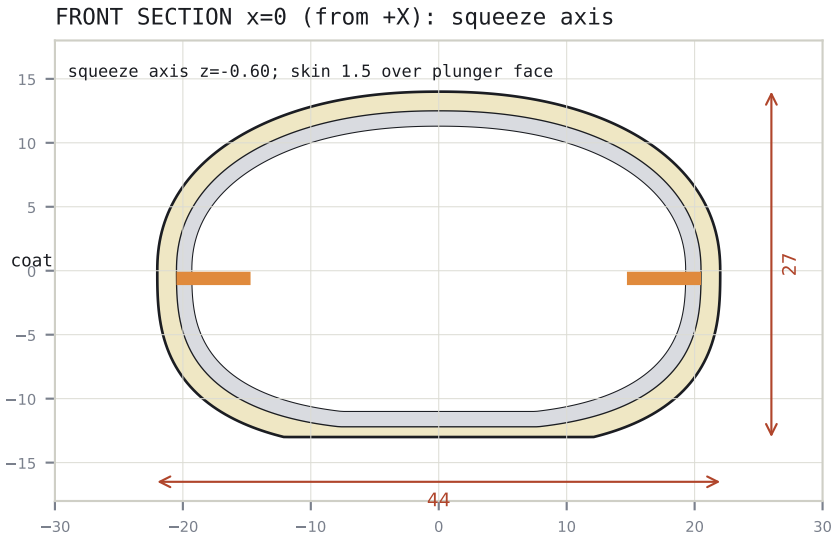
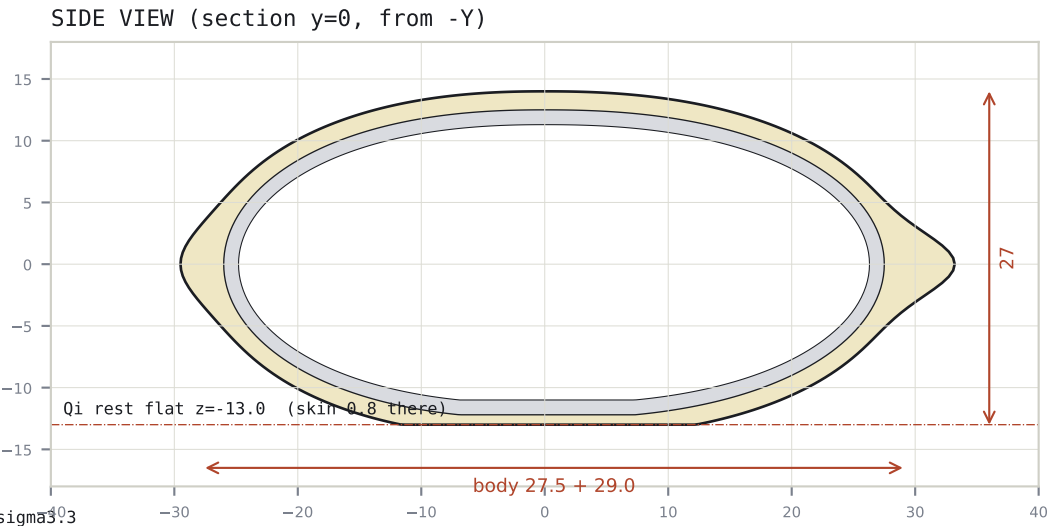
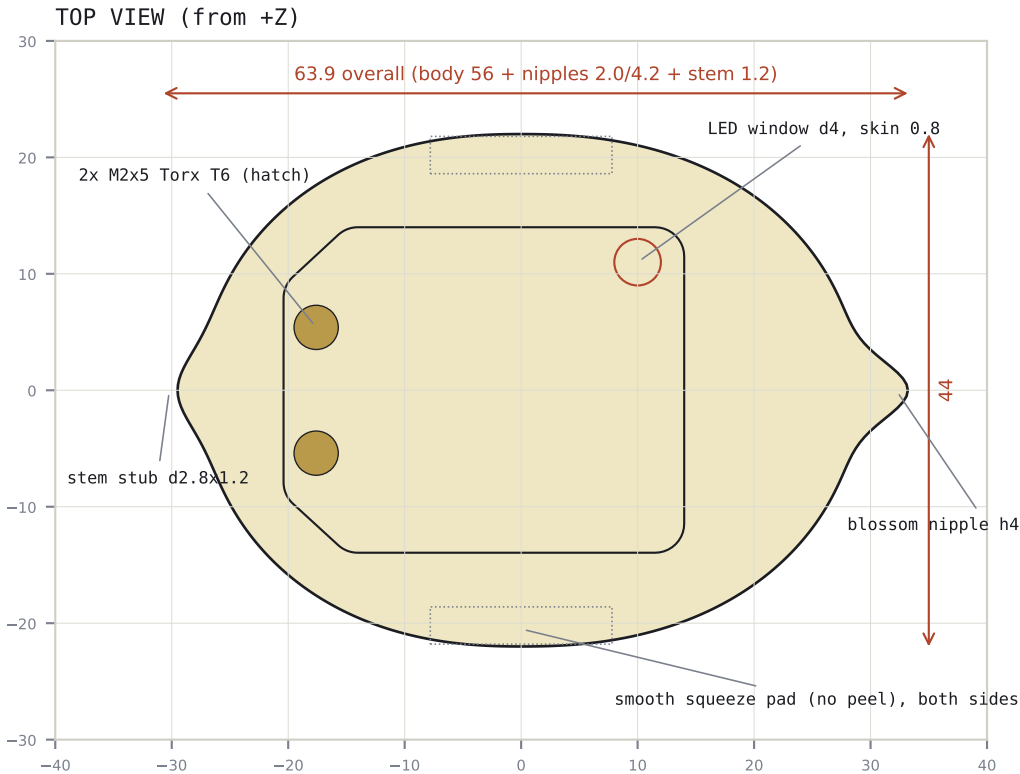


SHEET 1 - BODY: lemon outer skin (cast PU 70A over the printed core)

Envelope 63.9 x 44.0 x 27.0 mm incl. nipples, stem stub and leaf relief. Section functions: lemon\_geom.lemon\_F / nipple\_offset / flat\_z.



SKIN SPEC

material cast PU Shore 70A (Polytek PT Flex 70), pigmented lemon yellow; leaf relief green in-mould brush coat

wall 1.5 nominal; 0.8 under the Qi flat; 0.8 over the LED rod (d4, no pigment boost)

shape lemon:  $|x/A|^{2.3} + (|y/22|^n + |z/14|^n)^{2/n} = 1$ ,  $A = 29.0/27.5 (+X/-X)$ ,  $n = 2.2$  top / 2.8 bottom; gaussian nipples; Qi flat clipped at  $z = -13.0$

peel dimples on a jittered 3D grid: cell 1.85, radius 0.88, depth 0.2 (x0.6-1.0)

leaf masked out on: Qi flat, both squeeze pads, hatch seam (+/-1.3), LED window, screw counterbores

leaf relief 7.5 wide x 1.0 high, embedded 0.6; root at the stem, tip down the +Y flank.

