Building the 11 x 15 x 6 Control Enclosure (18 ga, plasma cut)

A step-by-step guide to making the four-piece sheet-metal enclosure: two bent L pieces plus a front and a back cover. File names refer to the `control-box/` folder, and the numbers come from README.md.

1. Materials and hardware

- **Sheet:** 18 ga (0.048 in) mild steel, cold-rolled or HR P&O. The nest needs **30.75 x 25.5 in**. A 36 x 30 in piece works, or cut it from a 48 x 96 sheet. Buy a little extra for test cuts and a test bend.
- **Fasteners:** 32 × **#8 x 1/2 in self-tapping sheet-metal screws** (pan or button head): 28 for the covers and 4 for the A-to-B joints.
  - **Pilot holes** in the tab flanges and in A's joining tabs: **0.116 in (#32 drill)**.
  - **Clearance holes** in the covers and in B's web at the joints: **0.177 in (#16 drill)**.
  - Check both sizes against the screw maker's chart.
- **About thread strength:** 18 ga gives a self-tapper only about one thread of engagement. Snug the screws, don't crank them, and avoid repeated removal.
- **Option for a front cover you'll open often:** use #8-32 rivet nuts on the front tabs. They need about a 0.257 in hole (check the maker's chart) and 0.75 in tabs (`LIP`), because 0.5 in tabs leave too little edge. Or use #10 self-tappers with a 0.140 in pilot.
- **Grounding:** a #10 ground stud or screw, a star washer, and a ring terminal.
- **Coating supplies:** degreaser (acetone or a dedicated pre-paint cleaner), high-temperature masking tape or silicone plugs, and powder.

2. Cutting (SheetCam)

1. Import `control-box-sheet-inch.dxf` (inch units). Check that it measures 30.75 x 25.47 in.
2. Map the layers:
   - **CUT:** cut it. Holes and slots get inside offset, outlines get outside offset.
   - **DRILL:** either set it up as a center-mark (spot) operation, or turn it off and lay out the holes by hand from the PNGs. Don't try to pierce 1/8 in holes in 18 ga with plasma.
   - **BEND: never cut it.** Turn it off, or use it only as a light scribe or mark operation.
3. Cut order: inside features first (relief slots), then outlines.
4. Cut settings: start from **your own tested 18 ga values** (from the coupon runs) or from the Razorweld chart for your consumables. Don't guess numbers. Run the coupon file first if you've changed tips.

5. Leave the parts to cool on the table, then check the blanks with a tape:
    - A: 27.154 x 6.737
    - B: 25.917 x 6.737
    - Covers: 11 x 15

3. Clean-up and holes

1. Knock off the dross and deburr every edge, including the relief slots. A file or a flap disc works; keep the edges square.
2. Drill each DRILL hole to its size: 0.116 (#32) in the tab flanges and A's joining tabs, 0.177 (#16) in the covers and B's web.
3. Drill the 0.177 clearance holes with a small pilot first, so they stay round and on center.
4. Deburr the holes on both sides.

4. Test bend first

1. Cut a scrap strip of the same sheet, about 6 x 3 in. Scribe a line exactly 1.500 in from one end.
2. Bend it 90° on that line in your brake, with the same nose and setup you'll use on the real parts.
3. Measure both outside legs.
4. Your bend deduction is **BD = (leg1 + leg2) − strip length**. The design assumes **0.083 in**.
5. If your result is off by more than about 0.01 in, update `BD` (or `K`) in `build_control_box.py`, rebuild, and recut. Also note where the bend line sits relative to the brake's clamp edge. For an inside radius of about t, the line is normally set at the clamp nose.

5. Bending (12 in finger brake, or hand seamer for the small tabs)

All bends are 90°, toward the inside of the box. Lay each blank **inside face up** so the flanges come up toward you.

