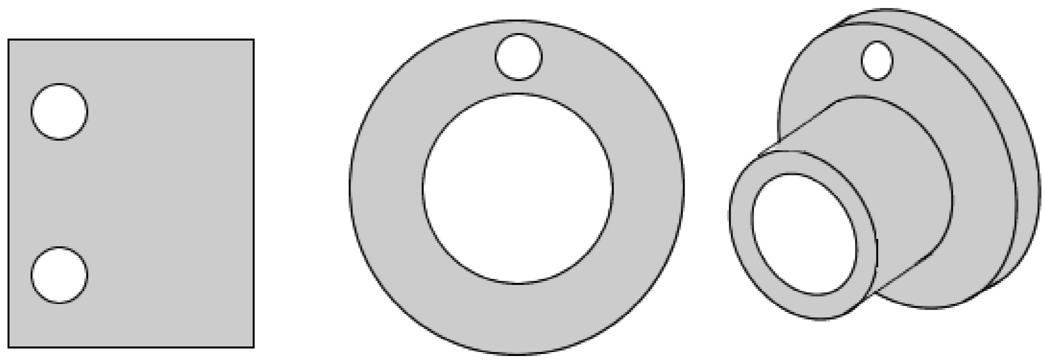
Application Tech Memo

Simple Alignment Methods

Purpose

To discuss alignment methods and, associate them with three different shaped parts.



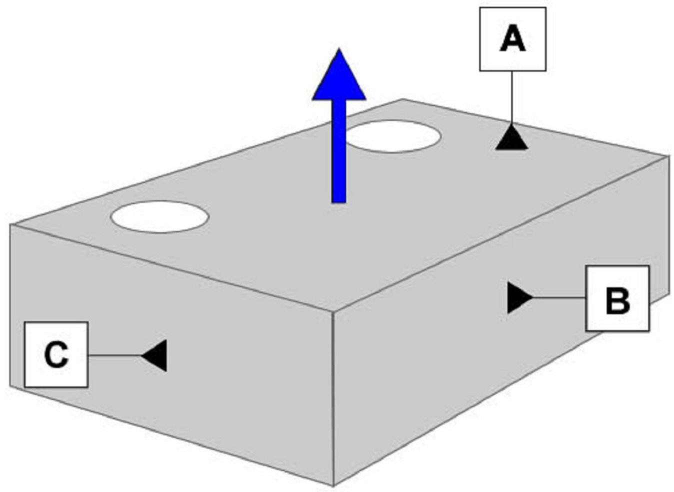
The three parts that will be discussed will be:

- a simple plate.
- a flange.
- a cylinder.

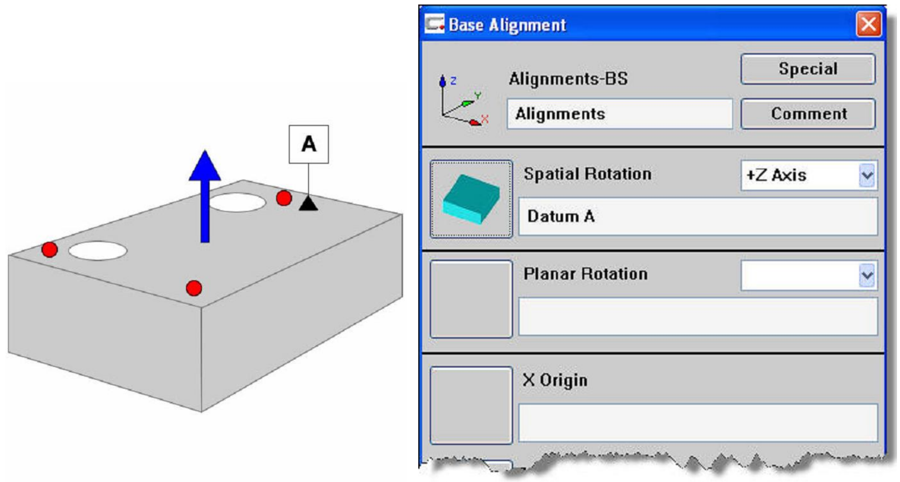
Procedure:

Let us take the base alignment procedure, and apply it to three different shapes and see how they differ in the approach.

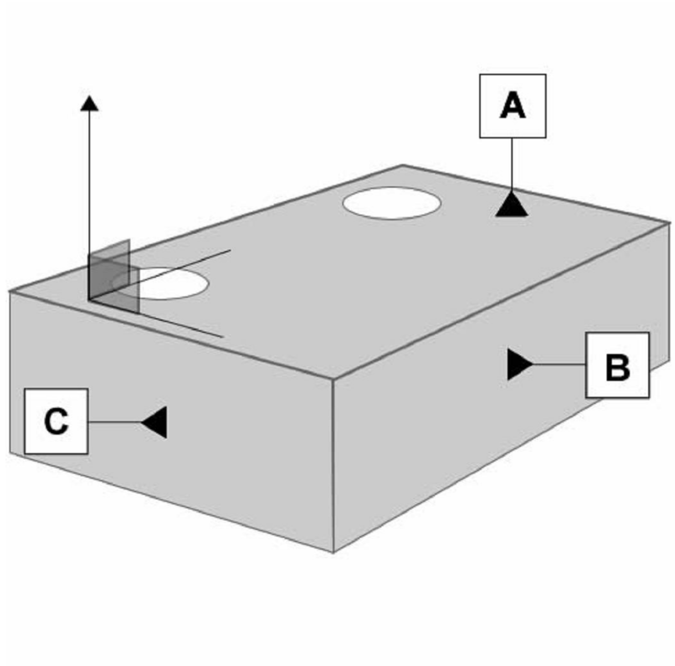
Shape 1 – Basic 3-2-1 Alignment



For our prismatic part, our Spatial or leveling plane is our Datum A.

