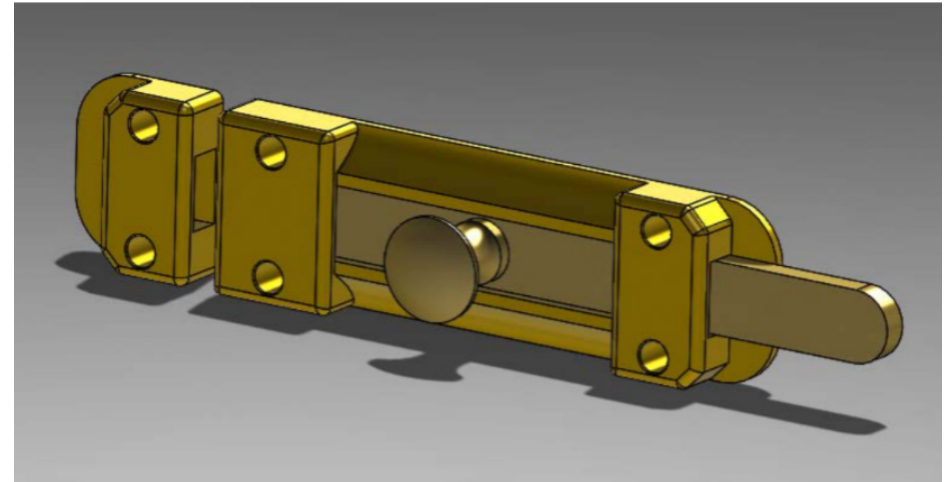


Tolerance Stack Instruction Guide

OVERVIEW

No manufacturing process is perfect and there will inevitably be discrepancies between parts. Tolerances quantify the allowable magnitude of these discrepancies. They communicate the range of acceptable sizes which exist between the upper specification limit, or maximum size, and the lower specification limit, or minimum size. Each dimension of a part has a tolerance and, although they are often small, when many parts are working in combination tolerancing becomes crucial to ensure proper function.

This template is designed to perform tolerance stacks using all the tolerances involved in a system. It will provide a nominal stack and specification limits according to both the Worst Case and RSS methods of tolerancing. Below is the assembly used as an example in this manual.



TEMPLATE INTRODUCTION

There are three interdependent sheets in this template:

- Table of Contents
- Dimension List
- Tolerance Stacks

Table of Contents	Dim List	Tolerance Stack 1	Tolerance Stack 2	Tolerance Stack 3
-----------------------------------	--------------------------	-----------------------------------	-----------------------------------	-----------------------------------

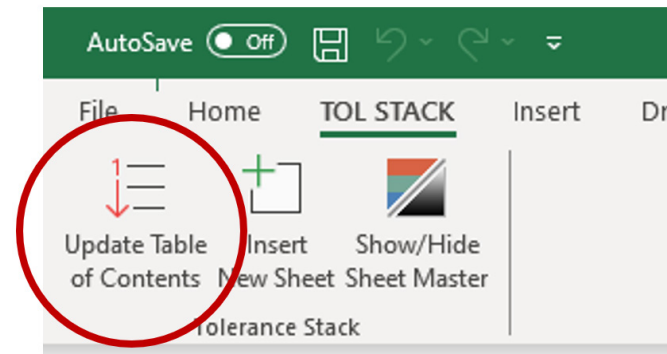


TABLE OF CONTENTS

The Table of Contents is used to organize all data relevant to the assembly. Using the title of each tolerance stack sheet, the Table of Contents will populate automatically and is searchable by Stack Type, Nominal Stack, and other parameters.

When changes are made to other areas of the template, the Table of Contents must be updated before those change will appear. To do this, select the Update Table of Contents button in the TOL STACK tab at the top of the page.