Piece A:

1. **Cover tabs (14):** clamp along each tab's BEND line, using one 1.75 in finger or the stacked smaller angle iron. Bend each tab 90° up. The relief slots let each tab fold without dragging the plain edge along. A hand seamer works for touch-ups. Check each tab with a square.
2. **Joining tabs (2):** bend them at 0.708 and 26.445 from the left end. These bends are 5.3 in long and go the same direction as the cover tabs.
3. **Main corner:** bend at 15.577 (5.9 in long). Set the fingers between the two rows of tabs (5.8 in clear), so the tabs aren't crushed under the clamp bar. Bend to 90° and check with a square.

Piece B:

1. Bend the cover tabs (14) the same way as on Piece A.
2. Bend the main corner at 10.958.

Tips:

- Bend a little past 90° to allow for springback.
- Check each tab against the next one so the cover will sit flat.
- If a tab won't fit under a finger, bend it in a vise between hardwood blocks or with a seamer.

6. Dry-fit

1. Set B (bottom and right side) on the bench. Drop in A, so that A's left leg sits on B's bottom and A's top butts against the inside of B's right wall. The joining tabs lap inside B's walls.
2. Clamp the pieces and drive the 4 joining self-tappers through B's web into A's tabs.
3. Place both covers and start a few screws. The tab holes should line up with the cover holes.
4. Measure the box: it should be **11 x 15 x 6**. Check that it's square: the two face diagonals should match (about 18.60 in on the 11 x 15 face). Adjust bends now if needed.
5. Mark the parts so they go back together the same way, then take everything apart.

7. Before coating

1. Run a screw into each pilot once and back it out, so the threads are formed before coating. (If you fitted the optional front-cover rivet nuts, install them now.)
2. Mask:
    - the pilot holes, using high-temperature plugs or tape so powder doesn't fill them;
    - one **bare-metal grounding spot** (about 3/4 in) at the ground stud location, inside, on both sides of the joint path;
    - the tab faces where the covers contact, if you want metal-to-metal bonding.
3. Degrease thoroughly. Then outgas: bake the bare parts a little above the cure temperature, and let them cool before powdering.

8. Coating

1. **Coat the L pieces after bending.** Flat they won't fit; folded they are about 15 x 11 x 5.9.
2. **Coat the covers flat** (11 x 15).
3. Both the folded L pieces (about 15 x 11 x 5.9) and the flat covers fit the oven (about 16+ W x 12 D) with margin. Hang them so the powder doesn't touch anything.

4. Spray, then cure following the **powder maker's time and temperature schedule**. Let the parts cool before handling.

9. Final assembly

1. Remove the masking and chase any threads.
2. Join A to B with the 4 self-tappers.
3. Fit the ground stud at the bare spot: star washer, then the ring terminal.
4. Mount the equipment, then fit the covers with 14 self-tappers each. Snug them; don't overtighten.

10. Safety (follow the manufacturers and code)

- Bond the enclosure to protective earth, following the equipment maker's instructions and local code. Check continuity between the covers and the body, because powder coat insulates.
- Follow each device's manual for clearances, ventilation, and heat. Add vents or a fan if the manuals call for them.
- Use proper cable glands or grommets and strain relief at every entry. Never run cable over bare sheet edges.
- Have the mains wiring done, or checked, by a qualified person to your local electrical code.
- Use plasma, drilling, and powder-coating PPE; ventilate while degreasing and curing.

Checklist

- [ ] Test cuts are good; blanks measure correctly
- [ ] Dross is removed; all edges and holes are deburred
- [ ] Holes drilled: 0.116 pilots in the tabs, 0.177 clearance in the covers and B's web
- [ ] Test bend done; BD confirmed (~0.083 in)
- [ ] Bends done in order: A = cover tabs, then joining tabs, then main corner; B = cover tabs, then main corner
- [ ] Dry-fit: 11 x 15 x 6, diagonals equal, holes line up
- [ ] Pilots pre-threaded; pilots and ground spot masked
- [ ] Parts degreased and outgassed
- [ ] Oven fit checked; L pieces coated folded, covers coated flat; cured to the powder maker's spec
- [ ] Final assembly done; ground bonded and continuity checked
- [ ] Glands and strain relief fitted; wiring done or checked to code

Appendix A: Design reference (README): Control enclosure: 11 W x 15 H x 6 D in, 18 ga (four pieces)

All dimensions are in inches. Every number comes from `build_control_box.py` (its parameters are at the top). Run order: `build_control_box.py` -> `merge_and_nest.py` -> `verify.py` -> `assembly.py` -> `draw_flats.py`, using the venv in `../.venv`. For the shop procedure, see **BUILD-GUIDE.md**.

