# Enclosure design for 3D Printing: A step-by-step guide

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## Introduction

3D Printing of enclosures allows design freedom, lets a designer print a prototype or final part in a matter of hours and is much cheaper when compared to traditional manufacturing methods. 3D printed enclosures offer an effective method of confirming form and fit and several of the materials that can be used for printing enclosures are suitable for end use applications.


Assembled 3D printed enclosure for a DIY loudspeaker

This article will discuss the most common 3D printing technologies that are used to print enclosures, methods for securing printed enclosures together and introduce some design considerations to help optimize enclosure design for 3D printing.

## 3D printed enclosure technologies

The table below discuss the main 3D printing technologies and whether they are appropriate for a range of enclosure applications.

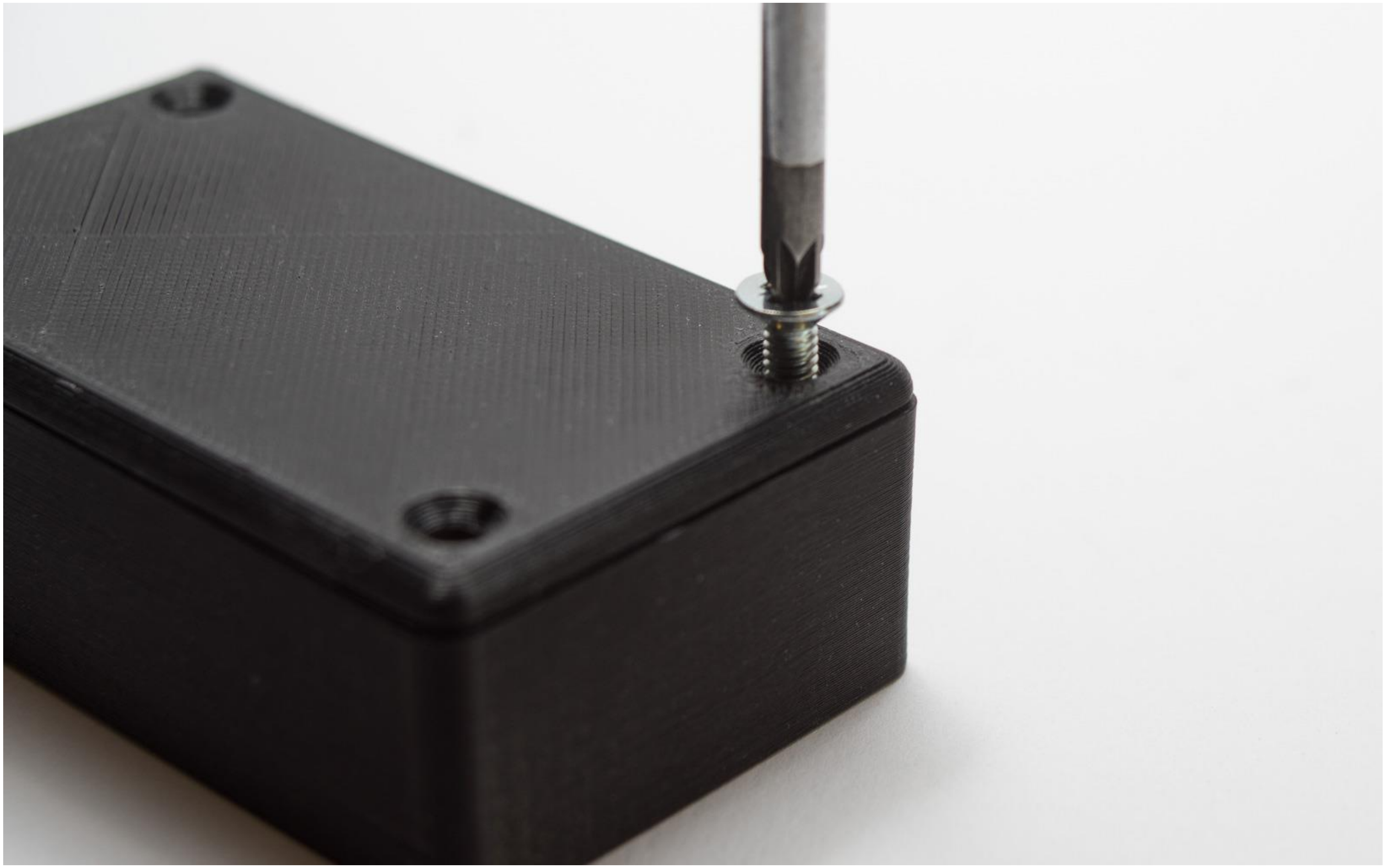
| Application | Description | Printing Technology |
|---|---|---|
| **Rapid prototyping** | Prototyping plastics are a cost effective and quick method of printing enclosures. | FDM |
| **High Temperature** | Heat resistant plastics are rated to remain stable up to temperatures as high as 80℃ after thermal post treatment. | Material Jetting |
| **High quality surface finish** | The selection of surface finish is usually governed by cost and time. SLS nylon results in a satin-like matte finish that is slightly grainy to the touch while Material Jetting and SLA offer fine-detail models with very smooth surfaces. | SLA or Material Jetting |
| **High accuracy** | SLS nylon, SLA and Material Jetting printed parts are highly accurate and are capable of printing to within 0.2 - 0.5 mm. They give an excellent surface finish. SLS nylon does no require any support while the support used for material jetting is typically dissolvable and easy to remove resulting in an smooth surface after post processing. | SLA, SLS or Material Jetting |
| **Transparent** | 3D printed transparent plastics allow for inspection or verification of internal components and are often applied to applications where fluids are being employed. | SLA or material jetting |
| **Flexible material** | Flexible enclosures allow the pressing of buttons or motion of switches through the sealed case. | Rubber-Like plastics or SLA flexible resin |