Part of the same casting: nothing to detach (no small parts, 14+ gift)

hatch top 'peel cap' carries its own 1.5 mm skin (separate open mould); seam 0.2

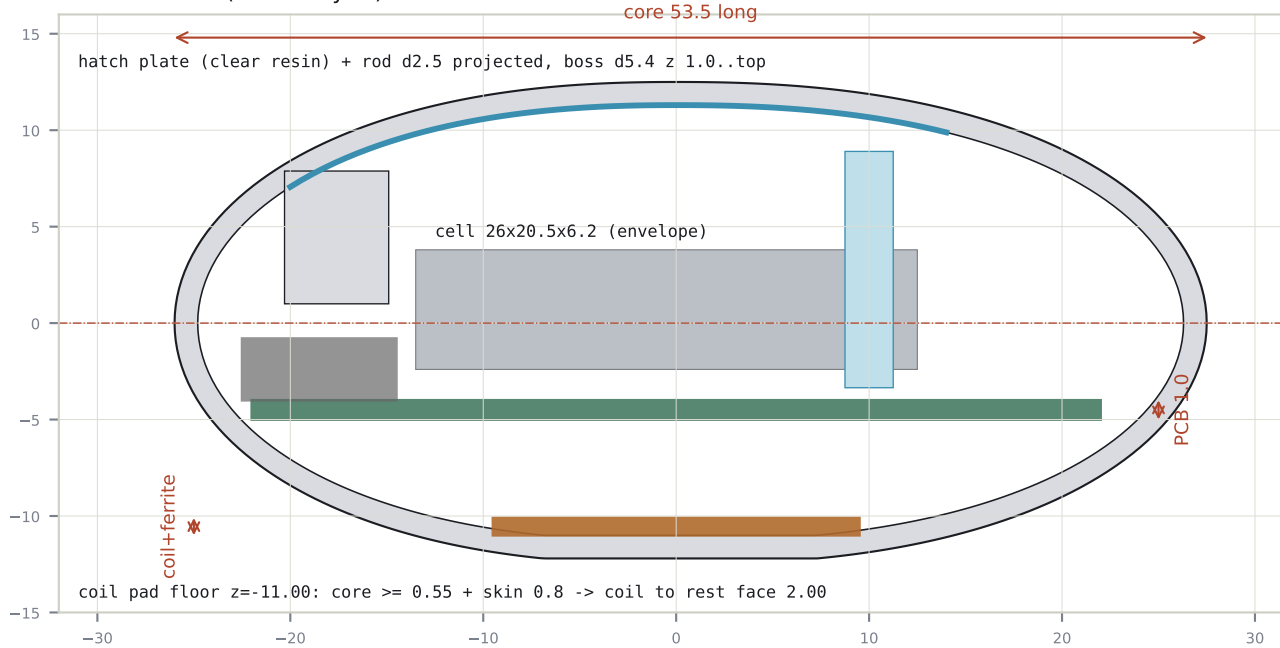
volume body skin 7.13 cm3 + hatch skin + leaf = 8.6 cm3 -> 9.6 g PU / lemon

mass 32.1 g complete (with cell)

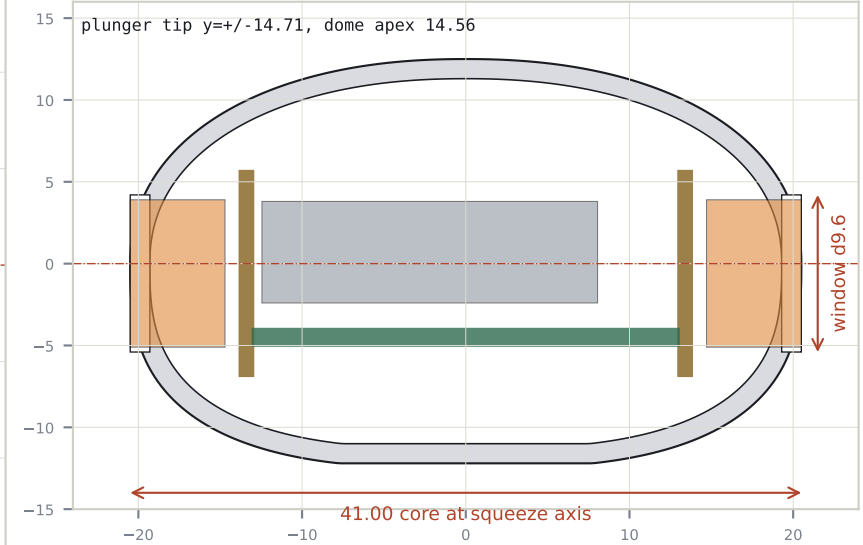
## SHEET 2 - RIGID CORE: two SLA halves (bonded, permanent) + hatch opening, windows, coil pad, ribs

Core outer = lemon offset 1.5 (skin cast on it), wall 1.2. PCB at z -5.0..-4.0; cell z -2.4..3.8; coil pad floor z -11.00.

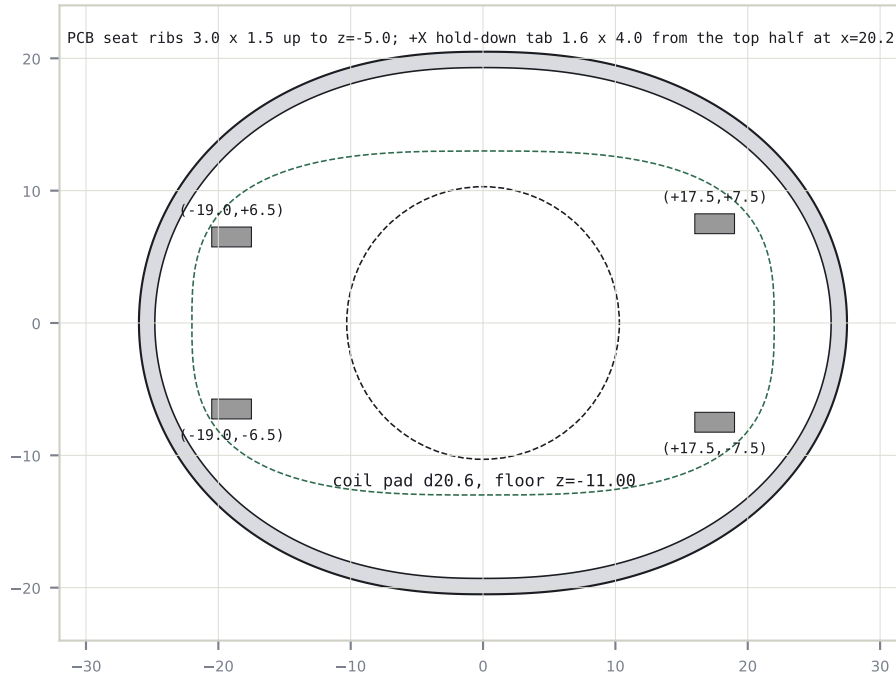
SECTION A-A (x-z at y=0)



SECTION B-B (y-z at x=0)



BOTTOM HALF, plan from above (z=0 cut face)