Parts and blanks

File	Part	Blank
piece-a-top-left-flat-inch.dxf	A: left side + top (one L) with joining tabs on both ends	27.154 x 6.737
piece-b-bottom-right-flat-inch.dxf	B: bottom + right side (one L)	25.917 x 6.737
front-cover-inch.dxf / back-cover-inch.dxf	flat covers	11.000 x 15.000
control-box-sheet-inch.dxf	all four parts nested, 0.25 spacing and margin	**30.75 x 25.47** (fits 48 x 33; buy 36 x 30 or larger, or cut from a 48 x 96 sheet)

Layers:

- **CUT** (white): closed outlines.
- **DRILL** (red): every fastener hole at its finished size. Tab flanges get 0.116 pilots (#32 drill) for #8 self-tappers. Covers and B's web joint holes get 0.177 clearance holes (#16 drill).
- **BEND** (blue, dashed): bend lines. These are reference only and must never be cut.

File format: R2000 DXF, $INSUNITS = 1 (inches), lines and true circles only. All files pass the checks in `verification.txt`.

Material and bend math

- t = 0.048, inside radius R = t, K = 0.44.
- Bend allowance: BA = π/2·(R + K·t) = 0.1086.
- Outside setback: OSSB = R + t = 0.096.
- **Bend deduction: BD = 2·OSSB − BA = 0.0834** per 90° bend.
- Flat length is the sum of the outside (mold-line) legs minus BD for each bend. For example, Piece A = 0.75 + 14.952 + 10.952 + 0.75 − 3·0.0834 = 27.154.

Do a test bend on scrap before cutting the real parts (see the guide). If your brake gives a different BD, change `BD` / `K` and rebuild.

The L pieces are 6 − 2t = 5.904 deep, so with both covers on, the box is exactly 6.000 deep.

Bend list (bend line position measured from the left end of each flat; all bends 90°, toward the inside of the box)

Piece A (flat x 0 → 27.154). Bend in this order:

1. **14 cover tabs**, 0.5 tall × 1.75 long, along both long edges. Their centers are at x = 2.619, 6.285, 9.952, 13.619 (left leg) and 17.535, 21.035, 24.535 (top leg), on both edges. Each bend is 1.75 long.
2. **Joining tabs** at x = 0.708 and x = 26.445. Each bend is 5.304 long.
3. **Main corner** at x = 15.577. This bend is 5.904 long.

Piece B (flat x 0 → 25.917; the bottom runs from 0 to 10.958):

1. **14 cover tabs**, centered at x = 2, 5.5, 9 (bottom) and 12.917, 16.583, 20.250, 23.917 (right side), on both edges.
2. **Main corner** at x = 10.958. This bend is 5.904 long.

Longest bend is 5.904 in. All bends are ≤ 11 in, so a 12 in brake is enough (the old design with continuous lips needed 15 in or more).

- The inside clear width at the main bend, between the tab rows, is 5.808. The cover tabs are already up at that point, so the finger set must fit between them (≤ 5.8 wide) or the tabs must clear the fingers.
- The cover tabs are bent with a 1.75 wide finger, or with the stacked angle iron.

