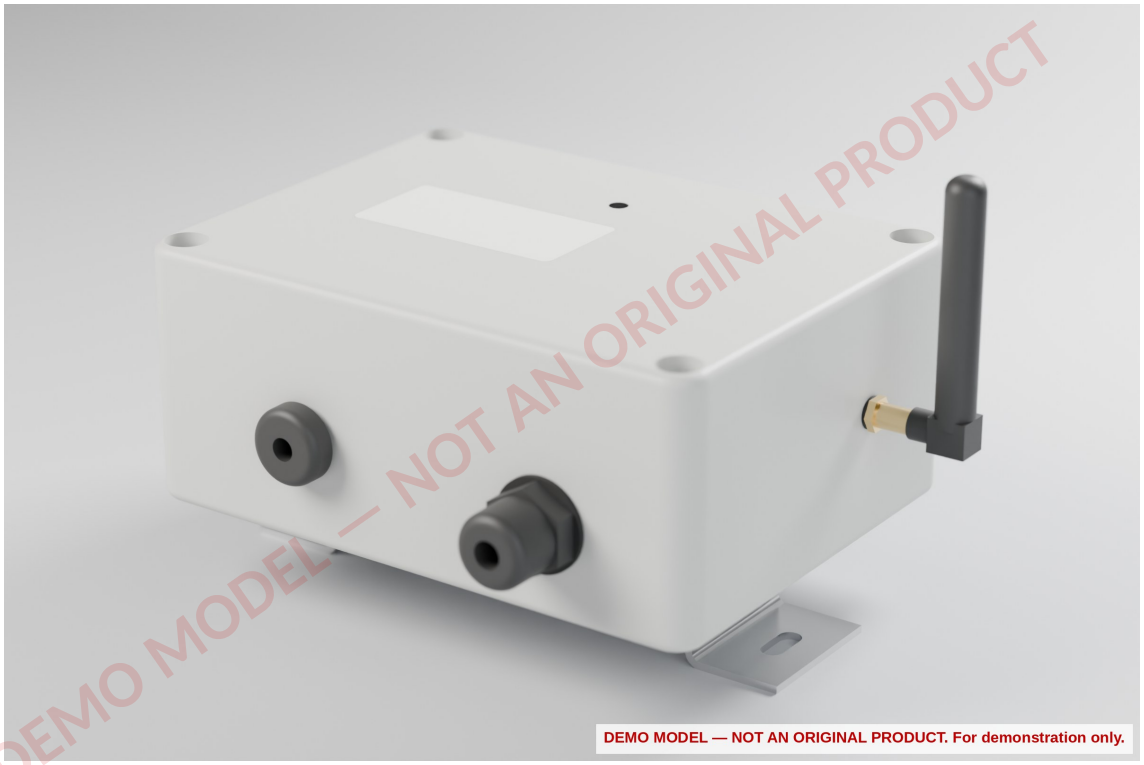
Assembly Instruction
ESB-1 Environmental Sensor Box
ESB-10000 rev A

DRAFT, NOT VERIFIED



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Document Revision History

Rev	Description of Changes	Updated by	Approved by	Date
A	First issue, made from assembly drawing **ESB-10000 rev A**, its BOM and its 3D model. Fictional device, made for demonstration.	Engineering OS	—	8/11/26

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1. Introduction

Description

ESB-1 (**ESB-10000 rev A**) is a compact sealed environmental sensor box: a die-cast aluminium housing base (1, **ESB-10001**) and lid (2, **ESB-10002**) hold the main PCB with the LoRa radio (6, **ESB-30001**), a temperature, humidity and pressure sensor board (7, **ESB-30002**) and a battery pack (8, **ESB-20013**). This document gives the assembly steps, the parts and tools of each step, the leak test and the record that the assembler and QC fill in.

DEMONSTRATION DOCUMENT. ESB-1 is a fictional device, made to demonstrate Engineering OS. Sources: assembly drawing **ESB-10000 rev A** (2 sheets), its BOM and its 3D model. The figures are exploded views built from the 3D model; arrows, leader labels and tightening order were added by Engineering OS; item numbers follow the parts list of the drawing. Torques and test values are the design values of the drawing notes. No engineering review of this document has taken place.

Blue arrows show the direction of installation. Each figure also shows the parts installed in the earlier steps, in their final positions; parts behind a wall are dashed. **Red** marks torques and tightening order. **Dark blue bold** marks part numbers (P/N) and drawing revisions (rev).

Key Facts

- Sealed IP65 box, 160 × 120 × 70 mm, about 1.15 kg (estimate from the 3D model); 47 parts, 29 items in the parts list.
- Electronics: main PCB (6, **ESB-30001**) on 4 standoffs (20), sensor board (7, **ESB-30002**) on 2 standoffs (21), battery pack 2 × 18650 (8, **ESB-20013**) under a plate (9, **ESB-10005**).
- Torques from the notes of drawing **ESB-10000 rev A**, sheet 2; tolerance ±10 %. The lid screws are tightened in 2 passes in the criss-cross order 1–2–3–4.
- Threadlocker only on the bracket screws M5×10 (28); no threadlocker on any other joint.
- **Leak test before the membrane vent (10) is fitted: 30 kPa, pressure drop max. 0.5 kPa in 60 s.**
- **Open questions for the designer: Q1 (step 9, nut 12) and Q2 (step 8, cable gland during the test).**

Source: drawing **ESB-10000 rev A**, BOM ESB-10000_BOM.xlsx and the 3D model ESB-10000_ESB-1_assembly.step. Quantities match the parts list of the drawing.

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Overview

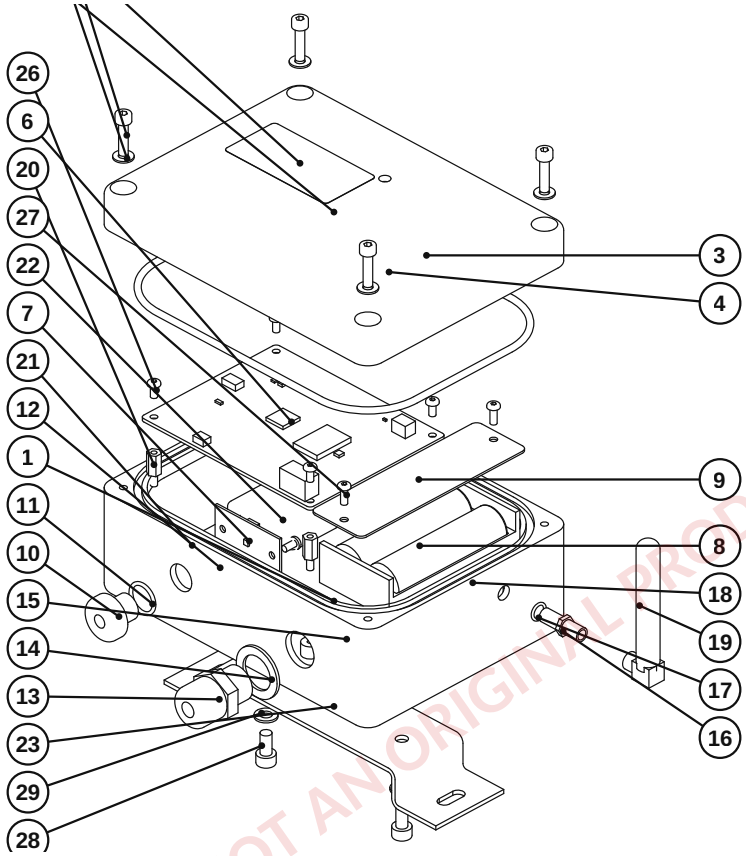


Figure 1-A: ESB-1 – exploded overview with the item numbers of the parts list (3D model)

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Sealing Concept

The housing is sealed to IP65 at five places. The silicone cord gasket (3, **ESB-10003**), d3.0 in a 3.4 × 2.4 mm groove of the base flange, is squeezed by 20 % when the 4 screws M4×16 (24) pull the lid down. The cable gland (13, **ESB-20006**) seals with its sealing washer (14, **ESB-20008**), the SMA jack (16, **ESB-20009**) with its O-ring (17, **ESB-20010**) and the membrane vent (10, **ESB-20003**) with its O-ring (11, **ESB-20004**). The ePTFE membrane of the vent lets air through but not water, so temperature changes do not load the gasket; the desiccant bag (22, **ESB-20014**) takes up the moisture closed in at assembly. The leak test (step 8) checks all seals through the vent hole before the vent is fitted.