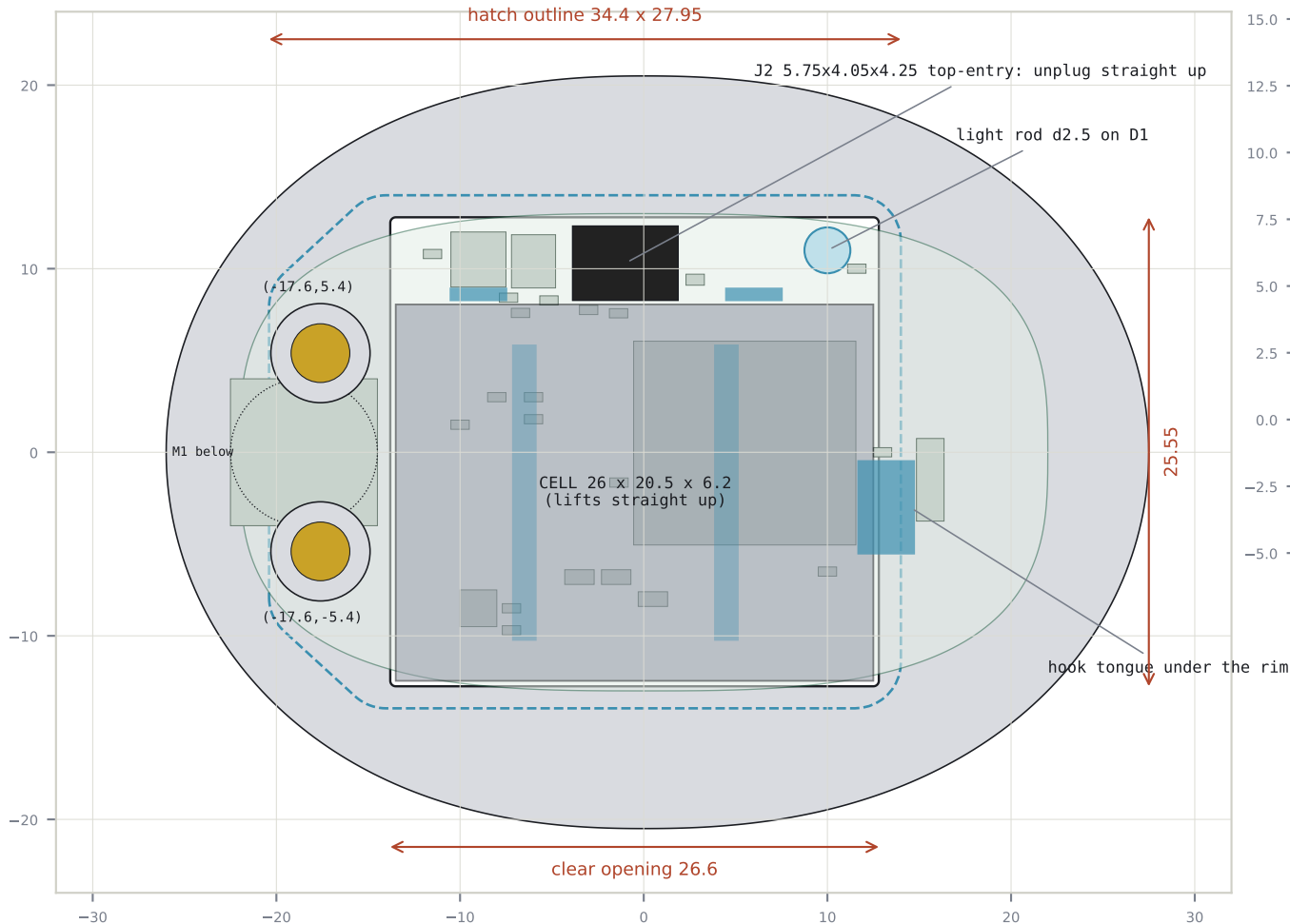
### CORE SPEC

|          |                                                                                                                 |
|----------|-----------------------------------------------------------------------------------------------------------------|
| material | SLA Formlabs Tough 2000 / Siraya Blu (prototype + batch), or MJF PA12 outsourced; 0.1 mm layers OK              |
| wall     | 1.2; >= 0.55 under the coil pad                                                                                 |
| split    | z = 0, butt joint, bonded with the printing resin + UV (405 nm) 60 s per side. Permanent: no cell inside.       |
| windows  | 2x d9.6 at z=-0.60, captive plunger inside, sealed outside with a d14 3M 850 PET disc before casting            |
| hatch    | opening + 0.8 ledge in the top half, 2x boss d5.4 with ruthex M2x4 brass heat-set inserts (hole d3.2, 4.2 deep) |
| ribs     | 4 PCB seat ribs (bottom-side keep-outs, sheet 4)                                                                |
| print    | halves standing on edge, supports on the outside only; ~20 halves per Form 4 plate (10 cores), ~2.5 h per plate |
| mass     | top 2.56 g + bottom 3.57 g                                                                                      |

# SHEET 3 - BATTERY ACCESS: top hatch ('peel cap'), user-replaceable cell (EU 2023/1542 Art. 11)

Default variant. Cell on a keyed, latching 2-pin plug; no glue or tape on the cell; opened with a T6 Torx driver (commercially available).

PLAN from +Z, hatch removed (hatch outline dashed)

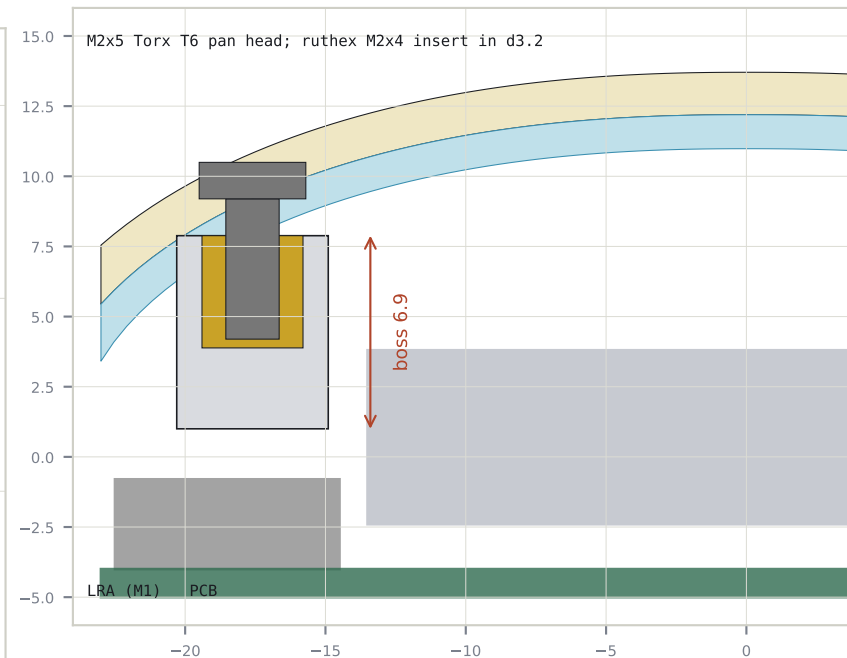


## WHY THE HATCH IS ON TOP (not on the Qi face)

- the rev B electronics stack keeps the cell above the PCB and the coil soldered below it: a top hatch needs no spring contacts to a coil in a removable base, and the Qi face stays one continuous 0.8 mm skin (best coupling);
- the hatch rim stays above  $z=+4.6$  at the sides, so both squeeze flanks are identical soft skin (A/B feel matches);
- screws at the stem end keep brass/steel  $>35$  mm from the +X antenna; the +X end uses a plastic hook.

Sealed variant (LEMON\_BATTERY\_ACCESS=sealed): no hatch, rod in the core top wall, cell glued: pre-18 Feb 2027 only.

SECTION through the screw bosses (x-z at  $y=+5.4$ )



## USER BATTERY REPLACEMENT (ships in the manual + online)

- 1 Take the lemon off the cradle (no need to charge first).
- 2 Unscrew the 2 screws at the stem end (T6 Torx driver) and keep them (spares ship with every replacement cell).
- 3 Lift the stem end of the hatch, slide it toward the stem to free the hook, lift off.
- 4 Pull the plug straight up by its tab (latching: squeeze the latch). Lift the cell out; no glue.
- 5 Fit the new cell label up, plug in (keyed), hook first, lower the hatch, 2 screws finger-tight + 1/8 turn (0.1 Nm).
- 6 Squeeze once: the click haptic confirms power.