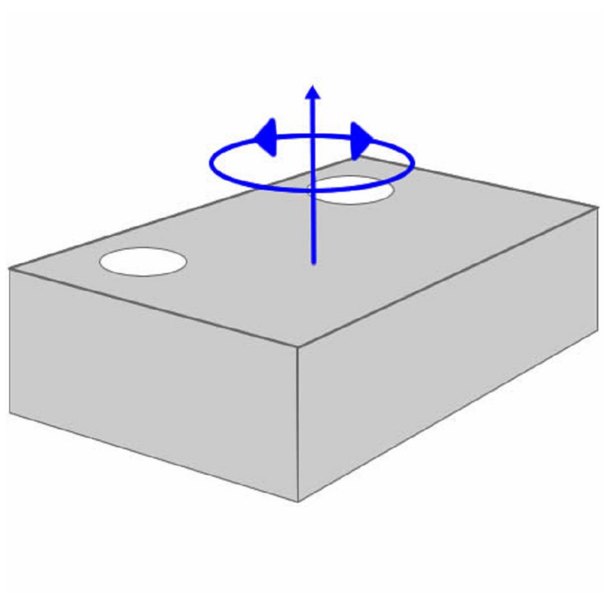


Take a minimum of three points on this surface; the plane that is created can be used as the spatial alignment feature.

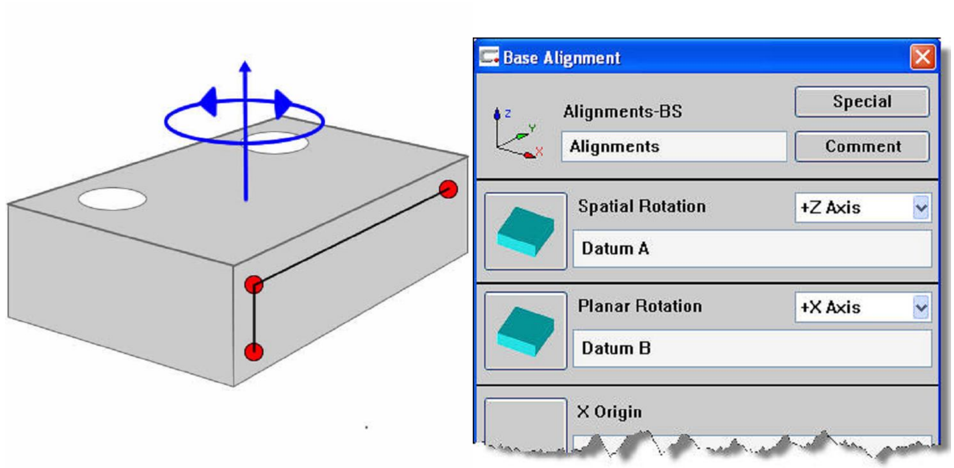


What this has done is to create an axis on the top surface that is perpendicular to the created plane.

Our Planer rotation for this feature is Datum B.
This is the feature that “times” the part.

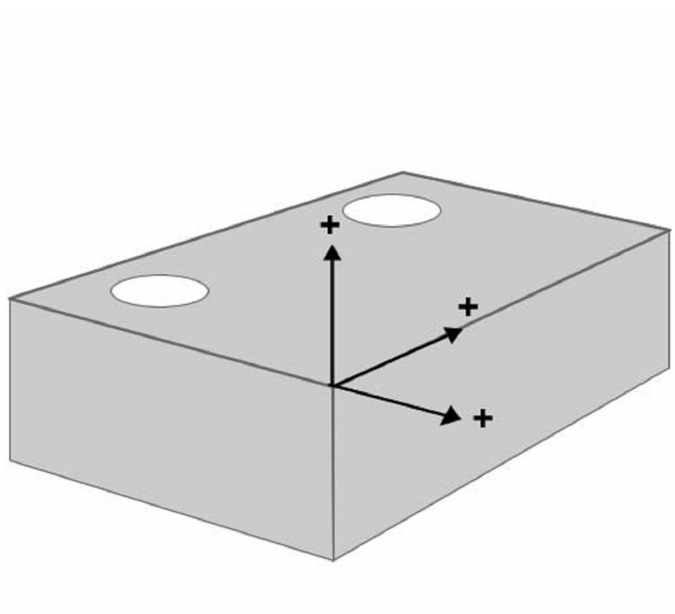


Although our spatial rotation leveled the part, the part is free to rotate.
Datum B will control this rotation. A plane or a line will be adequate.

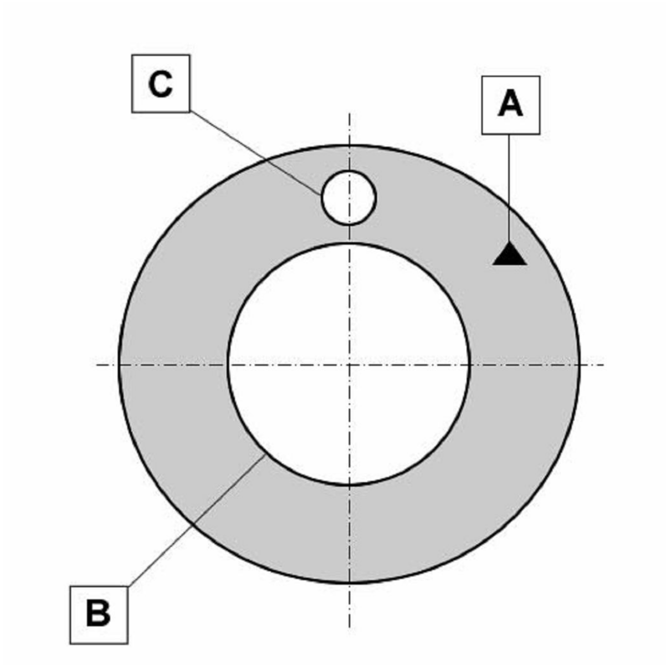


The part is now timed; all that is left is to define where the origins are. The original features are typically used along with points if they are needed.

