Making the dials

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This is the checklist for building a batch of PassDials, written for the first run of about twenty for the Libre Space Foundation off-site. Order the boards first, since everything else can happen while they are on their way.

A dial is one ready-made board (screen, touch, Wi-Fi, clock chip), a printed case in two colours, eight screws, a steel bar and a USB cable. Nothing needs soldering.

Bill of materials

Prices are what we saw on 23 September 2026, VAT included. Quantities are for 20 dials plus two spares.

Part	Per dial	For 22	Where	Price each
Waveshare ESP32-S3-Touch-LCD-2.8C, SKU 29086	1	22	Hellas Digital, Athens, 210 96 111 69	€39.90
USB-C cable with a **slim plug** (moulding at most 5.4 mm thick), 1.5 m	1	22	any	~€4
Rechargeable RTC cell ML1220 (3 V, 12.5 × 2 mm) with leads and a plug for the board's RTC header	1	22	Waveshare or any	~€2
M2 × 6 pan head machine screw, ISO 7045, head up to 4 mm	4	100	hardware shop	-
2.5 × 8 pan head thread-forming screw for plastic, head up to 5 mm	4	100	hardware shop	-
PETG, violet close to #6672D8 (shell and rings)	~25 g	1 kg	any	~€25/kg
PETG, black or charcoal (back plate and stand)	~80 g	2 kg	any	~€25/kg
Steel flat bar 30 × 10 mm, cut to 70 mm (about 165 g)	1	22 (1.6 m)	steel merchant	-
Cork sheet, 2 mm, self-adhesive, or four silicone feet	1	1 sheet	any	-
Instant glue (cyanoacrylate)	a drop	1	any	-
Recipient card, A6, 300 g/m², printed both sides	1	22	print shop	~€1
Foam insert, black PE (e.g. Plastazote) or EVA, cut to the DXF files: 5 mm base, two 10 mm sheets, 5 mm lid pad	1 set	22	foam cutter	-
Box, black, inside about 201 × 191 × 35 mm	1	22	box maker	-

That comes to roughly **€50 a dial**. No power adapter: the dial draws at most about 0.2 A at 5 V, so any phone charger or computer port runs it.

About the board: Hellas Digital listed it as in stock, but twenty is more than a shop keeps on the shelf. Call them, ask them to hold 22, and collect or have them shipped before you print anything. The same board is sold as “ESP32-S3 2.8inch Round Touch Display” elsewhere; check the SKU (29086) and the “C” in the name, because the 2.8” models without it have a different screen.

About the cable: the USB-C socket sits close to the display frame inside the case. Plugs with a standard 6.5 mm moulding do not go all the way in. Slim plugs are common on phone cables; measure one before buying twenty.

1. Print

The parts come out of `just enclosure` as STL and STEP files in `enclosure/out/` (also attached to every pipeline run).

Part	Colour	Orientation	Notes
`passdial_shell`	violet	front face down on the bed	no supports needed; the screw bosses have sloped undersides
`passdial_back_plate_and_rings`	black, then violet	back face down (the cell’s cup up)	pause at 3.0 mm and change to violet: the first 3 mm are the plate and its arms, the rest the rings. The lettering is on the bed side, so start on a clean, flat bed
`passdial_stand`	black	on its base	the steel bar’s pocket is open underneath

Without a pause at a layer, print `passdial_back_plate` in black and `passdial_ring_left` and `passdial_ring_right` in violet (back face down), and glue each ring on its arm.

PETG, 0.2 mm layers, three walls, 15 to 20 % gyroid infill for the stand.

Print one complete set first and assemble it with a real board and cable before printing the other nineteen. The rings on the back plate and the stand are new: check them first.

2. Flash

Either open https://pierros.gitlab.io/passdial/, plug the board in and press *Install* (Chromium-based browsers; use the board’s native USB port, which needs no driver), or from the repository:

```
just flash                  # picks the only serial port it finds
just flash /dev/ttyACM0     # or COM5 on Windows
```

3. First board only: check what the simulator cannot

These depend on the real panel and could not be verified before the boards arrived. Do them once, on the first board, and fix the defaults before flashing the rest.

- **Rotation.** The panel sits at 45 degrees to the USB ports, so the board is turned in the case and the port points down and to the right. Stood up that way the clock should be at the top; turned by quarters, the picture should follow within two seconds (the accelerometer; `imu` on the console prints what it reads). Checked on the first board: rotation 0 with the port at half past four.
- **Touch.** Tap a pass on the list: that pass should open on the whole screen, and a second tap should bring the list back. Drag the list up and down, swipe left and right through the five pages, and hold anywhere for 1.5 s: the last page and the hold both show the settings code. Each tap is logged on the serial console as `[touch] tap at x,y` in screen coordinates (0,0 top left). If a different pass opens,

or the list scrolls the wrong way, the touch axes do not match the panel: compare the logged points with where you tapped and fix the mapping in `board::readTouch()`.

- **Screen steadiness.** On the serial console, `lcd watch on` prints the frame timing every second and marks a bad second with `⟵ look`; then `stress flash 10`, `stress psram 10` and `stress net 10` load the flash, the PSRAM and the network in turn. The screen should not jump, and every line should say all frames were sent. On the first board, flash writes made the picture jump sideways (fixed by running code from PSRAM, `CONFIG_SPIRAM_XIP_FROM_PSRAM`) and heavy PSRAM traffic did the same above 14 MHz (the pixel clock is now 14 MHz). `lcd pclk <MHz>` tries another clock at once; `lcd test bars|checker|ramp|move` shows test patterns.
- **Edge of the picture.** In the case, the lip should just cover the edge of the lit area. A thin dark ring between lip and picture means `LIP_INNER_R` in the enclosure script should shrink by 0.2 mm; a visibly cropped clock means it should grow.
- **Plug.** The cable should click in fully with the dial in the case, and, plugged in, the dial should go down into the stand along its face without the plug catching anywhere.
- **Updates over Wi-Fi.** Upload the same firmware from the dial's settings page: the console should say `[health] new firmware, on trial` and, a minute later, `new firmware works; kept`. Upload it again and unplug the dial within that minute: on the next start it should say it went back (`the last update did not start`), and the settings screen should show "update undone".

