How to 3D print a waterproof box

Asked 3D Content Team
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Abstract. Print ASA or PETG with 2 to 3 mm walls, seal the lid with an O-ring at 20 to 30 percent squeeze under screws, use IP68 cable glands and a vent, then test.

Keywords: waterproofing, watertight, asa, petg

1 How do you 3D print a waterproof box?

Print it in ASA or PETG with 2 to 3 mm walls: four perimeters and 60 percent infill. Seal the lid with a greased O-ring in a groove and clamp it with screws, not clips. Bring cables in through bought IP68 cable glands and fit a membrane vent. Then sink it empty in a bucket overnight before adding electronics.

1.1 The steps

Table 1. The steps

Step	What to do
1. Material	ASA (acrylonitrile styrene acrylate) for sun and heat; PETG (glycol-modified PET) below 80 °C, epoxy-coated for immersion
2. Walls	2 to 3 mm, four perimeters and 60 percent infill as a start
3. Lid seal	O-ring or O-ring cord in a groove, 20 to 30 percent squeeze, silicone grease
4. Closure	Screws around the lid, so the seal is pressed evenly
5. Cable entry	A bought gland sized to the cable, such as LAPP SKINTOP ST-M
6. Vent	A membrane vent on a vertical wall
7. Test	Empty, overnight in a bucket, then at working depth

The walls, seal and test follow Prusa Research's Watertight 3D printing part 2, whose closed boxes and housings went on dives to 20 and 30 meters. Groove sizing is from Marco Rubber, glands from LAPP and vents from Gore.

1.2 Which filament for a weatherproof box

ASA if the box sits in the sun. The Prusa Knowledge Base lists ASA as highly UV resistant, suitable for outdoor use and good to 93 °C. It calls PETG water and humidity resistant and fit for most exterior use below 80 °C.

Rain is one job and submersion another. In Prusa's dive tests, untreated PETG "leaked really quickly through the seams and contact points" until a coat of epoxy sealed it. Acetone-smoothed ASA leaked slowly. PLA (polylactic acid) stayed dry but is prone to heat deformation. The filament comparison and the epoxy page have the details.

1.3 Walls and print settings

Prusa's starting point for a closed part is 2 to 3 mm walls with four perimeters and 60 percent infill. Deeper water needs walls "as solid and compact as possible". Per-material perimeter counts are on how many walls make a print watertight.

Keep openings few, since Prusa warns that "every opening, every moving part, and every printing error can cause leak-

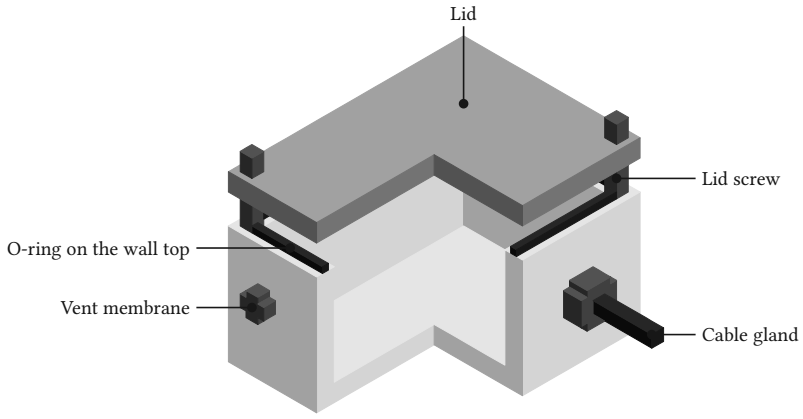


Figure 1. The printed walls only hold the parts in place. The O-ring, the gland's rubber seal and the vent membrane keep the water out.

age". Make the sealing face smooth: Prusa suggests ironing in PrusaSlicer or printing that face down on a smooth sheet.

