

Machining Tolerance Guide: What Each Process Can Hold

Tolerance is a cost decision. Tighten it and you add operations, fixtures and inspection time. This guide shows what each process holds as standard, what it takes to go tighter, and the roughness values that go with it.

Achievable tolerances by process

Process	Standard tolerance	Tightest practical	Cost note
CNC turning (diameter)	±0.01 mm	±0.005 mm, ground ±0.002 mm	Tighter needs finish passes and gauging
CNC milling	±0.02 mm	±0.005 mm on finish cuts	Fixture rigidity is the limit
Surface grinding	±0.005 mm	±0.002 mm	Flatness and finish add cost
Wire EDM	±0.005 mm	±0.003 mm	Slow on thick sections
Sheet metal bending	±0.1 mm, ±0.5°	±0.05 mm on small parts	Depends on tooling and material springback
Progressive-die stamping	±0.05 mm	±0.02 mm	Set by tooling build, not cycle time
Compression spring (wire)	wire ±0.02 mm, free length ±1%	wire ±0.01 mm	Set by coiling and stress relief
Extruded heat sink profile	±0.1 mm, cut ±0.2 mm	±0.05 mm machined	Profile tolerance from the die

Common GD&T symbols

Symbol	Name	What it controls
■	Flatness	How flat a surface is, no datum needed
■	Parallelism	Surfaces or axes kept parallel to a datum
⊥	Perpendicularity	Squareness to a datum
■	Position	True position of a hole or feature
■	Concentricity	Axis of a feature relative to a datum axis
■	Maximum material condition (MMC)	Bonus tolerance when a feature is at its largest
■	Total runout	Combined wobble over a full rotation

Surface roughness (Ra) reference

Process	Typical Ra (µm)
Rough turning	3.2 - 6.3
Finish turning	1.6 - 3.2

Process	Typical Ra (µm)
Fine turning / boring	0.4 - 1.6
CNC milling	1.6 - 3.2
Surface grinding	0.2 - 0.8
Lapping / polishing	0.05 - 0.4
Stamping (sheared edge)	1.6 - 6.3
Extruded aluminium	1.6 - 3.2
Anodized (matte)	0.4 - 1.6

Notes for quoting

- A tolerance tighter than the standard column usually means extra setup, in-process gauging and a CMM report - budget for it.
- Try to keep all tight features on one datum; stacked tolerances multiply inspection cost.
- Specify roughness only where it matters. Calling Ra 0.4 everywhere can triple the finishing time.

Frequently asked questions

What tolerance can BQUQ hold on CNC machined parts?

Our standard process control is ± 0.005 mm on critical features, with ± 0.01 mm as routine. We machine and inspect against your drawing and ship an inspection report with every batch.

How tight can a stamped part be?

Progressive-die stamping holds about ± 0.05 mm as standard and down to ± 0.02 mm on critical features. The limit is set when the tool is built, so the tolerance should be agreed before the die is cut.

What Ra value is normal for a machined surface?

Rough turning is 3.2 to 6.3 µm, finish turning 1.6 to 3.2 µm, and ground surfaces 0.2 to 0.8 µm. Specify only the roughness the function needs.

Do you provide dimensional inspection reports?

Yes. Every production batch ships with an inspection report, and full CMM reports are available for parts with tight or GD&T tolerances. Ask for the report level you need in the RFQ.