Concentricity

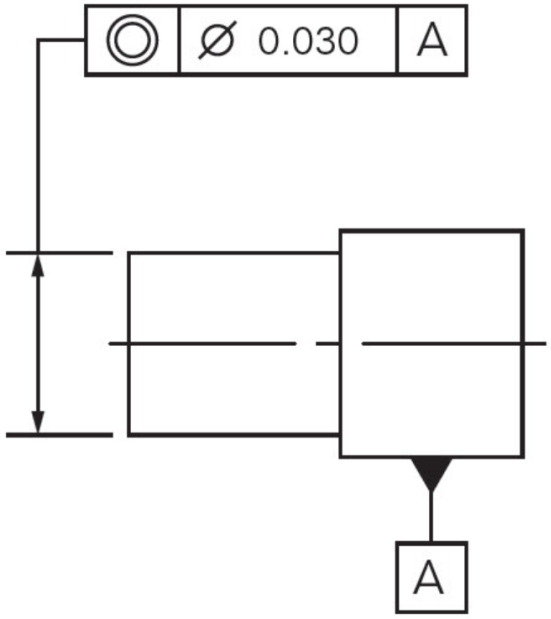
Concentricity

GD&T Symbol: ◎

Relative to Datum: Yes

MMC or LMC applicable: No

Drawing Callout:

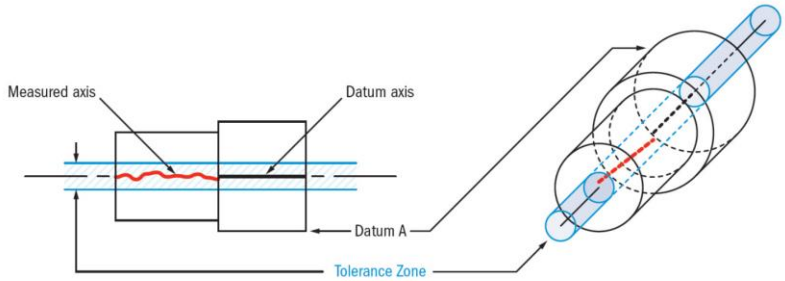


Description:

Concentricity, sometimes called coaxially, is a tolerance that controls the central axis of the referenced feature, to a datum axis. The axes for the datum and referenced feature are derived from the median points of the part or feature. Concentricity is a very complex feature because it relies on measurements from a derived axis as opposed tangible surface or feature.

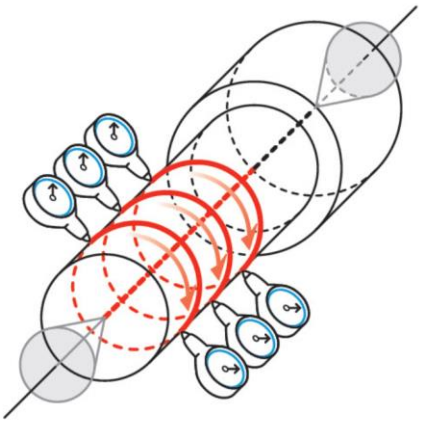
GD&T Tolerance Zone:

Concentricity is a 3-Dimensional cylindrical tolerance zone that is defined by a datum axis where all the derived median points of a referenced circular feature must fall into. the median points of the reference surface cross sections form the theoretical axis that must be in this tolerance zone.



Gauging / Measurement:

Concentricity is considered one of the most difficult GD&T symbols to measure for due to its difficulty in establishing the mid points of the feature. First you must establish a datum axis which to measure, Once the datum axis is established you must now take measure many a series of cross sections (however many is realistic). Once the cross sections are taken and the exact plot of the surface is obtained, the median points of these cross sections must be determined. Then these series of points must be plotted to see if they fall within the cylindrical tolerance zone. This can only be done on a CMM or other computer measurement device and is quite time consuming.



The following is usually done with a CMM:

1. Determine Datum axis
2. Measure referenced surface
3. Determine if central axis fall in TZ

Relation to Other GD&T Symbols:

Concentricity is considered the circular form of GD&T symmetry. While symmetry measured the true midpoint plane of a feature to a datum plane or axis, concentricity measures the derived midpoint axis to a datum axis. Both are notoriously difficult to measure.