Enclosures can be made from a range of different 3D printing materials like SLS (white), FDM (black) and SLA (gray) with each technology having benefits and limitations.

## Securing enclosure assemblies

Snap fits, interlocking joints, threaded fasteners, and living hinges are all viable options for 3D printed enclosure connections. Designing snap-fits and push-fits for an enclosure that does not require repeated opening is much easier because the joint does not have to be as wear-resistant. For quick prototypes, adhesives are a quick and easy method to permanently fasten the enclosure.

Snap-fits are regularly used for securing 3D printed enclosures



Fastening with threaded fasteners is a durable and quick option for reliable repeated opening

Using living hinges in conjunction with snap fit connections can create a simple, quick way to secure 3D printed enclosures

# Designing 3D printed enclosures

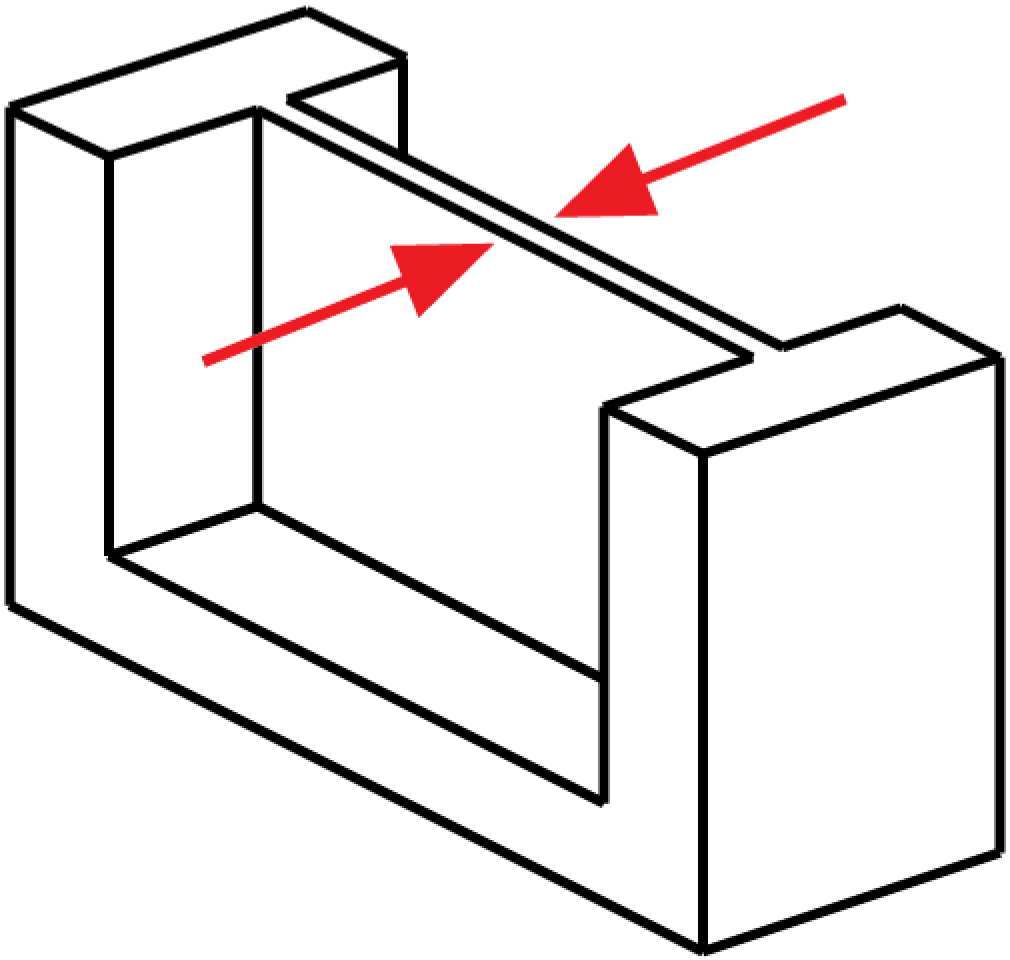
The design of enclosures for 3D printing typically follows 2 main steps:

## 1. Enclosure planning and component measurement

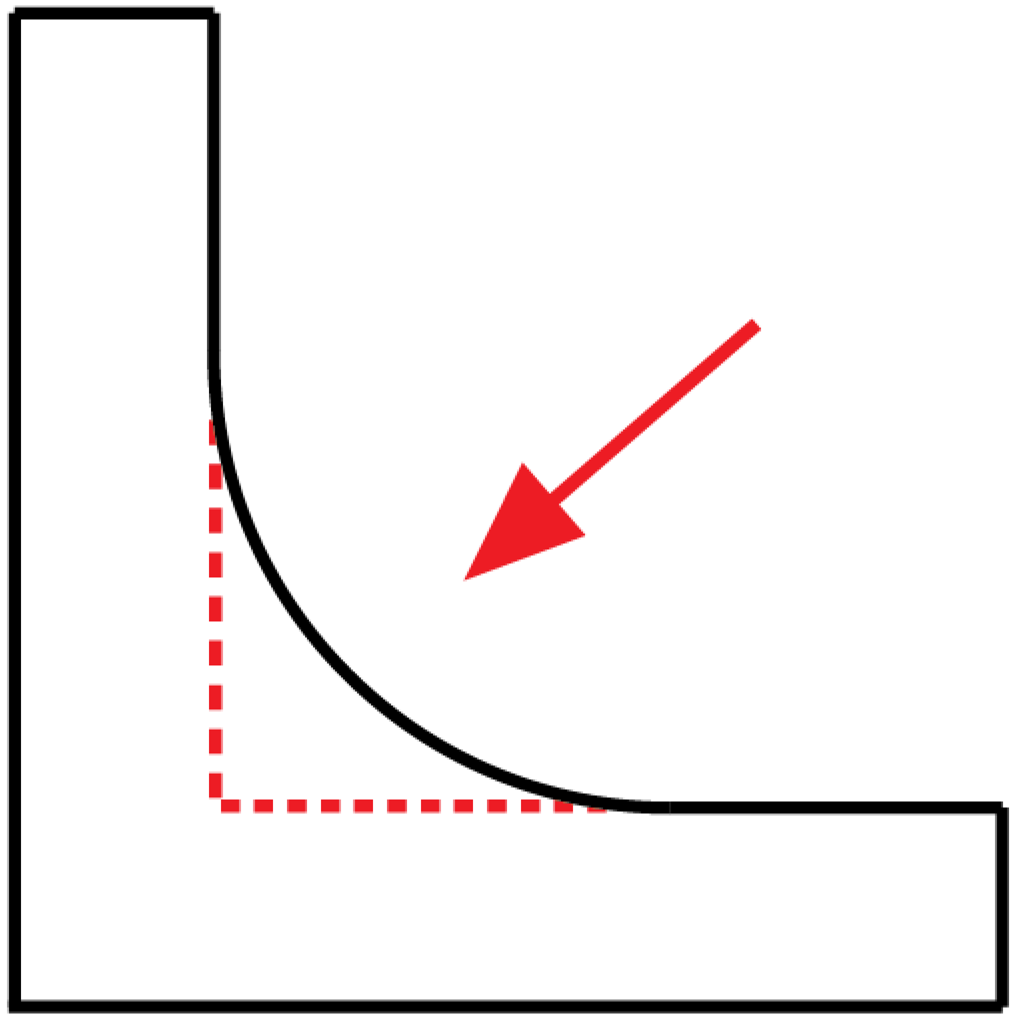
It can be useful to 3D model the internal enclosure components along with the enclosure to allow for easy clearance checks and to help determine the optimal component positions.