1.4 A waterproof lid: O-ring groove and screws

Use a bought O-ring. Prusa calls O-rings "the best, easiest, and most proven method". Its printed gaskets in Flexfill 98A, Flexfill 92A and FilaFlex 40 all failed: "none of our printed creations held water". Silicone caulk cast in a printed mold worked but was messy. More on printed seals is on 3D printed gaskets.

Clamp the lid with screws. Prusa's clip-lid Lock & Lock box leaked a few meters down because the lid did not press hard enough on the gasket. Heat-set inserts give the screws a brass thread to bite into, and the hole sizes are on the M3 insert page.

Size the groove from the O-ring. Marco Rubber's design guide gives these rules for a face seal:

- **Squeeze:** 20 to 30 percent of the O-ring's cross-section.
- **Fill:** about 75 percent of the groove volume, so the ring has room to deform.
- **Stretch:** 0 to 5 percent over the groove diameter.

Say you use 2 mm O-ring cord. A 20 to 30 percent squeeze means a groove 1.4 to 1.6 mm deep. At 1.5 mm deep, 75 percent fill makes it about 2.8 mm wide. Print a short test section of groove first, because Prusa names correct O-ring and part dimensions as the critical factor. Grease the ring with silicone grease before every closing.

1.5 Cable glands for a junction or project box

Buy the gland. A rated gland seals with a rubber ring squeezed around the cable: the SKINTOP ST-M uses a CR (chloroprene) ring, and LAPP rates it IP66, IP68 (5 bar/30 min) and IP69 to EN 60529. Match the size to the cable's outside diameter:

Table 2. Cable glands for a junction or project box

Thread	Cable diameter it clamps
M12x1.5	3.5 to 7 mm
M16x1.5	4 to 10 mm
M20x1.5	6 to 13 mm
M25x1.5	8 to 17 mm
M32x1.5	9 to 21 mm

Clamping ranges are from LAPP's SKINTOP ST-M data sheet. LAPP fits an O-ring for the housing side only on M40 and larger. Seal a smaller gland to the wall with a sealing washer, seated on a smooth flat face around the hole.

You can print a gland, but none of the sources here tested one. Prusa's failed flexible gaskets suggest buying the rubber seal even if you print the body. Whether a printed junction box may carry mains wiring is a question for your local electrical code, not for a leak test.

1.6 Condensation: add a vent

A sealed box still sees pressure swings. Gore says its membrane vents equalize pressure after temperature or altitude changes, such as a sudden heavy rain. That lowers the stress on the seals. The membrane also lets water vapor out, so less condensation and corrosion build up inside.

Mount the vent on a vertical wall. Gore says a vent must stay unobstructed to breathe, and a side wall keeps it clear.

1.7 What IP65, IP67 and IP68 mean

Table 3. What IP65, IP67 and IP68 mean

Code	Water protection (second digit)
IP65	Jets of water from any direction do no harm
IP66	Powerful jets do no harm
IP67	Temporary immersion: 1 m for 30 minutes
IP68	Continuous immersion, under conditions agreed between maker and user, harder than IP67

The first digit 6 means dust-tight in all four. Definitions are from LAPP's table of ratings to DIN EN 60529; the IP67 depth and time are from the D.L.S. Electronic Systems test lab.

A printed box has no IP rating until a lab tests it. Kiwa tests to IEC 60529 with the product in its production configuration: seals, closures and cable entries fitted. The rating is what the test report states, so IP68 glands on an untested box do not make the box IP68.

1.8 How to test your box

1. Close the box empty, with the O-ring greased and every gland tightened on a cable offcut.
2. Put a dry tissue inside so a single drip shows.
3. Weigh it down in a bucket overnight, the way Prusa ran its shallow tests.
4. Open it and check the tissue. Water at the lid edge points at the groove or the screws. Water at a gland points at a cable outside its clamping range.
5. If the box will be submerged, repeat at its working depth. Prusa's advice: test everything "before putting electronics inside".

Pass criteria are on how to test a print for leaks.

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