In this instance we require one more point on the end face and then we have enough to complete the alignment.

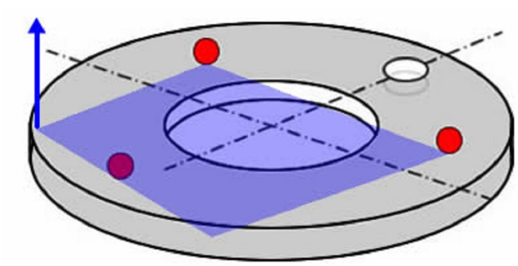


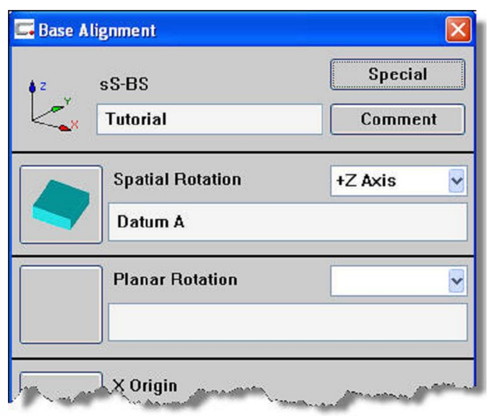
Shape 2 – Basic 3-2-1 on a circular part.



Circular parts can be considered in two ways, depending on their datum assignment.

If we consider this first method, the tertiary plane A is the flange face, the planar alignment is B rotated about C.

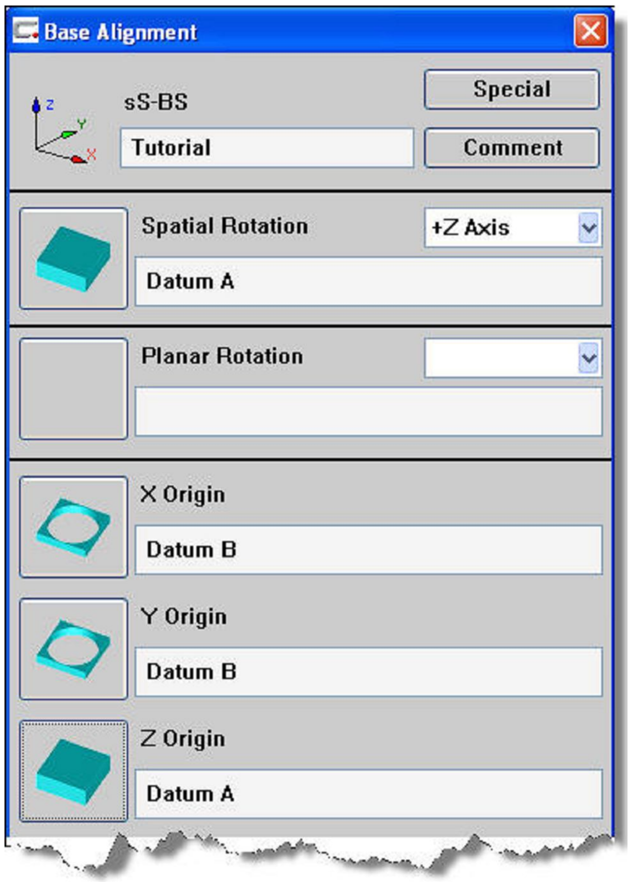




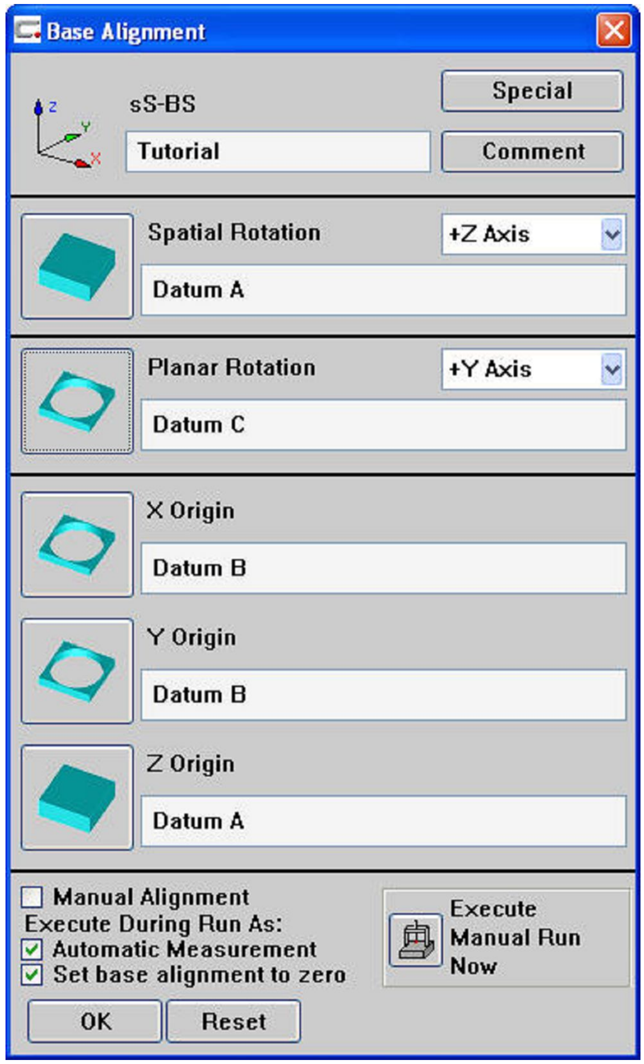
Take a minimum of three points on the top face. This will create a plane to define the spatial orientation of Plane A.