Table of Contents											
Number of Stacks: 2											
Everytime the table of contents is updated, all edits done to the table of contents sheet will be replaced. Any edits or changes must be done in the corresponding sheet. Table of Contents does not auto update.											
Sheet No	Sheet Title	Stack Title	Stack Goal	Status	Type	Nominal	Min	Max	Dimensions Involved	Parts Involved	
0	Dim List										
1	Tolerance Master	Tolerance Stack Title Here		In Progress		0	0	0			
2	Tolerance Stack 1	Tolerance Stack 1		In Progress		0.02	-0.09	0.125	81, 51,	Base, Slider,	

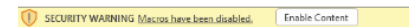


SECURITY WARNING

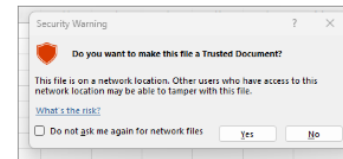
If Excel blocks the use of these macros in the “TOL STACK” tab, you will need to unblock them for full functionality. Instruction from <https://support.microsoft.com/> are below:

Make a document trusted to enable macros

If you see a security warning when you open a document or try to run a macro, you can choose to make it a trusted document and enable macros. This example is on an Excel workbook.



1. Select Enable Content.
2. In the Security Warning dialog, select Yes to make the document trusted.



Macros are now enabled on this document. To revoke a trusted document, you need to clear all trusted documents. For more info, see [Trusted documents](#).

Tip: Rather than enabling macros for each document, you can create a trusted location to store trusted documents. Microsoft 365 will then not check them with the Trust Center. For more info, see [Add, remove, or change a trusted location in Microsoft Office](#).



The Dimension List sheet is the only space where users input information directly to the system. This sheet organizes data according to dimension and should not be confused with the Table of Contents which organizes by tolerance stack. It is important that the entries in this sheet are accurate as the template will reference this data to perform the analysis.

The Tolerance Stacks sheets are where the tolerance analyses are performed. The Dim Tag column draws its information directly from the Dimension List. By selecting the appropriate Dim Tag the rest of the matrix will populate automatically. The remaining green boxes must be filled by the user manually but, they are not all required. It may be helpful to assign the Tolerance Stack sheets meaningful titles, this way each stack will easily identifiable in the table of contents.

As many sheets as necessary can be added to the template. To do this select the Insert New Sheet button in the TOL STACK tab at the top of the page.

[illegible]



TEMPLATE DETAILS

PART NUMBER

The part number is a unique code which identifies parts relevant within an analysis and differentiates them from each other. It is sometimes helpful to use the same code which identifies them in CAD models.

PART NAME

In this column enter the common part name as it corresponds to each part number.

REVISION (REV)

If a model or part has undergone multiple iterations it may be useful to enter the revision number here.

DIM TAG [DIMENSION LIST]

Dimension tags are used to distinguish relevant dimensions from each other. They must be manually assigned and should be entered in the row with the corresponding part information. The Dim Tag is how the file will recall relevant information about each dimension automatically.

DIMENSION DESCRIPTION

Use this column to describe which dimension the Dim Tag is referring to. This list will help users understand the dimension in question.

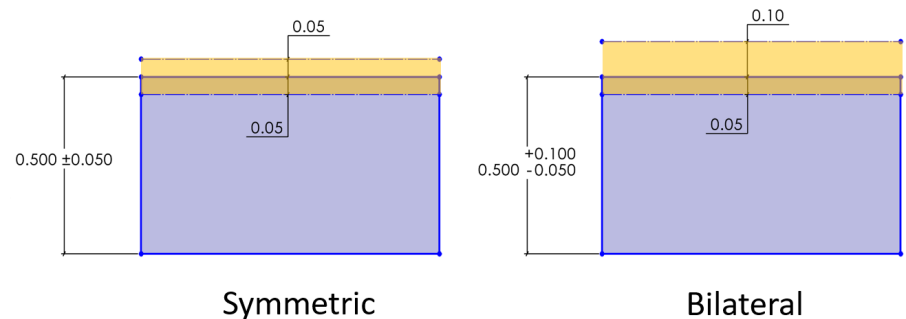
NOMINAL VALUE

The nominal value is the magnitude of the dimension in question according to the current CAD model. It typically used for generic descriptions and does not include any positive or negative tolerances or dimension limits.

TOLERANCE TYPE

While there are several common forms of tolerances this template is designed for plus/minus tolerances of which there are two kinds.

- Symmetric (unilateral) - Expresses variation as plus/minus a common size
- Bilateral – Expresses variation as plus/minus two independent sizes.





SYMMETRIC TOLERANCE/BILATERAL MINUS/ BILATERAL PLUS

After determining the tolerance type enter the magnitude of each tolerance in the appropriate fields.