## REPLACEMENT CELL SPEC (publish)

602025 Li-ion pouch, 3.7 V, 250-270 mAh, integrated PCM, envelope  $\leq 26 \times 20.5 \times 6.2$  incl. PCM, leads 30-40 mm, plug JST GHR-02V-S (pin 1 = +), IEC 62133-2, UN38.3, battery DoC

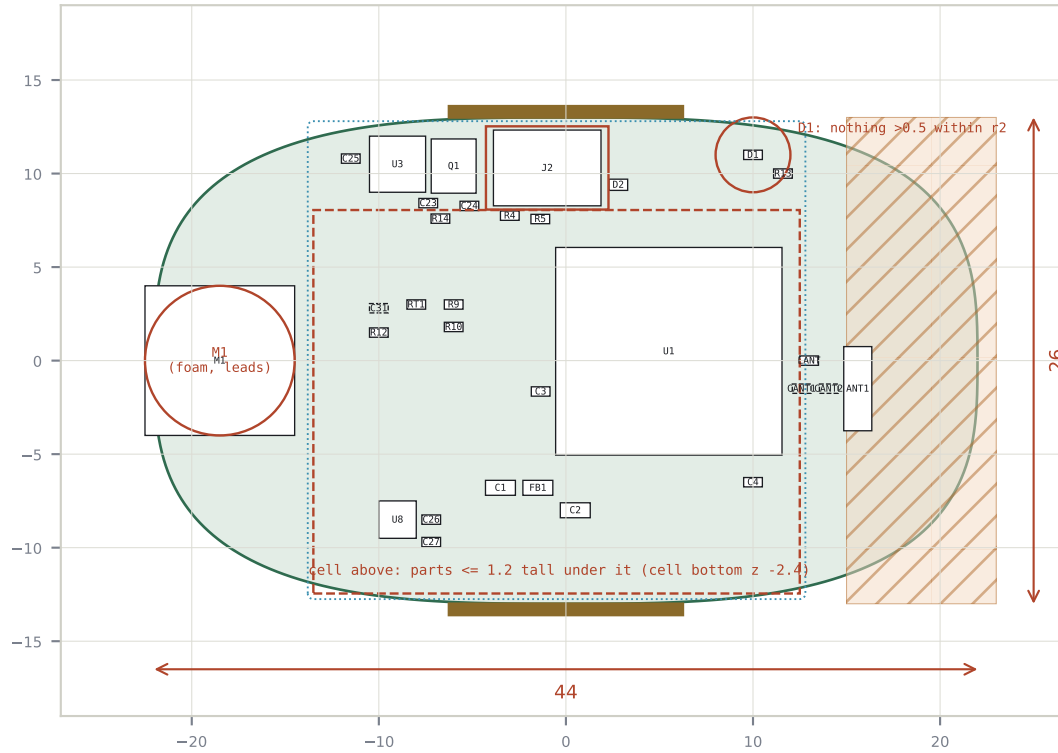
## HATCH PARTS

plate clear resin (SLA Clear / cast clear PU), rod + fingers + press ribs + hook integral; skin 1.5 PU cast on top  
foam PORON 1.5 on the press ribs (compressed to 1.0)  
label CE / bin / model / serial / address inside the plate

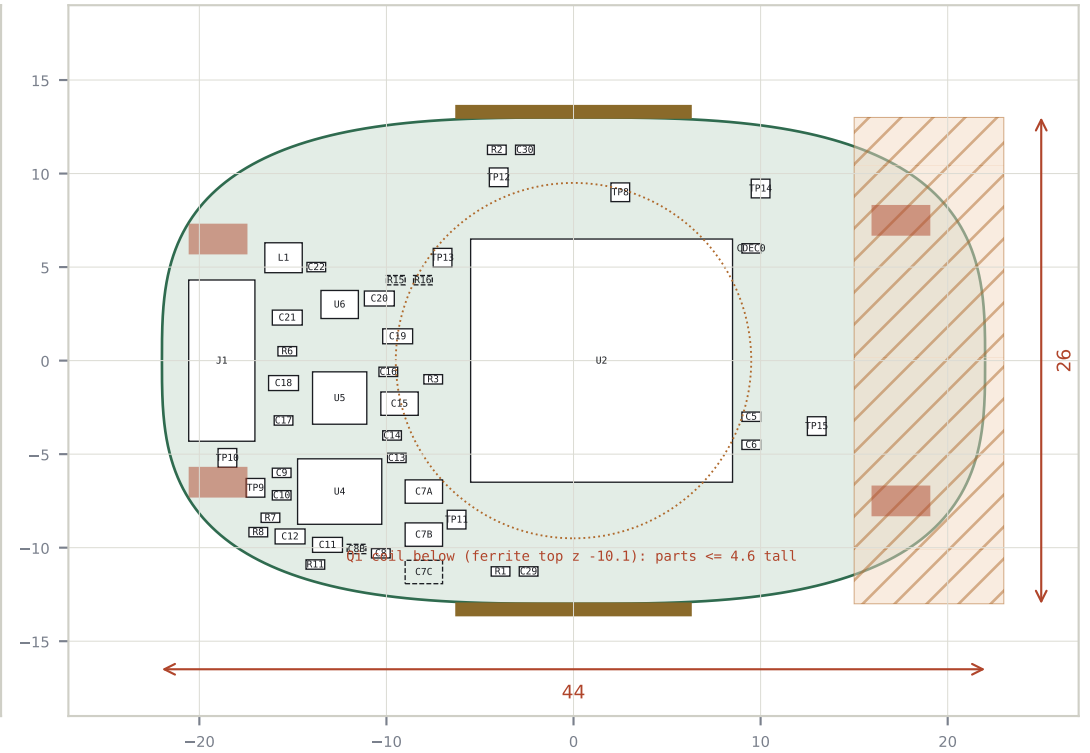
# SHEET 4 - PCB 44 x 26 x 1.0 (superellipse n=3): MECHANICAL INTERFACE to the electronics layout

Parts from drawings/pcb\_placement.csv (81 rows, electronics stream; read-only here). Red = mechanical keep-outs / fixed positions.

TOP SIDE (looking down from +Z through the board)



BOTTOM SIDE (looking down from +Z through the board)

