CircuitClarity RESOURCE

Worst case, RSS, and Monte Carlo

https://circuitclarity.com/resources/tolerance-analysis-methods/

The decision this guide supports

Worst case, RSS, and Monte Carlo answer different questions. The right method is the one whose assumptions match the error sources, correlations, distributions, and acceptance decision.

A useful calculation is not the finish line. It becomes useful when its method, units, source conditions, and omitted effects fit the actual design question. Use this reference to identify that boundary before treating a nominal result as an implementation decision.

DECISION MAP

From first estimate to defensible next step

1. **Define the output, limits, and input ranges.**
   Start by naming the physical quantity, operating condition, and decision at stake. A number without that context cannot establish a design margin.

2. **Use endpoint evaluation for bounded worst cases.**
   Keep this check explicit. It separates a useful first-pass model from an answer that only looks precise.

3. **Use RSS only for justified independent spreads.**
   Keep this check explicit. It separates a useful first-pass model from an answer that only looks precise.

4. **Document distributions, seed, sample count, and correlations for simulation.**
   Treat this as the handoff point. Compare the result with selected-part evidence, the real layout or assembly, and a measurement method that can reveal the remaining uncertainty.

Worked design review

Consider a designer using this method to make a first selection. The initial estimate establishes the nominal target, but it should not silently absorb a rating, curve, parasitic, temperature condition, or measurement setup from a different scenario. The correct outcome is often not a single chosen value: it is a short list of conditions that must be satisfied together.

Begin with the first two steps above, then ask whether the value still fits when the most consequential real-world condition changes. If it does, the estimate has earned a more detailed check. If it does not, the discrepancy identifies the design variable that deserves attention before a board, part, or test plan is committed.

> **Practical interpretation**
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> A numerical result cannot compensate for unknown distributions, hidden correlations, or incomplete component limits. That is not a weakness in the method. It is the cue to use the correct next source of evidence.

Questions to take into a design review

Have the tolerance sources been checked for independence before choosing RSS combination over worst-case addition?

If a Monte Carlo simulation was used, are its input distributions, sample count, and any modeled correlations documented alongside the result?

Is the reported number clearly labeled as a worst-case bound, an RSS statistical estimate, or a simulated percentile, rather than left ambiguous?

These questions prevent a common failure mode: moving a correct equation into a context where its assumptions no longer hold. They also make it easier for another engineer to reproduce the reasoning and identify which condition needs more evidence.

Common ways this reasoning goes wrong

Using RSS combination for tolerances that are actually correlated

If two components share a common cause of variation, such as coming from the same manufacturing lot or tracking the same temperature, they are not independent, and RSS combination will understate the real worst-case spread.

Running a Monte Carlo analysis without documenting the assumed distributions

A Monte Carlo result is only as trustworthy as its input distributions. A result reported without stating whether each tolerance was modeled as uniform, normal, or something else cannot be checked or reproduced later.

Presenting a worst-case bound as if it were a typical or expected outcome

Worst-case addition intentionally overstates the likely error to guarantee a bound; quoting that number as a "typical" expected error misrepresents how the circuit will actually behave in most production units.

Where this guide stops

A numerical result cannot compensate for unknown distributions, hidden correlations, or incomplete component limits.

For a consequential design, preserve the inputs and conditions used here, then compare them with the selected component or system evidence. That makes the follow-up review faster and keeps a useful first estimate from becoming an unsupported claim.

Frequently asked questions

▶ **Why does my RSS tolerance result look tighter than the worst-case result for the same circuit?**

▶ **How many samples does a Monte Carlo tolerance analysis need to be trustworthy?**

▶ **Can I mix worst-case and RSS terms in the same analysis?**

Related engines

Tolerance stack and Monte Carlo explorer

Preferred resistor value selector

Controlled-impedance tolerance explorer

Method authorities and source conditions

Use this guide alongside the engine-specific method and selected component or system data. The underlying reference families are Analog Devices precision references. Those sources establish condition-specific behavior; CircuitClarity uses them to frame the decision and its limits.