CUSTOM CP

Cp or process capability refers to how well a manufacturing process meets its specifications and is equal to $(USL - LSL)/6\sigma$ where USL and LSL are the upper and lower specification limits respectively.

ILLUSTRATION

It may be helpful to create an illustration to better visualize the system. If the analysis requires many Tolerance Stack sheets it is best to insert a screenshot of a completed illustration rather than to create the illustration in Excel. Assembling an illustration in a separate program, such as Word or PowerPoint and inserting a simple screenshot will prevent Excel from crashing.

DIM TAG [TOLERANCE STACK]

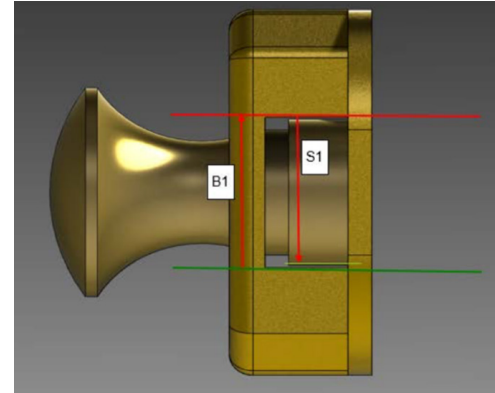
From the drop-down menu, select the appropriate dim tag and the associated fields will populate automatically.

- OR +

Enter a plus or minus symbol to indicate the directionality of the dimension.

NOMINAL STACK

This value is automatically returned upon completion of the tolerance stack. It is calculated from the Nominal Values associated with each dimension and represents the nominal clearance between components according to the model.



Part Number	Part Name	Rev	Dim Tag	
001	Base	1.0	B1	
002	Slider	1.0	S1	
			B1	
			B2	
			S1	
			S2	

Part Number	Part Name	Rev	Dim Tag	Dimension Description	- or +	Nominal Value
001	Base	1.0	B1	Slot Width	+	0.5700
002	Slider	1.0	S1	Slider Width	-	0.5500



WORST CASE $\pm$

Worst Case or Arithmetic tolerancing models return the largest and smallest possible amount of variation for a given component. Designing these results guarantees that every part will fall within the specification limits however, this model often requires the utmost precision and can make manufacturing expensive.

RSS $\pm$

The Root Sum Squared tolerancing model assumes that a normal distribution can describe the range of variation for each component and subsequently, the entire assembly. Using statistical analysis, this model predicts the distribution of part variation, not simply the extreme ends of that variation. It can increase flexibility for designers and decrease manufacturing costs however this model is likely to produce some components that do to fall within the specification limits. When more than 3 dimensions are in your tolerance loop, RSS is the most practical approach to tolerance analysis.

RSS VS WORST CASE SELECTION

To select which type of study is better suited for each sheet, there is a drop-down tool in the bottom right corner. For this example, only 2 dimensions are used so “worst case” is the best representation of the tolerances shown.

Tolerance Stack 1

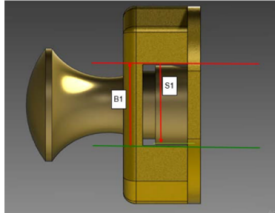
Goals:

Assumptions:

Delve

Deliverables: Status: **In Progress**

Part Number	Part Name	Rev	Dim Tag	Dimension Description	- or +	Nominal Value	Tol Type	Tol	Bilateral -	Bilateral +	Cp	Contribution %	Dimension Min	Dimension Max
001	Base	1.0	B1	Slot Width	-	0.5700	Symmetric	0.005			1.333	95.2%	0.4700	0.6700
002	Slider	1.0	S1	Slider Width	-	0.5500	Symmetric	0.005			1.333	4.8%	0.5450	0.5550



Nominal Stack
0.020
MM

Worst Case $\pm$
-0.085 0.125
0.1050 0.1050

RSS $\pm$
-0.0300 0.120
0.1001 0.1001

Summary
(Explanation of final results)

Tolerance Case: **Worst Case**

Overall: 4.00
Overall Cp: 1.33
Failures per 1000: 1000.000
Failures per 1000: 4.00

Dimensional Targets:
Assemblies Failures:
Total Failures:

A red arrow points to the 'Worst Case' selection in the 'Tolerance Case' dropdown menu.

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