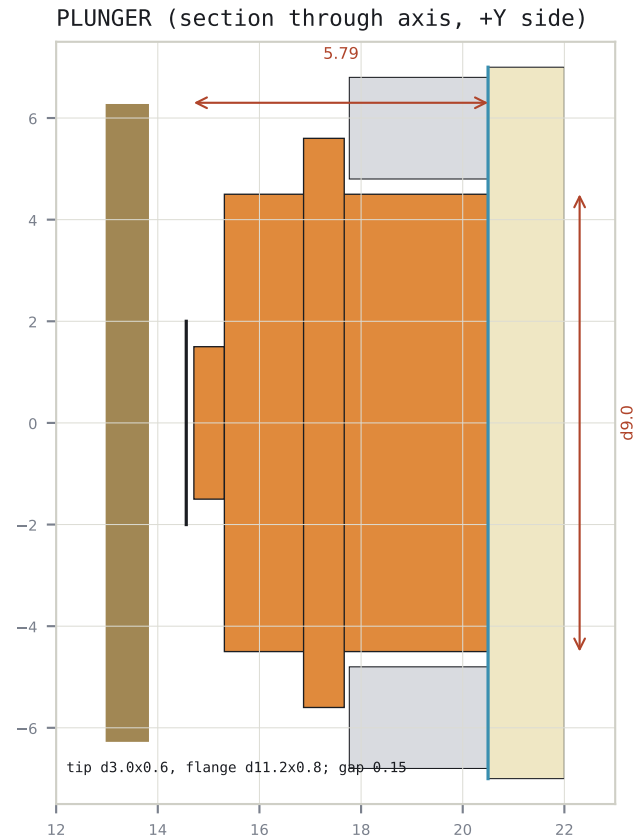
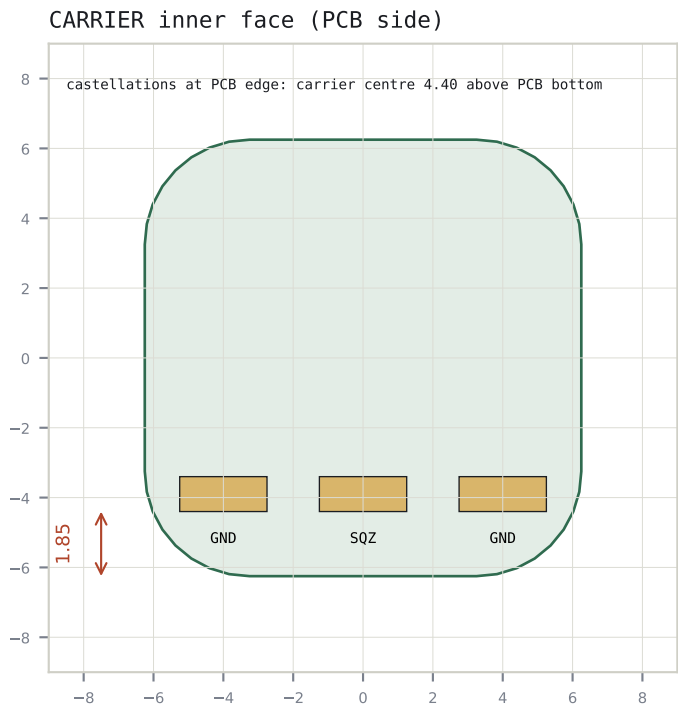
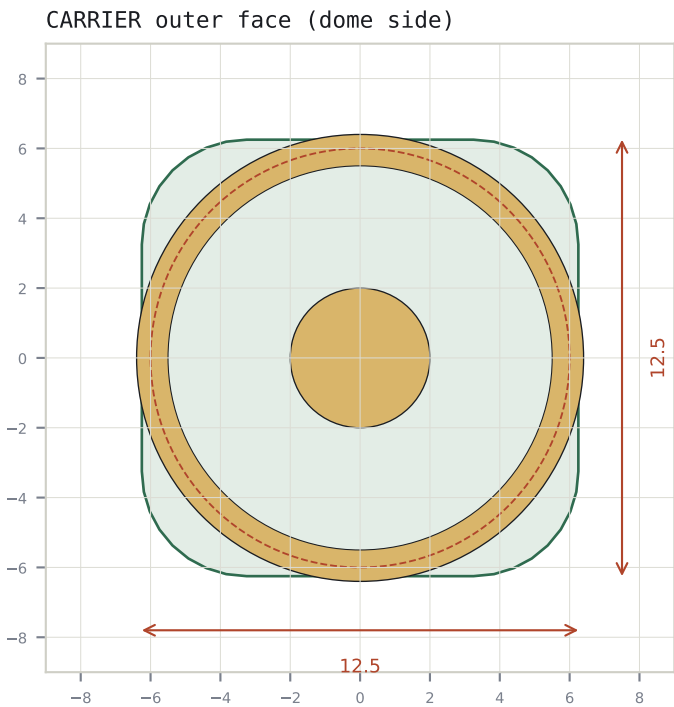


## MECHANICAL INTERFACE (numbers the layout must hold; change them only together with lemon\_geom.py)

board 44 x 26 x 1.0 superellipse n=3, bottom face z=-5.0; seated on 4 ribs (bottom keep-outs 3.0 x 1.5 at (+17.5,+/-7.5), (-19.0,+/-6.5)); +X tip clamped by a tab at x 19.4..21.0  
dome carriers castellated edge pads at y=+/-13.0, x -6.25..+6.25; carrier centre z=-0.60 (squeeze axis)  
cell 26 x 20.5 x 6.2 at (-0.5, -2.2), bottom z=-2.4 on a 0.4 foam pad on U1: top-side parts under it <= 1.2 mm  
J2 top-entry header at (-1.0, 10.3) 5.75 x 4.05 x 4.25: must stay inside the hatch clear opening and >= 0.2 from the cell footprint; hatch pad presses the plug home  
D1 + rod LED at (10.0, 11.0); rod d2.5 ends 0.3 above it; black foam ring d4.5 around D1; skin window d4.0 x 0.8  
M1 (LRA) on flying leads, foam-mounted at (-18.5, 0.0) under the screw bosses (boss bottom z=1.0); CSV position is overridden by the mechanical design  
bottom side tallest part <= 1.4 mm; Q1 coil pad below; J1 pogo grid must stay reachable before the core is closed (not from the battery bay)  
antenna no copper x > 15.0 except the ANT1 feed; no metal fasteners at +X (screws are at x=-17.6)

SHEET 5 - SQUEEZE PATH: dome carrier (x2, FR4 0.8) and captive plunger (x2, SLA)

Grip across Y -> skin 1.5 + PET film -> plunger slides in the d9.6 window -> 0.15 preload gap -> dome snaps -> SQZ low. Flange keeps the plunger captive.

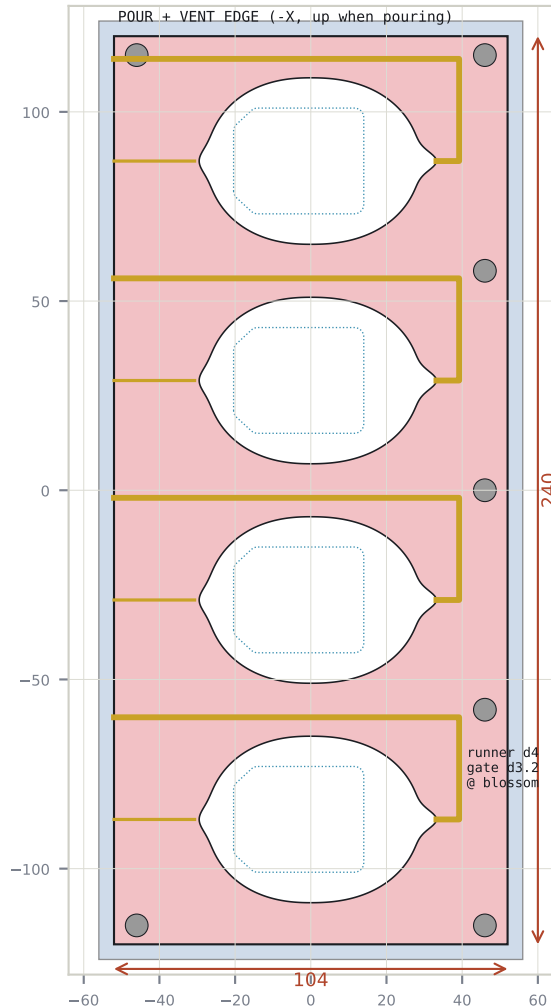


|         |                                                                                                                                                                                                                                                              |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SPEC    |                                                                                                                                                                                                                                                              |
| carrier | FR4 0.8 mm, 2-layer ENIG, corner R3; Snaptron pad set: ring OD12.8/ID11.0 = GND, centre d3.9 = SQZ; 3 castellations (GND/SQZ/GND) 2.5 wide at x = -4/0/+4 order as a panel of 20 with V-score; hand-solder to the main PCB edge in a 90 deg jig (station S2) |
| dome    | Snaptron F12450N (12.0 mm, 450 gf, 0.76 high); fixed with Snaptron dome tape (or d15 3M 850 disc)                                                                                                                                                            |
| plunger | SLA Tough 2000, printed 60 per plate; drops into the window from inside before the halves close; flange stops it at the wall; travel 0.15 + dome 0.35                                                                                                        |
| seal    | d14 x 0.05 3M 850 PET disc over each window, on the core outside: keeps PU out of the core and lets the plunger move                                                                                                                                         |
| trip    | grip force ~12-20 N across the width (skin + film compliance ~5 N on top of the 4.4 N dome); firmware requires both domes within 60 ms                                                                                                                       |

# SHEET 6 - SILICONE MOULD SET: 4-cavity body mould (Mold Star 30) from printed masters, 8-cavity hatch-skin mould

Masters: SLA print (50 um), sand 600, seal with 2 coats clear acrylic + Inhibit X barrier coat (platinum cure inhibition). Stand the closed mould on its +X edge to pour.