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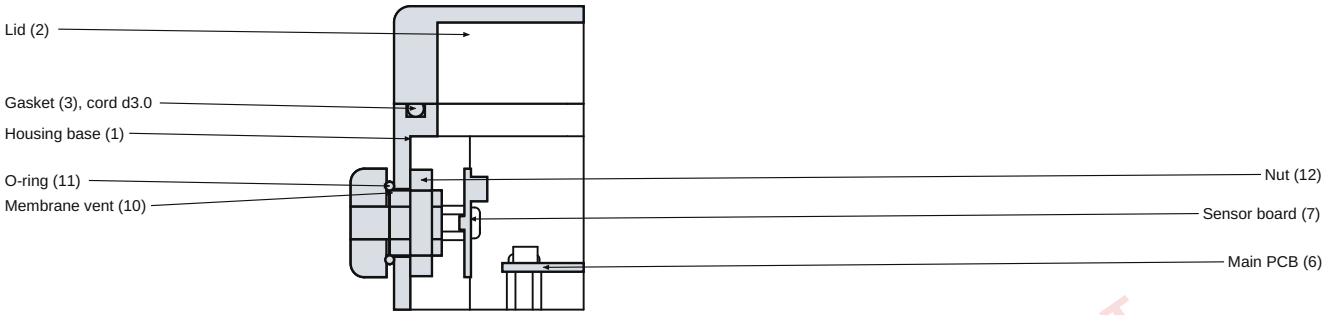


Figure 1-B: Section through the vent axis: gasket in its groove, membrane vent in the front wall (3D model)

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2. Parts List

Table 2-A: Parts list (from BOM ESB-10000, items as on drawing ESB-10000 rev A)

Item	P/N	Description	Material / specification	Qty	Step
1	ESB-10001	Housing base	EN AC-44300 die-cast Al, powder coat RAL 7035	1	1
2	ESB-10002	Lid	EN AC-44300 die-cast Al, powder coat RAL 7035	1	5, 7
3	ESB-10003	Lid gasket, cord d3.0	Silicone VMQ 50 Shore A, cut and bonded	1	6
4	ESB-10004	Light pipe d4.9	PC clear, UL94 V-2	1	5
5	ESB-10020	Rating label 60 x 30	Polyester 0.1, acrylic adhesive	1	9
6	ESB-30001	Main PCB assembly	FR-4 1.6, see sheet E-BOM	1	1
7	ESB-30002	Sensor board assembly (T/RH/p)	FR-4 1.2, see sheet E-BOM	1	2
8	ESB-20013	Battery pack 2 x 18650 in holder	Li-ion 3.6 V 1S2P, PCM	1	3
9	ESB-10005	Battery bracket plate	EN 1.4301 sheet 1.0	1	3
10	ESB-20003	Membrane vent M12x1.5	PA66 / ePTFE membrane, IP67	1	9
11	ESB-20004	O-ring 12 x 1.6 (vent)	FKM 75	1	9
12	ESB-20005	Hex nut M12x1.5 (vent)	PA66	1	9
13	ESB-20006	Cable gland M16x1.5, cable 4-8	PA66, IP68	1	4
14	ESB-20008	Sealing washer M16	NBR	1	4
15	ESB-20007	Lock nut M16x1.5	PA66	1	4
16	ESB-20009	SMA bulkhead jack, 50 ohm	Brass gold/nickel plated	1	4
17	ESB-20010	O-ring 6 x 1.2 (SMA)	FKM 75	1	4
18	ESB-20011	Hex nut 1/4-36 UNS (SMA)	Brass nickel plated	1	4
19	ESB-20012	Stub antenna 868 MHz, SMA, hinged	TPE whip	1	4
20	ESB-20001	Standoff M3 x 10 hex 5.5, male-female	Brass nickel plated	4	1
21	ESB-20002	Standoff M3 x 6 hex 5.5, male-female	Brass nickel plated	2	2
22	ESB-20014	Desiccant bag 5 g	Silica gel in Tyvek bag	1	6
23	ESB-10010	Wall bracket	EN 1.4404 sheet 2.0	1	10
24	ISO 4762 M4x16-A4-70	Socket head cap screw M4 x 16	Stainless A4-70	4	7
25	ISO 7089-4-200HV-A4	Plain washer 4	Stainless A4	4	7
26	ISO 7380-1 M3x6-A2-70	Button head screw M3 x 6	Stainless A2-70	6	1, 2
27	ISO 7380-1 M3x8-A2-70	Button head screw M3 x 8	Stainless A2-70	2	3
28	ISO 4762 M5x10-A4-70	Socket head cap screw M5 x 10	Stainless A4-70	2	10
29	ISO 7089-5-200HV-A4	Plain washer 5	Stainless A4	2	10

Every item of the parts list is installed in the step named in the last column. The electrical BOM of items 6 and 7 is the second sheet of ESB-10000_BOM.xlsx.

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3. Tools and Materials

Table 3-A: Tools and materials

Picture	Name	Use	Steps
	**Torque screwdriver 0.3–1.5 N·m**	Hex bits 2 and 3 mm, sockets 5.5 and 17 mm: 0.45 to 1.2 N·m	1, 2, 3, 4, 7, 9
	**Torque screwdriver 1–5 N·m**	Hex bit 4 mm, crowfoot 8 and 20 mm: 1.7 to 3.0 N·m	4, 8, 10
	**Hex keys 2, 3 and 4 mm**	Screws ISO 7380 M3 (26, 27), ISO 4762 M4 (24) and M5 (28) (sizes per the standards)	1, 2, 3, 7, 10
	**Open-end wrenches 8 and 20 mm**	Hold the SMA jack (16) and the cable gland (13) (sizes from the 3D model)	4
	**Threadlocker, medium strength**	Only on the bracket screws M5×10 (28)	10
	**Adhesive for the light pipe**	Not given on the drawing: the process engineer specifies it	5
	**ESD wrist strap**	Handling the main PCB (6) and the sensor board (7)	1, 2, 6
	**Leak tester with M12 test adapter**	Pressure decay test at 30 kPa (IP65)	8
	**Isopropyl alcohol, lint-free wipes**	Degrease the lid top before the label	9

Hex key sizes come from ISO 4762 and ISO 7380; wrench sizes from the 3D model. The torque tools cover the torques of the drawing notes.

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Fasteners at Actual Size (1:1)

Print at 100 % scale. Put the part on the picture to check it. Sizes are nominal per ISO 4762, ISO 7380, ISO 7089 and the parts list.

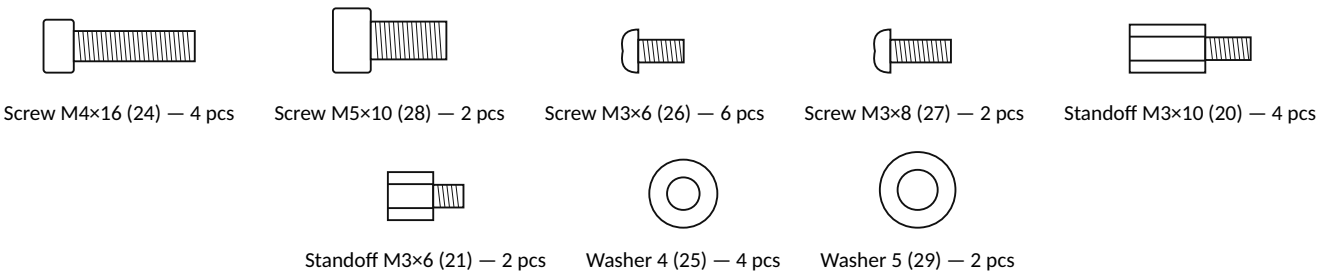


Figure 3-A: Fasteners at actual size (print at 100 %)