Holes (DRILL layer, at finished size)

- **Covers:** 14 each. These are 0.177 clearance holes, 0.298 from the edge and line up with the tab holes. The along-edge error is ~1e-15, from the math check in `build/assembly_check.txt`.
  - Along the 11 edges: x = 2, 5.5, 9.
  - Along the 15 edges: y = 2, 5.667, 9.333, 13.
- **Cover tabs:** 28 total on A and B. Each has one 0.116 pilot centered in the tab's flat height, 0.298 from the outside face and 0.202 from the free edge (1.7 × D).
- **Joining tabs:** 2 holes per tab, at depth 1.452 and 4.452. They are 0.116 pilots in A's tabs (the inner layer) and 0.177 clearance holes in B's web (the outer layer), 0.423 from the mating outside face and match 4 holes in B's web.

Checks

- Every bend is ≤ 11 in (longest 5.904), so **the brake must be 12 in**.
- No tab lies within 0.75 of a main bend. The nearest tab edge is 0.904 away (mold-line measure).
- The top tabs clear the wall tabs, and the tab rows clear the joining-tab reliefs (checked in `build/design.json`).
- The folded 3D model measures 11.000 x 6.000 x 15.000 (from SolidCraft eval). The two pieces do not overlap.
- **Oven fit (oven interior about 16+ W x 12 D, and well over 6 H):** the L pieces flat (27.2 / 25.9 x 6.7) are longer than the oven, so coat them **after bending**. Folded (about 15 x 11 x 5.9) they fit with margin, and so do the covers coated flat (11 x 15).