4. Flash and check each dial

Every dial greets with the Libre Space Foundation's motto, *Per liberum ad astra*, on the start-up and settings screens: there is nothing personal to set on the dial itself. The names go on the cards: put them in `production/recipients.csv` (copy `production/recipients.example.csv`; the real file is ignored by git), each with the language of its screens. Then, check out the release you are giving and run the batch:

```
git checkout v0.1.0
just batch production/recipients.csv COM5
```

The batch insists on a release tag: dials that start on a release take the next one by themselves, and only releases reach them (a merge to main does not). To make a release, tag the commit on main (`git tag v0.1.0 && git push --tags`); CI builds it, publishes it on the releases page and offers it to the dials that night.

For each person it asks for their dial on the USB port, erases it, writes the firmware built from this checkout, sets the language and runs the dial's self-test:

1. Colour bars while the light comes up: look for dead pixels and for the colours in order (white, yellow, cyan, green, magenta, red, blue, black).
2. What the board can check by itself: PSRAM and flash sizes, the clock chip, the accelerometer, the panel's frame rate (about 50 a second, no late lines) and Wi-Fi (networks found and the strongest signal, which tells a bad antenna). Then three notes on the buzzer: listen for them.
3. Five circles: tap each one. They turn green.

The dial then says ALL GOOD, or CHECK with what failed, and a line is added to `production/checklist.csv` (ignored by git): the name, the dial's own network and settings code, the version, the commit and image it was given, and each result. The checkout must be committed, so every dial runs the same code. A dial that fails goes back to step 3 of this guide. `--keep-settings` writes the firmware without erasing (a dial that is already on the office Wi-Fi). Handover (step 7) gives each dial a new settings code and erases everything of the office from it, the Wi-Fi driver's copy of the network included.

Single dials, or later changes: `just provision COM5 --info` prints what a dial knows, `--lang el` sets its language (the owner can change it with the switch on the settings screen or on the settings page),

`--rotation` fixes the rotation if the accelerometer should not choose it, and `selftest` on the serial console runs the self-test again.

Once handed over, the dials update themselves from the project site at night (see the architecture), so a fix released on the main branch reaches them all; the owner can turn that off on the settings page.

5. Assemble

1. Lay the shell face down on a soft cloth and drop the board in, glass first. The USB socket lines up with the opening in the rim, which is not at the bottom but at half past four: the board is turned 45 degrees on purpose.
2. Plug the RTC cell into the board's RTC header and press it into the cup on the inside of the back plate, leads through the gap in the cup's wall. Put the back plate on: its four black bridges drop into the notches at the back of the rim, and the rings lie beside the planet. Fix it to the board's four brass standoffs with the **M2 × 6** screws. Snug only: brass strips easily.
3. Drive the four **2.5 × 8** thread-forming screws into the shell's bosses. Stop as soon as the plate sits flat; the plate is designed to pull the glass against the lip, and more torque cracks the bosses.
4. Press the steel bar into the pocket under the stand with a drop of instant glue, and cover the underside with the cork (or stick on the four feet).
5. Plug the cable into the dial at the lower right, and set the dial down into the stand along its face: the plug goes into its pocket on the right. Press the cable into the groove that runs to the back.
6. The BOOT button is behind the small hole next to the USB opening: pressed with a pin it wakes the screen, held for ten seconds it forgets Wi-Fi.

6. Burn in

Power every dial for a night on the office Wi-Fi: go through the setup page as a recipient would, let it fetch elements and compute passes, and compare the next few passes with the simulator for the same place. Anything that restarts, freezes or shows no passes by morning goes back to step 2.

7. Hand over

The last step before packing:

```
just provision COM5 --handover
```

This forgets the office Wi-Fi and location, erases every page of the settings storage (old values linger in flash until their page is erased, and the Wi-Fi driver kept its own copy of the network) and gives the dial a new settings code; the rotation, language and other choices are kept. At its new home the dial starts on the setup screen. Unplug it, lift the dial out of the stand and unplug the cable, then pack the dial, the stand, the cable and the card. On the desk the dial and stand are about 180 mm wide, 58 mm deep and 113 mm tall; apart, the dial with its rings is 179 × 101 × 14 mm and the stand 112 × 58 × 23 mm.

In the box they lie side by side in a foam insert 200 × 190 mm. `just enclosure` writes it as one DXF per sheet (`enclosure/out/passdial_insert_*.dxf`, all four drawn in `passdial_insert.png`) for a foam cutter: a solid 5 mm base; sheet A, 10 mm, with pockets for the stand and the coiled cable; sheet B, 10 mm, with those and the dial; and a 5 mm pad glued inside the lid, with a window over the glass. Stack the base, A and B, glued or loose. The stand and the cable (coiled and tied) sit on the base, the dial lies face up on A, and both stand about 4 mm proud, so the lid pad holds them down by the rim; the card and the cloth go on top. The box should be about 201 × 191 × 35 mm inside.

Cards

```
just cards production/recipients.csv
```

writes one A6 PDF per person into `build/docs/cards/`, front and back, in the language set for them in the CSV. `just docs` builds the unnamed Greek and English cards. Ask the print shop for 300 g/m² matt card, both sides; if they want bleed, build with `just cards production/recipients.csv 3` for 3 mm.