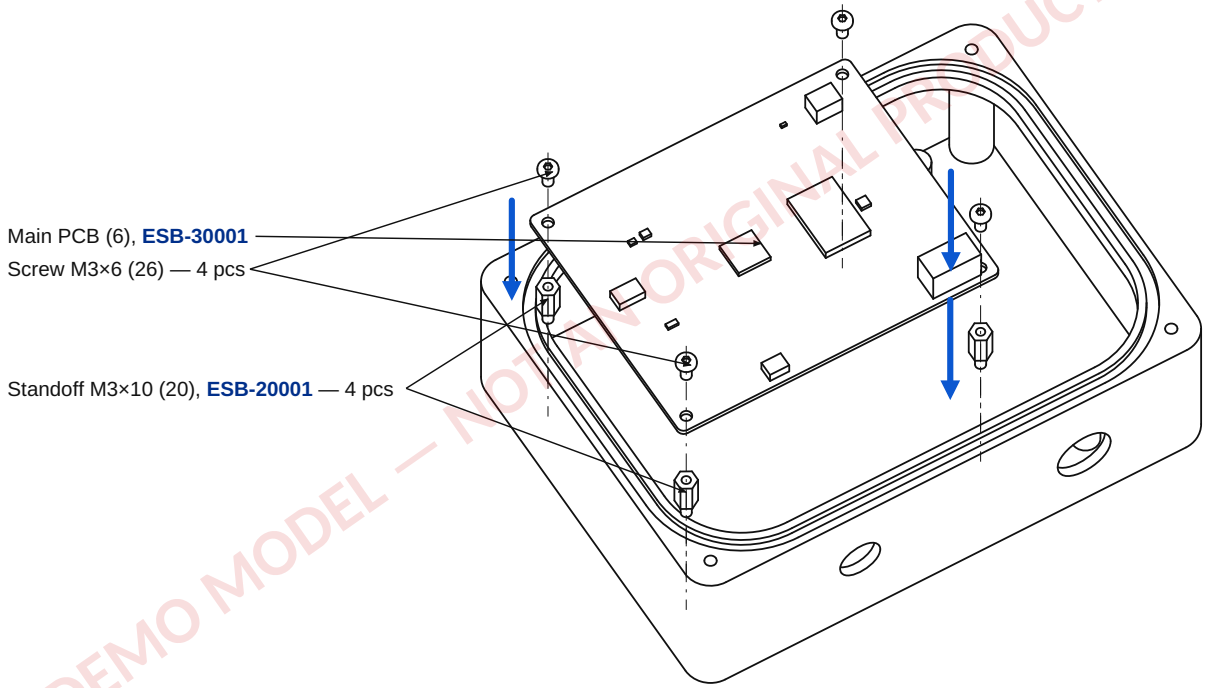
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4. Assembly Procedure

Step 1 – Standoffs (20) and main PCB (6)

a) Wear a grounded ESD wrist strap. Turn the 4 standoffs M3×10 (20, **ESB-20001**) into the 4 floor bosses of the housing base (1, **ESB-10001**) and tighten them with a 5.5 mm socket: 0.5 N·m.
b) Hold the main PCB (6, **ESB-30001**) by its edges. Put it on the standoffs, with the terminal block J3 toward the front wall (cable gland hole).
c) Attach the PCB with 4 screws ISO 7380 M3×6 (26) and a 2 mm hex key. Tighten them crosswise: 0.5 N·m.

CAUTION
The main PCB is sensitive to static electricity. Put on and ground the wrist strap before you open the package.



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Standoffs (20): 0.5 N·m
Screws (26): 0.5 N·m

Tools:
5.5 mm socket
2 mm hex key
ESD wrist strap

Figure 4-A: Step 1: Standoffs (20) and main PCB (6)

Table 4-A: Parts of step 1

Item	P/N	Name	Qty
20	ESB-20001	Standoff M3 x 10 hex 5.5, male-female	4
6	ESB-30001	Main PCB assembly	1
26	ISO 7380-1 M3x6-A2-70	Button head screw M3 x 6	4

Drawing **ESB-10000 rev A**, sheet 2, notes 1, 4 and 6; items 6, 20, 26

Step 1 done	Assembler name	Employee no.	Signature	Date
Step no. 1				

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Step 2 – Sensor board (7)

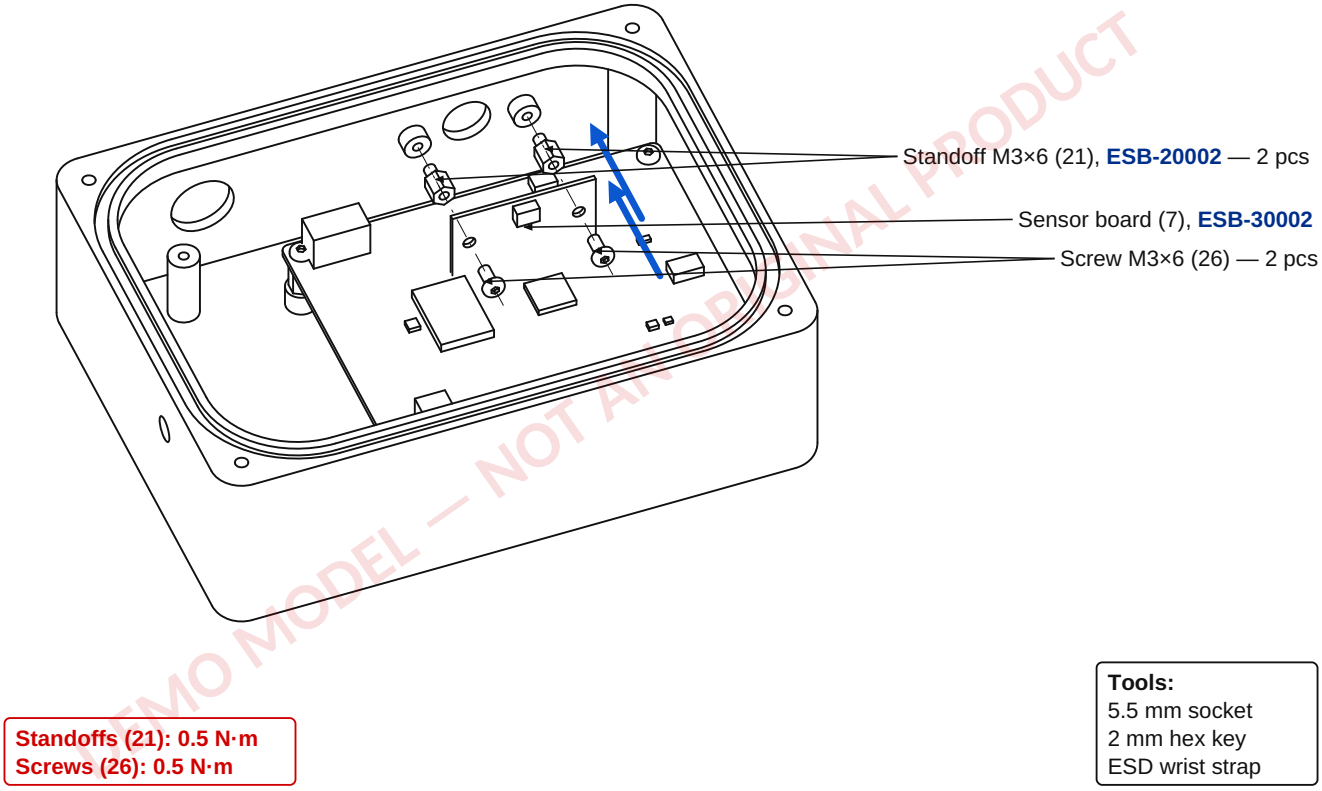
a) Keep the wrist strap on. Turn the 2 standoffs M3×6 (21, **ESB-20002**) into the 2 bosses on the inside of the front wall, beside the vent hole: 0.5 N·m.

b) Hold the sensor board (7, **ESB-30002**) by its edges. Put it on the standoffs, with the sensor toward the vent hole.

c) Attach it with 2 screws ISO 7380 M3×6 (26): 0.5 N·m.

CAUTION

The sensor board is sensitive to static electricity. Keep the wrist strap on. Do not touch the sensor opening.