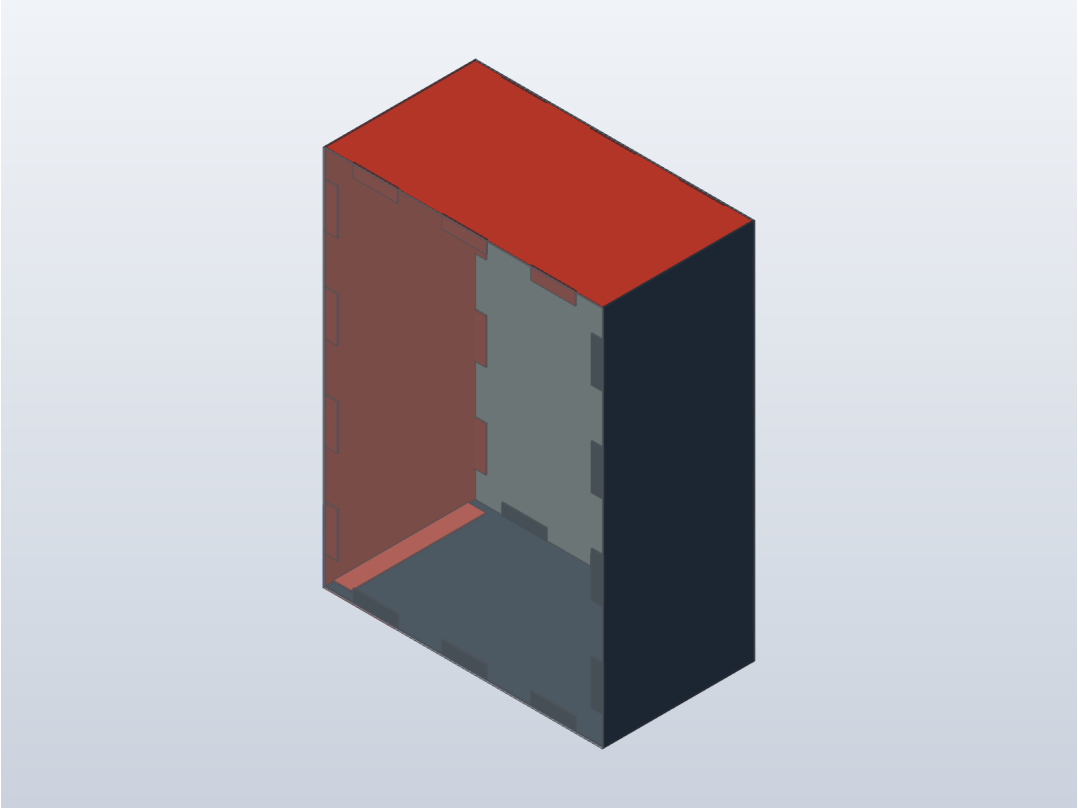
Assumptions and design notes

- A's top leg stops at x = 11 − t, against the inside of B's right wall. A's left leg sits on B's bottom.
- Cover tabs start 2 in from the corners, not 1 in, so that they stay 0.75 from the main bends. This leaves the corners with a looser seal.
- Bend reliefs are 0.125 wide slots. That is narrow for plasma, so consider drilling a 1/8 hole at the slot's root instead.
- **Fasteners:** 32 × #8 self-tapping sheet-metal screws (28 for the covers, 4 for the joints).
    - 18 ga gives the screw only about one thread of engagement, so avoid taking the covers off and on repeatedly. The pilots strip after a few cycles.
    - If the front cover will be opened often, use #8-32 rivet nuts there instead (optional). They need about a 0.257 hole; check the maker's chart. With 0.5 tabs that leaves only about 0.07 of metal to the edge, so raise `LIP` to 0.75 first. The other option is a #10 self-tapper with a 0.140 pilot (check the screw maker's chart).

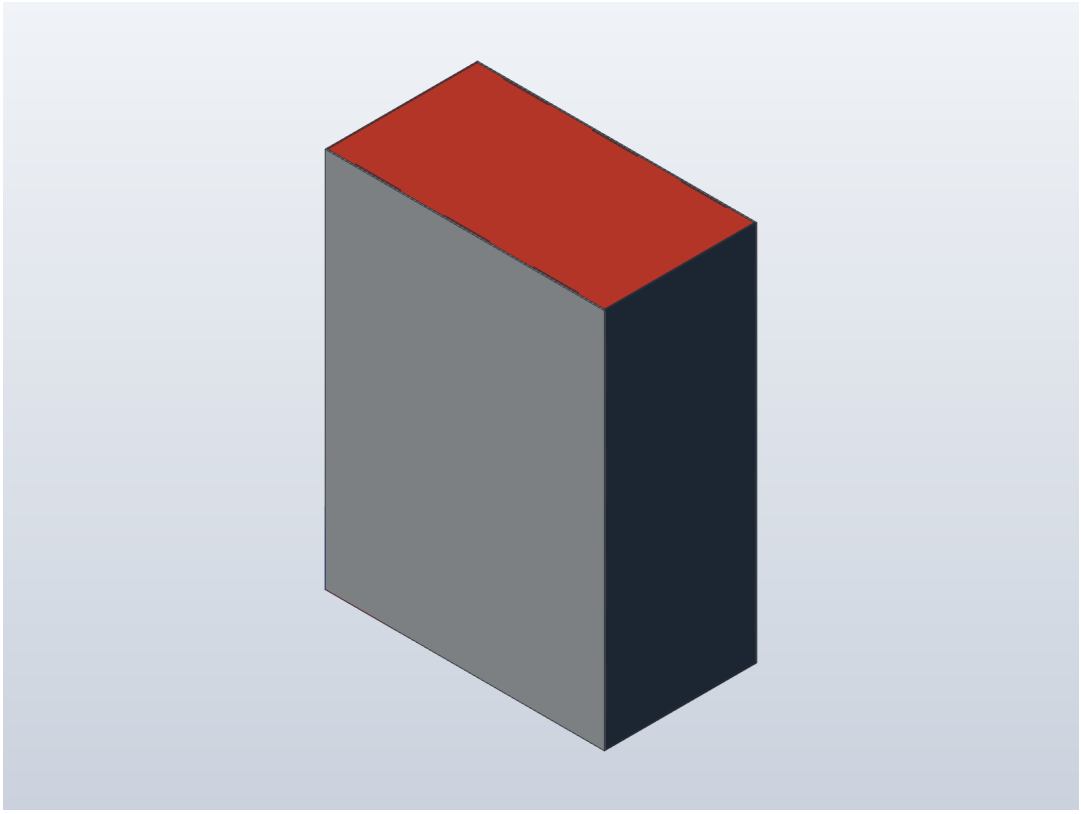
Other files

- `assembly-iso.png` (front cover transparent) and `assembly-iso-closed.png`.
- `*-flat-dims.png`.
- `control-box-assembly.sc`.
- The per-piece `.sc` files and their `.json` scripts.
- `verification.txt`.
- `control-box-drawings.pdf` (shop drawings, rev A).
- The `build/` folder.