Once again the part is free to rotate, but this time we have a point about which it is rotating, this is the Datum B.

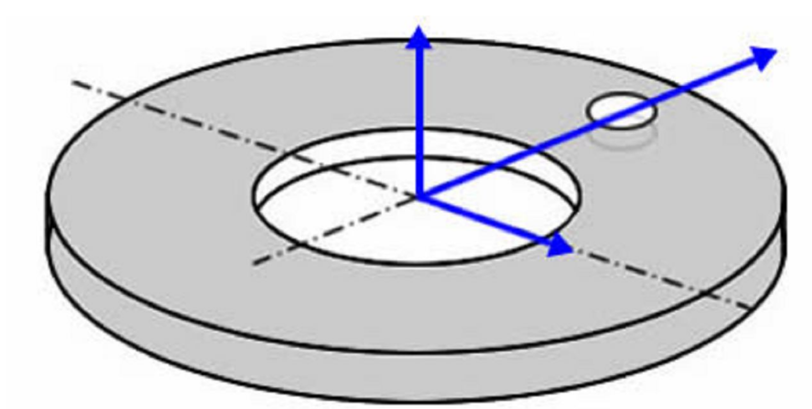
Create this is in the alignment window, by setting the origins.



Note that the planar rotation has been left empty, this is because the entity that gives us our timing is a single feature aligned with Datum B.

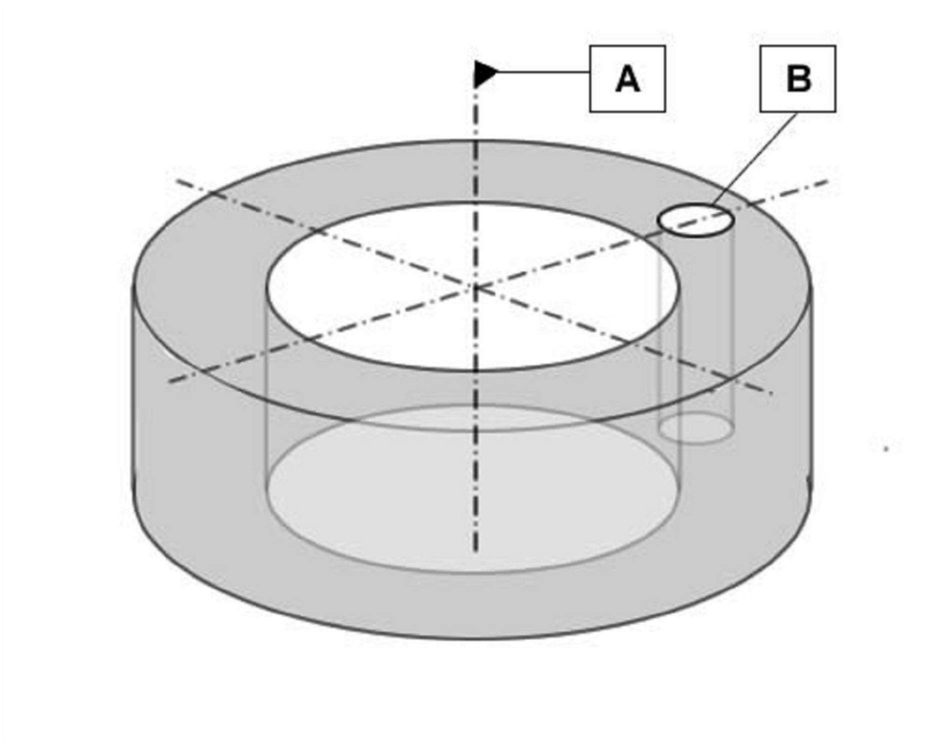


Here you see our completed axis system in the alignment window.

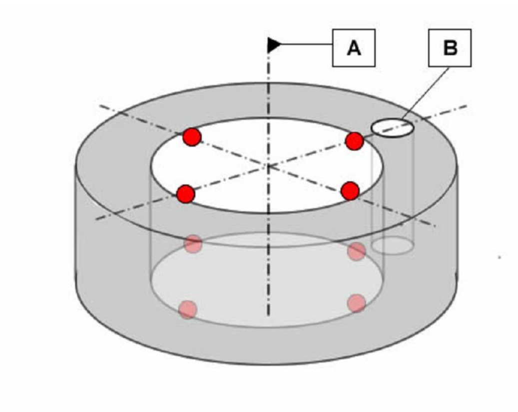


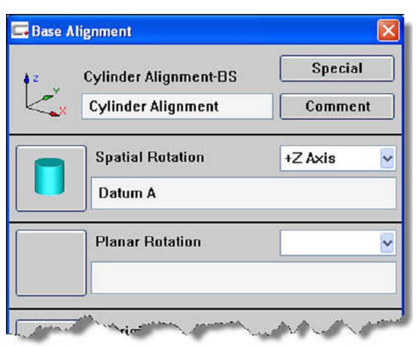
Also shown on our part.

