

CNC Machining DFM Guidelines & Size Capabilities Quick Reference

A quick reference guide to standard recommended values vs. maximum/minimum manufacturing limits for CNC prototyping & production.

Key Notes for Design Engineers:

- **Recommended Values:** Standard tooling, stable yield, optimal lead time, and normal cost. Priority choice for DFM.
- **Extreme Limits:** Requires special micro-cutters, high-speed spindles, or special setups. Incurs higher cost, longer lead times, and reduced yield. Prior engineering confirmation required.
- **Max Dimensions:** Refers to maximum effective machining volume (excluding fixture/clamp clearance), not bare machine stroke.
- **Material Baseline:** Aluminum 6061. For Stainless Steel, Titanium, or Hardened Steel, increase wall/slot minimums by 1 step. Plastics deform easily under heat; enlarge wall thickness accordingly.

01 3-AXIS & 4-AXIS CNC MILLING (VERTICAL MACHINING CENTER)

PARAMETER / FEATURE	RECOMMENDED (SAFE)	EXTREME LIMIT	ENGINEERING NOTES
Min. Slot Width / Cutter Dia.	≥ 1.0 mm (0.039")	0.3 – 0.5 mm	Micro-milling reaches 0.15–0.2mm; high cutter breakage risk.
Min. Wall Thickness (Al / Cu)	≥ 0.8 mm (0.031")	0.5 mm (0.020")	Thin walls vibrate & deform. Stainless/Titanium recommend ≥1.0mm.
Min. Wall Thickness (Plastics)	≥ 1.5 mm (0.059")	1.0 mm (0.039")	Heat generation causes thermal springback and warping during cut.
Internal Cavity Corner Radius (R)	≥ 0.5 mm (0.020")	0.2 mm (0.008")	Square internal corners are unmillable; internal radii always required.
CNC Drilling Min. Hole Dia.	≥ 1.0 mm (0.039")	0.5 mm (0.020")	For holes <0.5mm, Micro-EDM/EDM drilling is preferred over CNC.
Drill Hole Depth-to-Diameter Ratio	≤ 4:1	≤ 8:1 (Peck Drill)	Ratios >10:1 require specialized Gun Drilling or Hole-POP EDM.
Standard Part Max Envelope	≤ 920 × 540 × 500 mm	≤ 1100 × 620 × 600 mm	Based on standard 1060 / 1270 VMC mainstream equipment.
Oversized Part Capability	Single edge > 1500 mm	Up to several meters	Requires large Gantry Milling (Bridge CNC); substantial cost increase.

02 5-AXIS CNC MILLING (AC TRUNNION MACHINE)

PARAMETER / FEATURE	RECOMMENDED (SAFE)	EXTREME LIMIT	ENGINEERING NOTES
Max Bounding Envelope	Φ 500 × H 300 mm	Φ 800 × H 400 mm	Rotational clearance limits usable volume; do not rely on axis strokes.
Min. Slot Width & Wall Thickness	Same as 3-Axis Milling	Same as 3-Axis Milling	Tilted machining angles increase thin-wall chatter and vibration risk.

03 CNC TURNING & LATHE MACHINING

PARAMETER / FEATURE	RECOMMENDED (SAFE)	EXTREME LIMIT	ENGINEERING NOTES
Min. Outer Diameter (OD)	≥ 1.0 mm (0.039")	0.5 mm (0.020")	Micro-turning requires special collets and delicate workholding.
Min. Inner Bore Diameter (ID)	≥ 2.0 mm (0.079")	0.8 – 1.0 mm	Small boring bars lack rigidity; high risk of tool deflection.
Min. Wall Thickness (Rotational)	≥ 0.8 mm (0.031")	0.5 mm (0.020")	Aluminum baseline. Stainless steel recommends ≥ 1.0 mm.
Standard Max Turning Diameter	Φ 300 mm	Φ 400 mm	Standard horizontal CNC turning lathes.
Standard Max Part Length	≤ 800 mm	≤ 1000 mm	Long shafts require steady rest or follow rest to prevent deflection.
Heavy / Large Scale Lathe	Swing: 800–1600 mm	Length: 2 – 8 meters	Custom/specialized machinery; higher setup costs and limited capacity.

04 THREADING CAPABILITIES (INTERNAL METRIC)

PARAMETER / FEATURE	RECOMMENDED (SAFE)	EXTREME LIMIT	ENGINEERING NOTES
Min. Metric Internal Thread	M2	M1.6	High risk of tap breakage/stripping; not recommended for mass production.

05 SMALL COMPONENT WORKHOLDING & FIXTURING LIMITS

STANDARD STOCK RAW SIZE

≥ 5 × 5 × 2 mm

Standard vise, soft jaws, or standard modular clamping can be reliably used for medium to high volume production runs.

MICRO PART HANDLING (< 5MM)

Adhesive Fixtures / Vacuum Chucks + Micro CNC

Yield rate drops significantly. Recommended primarily for functional prototypes, not scalable for high-volume mass production.

06 MANDATORY DFM CONSTRAINTS & GUIDELINES

- ⚠ **Max Part Dimensions ≠ Machine Axis Travel:** Always reserve 50–100 mm safety margin for clamps, fixtures, tool clearance, and anti-collision zones.
- ⚠ **Machine Table Weight Capacity:** Exceeding table load limits compromises motion accuracy, degrades surface finish, and risks permanent spindle/bed damage.
- ⚠ **4-Axis / 5-Axis Rotational Envelope:** Always evaluate the full 3D rotational interference sphere rather than static X/Y/Z machine travel limits.
- ⚠ **Slender Shafts & Thin-Walled Structures:** Even if physical size fits inside table boundaries, chatter and chatter-induced deformation will cause tight tolerances to fail.
- ⚠ **Narrow Slots (< 0.3mm) & Micro Holes (< 0.5mm):** Prefer Wire EDM, Sinker EDM, or Micro-EDM drilling over conventional mechanical CNC milling or drilling.