

Product definition and specification

Reference for defining a hardware product and writing the specification sheet that engineering and suppliers will quote against.

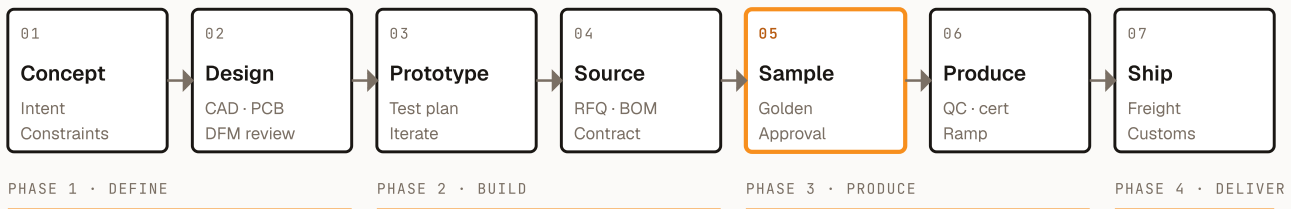
REVISION	ISSUED	OWNER	COMPANION
2.0	May 2026	Ideambox engineering	XLSX spec sheet template

ABSTRACT

Two adjacent deliverables: the **product definition** (intent, constraints, risk questions) and the **product specification sheet** (the technical attachment that goes with every RFQ, sample order, and supplier contract).

Section 1 captures intent. Section 2 captures engineering constraints. Section 3 surfaces risk questions. Section 4 covers the spec-sheet structure that the companion XLSX template (product-spec-sheet-template.xlsx) implements as fillable fields.

HARDWARE PRODUCT DEVELOPMENT – 7-STAGE PIPELINE



THIS DOCUMENT COVERS PHASE 1 (DEFINE) OF THE HARDWARE PRODUCT DEVELOPMENT PIPELINE.

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| 1. Product intent | 3. Risk questions |
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1. Product intent

Capture what the product is for and who it is for before any technical or commercial decisions are committed.

1 TARGET USER specific persona, not market segment	2 USE ENVIRONMENT drives sealing, materials, certifications	3 COMMERCIAL TARGET retail price, manufacturing cost, volume
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1.1 Target user and context

– Target user

Specific persona. "Field technician working outdoors in cold weather" is usable; "professional users" is not.

– Use environment

Indoor desk, outdoor wet, vehicle dashboard, harsh industrial floor. Map to IP rating + temperature range + drop spec.

– Frequency of use

Daily, occasional, emergency-only. Drives durability vs. reliability trade-off and warranty terms.

– Skill level

Technical user, prosumer, mass-market consumer. Drives interface complexity and instructions.

1.2 Commercial targets — pricing framework

Most consumer hardware sold through distribution follows a recognised retail markup multiplier. Pick the channel; the multiplier sets the cost ceiling.

CHANNEL	MULTIPLIER ON COGS	EXAMPLE
Direct-to-consumer (DTC)	2.0–2.5x	\$20 product → \$40–50 retail
Online marketplace (Amazon)	2.5–3x	\$20 COGS → \$50–60 retail (after fees)
Specialty retail	3–4x	\$20 COGS → \$60–80 retail
Mass retail (Target, Walmart)	4–5x	\$20 COGS → \$80–100 retail
Premium / luxury	5–10x	\$20 COGS → \$100–200 retail

COGS includes: BoM + assembly labor + tooling amortisation + freight + duties + QC + warranty reserve (5–10 % of COGS).

1.3 Function and scope

– Primary function

One sentence. "Measures soil moisture and reports it over LoRa once an hour."

– Secondary functions

Two or three that round it out. Mark each as "must" or "nice-to-have".

– Out of scope

What the product deliberately does

not

do. Saves more downstream time than any other line in the brief.

2. Engineering requirements

Define the lines the product must not cross. Each constraint is evaluated during prototyping and verified before tooling.

