DESIGN GUIDELINE

Tolerance & Fit Clearance Design Guide

When two printed parts slide together, plug in or rotate, too little clearance and they will not assemble, too much and they rattle. Model the clearance into your parts by use case and they go together straight off the printer.

01 · FIT CHART

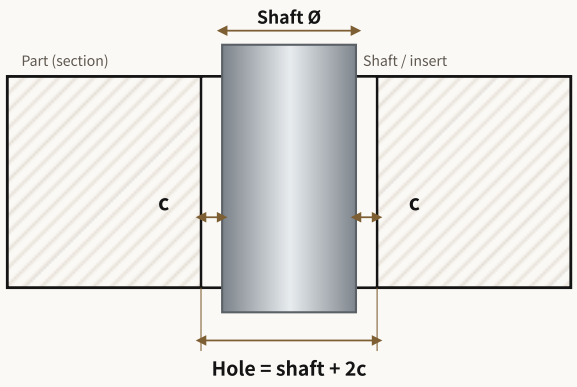
Clearance chart

Fit	Gap per side c FDM	Hole − shaft FDM	Gap per side c Resin	Typical use
Press fit permanent	0–0.05	0–0.1	0	Pins and sleeves pressed in for good; will not work loose
Snug fit push by hand	0.1	0.2	0.05	Goes in by hand with no play; locating pins, lids
Sliding	0.15–0.2	0.3–0.4	0.1	Drawers, rails, removable inserts
Rotating	0.25	0.5	0.15	Hinge pins, knobs, wheels
Loose	0.3–0.4	0.6–0.8	0.2	Easy assembly with a little play; enclosure slots
Print-in-place moving parts	0.4–0.5	—	0.3	Moves straight off the printer; hinges, chain links

Units: mm. FDM values assume a 0.4 mm nozzle, 0.2 mm layers and PLA; "hole − shaft" = 2 × gap per side. The values already include normal print error: with holes and shafts printed axis-up, model them at the sizes in the chart. Add another 0.1 mm for horizontal holes.
Materials, colours and machines vary slightly. For tight fits or larger batches, print a short test piece first.

02 · CROSS SECTION

Clearance diagram



c Gap per side: the space between the hole wall and the shaft on one side. Pick it from the chart by fit type.

Hole Hole = shaft + 2c. Example: an Ø8 shaft that should slide gets an Ø8.3–8.4 hole.

Shaft You can shrink the shaft instead. When both parts are printed, count the clearance once: do not enlarge the hole and shrink the shaft as well.

03 · ACCURACY

General accuracy

Feature	FDM PLA / PETG / ABS	Resin SLA / LCD
General dimensions	±0.2 mm or ±0.2% (whichever is larger)	±0.1 mm or ±0.15%
Vertical holes (axis up)	About 0.1–0.2 mm undersize	About 0.05–0.1 mm undersize
Horizontal holes	Top sags, about 0.2–0.3 mm undersize	About 0.1 mm undersize
First layer	Spreads 0.1–0.3 mm (elephant foot)	Support contact areas need sanding
Height (Z)	±1 layer height	±0.05 mm
Large ABS / ASA parts	Shrinks 0.5–0.8% as it cools	—

Typical values for ordinary parts, not guarantees: shape, size, material and orientation all affect accuracy. If specific dimensions matter, list them in the order notes and we will orient and tune the print around them.

04 · DESIGN TIPS

Design tips

Print orientation

- Holes and shafts printed **axis-up (perpendicular to the bed)** come out roundest and most accurate.
- Shafts printed lying down come out slightly flattened; add another 0.1 mm of clearance.
- Keep mating faces in the same orientation relative to the bed so errors match.

Chamfers and elephant foot

- Add a **0.5 mm chamfer** to hole entries and shaft ends for easy alignment.
- A 0.3–0.5 mm chamfer on bottom edges cancels the first-layer spread (elephant foot).
- If the bottom face must sit flush against another part, say so in the notes.

Long and multi-point fits

- For fits longer than 3× the diameter, relieve the middle by 0.1–0.2 mm so only the ends locate; it will not bind.
- When several pins must line up with several holes, use a sliding fit on the holes to absorb position error.

Print a test piece

- For tight fits or larger batches, print a short test piece with only the mating features.
- Use the same material and orientation as the real part.
- Bearings, magnets and screws have their own guides: bearing housings, magnets, screw holes.

05 · MATERIALS

Material notes

Good	**PLA / PLA+**	Most dimensionally stable with little shrinkage; use the chart as is.
Good	**PETG**	Slightly sticky surface and light stringing; add 0.05 mm to sliding and rotating fits.
Good	**ABS / ASA**	Shrinks more as it cools; hole spacing on parts over 100 mm comes out 0.5–0.8% small. Print mating parts together, in the same orientation.
Good	**PA / PA-CF**	Swells slightly as it absorbs moisture; add 0.05 mm. Carbon fibre leaves a rougher surface, so sliding parts run tighter.
Caution	**TPU**	Too soft for sliding or rotating fits. To clamp, use negative clearance (shaft 0.1–0.2 mm larger than the hole).
Good	**Resin**	Highest accuracy; use the resin column. The material is brittle, so do not make press fits too tight or the part may crack.

06 · CHECKLIST

Pre-submission checklist

- ☐ Every mating feature has a clearance chosen for its use
- ☐ Holes and shafts are axis-up where possible; horizontal holes have +0.1 mm
- ☐ Bottom edges are chamfered against elephant foot
- ☐ Print-in-place gaps are at least 0.4 mm and supports can be removed
- ☐ Clearances are modelled in (not left for us to add)
- ☐ Hole entries and shaft ends are chamfered
- ☐ Long fits are relieved in the middle
- ☐ Critical dimensions are noted, e.g. "Ø8 shaft must slide"

Questions about your design? Send it to us first

Attach your file or a screenshot and we will check the clearances

LINE @apexion
Email support@apexionstudio.com
Web apexionstudio.com