## 2. Designing the structure

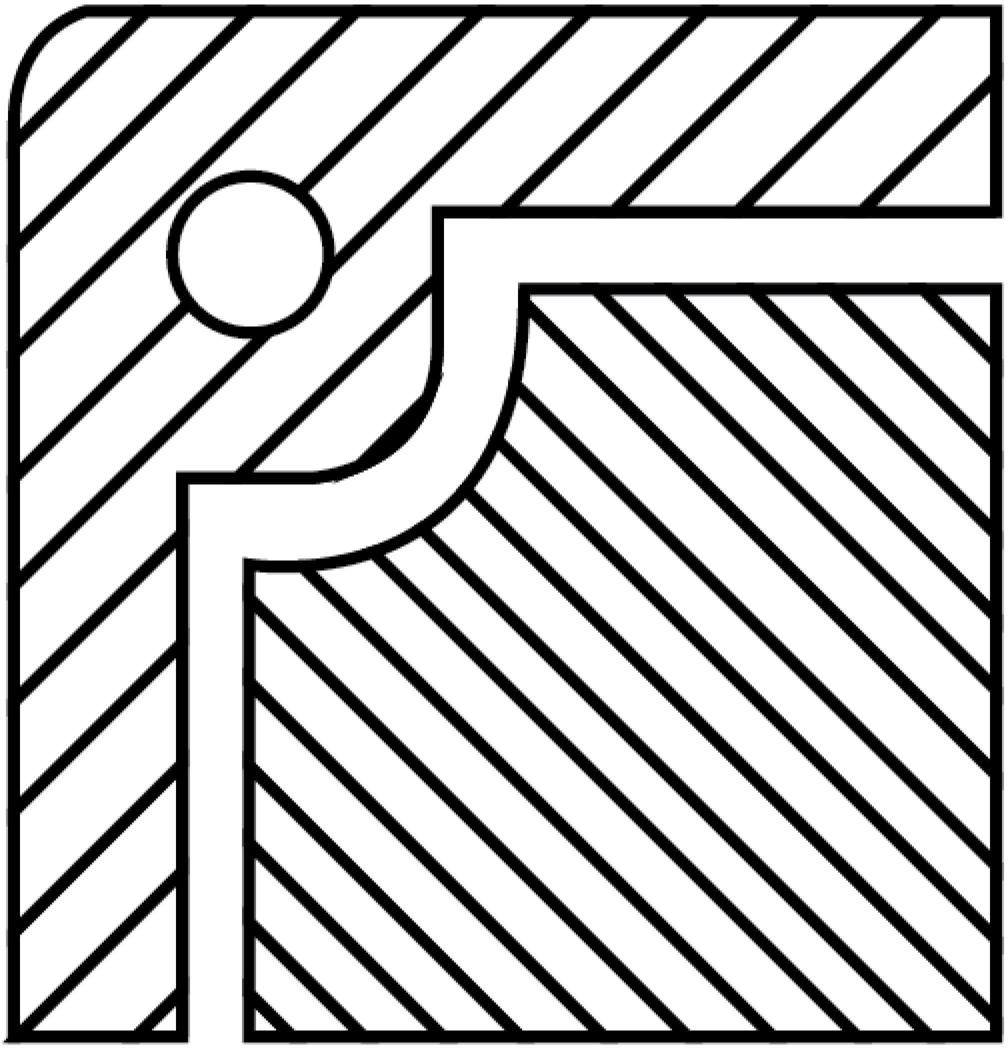
While tolerance and clearance recommendations will vary with printer technology and calibration the bullet points below offer a set of design guideline to use:



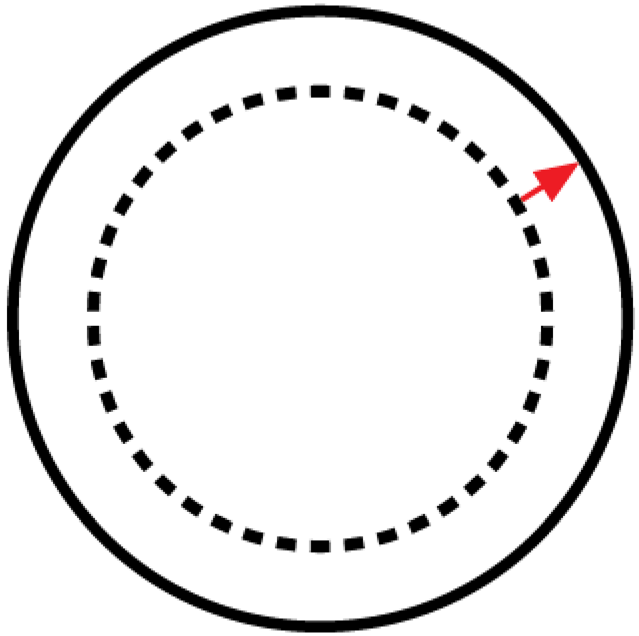
**Wall thickness** A minimum wall thickness of 2 mm is recommended for all enclosure walls.