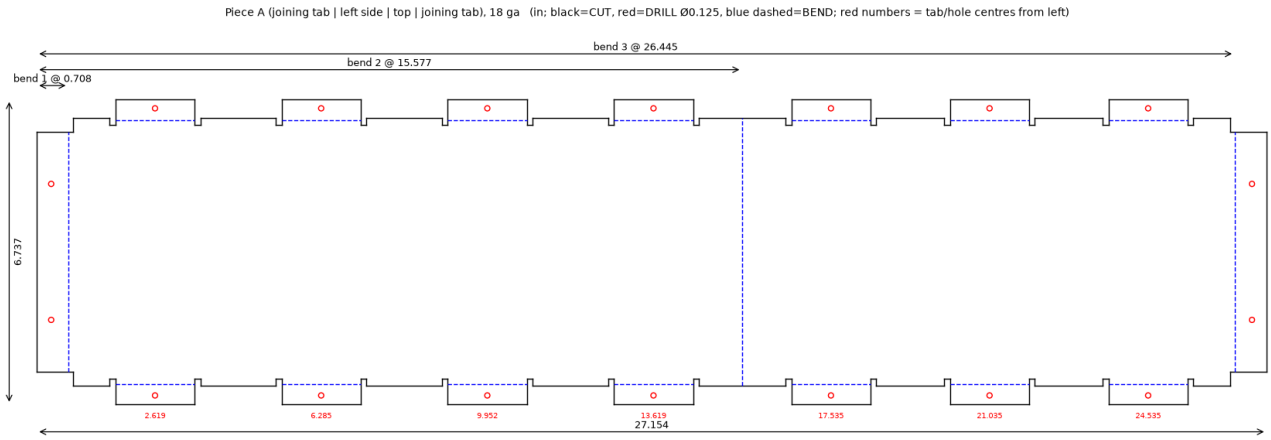
Figures



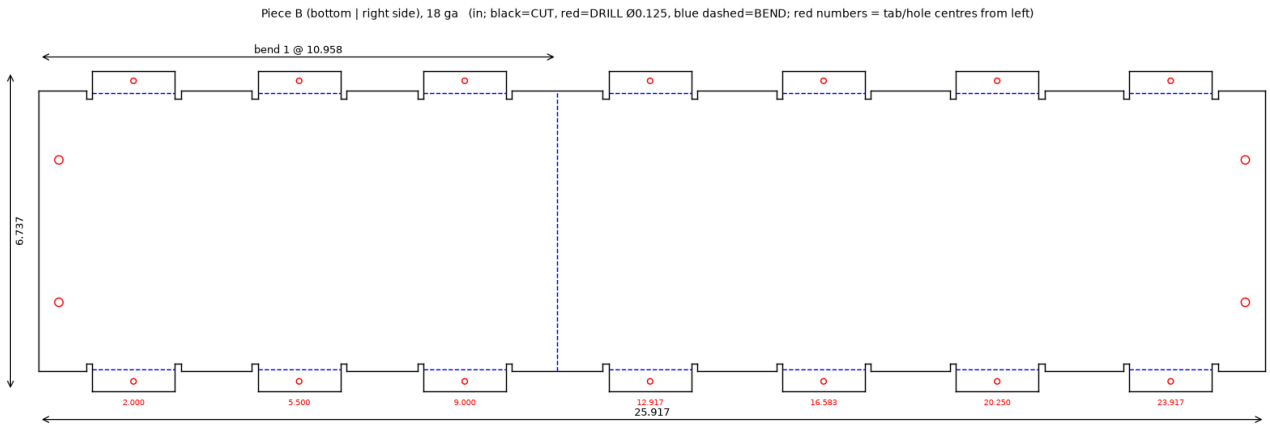
Isometric view - front cover transparent `assembly-iso.png`