BOTTOM HALF, parting face (4 cavities)

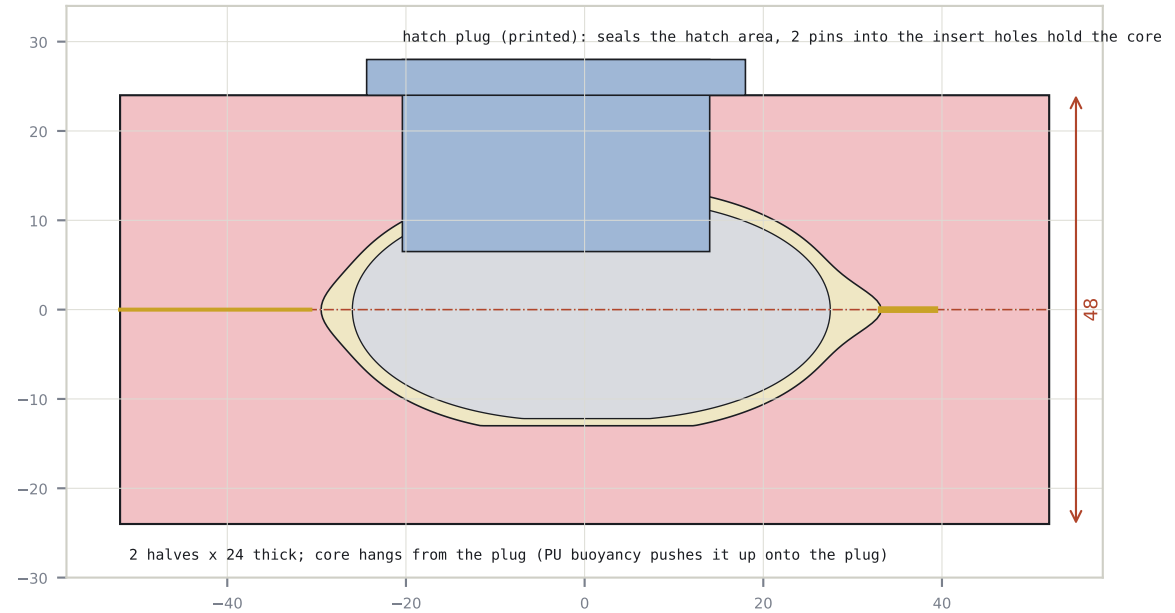


## MOULD FILES (print)

|                             |                                                      |
|-----------------------------|------------------------------------------------------|
| stl_master_lemon_skin.stl   | textured skin + leaf + gate/runner/vent + plug print |
| stl_mould_parting_board.stl | board with 4 equator cut-outs + registration keys    |
| stl_mould_box_frame.stl     | frame, 4 mm walls (pour half 1, flip, pour half 2)   |
| stl_mould_hatch_plugin.stl  | one per cavity (SLA, reusable, release each cycle)   |

MAKING THE MOULD: masters into the board to the equator, frame on, pour Mold Star 30 (vacuum 3 min), cure 6 h; flip, remove board, release coat, pour half 2, cure 6 h; cut plug holes clean; post-cure 4 h at 60 C.

SECTION through one cavity (y = cavity axis), mould closed



PROCESS PER BODY MOULD (4 cavities, Polytek PT Flex 70, 23 C, mould pre-warmed 35 C)

t=0 release (Ease Release 200) both halves, flash 5 min

t+6 4 closed cores on 4 hatch plugs, lower into the bottom half, close top half on keys (plugs pass through), 2 printed clamp plates + 4 M5 bolts, stand on the +X edge

t+10 weigh A+B 42 g (body skins + runners + 10 %), mix 45 s, vacuum 60 s

t+12:30 pour into the 4 runner mouths, 20-30 s each, until PU shows in every vent (pot life 4-5 min: max 2 moulds per mix)

t+14 into the 40 L pressure pot, 3.5 bar (50 psi), 35 C

t+2:00h demould (PT Flex 70: 2 h), cut runners/vents, inspect; post-cure 24 h rack

CYCLE ~2 h 20 min per mould -> 3 cycles / 8 h day

HATCH SKINS: open-face 8-cavity silicone mould, textured face down; pour 1.8 g per cavity, press the clear hatch plate in on 2 locating pins, 2 h. 1 mix = 2 moulds.

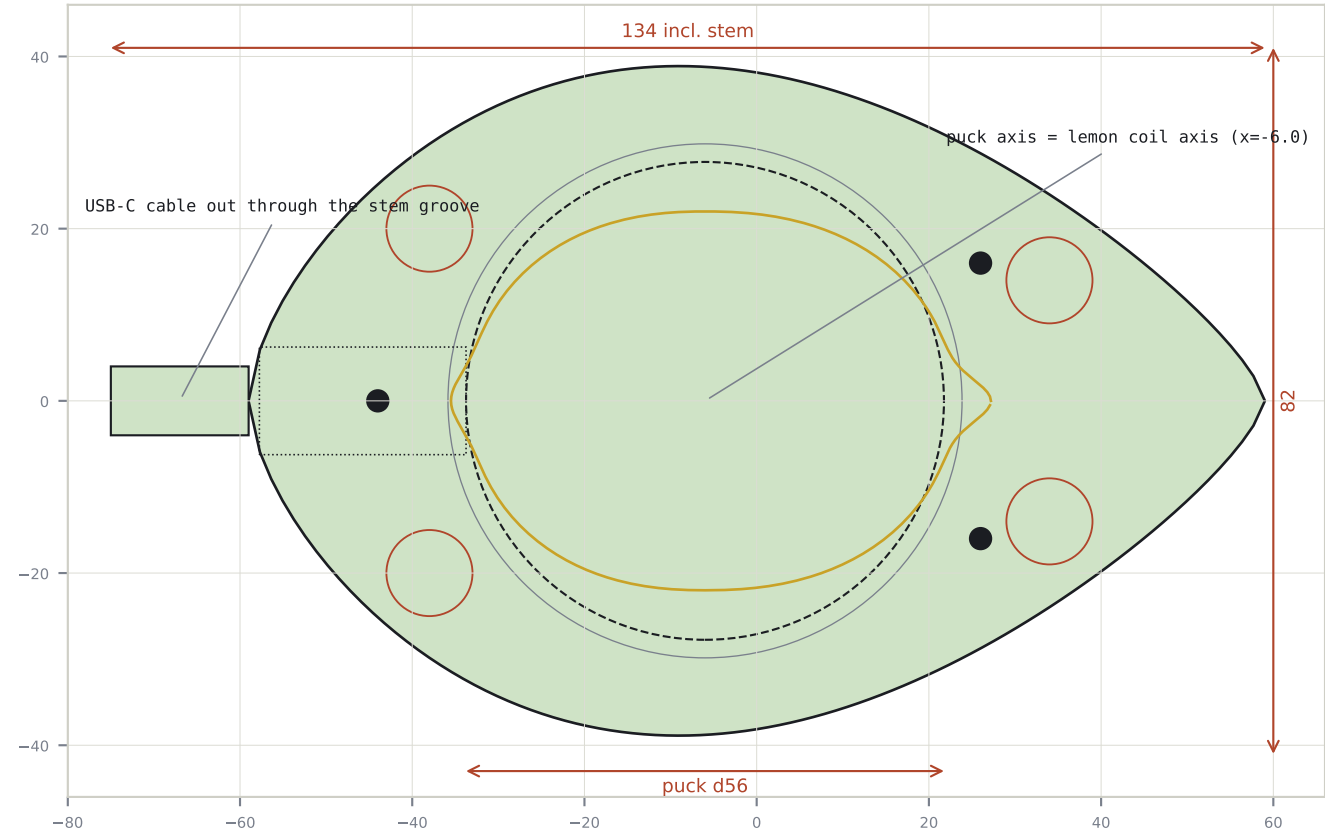
## CAPACITY FOR 525 (500 + 5 % scrap)