Runout is a combination of concentricity and circularity.

Runout = Circularity + Concentricity

If a part is perfectly round, the runout will equal the concentricity.

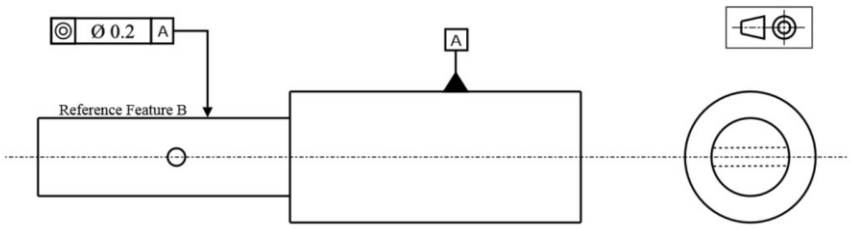
Concentricity is also a 3D form of 2-Dimensional True Position when applied to a circular feature. While true position is usually controlled to a fixed point in space that forms from coordinate measurements from a datum, concentricity is controlled to the axis derived from a all the median points of a datum surface or feature.

When Used:

Due to its complex nature, Concentricity is usually reserved for parts that require a high degree of precision to function properly. Transmission gears, which need to always be coaxial to avoid oscillations and wear, may require concentricity to ensure all the axes line up correctly. Equal mass or inertial concerns are one of the leading causes for the concentricity callout. Any application where the median points of a feature need to be controlled relative to a datum would require cylindricity. However in many cases, the use of runout or true position can replace the need for concentricity and be much easier to measure for.

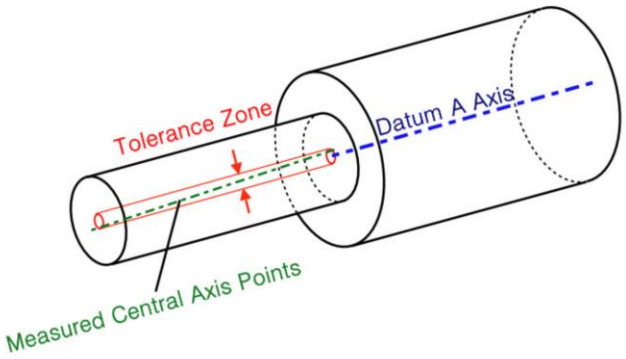
Example:

An intermediate shaft in a transmission is composed of two different diameter sections which are coaxial. Datum A is the drive side and relatively fixed with bearings to the housing, The referenced surface B is desired to be concentric with Datum A to avoid oscillations at high speed.



Two gears with the concentricity callout.

Concentricity would require side B to be measured in all dimensions several times to obtain a full dimensional scan of the surface of the reference feature. This scan must then be analyzed to determine the central axis points at each location along the cylinder, forming the true part axis. The tolerance zone would then need to be established by measuring Datum A to determine *its* axis. Both the datum tolerance zone and the measured central points from the reference surface would be compared. The measured central axis points would all need to fall into the cylindrical tolerance zone surrounding datum A. This would all be done with a CMM and measurement software and required special measurement programs to compare the axes



In this example the measured axis falls within the cylindrical tolerance zone surrounding datum axis A, ensuring a smooth, near-perfect rotational system

Final Notes to Remember:

Avoid Concentricity!

You will always hear from most machinists, measurement techs and designers to avoid concentricity like the plague. Unless it is absolutely necessary to control the distribution of mass around a part's median points you should look to other more applicable GD&T symbols. A good replacement for concentricity is runout since it relates the surface of a feature to a datum axis, while concentricity relates the derived axis to said datum. You can physically touch and measure the surface of the part to obtain a runout measurement. Controlling runout will also control the concentricity, albeit at a lesser extent than when concentricity is applied on its own. (Runout tolerance > Concentricity because Runout = Concentricity + Circularity)

Bullets

Often you will see concentricity gauges that are applied to homemade bullet casings. These gauges however do not measure concentricity by actually measure runout. However, since runout is just a combination of circularity and concentricity, you can technically say that you are measuring the concentricity of the bullet.

Contact Willrich Precision for more information on concentricity measurement.

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