2.1 Mechanical

- Enclosure material + grade
- Wall thickness target
- Surface finish (SPI/VDI codes)
- Colour (Pantone + sample chip)
- Sealing (IP rating + gasket)
- Drop / impact spec (height + class)
- Mounting interface
- Service access (battery, board)

2.2 Electronics

- Power source + capacity
- Voltage rails (input + internal)
- Wireless module + bands
- Antenna type + position
- Display type + resolution
- Sensors + accuracy
- Connectors + mating cycles
- Firmware OTA / test mode

2.3 IP rating reference (IEC 60529)

The two-digit IP code: **IP[solids][liquids]**.

CODE	FIRST DIGIT (SOLIDS)	SECOND DIGIT (WATER)
0	No protection	No protection
1	>50 mm objects	Dripping water
2	>12.5 mm objects	Dripping at 15° tilt
3	>2.5 mm objects	Spraying water
4	>1.0 mm objects	Splashing water
5	Dust-protected	Water jets
6	Dust-tight	Powerful water jets
7	—	Immersion ≤ 1 m for 30 min
8	—	Continuous immersion (depth specified)
9K	—	High-temp/pressure jets

Common ratings:

- **IP54**
Indoor electronics, splash-resistant (handheld, smart-home, garden tools)
- **IP65**
Outdoor electronics, dust-tight + water jets (security cameras, fitness wearables)
- **IP67**
Submersion-resistant (some watches, ruggedised phones, sensors)
- **IP68**
Continuous immersion (dive computers, professional outdoor)
- **IP69K**
High-pressure cleaning (food service, industrial cleaning equipment)

2.4 Drop spec by product class

CLASS	DROP HEIGHT	SURFACE	REFERENCE
Tabletop	0.76 m (30")	Hardwood / vinyl	IEC 60068-2-32 (free fall)
Handheld consumer	1.0 m (40")	Concrete	IEC 60068-2-32
Outdoor consumer	1.2 m (48")	Concrete	MIL-STD-810H Method 516.8
Rugged / industrial	1.5 m (60")	Steel	MIL-STD-810H + IK rating
Mobile phone	1.0 m (40")	6 faces + 4 edges + 4 corners	Internal carriers ('phones)
Body-worn / sport	1.0–1.5 m (40–60")	Concrete	IEC 60068-2-31 (tumble) + drop

2.5 Compliance constraints

– Target markets

EU, US, UK, Japan, Australia. Each adds a stack of directives.

– Applicable directives

CE (LVD, EMC, RED, RoHS, REACH), FCC, CPSIA, UL, RCM, PSE, KC.

– Substance restrictions

RoHS list (10 substances), REACH SVHC (~240 substances, twice-yearly updates), Prop 65 (~900 chemicals).

– Label requirements

CE mark, FCC ID, country of origin, importer details (EU 2025), batch ID, WEEE bin, battery icon.

– Test plan

Pre-compliance during prototyping vs. only at the end. Pre-compliance is 5–10× cheaper.

WATCH OUT – SCOPE CREEP IS THE MOST EXPENSIVE KIND

Every "nice to have" added to the engineering requirements turns into a tolerance, a part on the BoM, or a certification line. Three common scope-creep failure modes: - **Adding wireless** — Triggers RED (EU) + FCC Part 15C (US). +\$10–30k lab + 4–8 weeks schedule + antenna design. - **Adding battery** — Triggers UN 38.3, IEC 62133, Battery Regulation (EU 2027). +\$3–8k lab + 2–4 weeks. - **Adding "premium feel"** — Drives PC+ABS vs. ABS, SPI A2 vs. B1, tighter tolerances. +20–40 % on tooling and unit cost. Cut features rather than relax constraints. Cost targets and certifications are external; feature lists are internal.

3. Risk questions

Risks are the questions whose answers determine whether the project ships. Capture them explicitly so the team can address them in priority order.

3.1 What the first prototype must prove

- **Most uncertain technical question**

Mechanical fit, sensor accuracy, wireless range, thermal behaviour, antenna performance. Pick one.