**Add radii/fillets to corners** Radii or fillets help to reduce stress concentrations at corner and edges and also make parts easier to 3D print. Even a small radius can make a big difference.

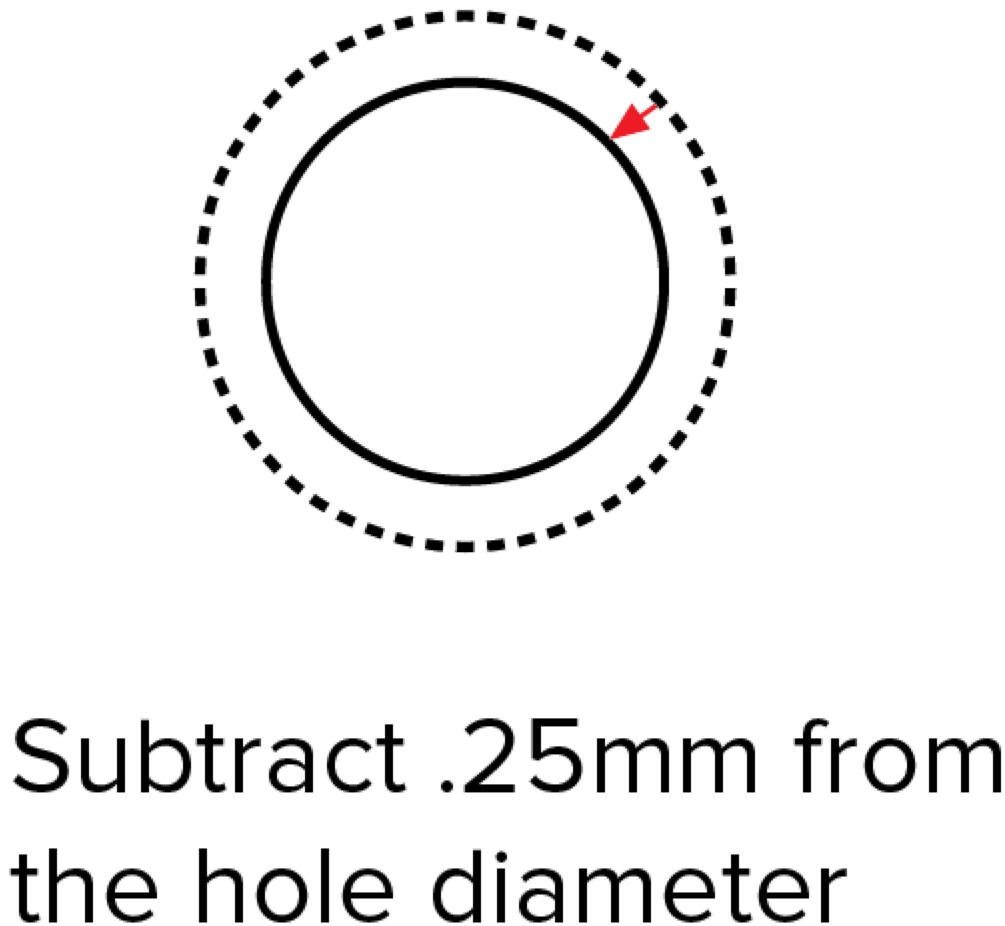


**Component clearance** Allow 0.5 mm around all internal components to compensate for distortion, shrinkage and printer tolerances. The [accuracy 3D printers are able to produce parts varies by technology]