4 body moulds in rotation x 4 x 3 cycles = 48 skins / day, above the ~35 / day core-closing rate (station S4), so casting never waits; 8 moulds made (4 swap-in) mould life with PU ~40-60 pulls; 525/4 = 132 pulls -> ~17 per mould of 8 silicone ~1.1 kg per body mould (Mold Star 30 ~EUR 31/kg) = EUR 35 each; 8 = EUR 280 hatch skins: 4 x 8-cavity moulds (+1 spare) = 96 / day masters: 4 prints of stl\_master\_lemon\_skin.stl, reused for every mould

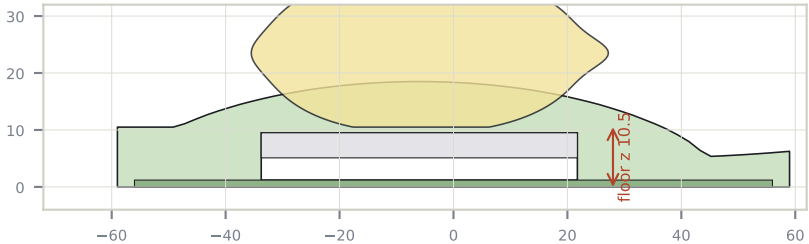
SHEET 7 - LEAF CRADLE: passive shell around an unmodified, CE/Qi-certified puck (no electronics of its own)

Puck d56 x 4.4-8 (parametric), USB-C at 180 deg. Lemon nests on its Qi flat, coil centred on the puck axis. build\_cradle.py

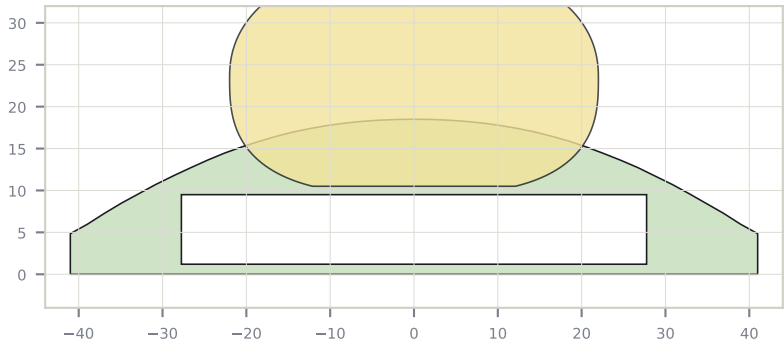
PLAN from +Z



LONG SECTION y=0



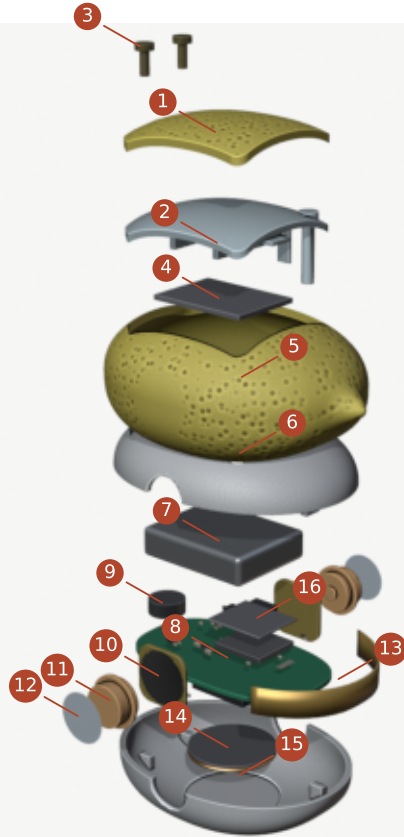
CROSS SECTION x = puck axis



|             |                                                                                                                                                                                          |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CRADLE SPEC |                                                                                                                                                                                          |
| leaf shell  | 134 x 78 x 16 (incl. stem); wall 2.2, hollow underside; midrib + 12 vein grooves 0.5 deep; nest = lemon outer + 0.6 clearance, depth 4.4 below the rim                                   |
| puck        | Samsung EP-P2900 (SOURCING.md) or any certified Qi (WPC) puck d56 +/-2 (edit PUCK D), 4.4-8 tall: 4 crush ribs centre it, a foam spacer on the cover presses it up against the 1.0 floor |
| coupling    | Rx coil bottom to puck top 3.0 mm (lemon 2.0 + cradle floor 1.0) + the puck's own cover; lateral play 0.6 mm; coil centred on the puck axis                                              |
| cable       | the puck's own USB-C cable: plug boot 12.5 x 7.0 x 24.0 lies in the underside channel, cable out through the stem groove (strain relief = groove bend)                                   |
| cover       | 1.2 plate, 3x M2x6 thread-forming screws (PT), 4 foot pockets d10.0 x 0.8 for 3M Bumpon feet                                                                                             |
| material    | prototypes: PETG FDM 0.2 (green); batch: SLA green or cast Smooth-Cast 300 + green pigment in a 2-part silicone mould (~EUR 0.75 material)                                               |
| compliance  | no electronics added and the puck is not opened: its CE/RED DoC and Qi certification stay valid; the cradle only needs GPSR (risk analysis, labels)                                      |
| open risk   | small Rx coil (d19) vs. an unmodified puck's ping/FOD thresholds: test 3 candidate pucks with the first lemons before choosing (MECHANICAL_REVB.md)                                      |

## SHEET 8 - EXPLODED ASSEMBLY (render\_exploded.png) and parts list

Item numbers are used by ASSEMBLY.md stations.



### PARTS LIST (one lemon)

- 1 Hatch skin, cast PU 70A
- 2 Hatch plate, clear resin (rod, hook, ribs)
- 3 2x screw M2x5 Torx T6 (ISO 14583)
- 4 Foam pad on the hatch press ribs
- 5 Body skin, cast PU 70A, with leaf relief
- 6 Core top half (SLA) + 2x ruthex M2x4 brass insert
- 7 Cell 602025 with PCM + JST GHR-02V plug
- 8 PCBA: nRF9151, J2, D1, U8, Qi RX ...
- 9 LRA VG0832012 (foam-mounted)
- 10 Dome carrier + Snaptron F12450N (x2)
- 11 Captive squeeze plunger (x2)
- 12 PET seal film d14 (x2)
- 13 FPC antenna on the +X tip wall
- 14 Qi Rx coil Wurth 760308101214
- 15 Core bottom half (SLA)
- 16 Foam pad under cell (on U1)

SHEET 9 - COMPONENT REFERENCE PHOTOS (goods-in check, station S0)

Distributor photos per SKU (rev A set). Rev B additions (U8 LIS2DW12, D1 APHHS1005SYCK, J2 JST GH, Q1 A03401A): see production/ELECTRONICS\_REVB.md.