Shape 2 – Alignment based on a cylinder axis

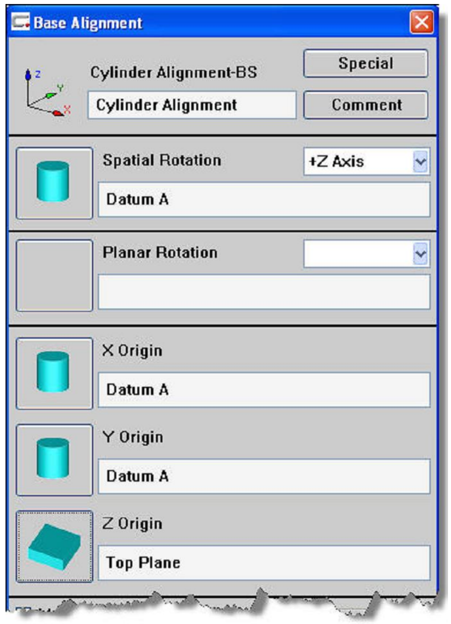


In this example, our plane has disappeared and the axis of the cylinder has taken over as our spatial. The number of datum features has reduced to two.

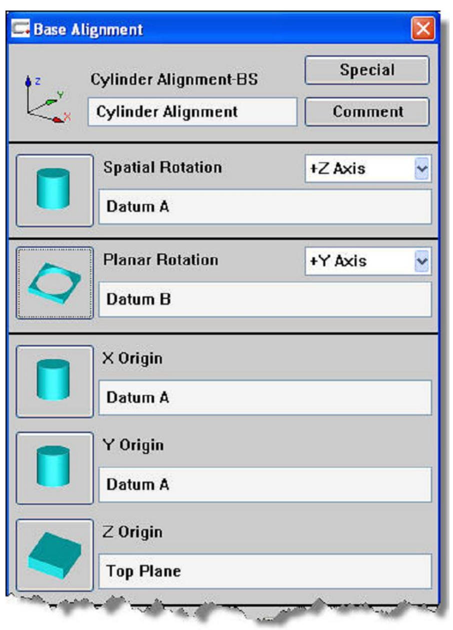


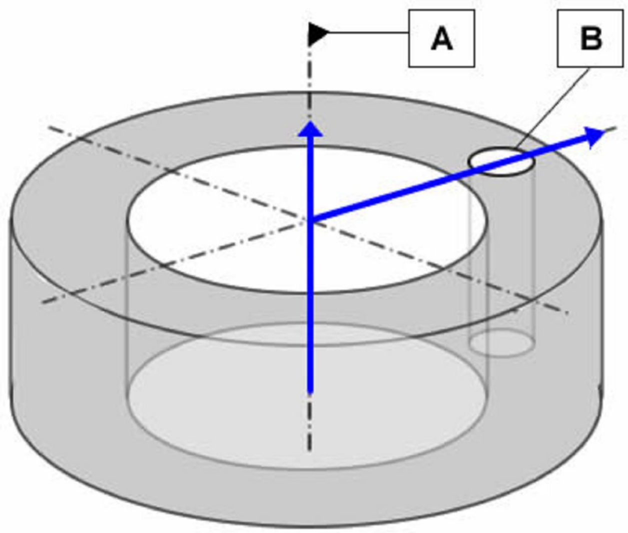


In this instance, our spatial setting for the part is the central axis of the cylinder.

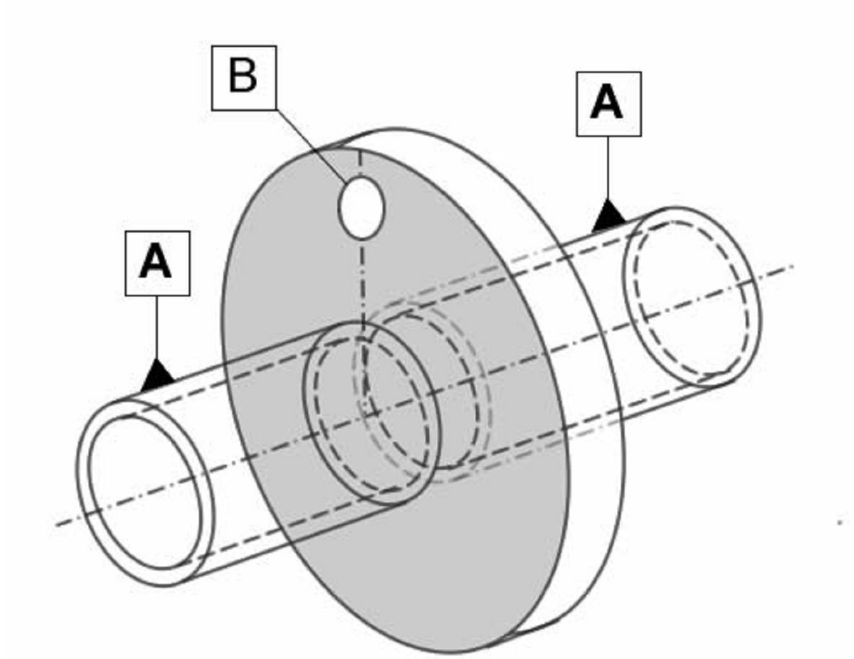


The origin is the cylinder for X and Y and the Z has been zeroed with a plane on the top. All that remains is our planar rotation.