- **Most uncertain user-facing question**

Form factor, interaction, runtime, audible/visual feedback.

3.2 What could block the project

- **Single-source components**

Anything that cannot be dual-sourced is a schedule risk.

- **Tooling-heavy parts**

Decisions that cannot be changed cheaply after pilot production.

- **Certification**

Standards that could force a re-spin of mechanics, electronics, or firmware.

- **IP**

Patents or trademarks held by competitors. Run FTO before tooling.

3.3 What must be documented before tooling

- **Mechanical critical dimensions and tolerances.**

- **Stable electronics architecture and schematic.**

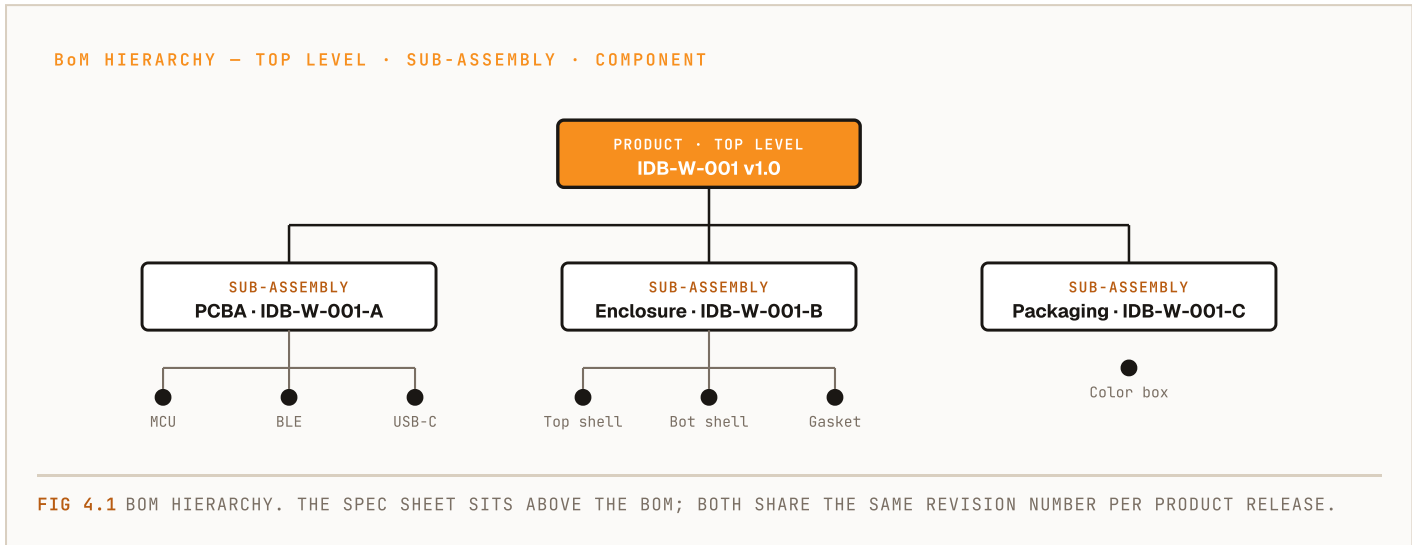
- **BoM with at least two viable suppliers per critical line item.**

- **Pre-compliance plan and a known certification body.**

- **Approved cosmetic standards (golden colour chips, surface finish samples).**

4. Specification sheet

The specification sheet is the file every supplier quotes against. The companion XLSX template implements the structure below as fillable fields.