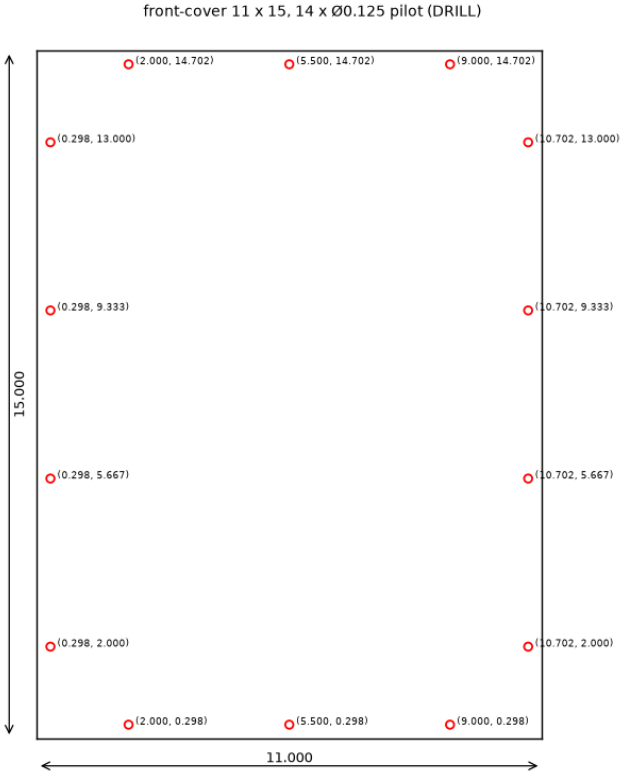
Isometric view - closed `assembly-iso-closed.png`



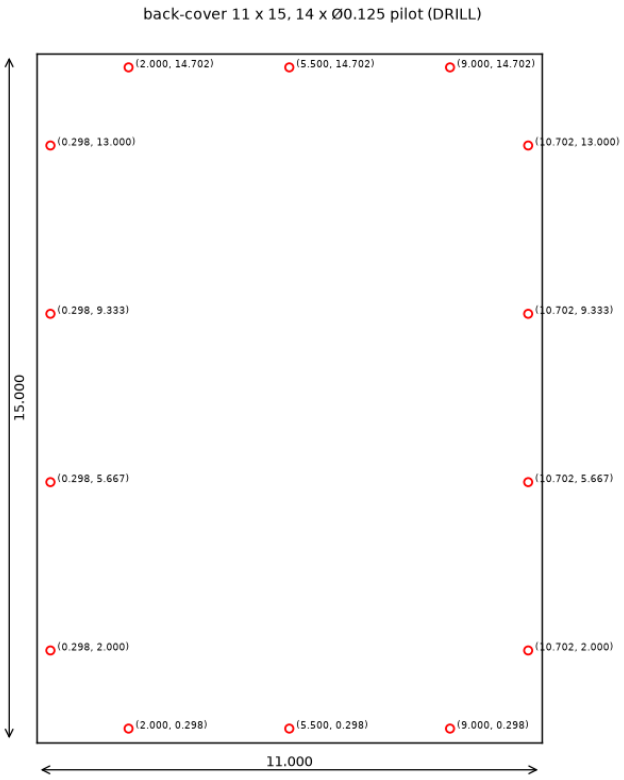
Piece A flat pattern `piece-a-top-left-flat-flat-dims.png`



Piece B flat pattern `piece-b-bottom-right-flat-flat-dims.png`



Front cover `front-cover-flat-dims.png`



Back cover `back-cover-flat-dims.png`