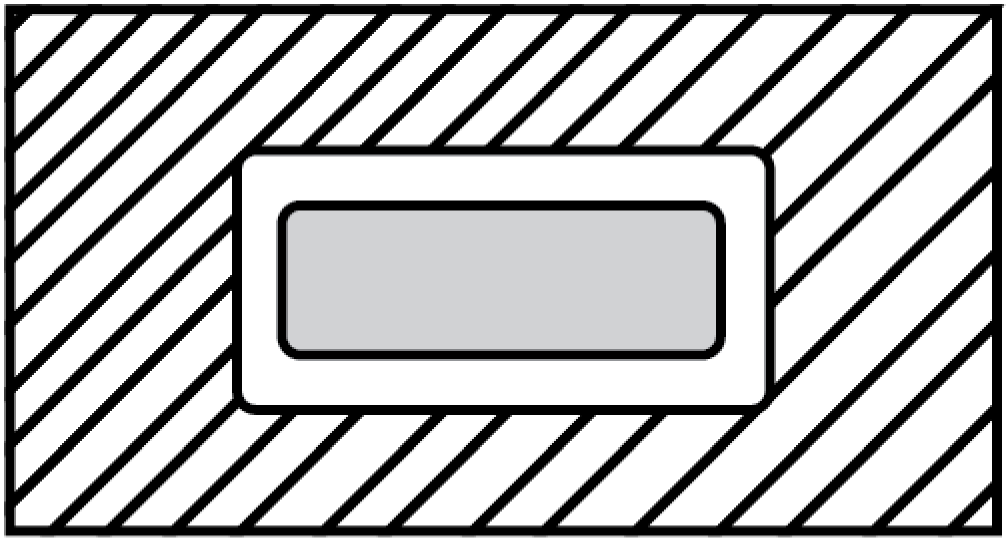


Add .25mm to
the hole diameter

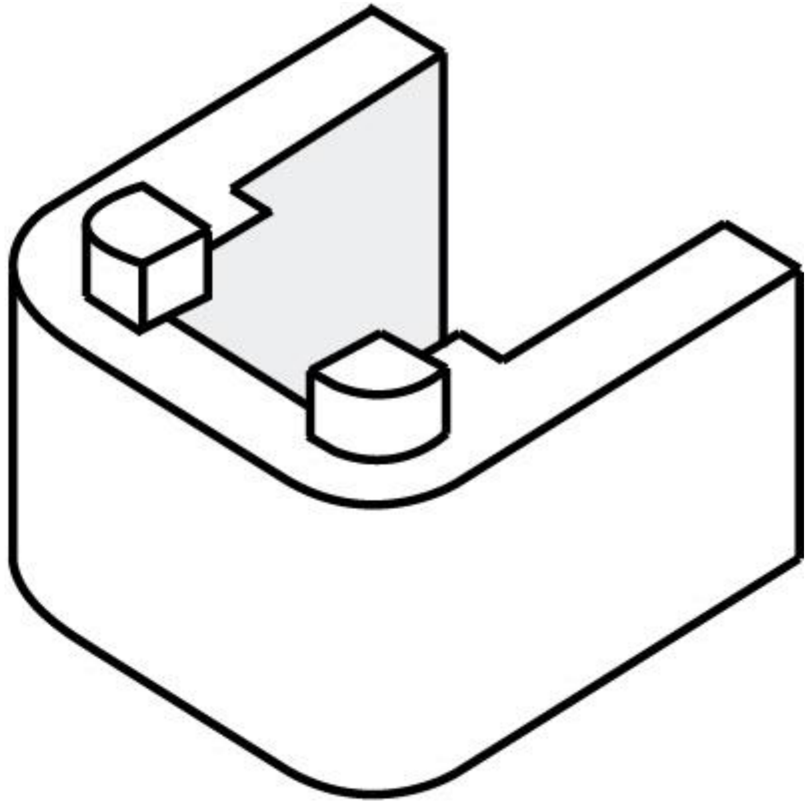
**Clearance holes** Add 0.25 mm to the diameter of screw and fastener clearance holes. For more accurate clearance holes, drill the holes after printing.