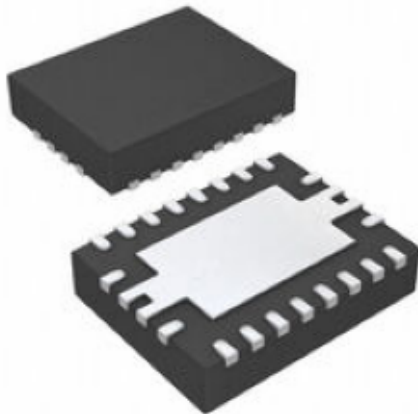
U1 nRF9151-LACA-R  
113-LFLGA 12.1x11.1mm



U2 Same Sky NSIM-2-C  
hinged nano-SIM socket



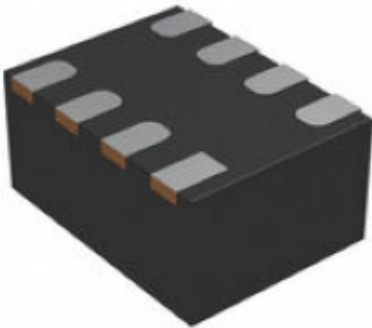
U3 DRV2605LDGSR  
VSSOP-10 3x3mm



U4 BQ51013BRHLR  
VQFN-20 4.5x3.5mm



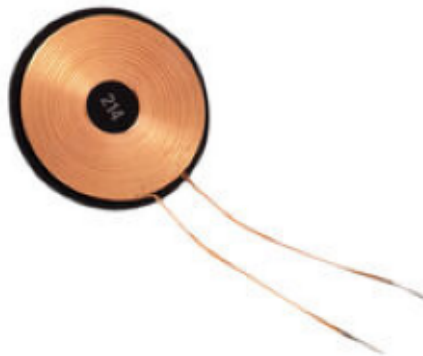
U5 MCP73831T-2ACI/OT  
SOT-23-5



U6 TPS62849DLCR  
WSON-8 2x1.5mm



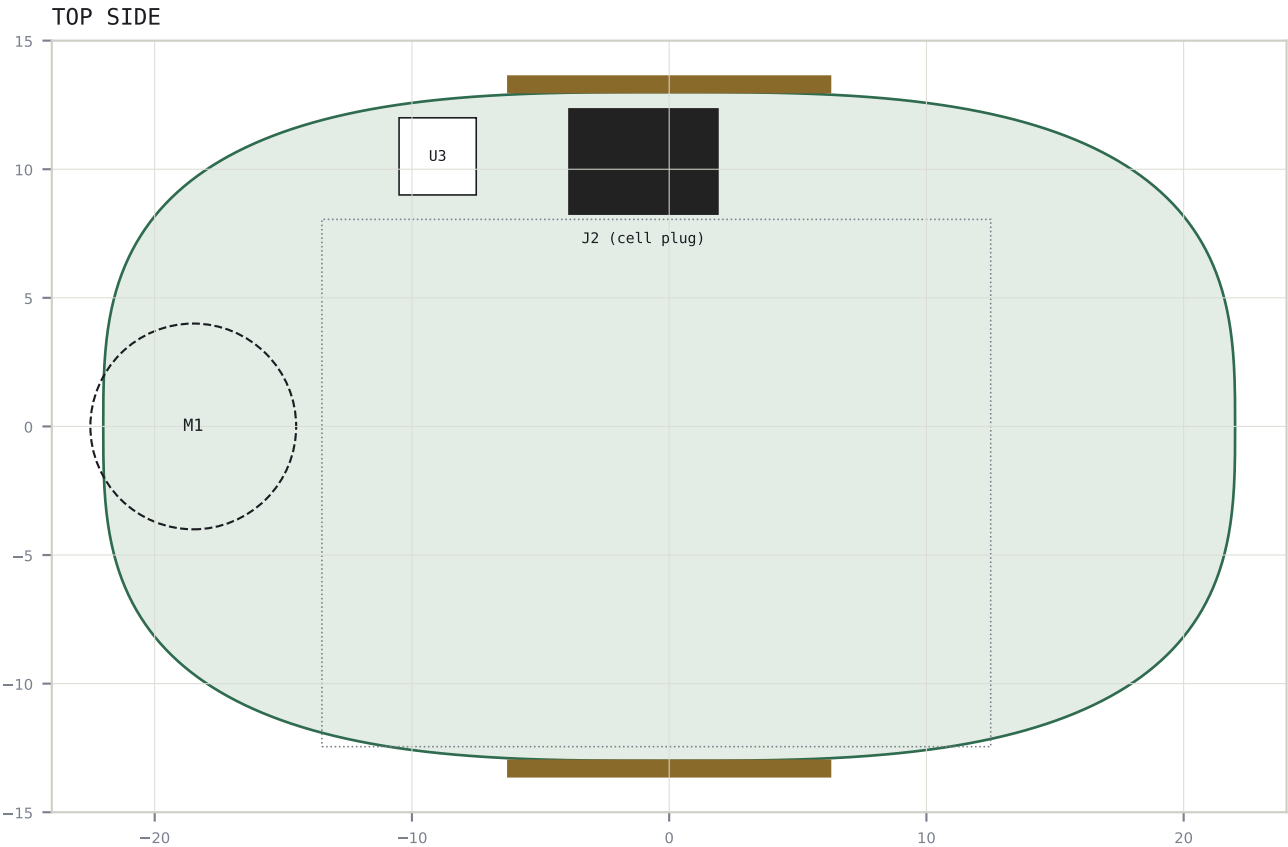
M1 Vybronic VG0832012  
d8x3.25mm LRA, 2 leads



L2 Wurth 760308101214  
d19mm Qi Rx coil, 2 leads

# SHEET 10 - HAND CONNECTIONS (everything not reflowed by the PCBA house)

Rev B: the cell is no longer soldered - it plugs into J2. Remaining hand work: dome carriers, LRA leads, Qi coil leads, SIM card.



## CONNECTIONS

| ref  | from              | to                   | note                             |
|------|-------------------|----------------------|----------------------------------|
| SWA  | carrier A pads    | PCB edge y=-13       | 3 castellations, 90 deg jig      |
| SWB  | carrier B pads    | PCB edge y=+13       | 3 castellations, 90 deg jig      |
| M1+  | LRA red lead      | LRA_P pad (U3.7 net) | twist, < 20 mm                   |
| M1-  | LRA blue lead     | LRA_N pad (U3.9 net) | foam-mount M1 at (-18.5, 0.0)    |
| L2.1 | coil lead         | QI COIL1 pad (C7A)   | twist, < 15 mm, AC               |
| L2.2 | coil lead         | AC2 pad (C8)         | coil face-down on pad            |
| SIM  | INCE card (4FF)   | U2 hinged socket     | before core close                |
| BT1  | cell plug GHR-02V | J2 (keyed, latching) | at FINAL assembly, after casting |

Pad positions for LRA P/N and the coil pads come from the routed layout (ROUTING.md); keep them within 6 mm of M1 / at the -X edge of the coil so leads stay short.

WHY: EN 18031 (no exposed debug) + Battery Regulation Art. 11 (user-replaceable cell). The cell is inserted only after the skin is cast, so the casting can be pressure- and warm-cured (35-40 C) without a lithium cell in the mould, and cores can be scrapped without a battery hazard.