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Design Guidelines for Selective Laser Melting

Valid for the following Materials: AlSi10MG

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About the Process

Selective Laser Melting (SLM) – Additive Manufacturing for High-Performance Metal Parts

In Selective Laser Melting, metal powder is fully melted layer by layer. This results in extremely dense and highly durable structures, ideal for functional prototypes, technical components, and small-series production. Unlike Selective Laser Sintering (SLS), the powder is not sintered but fully liquefied during SLM—a process that enables maximum part strength. The build chamber is heated and flooded with inert gas to prevent oxidation. The result: industrial-grade metal components that can replace or significantly accelerate conventional manufacturing.

Wall Thickness Requirements

How thick do walls need to be to ensure stability and reliable printability?

For functional and process-stable components, we recommend the following design minimums:

- **Minimum wall thickness for structures: 1.0 mm** (see Figure 1). Smaller wall thicknesses **between 0.5 mm and 1.0 mm** may be manufactured at the customer's risk. Features **smaller than 0.5 mm** cannot be reproduced reliably.
- **Free-standing ribs or fins require greater thickness**, as they are more prone to distortion. Additional reinforcement may be beneficial depending on the part's function.
- **For free-standing pins, a minimum diameter of 2.0 mm is required**.
- Long, thin sections tend toward distortion due to the process. Optional heat treatment can reduce this effect.
- Wall thickness is defined as the shortest perpendicular distance between two surfaces. For non-parallel walls, the smallest value applies (see Figure 2 – the green-marked wall thickness is relevant).

Wall Thickness Requirements

Figure 1:
Minimum wall thickness for structures: 1.0 mm

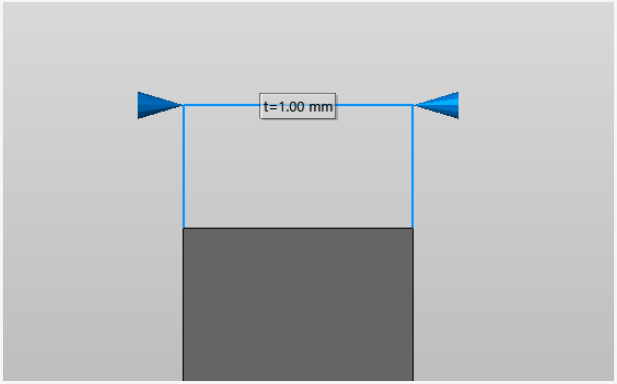
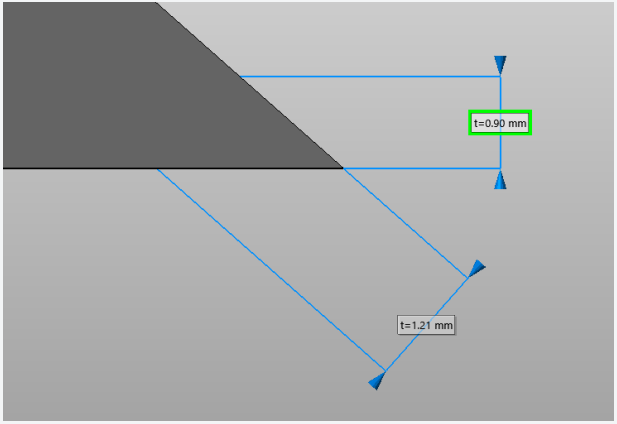


Figure 2: For non-parallel surfaces, the smaller value applies



Avoiding Abrupt Wall Thickness Transitions

Why should wall thickness remain as uniform as possible?

In Laser Powder Bed Fusion, wall thicknesses should remain as consistent as possible throughout the part. Abrupt transitions—especially step-like volume jumps—can cause issues. Where possible, **use large radii instead of sharp edges**. This also improves mechanical strength by reducing notch effects.
During the build process, local stresses occur. Significant differences in wall thickness or step transitions can lead to **warping, banding, surface defects, deformation.**

Holes & Channels

What sizes are manufacturable? Are there length-to-diameter considerations?

- **Minimum reliable internal channel diameter: 2 mm**
- Smaller channels may require **mechanical post-machining.**
- Curves or direction changes: use the largest possible radii **to avoid powder clogging.**
- **Channels only reliably build in one direction**: Depending on part orientation, one channel direction is favored. If the channel changes direction, its shape may distort.

Please contact us to determine the optimal build orientation for your part.

Cavities & Closed Volumes

What must be considered for enclosed or hard-to-reach cavities?

- Metal powder is hazardous to health and, for reactive metals such as aluminum and titanium, **flammable or explosive.**
- Closed cavities trap unmelted powder that cannot be removed safely. Therefore:
  - **closed or non-cleanable cavities are not permitted**
  - enclosed cavities pose **explosion or implosion risks** when exposed to temperature changes
- If cavities cannot be avoided: Design **accessible openings** and **large extraction channels** to allow powder removal.

Text, Engravings and fine Details

What minimum sizes ensure good visibility?

- SLM allows text, logos, and fine details to be integrated directly into the part. **Minimum line width: 1 mm** for engravings and embossed features
- **Minimum depth/height**: 1 mm
- **Minimum text height**: 5 mm for standard fonts, for both recessed and raised text, to ensure readability

Structural Optimization

Which reinforcements improve stability without unnecessary material?