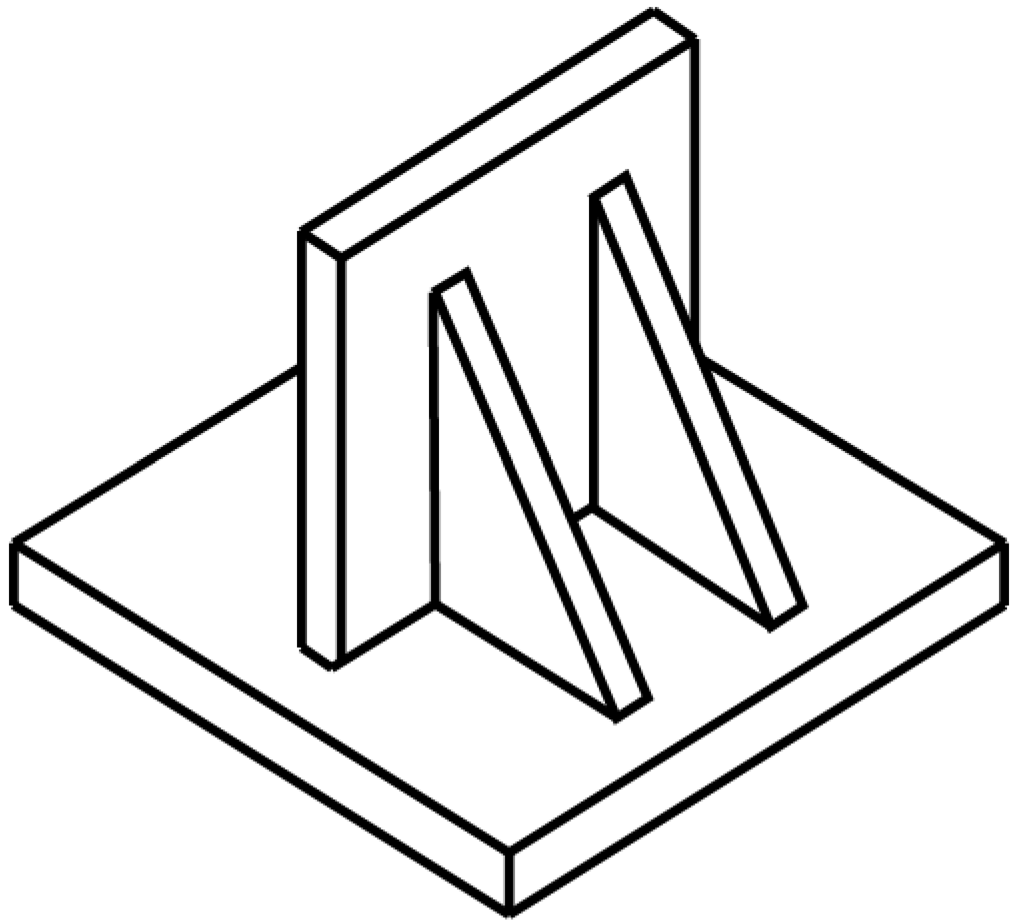

**Self taping holes** Subtract 0.25 mm from the diameter of holes if you are wanting the screw or fastener to bite into the case. For a range of fasteners options refer to this article.



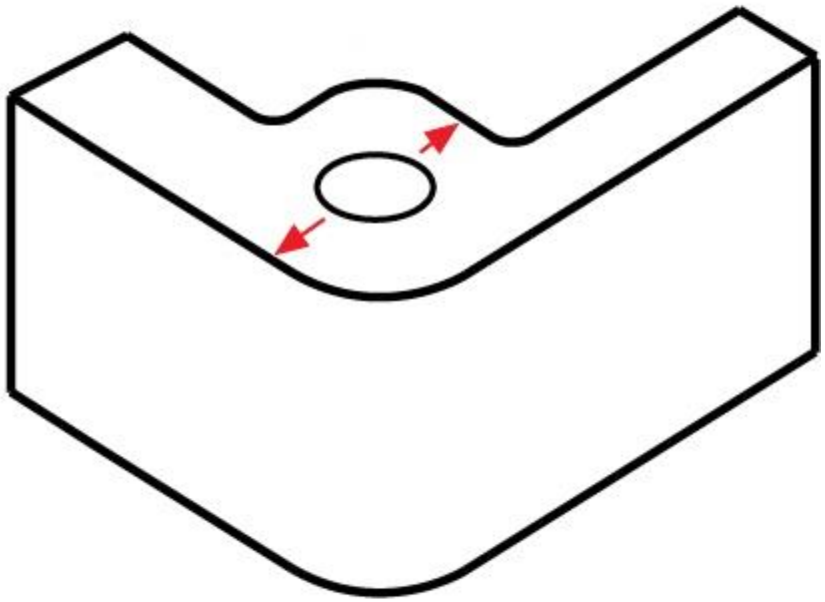
**Port clearance** For all ports or plugs allow 2 mm clearance (1mm each side). The input port can also be super glued into place for a secure connection.