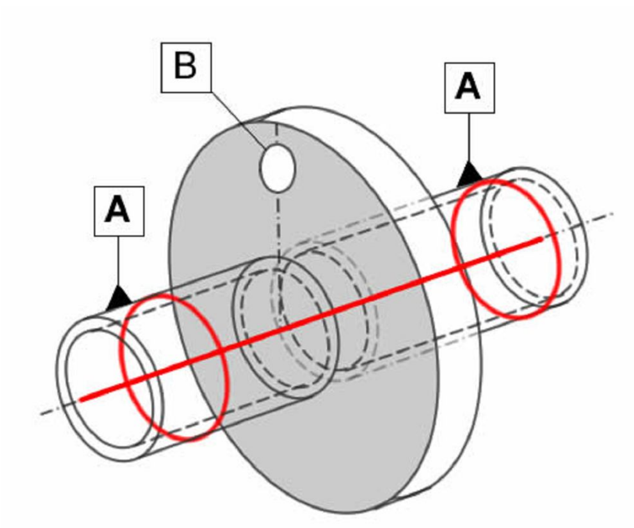


Shape 3 – Alignment based on a cylinder axis



Here we have another instance of a cylinder that creates new considerations. In this instance, our main axis in the datum reference frame is the axis that runs the length of the cylinder e.g. an axle.

Our intention is to create a true axis along the cylinder. The sections that we probe need to be at 90 degrees to the axis.



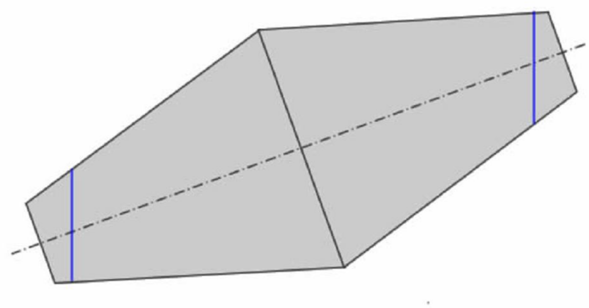
If we look at the cylinder, we are measuring an interrupted axis i.e. the flange is in the way.

Our procedure will be to create a 3D line between the two circles to create the cylinder axis.

To create this 3D line we need to measure a circle at each end of the cylinder and create a 3D line between the circles.

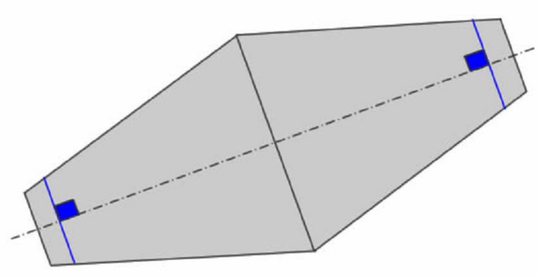
However depending on the amount of physical misalignment of the part, we have an inaccuracy that we wish to remove.

Let us take a moment to see what we have created so far and what inaccuracies are still possible.



To make what is happening more visual, let us consider the cylinder as a pair of cones, it makes what is happening more apparent.

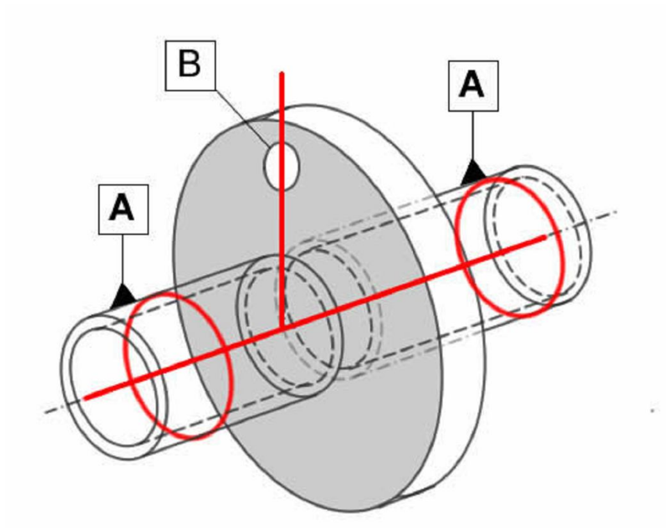
The circles that we have measured are not necessarily perpendicular to the axis that has been created.



We want to ensure that the section that we measure is at 90 degrees to the axis of the cylinder. This is why we are viewing the cylinder as a visual cone, because it is more apparent what is happening.

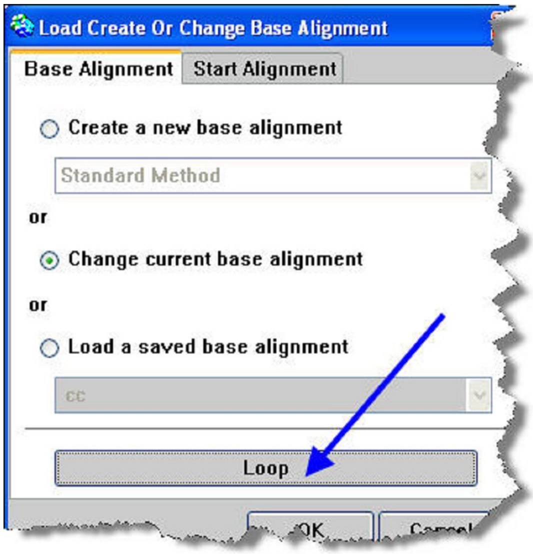
Create the initial alignment under the following conditions:

- Spatial rotation is the 3D line.
- Planar rotation is the alignment hole.
- The origin is typically the center of the shaft and the third axis origin is in its relevant location (which could be the end of the shaft or the flange face).

