. The width between the planes is equal to the symmetry control tolerance value. The median points must lie within the parallel plane tolerance zone, regardless of feature size. When using a symmetry control, the specified tolerance and the datum references must always be applied on an RFS basis.
Symmetry Control

Tolerance zone - 2 parallel planes centered around the datum centerplane

Datum centerplane A

FIGURE 10-7 Symmetry Control Tolerance Zone
Symmetry Control

Symmetry Application
Symmetry controls are only used in a few unique applications in industry. Symmetry is used when a primary consideration of symmetrical features is precise balance of the part, equal wall thickness, or another functional requirement that calls for equal distribution of part mass. Otherwise, TOP is recommended to control symmetrical relationships. When symmetry is applied to a slot, the following conditions apply:

- The slot must meet its size and Rule #1 requirements.
- The symmetry control tolerance zone is two parallel planes that are centered about the datum centerplane.
- The tolerance value of the symmetry control defines the distance between the parallel planes.
- All the median points of the tolerated slot must be within the tolerance zone.
Symmetry Control

Tolerance zone - 2 parallel planes 0.6 apart

Datum centerplane A

Median points of toleranced feature must be within the tolerance zone

FIGURE 10-8 Symmetry Applications
# Symmetry Control

<table>
<thead>
<tr>
<th>CONCEPT</th>
<th>GEOMETRIC CONTROL</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>SYMMETRY</td>
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<tr>
<td>Tolerance zone</td>
<td>Two parallel planes</td>
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<tr>
<td>Tolerance zone applies to . . .</td>
<td>Median points of tolerated FOS</td>
</tr>
<tr>
<td>Types of part characteristics being controlled</td>
<td>Orientation and location</td>
</tr>
<tr>
<td>Relative cost to produce</td>
<td>$$$</td>
</tr>
<tr>
<td>Relative cost to inspect</td>
<td>$$$</td>
</tr>
</tbody>
</table>

FIGURE 10-9 Differences Between Symmetry and TOP
Symmetry Control

QUESTIONS

① Do the datums referenced specify a centerplane?

② Is the feature control frame applied to two or more feature surfaces that are symmetrical about the datum axis or centerplane?

③ Are any of the following modifiers specified? (M, L, P, T, ∅)

This is a LEGAL specification of a symmetry control.

This is an ILLEGAL specification of a symmetry control.

FIGURE 10-10 Legal Specification Flowchart for a Symmetry Control
Symmetry Control

1. Using the height gage, measure the opening of the variable jaws:
   - Establish the location of the datum centerplane from the surface plate.
   - Locate the dial indicators to be at the datum centerplane.

2. Take a two-point measurement on opposing part surfaces:
   - The difference in the gage reading—divided by two—is the symmetry error of the median point.

3. Repeat as many times as necessary.

FIGURE 10-11 Inspecting Symmetry
## Summary

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Datum reference required</th>
<th>Can be applied to a</th>
<th>Can affect WCB</th>
<th>Can use M, L, T, P modifier</th>
<th>Can override Rule #1</th>
<th>Tolerance zone shape</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Two or more planar feature surfaces</td>
<td>Cylindrical or surface of revolution</td>
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<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

**FIGURE 10-12** Summarization of Concentricity and Symmetry Controls
References

http://www.kxcad.net/topsolid/Topsolid_Control/controle/geometrical/ctrl_geometrique_coaxialite.htm
http://video.filestube.com/video,e60fc369902d0a1103ea.html
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