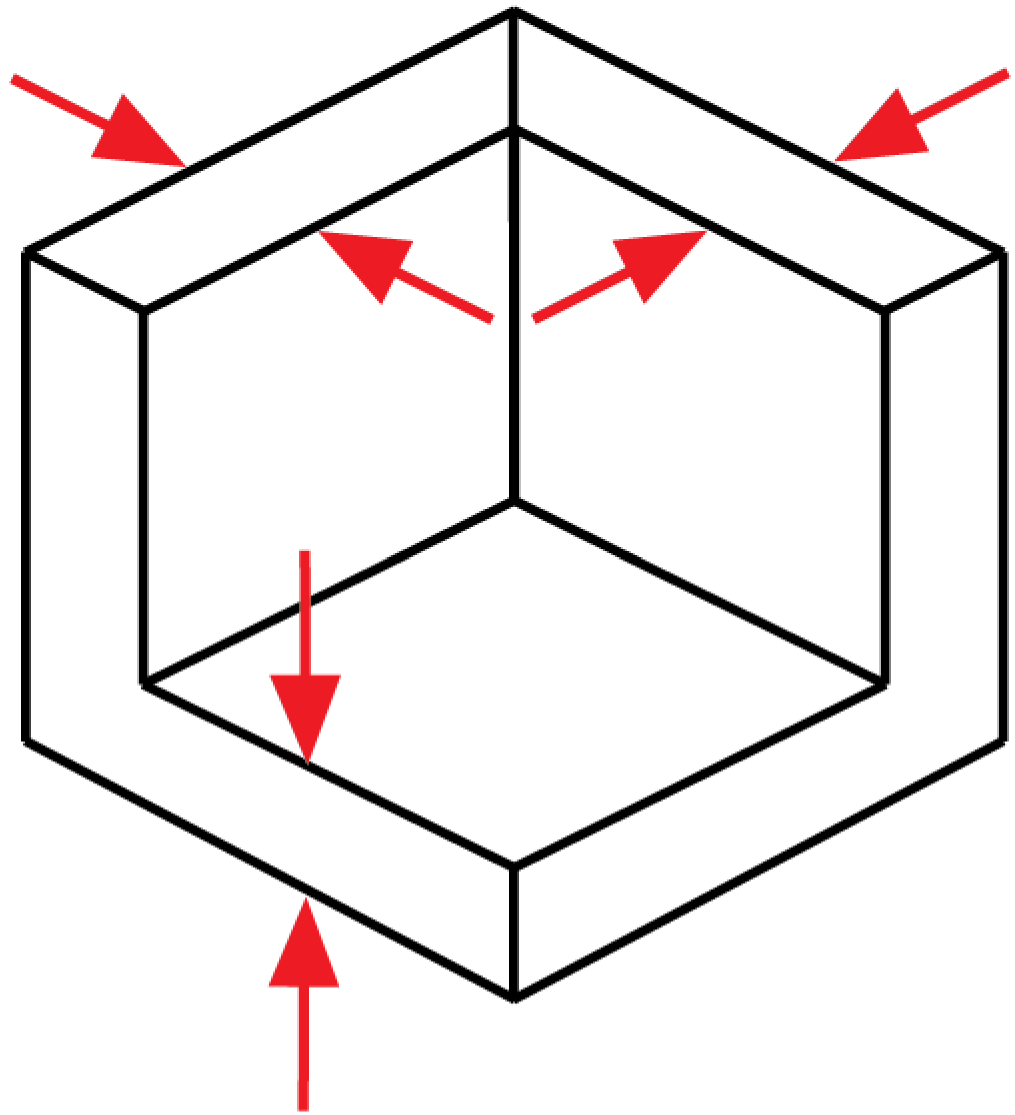
**Add lugs** Add lugs, cut outs and lips to assist with assembly/disassembly and alignment if the enclosure with multiple parts (base & lid). These features are very simple to include in a design and can greatly increase the strength of your assembled enclosure. Lugs should be a minimum of 5mm in width.



**Ribs and gussets** While ribs and gussets are critical design features of injection molding and not essential for 3D printing their inclusion can help reduce and distribute stresses throughout the part and improve rigidity. To save on material, ribs and gussets can be designed to 75-80% of wall thickness.



**Bosses** Include bosses around holes in locations where threaded fasteners will be used to reduce the likelihood of bulging, distortion and potential fracture. A minimum of 1 hole diameter for the wall thickness around the hole is a good starting point (e.g. if the hole is for an M5 screw include a minimum 5mm of wall thickness around the hole).



**Uniform wall thickness** If your enclosure design is eventually going to be injection molded remember to use uniform wall thickness in your design. For 3D printing process (particularly SLS and SLA) this is good design practice.

## Rules of thumb

- For enclosures that will experience repeated opening and closing a wear-resistant material such as SLS nylon. For rapid prototypes where form or fit are being tested FDM provides a fast low-cost method of production.
- If the enclosure will be subjected to loads include gussets, ribs, and bosses to improve strength
- A minimum wall thickness of 2 mm, 0.5 mm tolerance around internal components and ± 0.25 mm for clearance/bite holes are good start points to consider when designing a 3D printed enclosure.