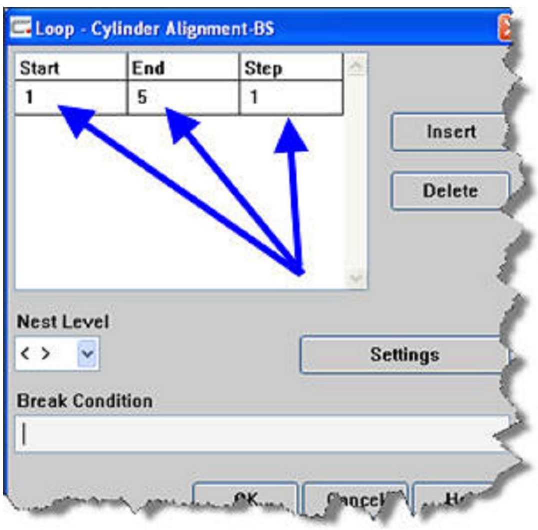


As we have already mentioned, our initial probing was probably not perpendicular to the axis of the shaft, we need to loop our alignment until this case is corrected.

Within our alignment is a loop capability and what we need to do is to loop the alignment until it no longer improves the orientation of the alignment.

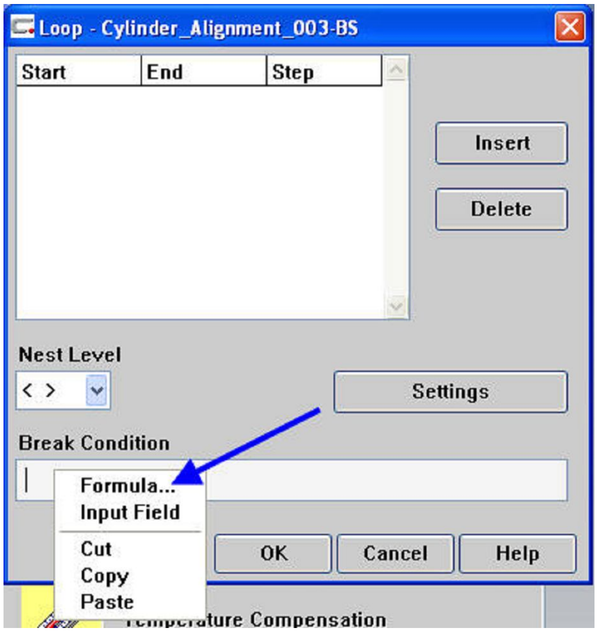


Within the alignment, select the loop button.

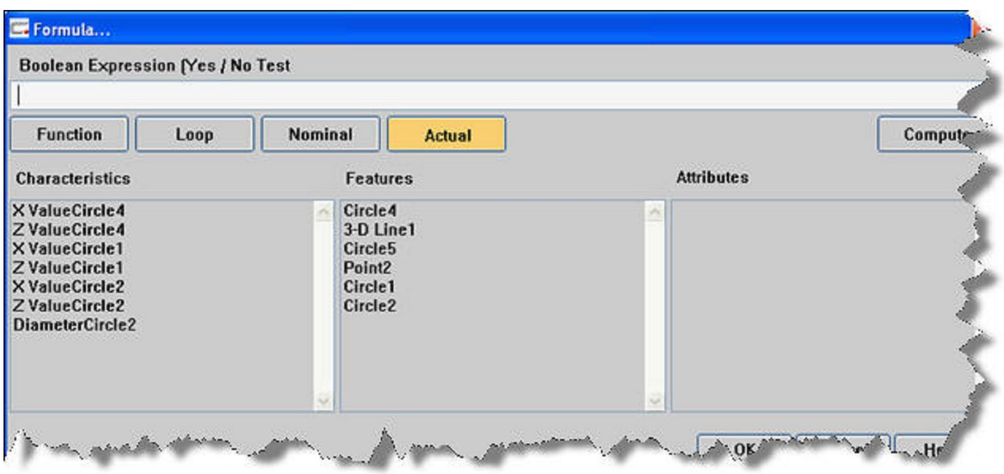


Set the loop parameters to start at one, finish at 5 and step through the loop parameters one at a time.

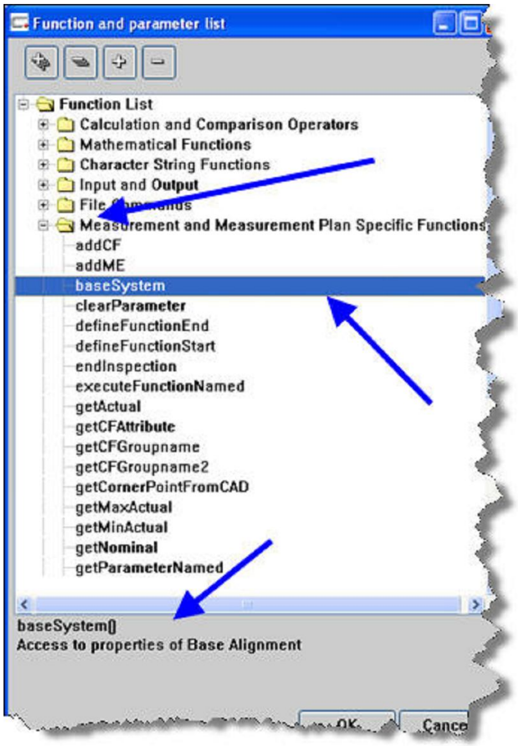
Click inside the break condition, right mouse click and select Formula.



You will be transferred to the Formula environment where you are given access to the application of a Formula.



Clicking on the Function key accesses the Formula, that we are interested in applying.



Click on the "Measurement and Measurement Plan Specific Functions" folder to expose the contents. Click on the function that we are looking for which is the baseSystem function.