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Figure 4-B: Step 2: Sensor board (7)

Table 4-B: Parts of step 2

Item	P/N	Name	Qty
21	ESB-20002	Standoff M3 x 6 hex 5.5, male-female	2
7	ESB-30002	Sensor board assembly (T/RH/p)	1
26	ISO 7380-1 M3x6-A2-70	Button head screw M3 x 6	2

Drawing **ESB-10000 rev A**, sheet 2, notes 1, 4 and 6; items 7, 21, 26

Step 2 done	Assembler name	Employee no.	Signature	Date
Step no. 2				

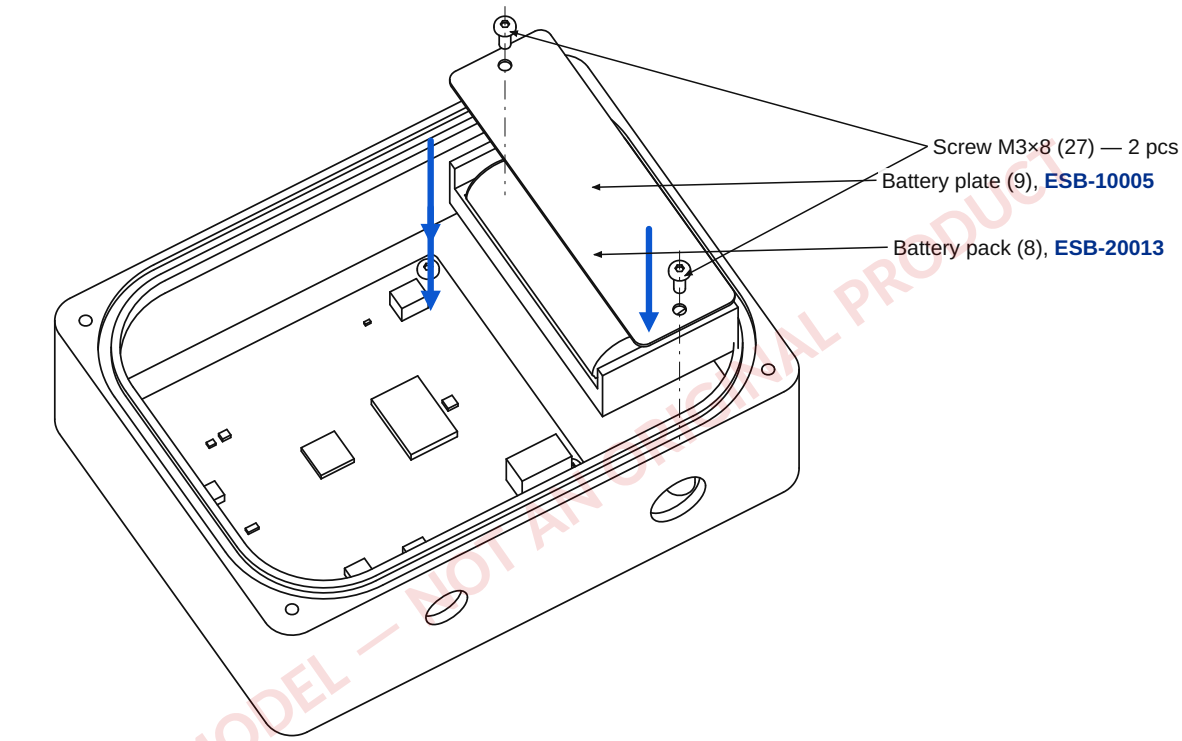
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Step 3 – Battery pack (8)

a) Put the battery pack (8, **ESB-20013**) on the floor of the right half of the housing, between the 2 battery bosses.

b) Put the battery plate (9, **ESB-10005**) over the pack. Attach it with 2 screws ISO 7380 M3×8 (27) on the bosses: 0.5 N·m.

c) Do not connect the battery lead yet: it goes to J1 of the main PCB in step 6, as the last connection.



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Figure 4-C: Step 3: Battery pack (8)

Table 4-C: Parts of step 3

Item	P/N	Name	Qty
8	ESB-20013	Battery pack 2 x 18650 in holder	1
9	ESB-10005	Battery bracket plate	1
27	ISO 7380-1 M3x8-A2-70	Button head screw M3 x 8	2

Drawing **ESB-10000 rev A**, sheet 2, note 7; items 8, 9, 27

Step 3 done	Assembler name	Employee no.	Signature	Date
Step no. 3				

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Step 4 – Cable gland (13) and SMA jack (16)

a) Put the sealing washer (14, **ESB-20008**) on the thread of the cable gland (13, **ESB-20006**). Put the gland into the M16 hole of the front wall from outside.
b) From inside, turn on the lock nut (15, **ESB-20007**). Hold the gland with a 20 mm wrench and tighten the lock nut: 3.0 N·m. The dome nut is tightened after the cable is fitted: 2.5 N·m.
c) Put the O-ring (17, **ESB-20010**) on the SMA jack (16, **ESB-20009**). Put the jack into the hole of the right wall from outside. From inside, turn on the nut (18, **ESB-20011**) and tighten it: 1.7 N·m.
d) Turn the antenna (19, **ESB-20012**) onto the SMA jack by hand: 0.45 N·m, hand tight.

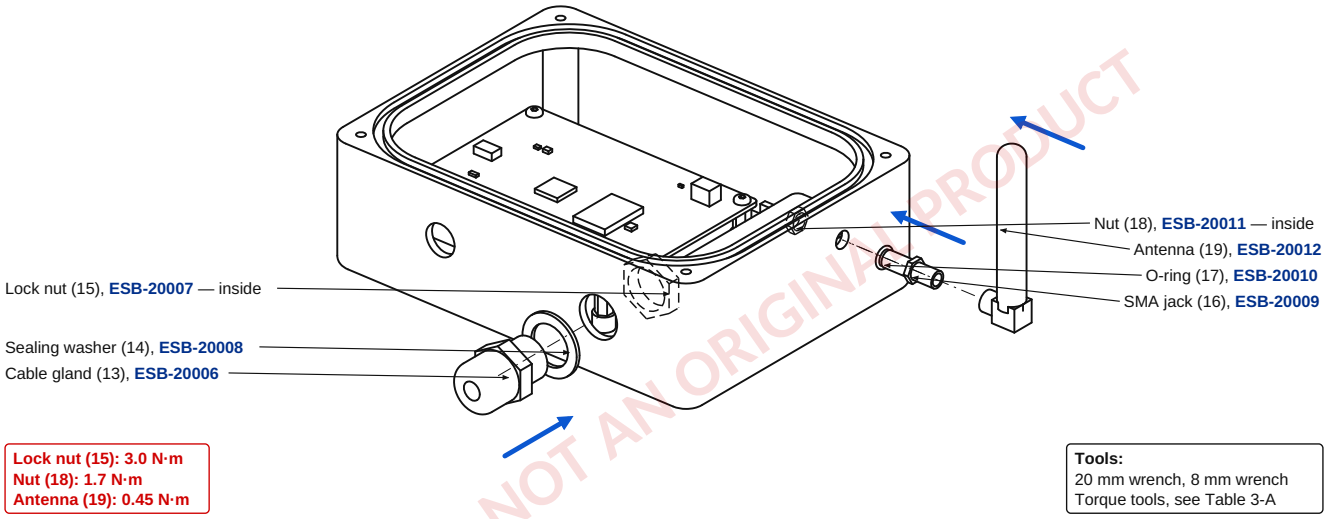


Figure 4-D: Step 4: Cable gland (13) and SMA jack (16)

Table 4-D: Parts of step 4

Item	P/N	Name	Qty
13	ESB-20006	Cable gland M16x1.5, cable 4-8	1
14	ESB-20008	Sealing washer M16	1
15	ESB-20007	Lock nut M16x1.5	1
16	ESB-20009	SMA bulkhead jack, 50 ohm	1
17	ESB-20010	O-ring 6 x 1.2 (SMA)	1
18	ESB-20011	Hex nut 1/4-36 UNS (SMA)	1
19	ESB-20012	Stub antenna 868 MHz, SMA, hinged	1

Drawing **ESB-10000 rev A**, sheet 2, notes 2 and 3; items 13 to 19

Step 4 done	Assembler name	Employee no.	Signature	Date
Step no. 4				

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Step 5 – Light pipe (4) in the lid

a) Lay the lid (2, **ESB-10002**) upside down on a clean, soft pad.

b) Put the light pipe (4, **ESB-10004**) into the hole of the lid from inside, until its collar touches the lid.

c) Bond it from inside. Keep the adhesive off the gasket face. Let the adhesive cure before step 7.

Note: the drawing does not name the adhesive; the process engineer specifies it.