- **Ribs and braces:** Reinforce thin walls or large surfaces using ribs or diagonal struts
- **Lattice structures:** Internal lattices can improve strength but must not create inaccessible cavities
- **Fillets:** Round edges and transitions to avoid stress concentrations and reduce notch effects

Structural Optimization

- **Topology Optimization:** Topology optimization is an **FEM-based method** to distribute material according to defined goals (e.g., weight reduction, mechanical performance) and boundary conditions. It requires a solid understanding of part function and load distribution but enables highly efficient reductions in weight and cost compared to the original design.
- Example:

Dimension: 68.30 mm x 50.00 mm x 40.22 mm
Volume. 61.45 cm^3

Dimension: 68.30 mm x 50.00 mm x 40.22 mm
Volume. 10.35 cm^3

Tolerances and Fits

What tolerances are typical for SLM?

Typical achievable tolerances depend on part size, geometry, and post-processing:

General tolerances:

- **≤ 100mm ±0,3 mm // >100mm ±0,3%**
- Tighter tolerances require **CNC machining** or other mechanical post-processing. This must be requested in advance and requires a technical drawing.

Threads (Direct vs. Post-Machined)

Which threads can be printed? Which must be machined afterward?

- In general, **threads should not be printed** in SLM. They should be created by **tapping, milling, or turning after printing.**
- The part must include the appropriate hole (minor diameter)at least the required relief grooves according to standards.
- Examples:
  - **DIN 13-1** for hole diameters of ISO metric threads
  - **DIN 76-1** for relief grooves — at least 3.5 × pitch
- Ensure that the part can be properly clamped and that there is enough clearance for tools.
- Thread machining must be ordered separately.

Print-in-Place Designs

What should be considered for interlinked movable assemblies?

Print-in-place assemblies (e.g., hinges, chains, captive mechanisms) are considered experimental in SLM.

Please contact us so we can evaluate feasibility for your specific project.

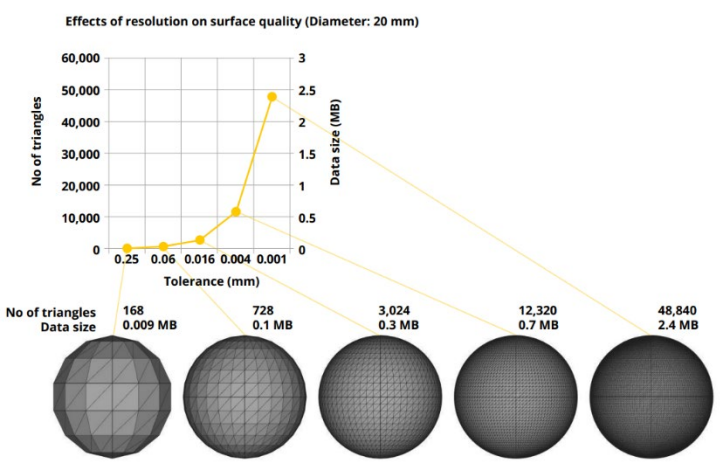
Data Quality (STL, Triangulation)

How to recognize good versus problematic 3D-Data? Which factors often result in process-related problems?

- Typical STL file sizes vary between 1 MB and 30 MB, depending on geometry. The size depends on the software as well as on the number of triangles and the level of detail. For most models, an STL **file size of < 5 MB** is completely sufficient. For very complex geometries with lattices, freeform surfaces, or 3D scans, **< 50 MB** is generally sufficient.
- When exporting to STL in a CAD package, you often have to enter several parameters such as angular tolerance and chordal deviation. These parameters define the resolution and the file size of the part.
- The following **tips** help you to export with **the best ratio of surface quality and file size**.
  - Too many triangles are difficult to process. If a certain size is exceeded, the additional triangles do not provide any further advantage in quality or accuracy.

Data Quality (STL, Triangulation)

- Recommended **export settings**:
  - Format: binary
  - Chordal deviation: 0.05 mm
  - Angular deviation: 2°



- **Rule of thumb:** If facets are visible on-screen at 1:1 zoom, they will also be visible on the printed part.

Correct Build Orientation for Function & Strength

Choose orientation primarily to ensure **printability and detail accuracy.** SLM produces **fully fused layers**, so anisotropic layer weaknesses do not occur.

- **Part-dependent:** The optimal orientation depends on the geometry and the desired functions.
- **Layer Fusion:** In SLM, the layers fuse completely, so strength problems due to layering do not occur.
- **Visibility and detail accuracy:** Movable parts, engravings, delicate details or complex geometries benefit from an orientation that enables a clean representation and minimal post-processing.
- **Test prints:** For complex or very fine parts, test prints can help to determine the optimal orientation.
- **Surface roughness:** Differences in surface roughness may occur depending on the orientation.

Feel free to contact us so that we can determine the optimal build orientation together. If you already have experience and would like to choose an orientation yourself, please submit the part in the desired orientation during the ordering process and note 'keep orientation' in the comment field.

Minimum Distances Between Walls, Ribs & Surfaces

How much spacing is necessary to avoid fusion or breakage?

- A minimum clearance **of 1.0 mm** is recommended for reliable results.

Design for Post-Processing

How much additional material should be added for machining?

- **Machining allowance/material allowance**: Due to the tolerances, **approximately 1.0 mm** of material allowance should be planned on critical surfaces to enable subsequent machining.

We look forward to hearing from you!

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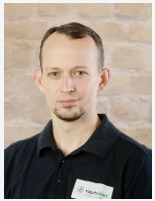
Your 3D Printing Experts



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Do you have further questions?

- Which material is best for my application?
- Which surface finishing options are possible and useful?
- How can I reduce costs and increase product quality?
- What must I consider during data preparation?

ISO 27001 | ISO 9001 | ESG-Rating 2023 A Gold | ISO 14001 | ISO 52920

COMPETENCE **INNOVATION** **QUALITY** **SUSTAINABILITY**