

Tolerance stack-up: worst-case and RSS formulas, worked example

1. The formulas

T_i is the tolerance range of dimension i (max – min). For a dimension with unequal deviations, use its mean value and the centred half-tolerance: 20 +0.1/0 becomes 20.05 ± 0.05.

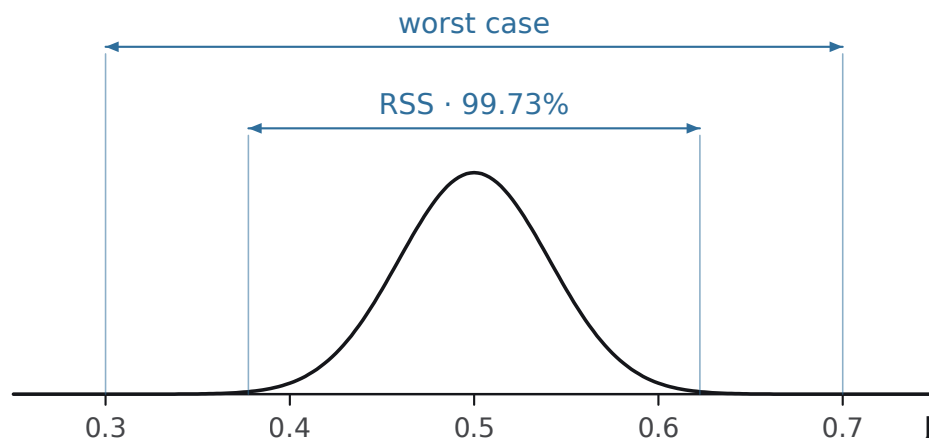
Quantity	Formula	Note
Nominal J	$J = \Sigma (+ \text{ dimensions}) - \Sigma (- \text{ dimensions})$	Using nominal (or mean) dimensions
Max J, worst case	$\Sigma (+ \text{ max dimensions}) - \Sigma (- \text{ min dimensions})$	Every dimension at its unfavourable limit
Min J, worst case	$\Sigma (+ \text{ min dimensions}) - \Sigma (- \text{ max dimensions})$	Guarantees 100% of assemblies
Tolerance of J, worst case	$T_J = \Sigma T_i$	T: tolerance range (max – min)
Tolerance of J, RSS	$T_J = \sqrt{(\Sigma T_i^2)}$	Independent, centred, normally distributed dimensions

2. Worked example

The housing and two parts from the drawing in section 2. Dimensions in mm.

Dimension	Sign	Nominal	Tolerance	Min	Max
a	+	50	±0.1	49.9	50.1
b	–	20	±0.05	19.95	20.05
c	–	29.5	±0.05	29.45	29.55

Result	Gap J (mm)	Calculation
Nominal J	0.5	50 – 20 – 29.5
Worst case	0.3 ... 0.7	$0.5 \pm (0.1 + 0.05 + 0.05) = 0.5 \pm 0.2$
Root sum square (RSS)	0.378 ... 0.622	$0.5 \pm \sqrt{(0.1^2 + 0.05^2 + 0.05^2)} = 0.5 \pm 0.122$



3. Worst case or RSS?

The more dimensions in the loop, the wider the gap between the two methods. With n dimensions of equal tolerance ±0.1 mm:

Dimensions n	Worst case	RSS	RSS / worst case
2	± 0.2	± 0.141	71%
3	± 0.3	± 0.173	58%
4	± 0.4	± 0.2	50%
5	± 0.5	± 0.224	45%
6	± 0.6	± 0.245	41%
8	± 0.8	± 0.283	35%
10	± 1	± 0.316	32%

Reference values taken from the article <https://www.baouch.fr/en/blog/chaine-de-cotes-tolerance-stack-up/>, which explains the assumptions, formulas and edge cases. For critical use, check the current standard or the manufacturer's documentation. Free to print and share with credit to the source.