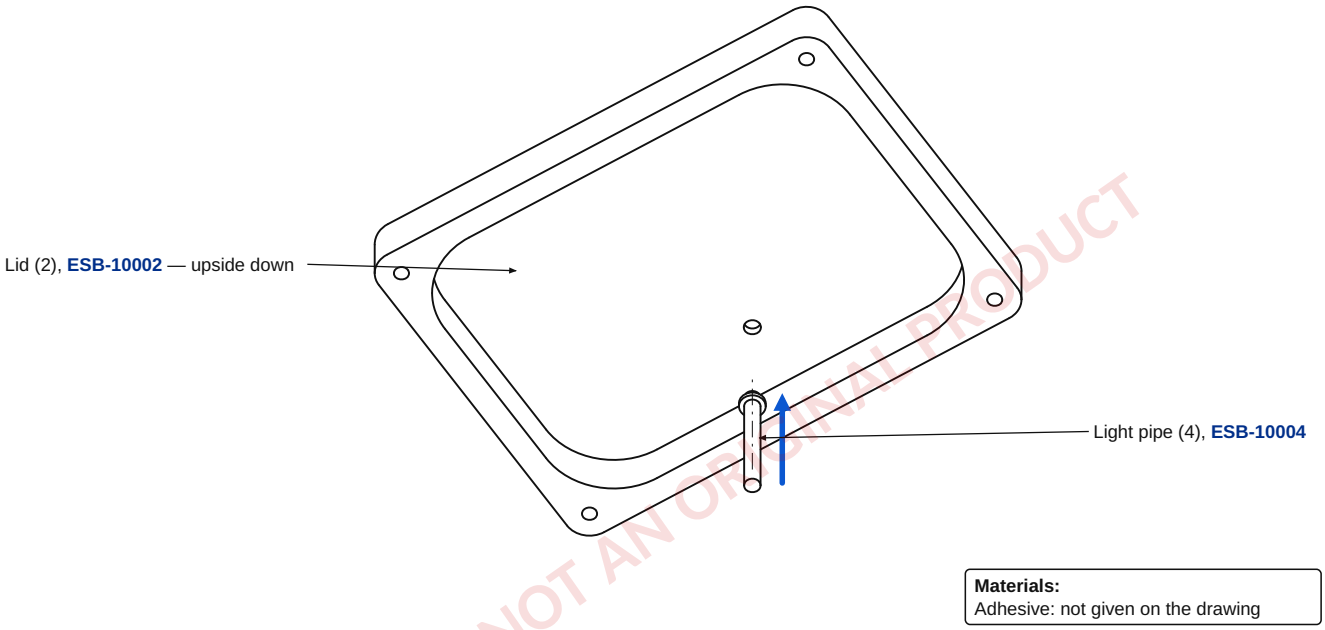


Figure 4-E: Step 5: Light pipe (4) in the lid

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Table 4-E: Parts of step 5

Item	P/N	Name	Qty
2	ESB-10002	Lid	1
4	ESB-10004	Light pipe d4.9	1

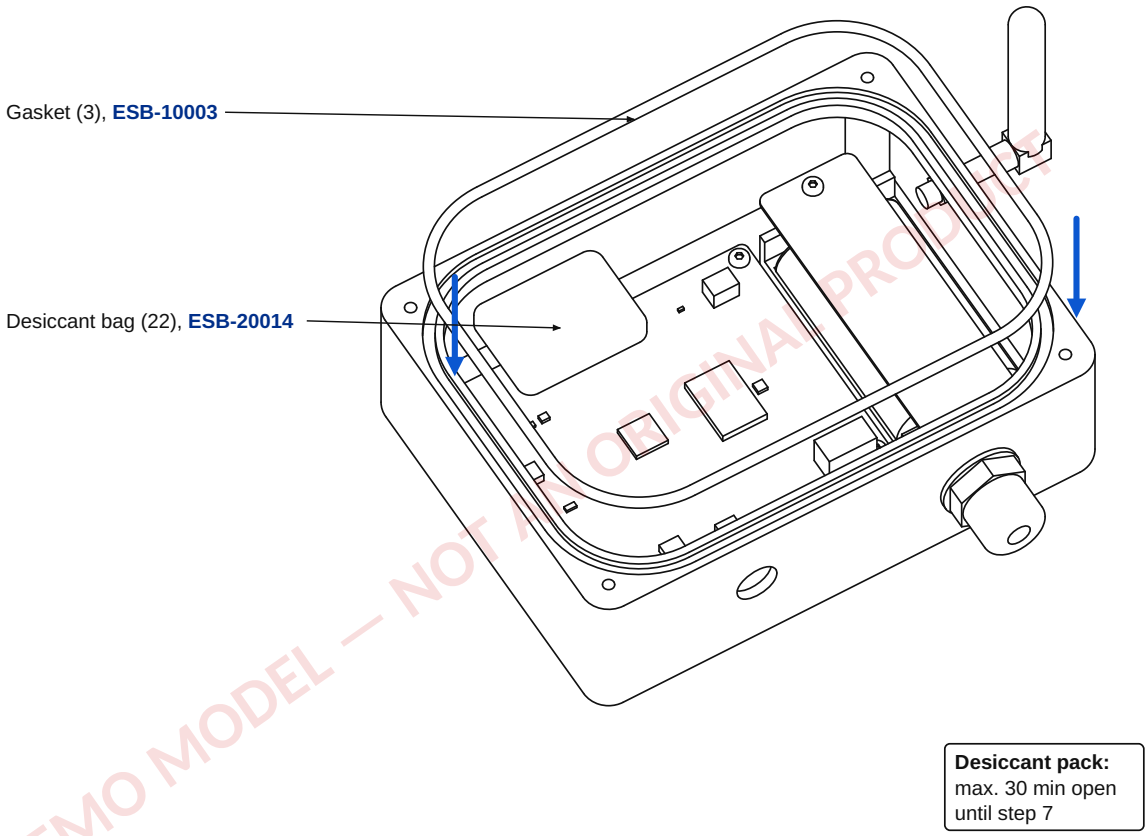
Drawing **ESB-10000 rev A**, sheet 2, note 9; items 2, 4

Step 5 done	Assembler name	Employee no.	Signature	Date
Step no. 5				

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Step 6 – Desiccant (22), battery lead and gasket (3)

a) Open the desiccant pack only now: the bag may be open for max. 30 min until the lid is closed in step 7. Slide the desiccant bag (22, **ESB-20014**) onto the floor under the main PCB, at the place shown.
b) Connect the battery lead of the battery pack (8) to J1 of the main PCB. This is the last electrical connection.
c) Check that the groove is clean and dry. Press the gasket (3, **ESB-10003**) into the groove without stretching it, with its butt joint on a long side.



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Figure 4-F: Step 6: Desiccant (22), battery lead and gasket (3)

Table 4-F: Parts of step 6

Item	P/N	Name	Qty
22	ESB-20014	Desiccant bag 5 g	1
3	ESB-10003	Lid gasket, cord d3.0	1