4.1 Header block

FIELD	EXAMPLE
Product name	Soil Moisture Sensor (Garden)
Model / SKU	IDB-SMS-G-001
Revision	v1.0
Date issued	2026-05-28
Owner	One person (not a committee)
Target markets	US / EU / UK
Effective date	2026-06-15
Supersedes	v0.9 (2026-04-12)
Status	Pre-RFQ / Quoting / Sampling / Production

4.2 Mechanical specification (template)

`` Overall dimensions: 120 × 80 × 18 mm (L × W × H) Tolerance: ±0.3 mm general (ISO 2768-m) ±0.05 mm critical mating surfaces (ISO 2768-f) Weight target: 75 ± 5 g Enclosure material: PC + ABS 10% glass-filled, UV-stable Surface finish: SPI A2 (matte) Colour: Pantone 287 C (deep blue) Coatings: UV-cured pad print, logo white Sealing: IP65, silicone O-ring + ultrasonic weld Mounting: M3 inserts × 2, threaded brass Service access: Battery hatch with captive screw Drop spec: 1.2 m onto concrete, 6 faces ``

4.3 Electronic specification (template)

`` Power source: Li-Po 3.7 V 1200 mAh (UN 38.3 cert) Voltage rails: 5 V (USB) / 3.3 V (MCU) / 1.8 V (sensor) Sleep current: <10 µA (firmware-verified) Active current: 45 mA typical, 80 mA peak (Tx) Battery life: 12 months @ 1 reading/hour Wireless: BLE 5.2, Nordic nRF52840 (pre-cert) Antenna: PCB trace, 2.4 GHz, +1 dBi Sensors: Capacitive moisture sensor, ±2 % FSR Soil temp NTC, ±0.5 °C 0–40 °C Connectors: USB-C (4-pin, no data) Firmware: v1.0, OTA via BLE, manufacturing test mode ``

4.4 Bill of materials (per line, ref companion XLSX)

- **Every line item**

Part number, manufacturer, qty, target cost.

- **Sourcing flag**

Factory-sourced (default) or customer-supplied (CKD).

- **Critical-component flag**

Single-source or long-lead items.

- **Alternates**

Where dual-sourcing is acceptable, list second-source MPN.

- **Revision tracking**

Component-level revisions when needed.

4.5 Packaging specification (template)

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`` Primary packaging: Color box, 130 × 90 × 30 mm Matte litho print, 350 gsm SBS Magnetic-close flap, foam tray insert Inner packaging: Recyclable molded pulp tray Master carton: 48 units/carton, 540 × 320 × 200 mm Double-wall corrugated, BC flute Pallet config: 24 cartons/pallet (3 × 8) Pallet 1200 × 800 mm (Euro pallet) Pallet weight: ~85 kg ISPM 15 stamp: Required (HT-treated wood) ``
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4.6 Standards + labels (template)

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`` Standards applied: US: FCC Part 15B/15C, CPSIA, Prop 65, FDA (food-safe) EU: LVD 2014/35/EU, EMC 2014/30/EU, RED 2014/53/EU RoHS, REACH, Battery Regulation UK: UKCA equivalent to above Substance: RoHS 2.0 compliant, REACH SVHC <0.1%w Required labels: CE, FCC ID, UKCA, country of origin Importer details (EU 2025) WEEE bin, battery icon Tracking label: Mfr, location, date code, batch ID Format: YYWW-XXXX (year-week-sequence) ``
```

4.7 Files attached

3D CAD	model.step (v1.0), Native: SolidWorks .sldprt (v1.0)
Drawings	drawings.pdf (v1.0) — critical dimensions, tolerances, finish callouts
BoM	bom.xlsx (v1.0) — all line items with sourcing fields
Schematic	schematic.pdf (v1.0) — full electrical
Layout	gerber-rev1.zip — Gerbers, drill files, IPC-2581
Firmware	firmware-v1.0.hex — production-tagged binary, MD5 in repo
Artwork	logo.svg, silkscreen.svg, packaging-die.svg
Production photos	golden-sample-photos.zip (high-res, calibrated)

4.8 Sign-off block

- **Both parties sign the same revision of the spec sheet.**

- **Authorised signatory**

One name per party. Title, email, phone.

- **Effective date**

When supplier commits to building to this revision.

- **Supersede process**

Spec is invalid for revisions beyond listed version unless re-signed.

FINAL NOTE. A spec sheet is a contract attachment, not a sales document. Write it as if a stranger had to build the product from it. Every dimension, every material grade, every label position must be unambiguous and verifiable.