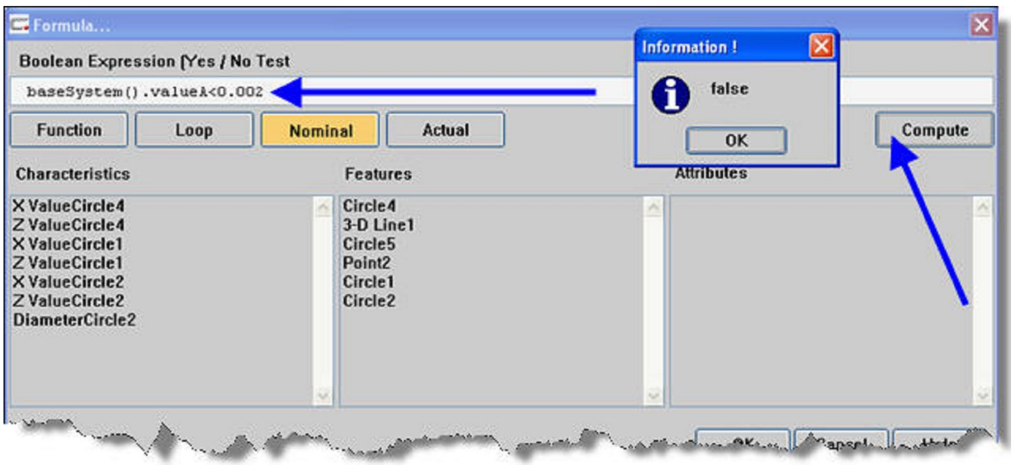
On the bottom of the dialog box is an explanation of what we have selected. In our instance, we have accessed the function baseSystem, which contains all of the properties of the alignment. It is one of these properties that we are interested in, that property is "valueA".

The valueA property allows us to access the amount of movement that took place in the alignment since the last setting. It is the sum of all rotations and translations that happened in the alignment. In other words how much did it move.

Insert the following code:

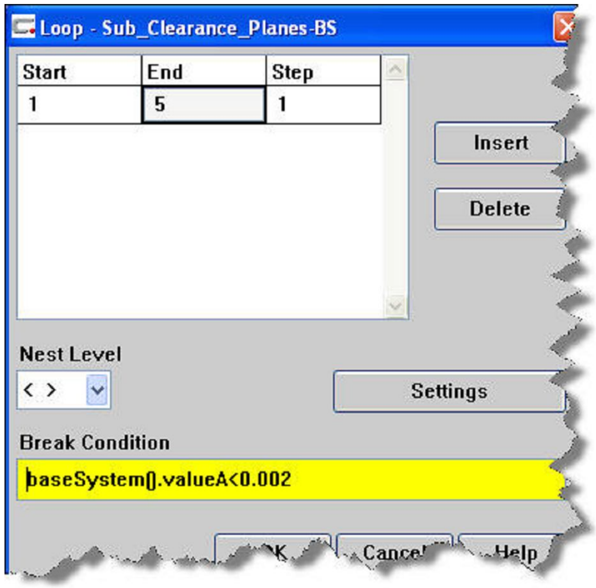
baseSystem().valueA<0.002

To make sure that there are no typing mistakes, click on the “Compute” button. This will compute the answer or calculation to the formula we have just added.



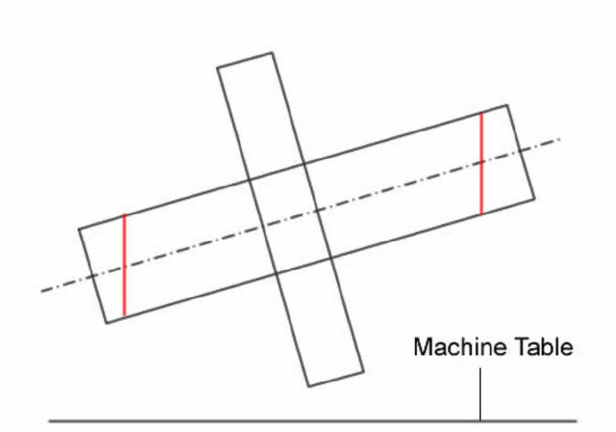
We did not receive any error messages, which means that our entries were OK and the current check on the statement is “False”. In other words the alignment is still moving and needs to be redone.

Click on OK to close the Formula window.

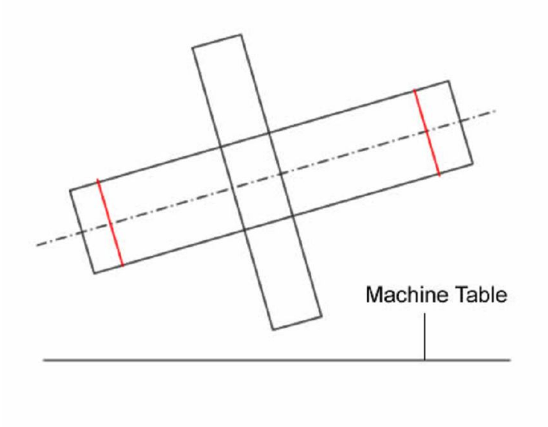


Due to this calculation being a man made Formula calculation, the break condition turns yellow. This tells you that this setting was made in Formula.

The settings that have been assigned here are to loop the alignment up to a maximum of 5 times. Each time, check the result of the deviation in the alignment and, when it is less than 0.002mm, jump out of the alignment.



As we go through the loop, the perpendicularity of measurement of the circle improves



When the perpendicularity of the circle to the axis does not improve by more than 0.002mm jump out of the loop.

The cycle loops up the 5 times that we have allowed and, normally after the second or third run, meets the criteria that we set.

In summary, for this last example:

- Set up the part manually.
- Measure it again (because of the loop)
- Check to see if it moved
- If it did measure it again
- If it did not move, it is now within 0.002
- Continue with the inspection.

It is recommended to use this procedure at any time that an alignment is used where the orientation of the part cannot be guaranteed.

The part is now correctly aligned and, if someone asks you how well it is aligned, you can say within 0.002mm.