Drawing **ESB-10000 rev A**, sheet 2, notes 5, 7 and 8; items 3, 22

Step 6 done	Assembler name	Employee no.	Signature	Date
Step no. 6				

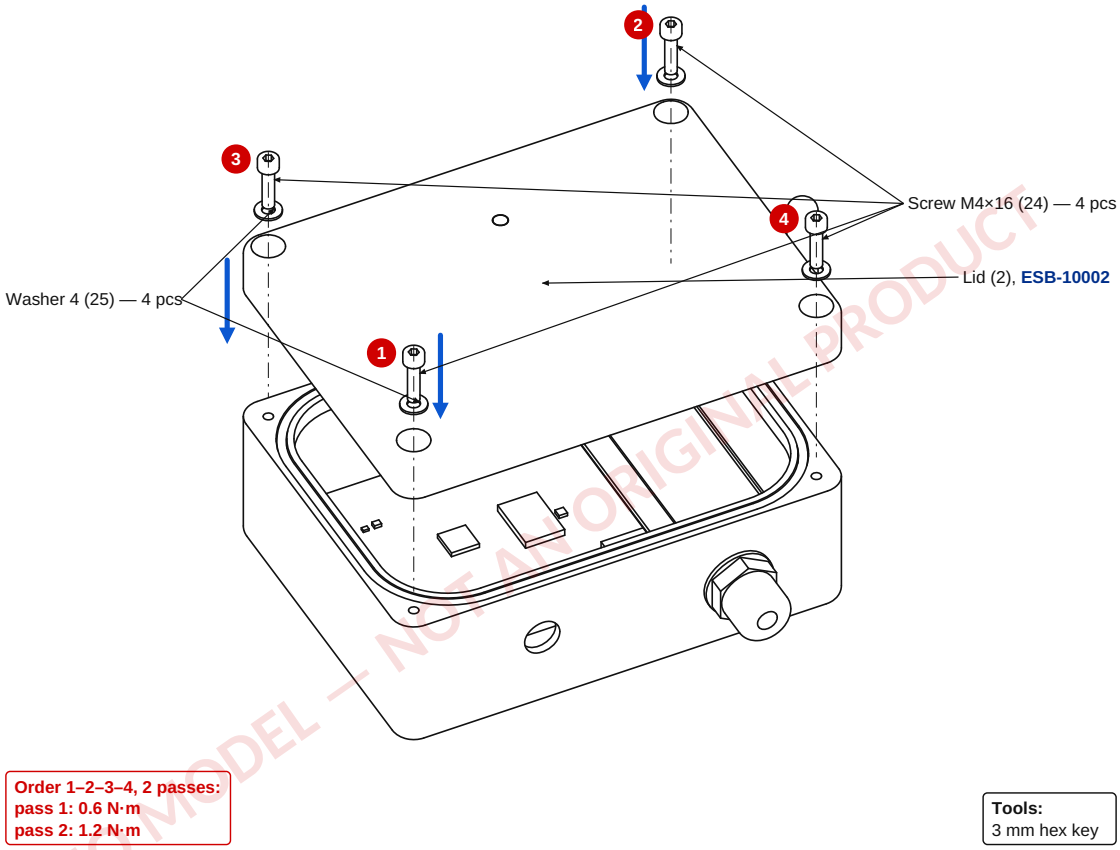
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Step 7 – Lid (2) in criss-cross order

a) Put the lid (2) with the light pipe on the housing base. Do not move the gasket.

b) Put a washer (25, ISO 7089-4) on each screw ISO 4762 M4×16 (24). Turn the 4 screws in by hand.

c) Tighten them with a 3 mm hex key in the criss-cross order 1–2–3–4 (red numbers in the figure), in two passes: pass 1: 0.6 N·m; pass 2, same order: 1.2 N·m.



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Figure 4-G: Step 7: Lid (2) in criss-cross order

Table 4-G: Parts of step 7

Item	P/N	Name	Qty
2	ESB-10002	Lid	1
24	ISO 4762 M4x16-A4-70	Socket head cap screw M4 x 16	4
25	ISO 7089-4-200HV-A4	Plain washer 4	4

Drawing **ESB-10000 rev A**, sheet 2, note 10 and the lid screw order; items 2, 24, 25

Step 7 done	Assembler name	Employee no.	Signature	Date
Step no. 7				

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Step 8 – Leak test

a) The vent hole stays open: the membrane vent is fitted in step 9, after a passed test.

b) Close the cable gland (13) for the test (see Q2 below).

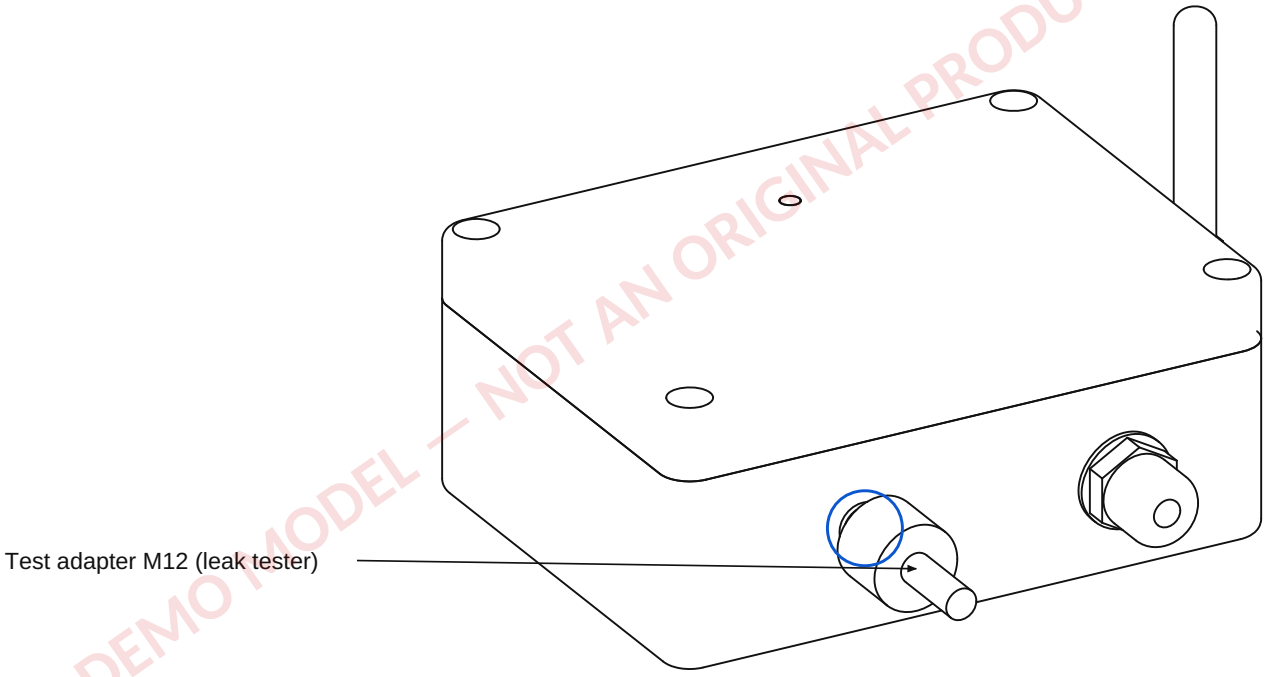
c) Put the M12 test adapter of the leak tester into the vent hole.

d) Apply air at 30 kPa. Let it stabilise for 10 s, then measure the pressure decay over 60 s.

e) Passed: pressure drop max. 0.5 kPa. Write the result with the unit serial number into Table 5-A. Failed: stop, mark the unit and report it.

NOTICE

Open question Q2: the drawing does not say how the cable gland is closed during the leak test. Until the designer answers, close it with the cable or a test plug and tighten the dome nut to 2.5 N·m.



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Test: 30 kPa, stabilise 10 s, measure 60 s: drop max. 0.5 kPa

Tools:
Leak tester, M12 adapter

Figure 4-H: Step 8: Leak test

Drawing **ESB-10000 rev A**, sheet 2, note 12

Step 8 done	Assembler name	Employee no.	Signature	Date
Step no. 8				

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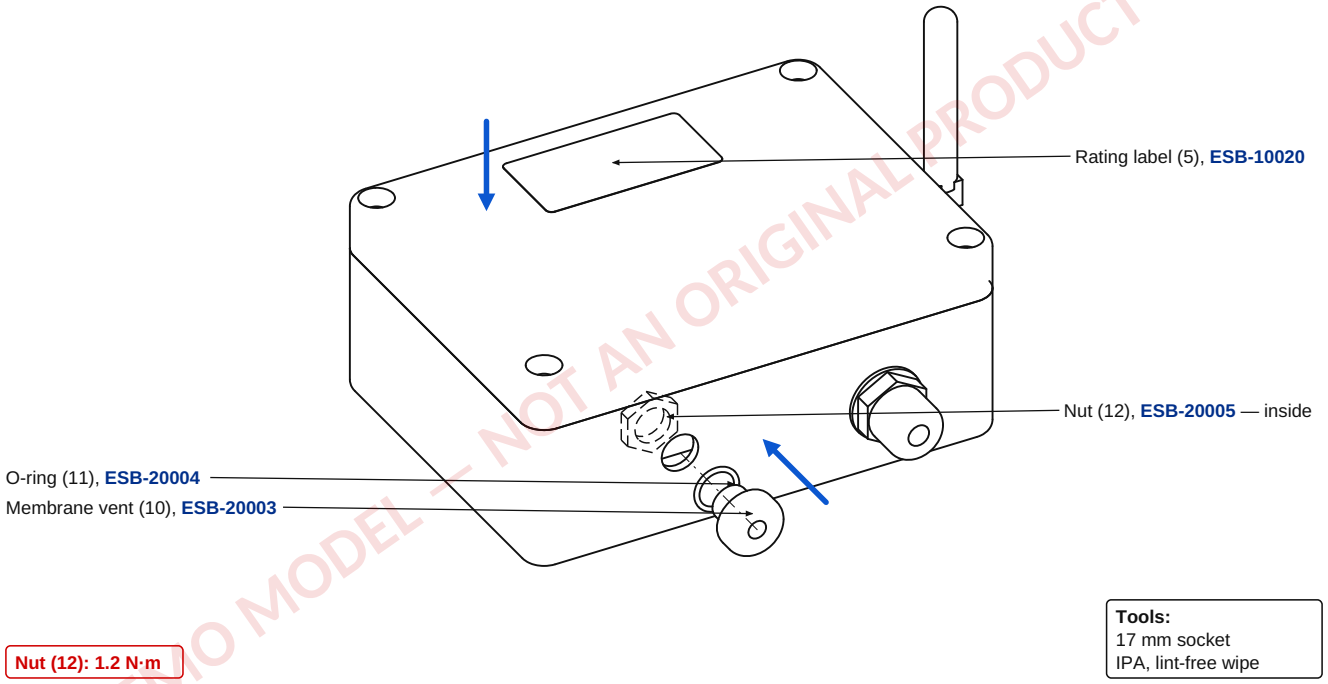
Step 9 – Membrane vent (10) and rating label (5)

a) Take off the test adapter. Put the O-ring (11, **ESB-20004**) on the membrane vent (10, **ESB-20003**). Put the vent into the vent hole from outside.

b) From inside, turn on the nut (12, **ESB-20005**) and tighten it with a 17 mm socket: 1.2 N·m (see Q1 below).

c) Degrease the lid top with isopropyl alcohol and let it dry. Put the rating label (5, **ESB-10020**) on the lid at the place shown. Press it flat, without bubbles.

NOTICE
Open question Q1: drawing note 13 puts nut 12 inside the housing, behind the sensor board (7), after the leak test, when the lid is closed. Do not open the lid after a passed test before the designer answers.



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Figure 4-I: Step 9: Membrane vent (10) and rating label (5)

Table 4-H: Parts of step 9

Item	P/N	Name	Qty
10	**ESB-20003**	Membrane vent M12x1.5	1
11	**ESB-20004**	O-ring 12 x 1.6 (vent)	1
12	**ESB-20005**	Hex nut M12x1.5 (vent)	1
5	**ESB-10020**	Rating label 60 x 30	1

Drawing **ESB-10000 rev A**, sheet 2, notes 9 and 13; items 5, 10, 11, 12

Step 9 done	Assembler name	Employee no.	Signature	Date
Step no. 9				

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Step 10 – Wall bracket (23)

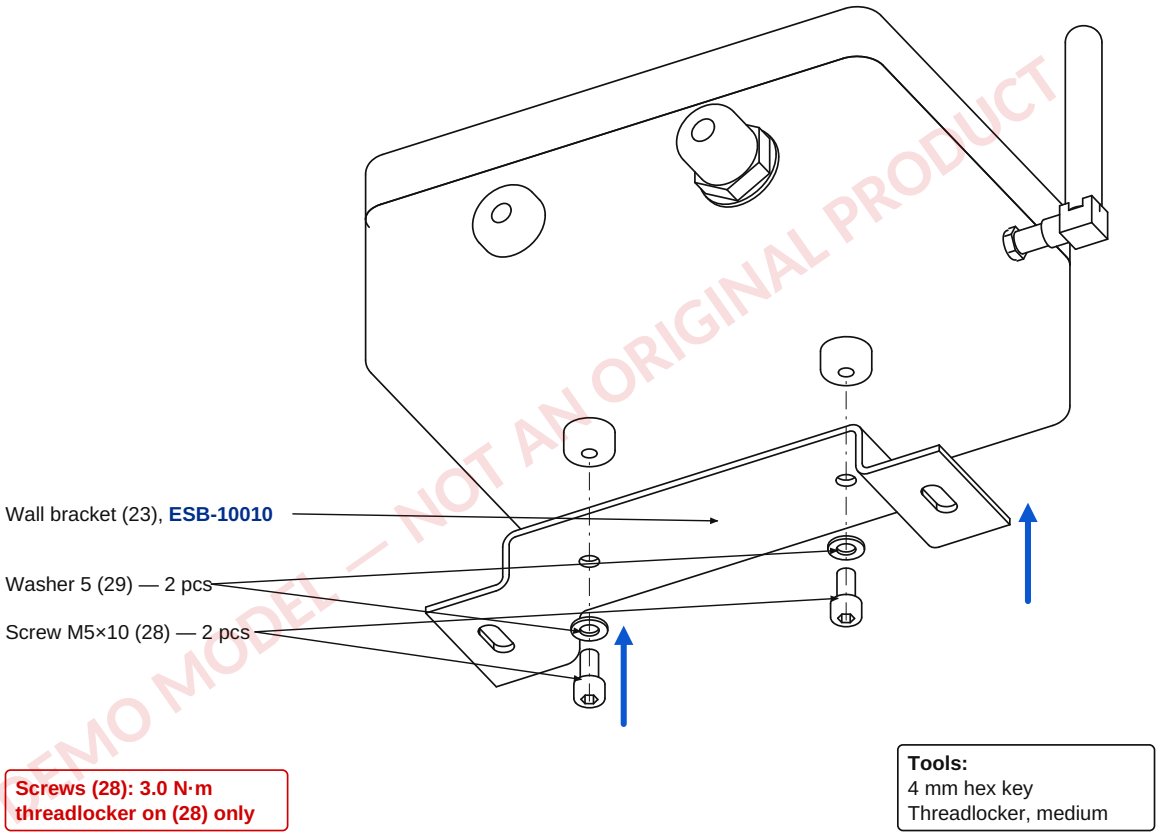
a) Turn the unit over onto a soft pad.

b) Put the wall bracket (23, **ESB-10010**) on the 2 bosses under the floor.

c) Apply medium-strength threadlocker to the 2 screws ISO 4762 M5×10 (28), only to these screws. Put a washer (29, ISO 7089-5) on each screw. Tighten them with a 4 mm hex key: 3.0 N·m.

CAUTION

Threadlocker irritates the eyes and the skin. Wear gloves and safety glasses.



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Figure 4-J: Step 10: Wall bracket (23)

Table 4-I: Parts of step 10

Item	P/N	Name	Qty
23	ESB-10010	Wall bracket	1
28	ISO 4762 M5x10-A4-70	Socket head cap screw M5 x 10	2
29	ISO 7089-5-200HV-A4	Plain washer 5	2

Drawing **ESB-10000 rev A**, sheet 2, note 11; items 23, 28, 29

Step 10 done	Assembler name	Employee no.	Signature	Date
Step no. 10				

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5. Final Inspection and Assembly Record

(Print this chapter for every assembled unit)

Assembled item (P/N): ESB-10000 rev A Unit serial number: _____

Work order: _____ Supervisor's name: _____

Remarks/comments: _____

Table 5-A: Final inspection and leak test – results

Action	Expected Outcome	Result	Notes
Leak test of step 8: 30 kPa, 10 s stabilisation, 60 s measurement	Pressure drop max. 0.5 kPa; measured: _____ kPa		
Check the joints of steps 1 to 10	Every joint tightened to the torque of its step		
Membrane vent (10), O-ring (11), nut (12)	Fitted after the passed leak test; nut at 1.2 N·m		
Look at the joint of lid and base all round	The gasket (3) is not pinched or visible		
Light pipe (4) and rating label (5)	Light pipe firm; label flat and legible		
Antenna (19) and cable gland (13)	Antenna hand tight; gland and its lock nut firm		
Wall bracket (23)	Firm; threadlocker on the screws (28) only		
Shake the unit	Nothing rattles: no loose parts		
RESULT:	☑ PASSED / ☒ FAILED		
Date: _____	Tested By: _____	Signature: _____	

The inspection items are a proposal of the author. The process engineer or QC must approve them.

Table 5-B: Assembly record – steps

Step no.	Operation	Assembler				QC		
		Name	Employee no.	Signature	Date	Name	Signature	Date
1	Standoffs (20) and main PCB (6)							
2	Sensor board (7)							
3	Battery pack (8)							
4	Cable gland (13) and SMA jack (16)							
5	Light pipe (4) in the lid							
6	Desiccant (22), battery lead and gasket (3)							
7	Lid (2) in criss-cross order							
8	Leak test							
9	Membrane vent (10) and rating label (5)							
10	Wall bracket (23)							

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	Final	Final inspection (Table 5-A)							

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6. Assembled Unit

These pictures are renders made from the 3D model (ESB-10000_ESB-1_assembly.step), not photographs of a real unit. Finishes follow the parts list: powder coat RAL 7035 light grey on the housing, stainless fasteners and bracket, black PA66 gland and vent, brass SMA jack. The colours of the gasket, the seals and the antenna are typical catalogue colours.

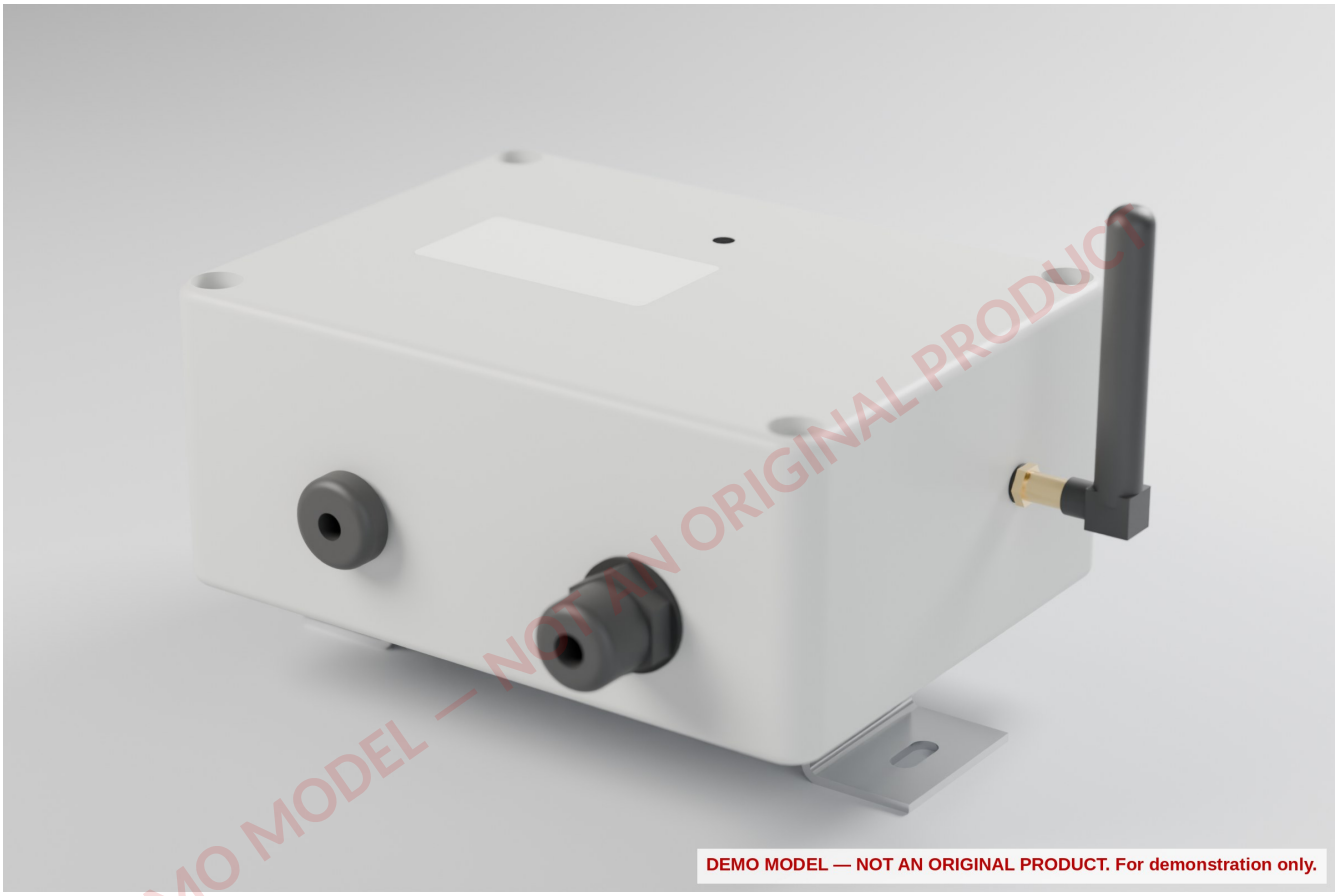


Figure 6-A: Assembled unit, front with the vent, the cable gland and the antenna (render from the 3D model)

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Figure 6-B: Mounting side with the wall bracket (render from the 3D model)

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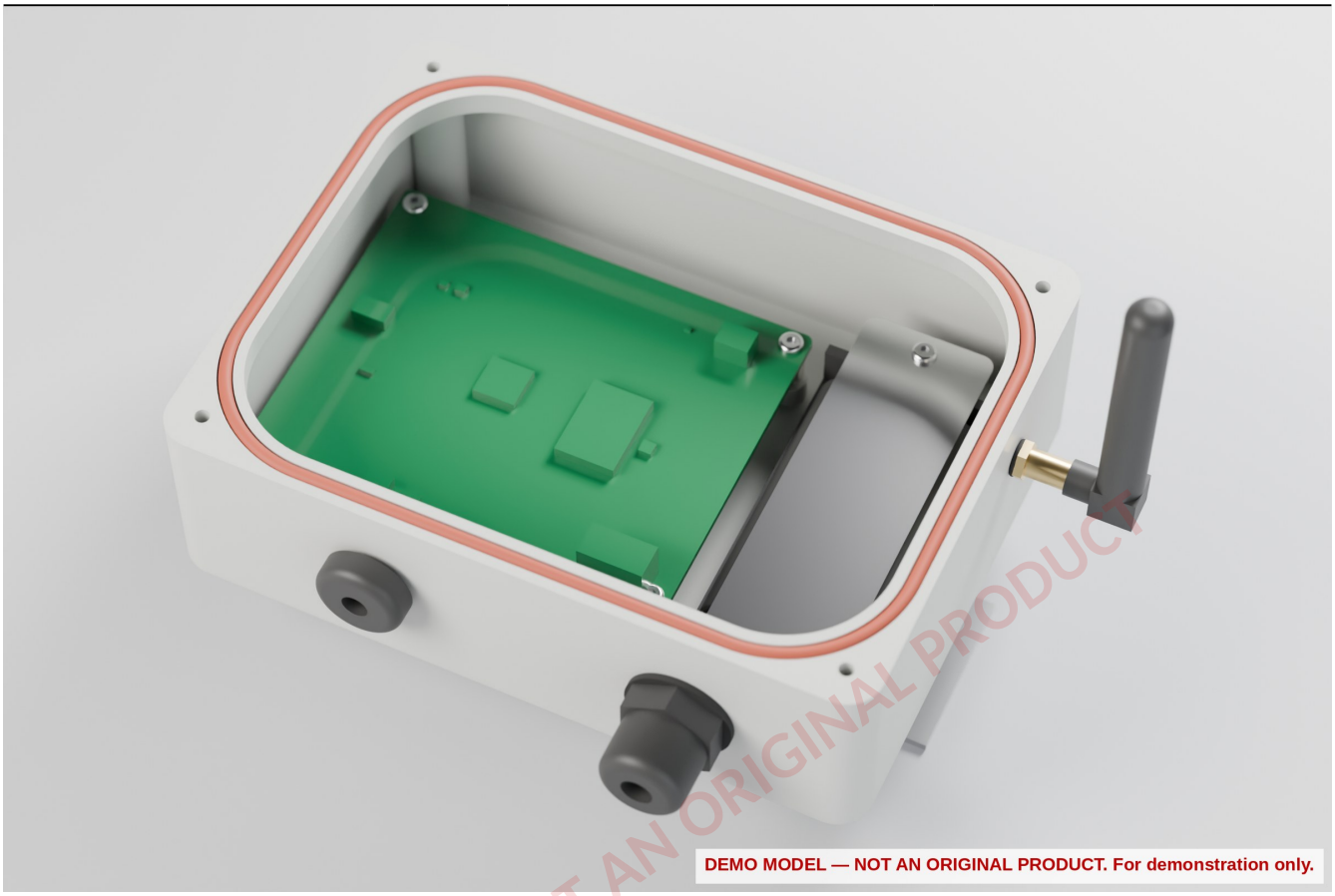


Figure 6-C: Interior with the lid off (render from the 3D model)

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