

Kestrel R1 – Technical Specification

Two-Body Wearable Warehouse Scanner

Program kickoff spec · Kestrel program · Hardware & manufacturing engineering Revision A · September 28, 2026 · All figures are program-kickoff engineering targets unless a cited standard is named

How to read this document

This is a **buildable target spec**, not a finished datasheet. Every number below is one of two kinds, and the document is explicit about which:

- **Standards-bound facts** (IP ratings, MIL-STD-810H drop, symbologies, radio versions, temperature limits). These reference real, checkable standards and real component classes. They are true to the standard cited or they are a defect.
- **Design targets** (masses, dimensions, runtime, scan counts). These are the numbers the program commits to hit and holds the design accountable to. They descend from a real component class and a real power budget, shown in the runtime math in §4. They are engineering targets for a device not yet built, and they are labeled *target*.

The reference set the device is measured against — and the numbers are calibrated against their published specs — is the **Zebra RS5100 / RS6100**, the **Honeywell 8670**, and the **ProGlove MARK 3**. Where our target beats or trails theirs, §11 says so plainly.

1. Architecture summary

A **two-body worn scanner** connected by an over-molded flex bridge:

Body	Location	Carries	Target mass
Scan module	Index finger (saddle + loop)	Imager, aimer, illumination, scan window, primary trigger, status LED, tap haptic	≤ 22 g
Wrist pack	Back of hand → wrist cuff	Main board, SoC, radio, hot-swap battery, second trigger, piezo, strong LRA haptic, LED bar	≤ 78 g (incl. battery)
Flex bridge	Over the index metacarpal	Power + data, 4-conductor over-molded flex	~ 4 g

Body	Location	Carries	Target mass
Mount / strap	Back of hand + wrist	Soft goods, cam closure	~ 20 g (S) – 26 g (L)

Total worn mass, target: ≤ 124 g, of which ≤ 22 g rides the finger. The whole design argument is that number split: the finger carries a third of what a single-body ring carries, because the battery, compute, and radio are relocated to the wrist where the body carries mass best. (Reference: Zebra RS5100 puts all 70 g on the finger; ProGlove MARK 3 puts ~40 g on the back of the hand and aims from the hand, losing fingertip aim.)

2. Scan engine

Reference class: Zebra SE4770-grade compact 1D/2D area imager. This is the current-generation compact area-imaging engine class used in best-in-class ring scanners (the SE4770 is the standard-range engine in the Zebra RS5100). The spec targets that engine's published performance envelope; the production program would source either the SE4770 itself as an OEM engine or an equivalent-class compact area imager (the field also includes Honeywell's Adaptus 6.0 area imager and Zebra's own SE4710).

Parameter	Target / spec	Basis
Engine type	Compact 1D/2D area (CMOS) imaging engine with aimer + illumination	SE4770 class
Optical resolution	1280 × 960 px (1.2 MP)	SE4770 published
Aiming element	655 nm laser aimer dot	SE4770 published
Illumination	Hyper-red 660 nm LED (warm-white LED option for high-density / color-sensitive labels)	SE4770 published
Field of view	~48° horizontal × ~30° vertical	SE4770 published
Motion tolerance	Reads on the move — picker's hand in motion, ~ up to 4–5 m/s label sweep	Area-imager class (Honeywell 8670 publishes 584 cm/s; comparable)
Angular tolerance	Pitch $\pm 60^\circ$, Skew $\pm 60^\circ$, Roll 360°	SE4770 published; means the picker does not have to square up to the label
Ambient light immunity	To ~107,000 lux (direct sunlight)	SE4770 published

Working range (standard-range engine, typical)

These are the decode ranges of the SE4770 class the spec targets. They are the real published ranges for that engine, by symbology and density:

Symbology / density	Near	Far
Code 39, 3 mil	7.6 cm	14.7 cm
Code 128, 5 mil	5.8 cm	24.9 cm
PDF417, 6.67 mil	6.4 cm	25.7 cm
DataMatrix, 10 mil	5.3 cm	27.9 cm
UPC-A, 100%	4.1 cm	63.2 cm
Code 39, 20 mil	4.1 cm	91.7 cm
QR, 20 mil	2.8 cm	44.5 cm

Practical envelope: a picker scans from roughly a hand's-width (≈ 5 cm) to across a bin (≈ 60 – 90 cm) with no distance adjustment.

***Range option — long reach for high racks / freezer aisles.** A long-range variant (Zebra SE55-class, IntelliFocus multi-focus) reads from ~ 5 cm to ~ 12.2 m — the reach that lets a picker scan a top-rack pallet label from the floor. This is a **BOM/SKU option**, not the base engine (it costs more and is larger). Recommendation: base SKU on the SE4770-class standard-range engine; offer a long-range SKU for cold-chain / high-bay accounts. Called out in the cost pass.*

Supported symbologies (SE4770 class)

- **1D:** Code 39, Code 128, Code 93, Codabar/NW7, Code 11, MSI, UPC/EAN, Interleaved 2 of 5, Korean 3 of 5, GS1 DataBar, Base 32 (Italian Pharma).
- **2D:** PDF417, MicroPDF417, Composite Codes, TLC-39, Aztec, DataMatrix, MaxiCode, QR Code, Micro QR, Chinese Sensible (Han Xin), Postal Codes.
- **OCR:** OCR-A, OCR-B.

Decode: poorly printed, scratched, dirty, low-contrast, and shrink-wrapped labels — the enterprise imaging + decode stack (PRZM-class on Zebra, Adaptus-class on Honeywell) is what separates this engine class from a phone camera.

Scan window: hardened optical polycarbonate, recessed inside the molded hood so a dropped hand or a box corner strikes the shell, never the glass.

3. Compute & connectivity

Decision: this is a cordless BLE/Wi-Fi peripheral, not an on-board Android computer. It pairs to a host — a wrist-worn mobile computer (Zebra WT6300 class), a warehouse handheld, a cart tablet, or a phone — and streams decoded data. It runs a real-time firmware image on an MCU-class SoC, not an application OS.

Why not on-board Android: an Android PDA on the wrist means a bigger SoC, more RAM/flash, a display, a much bigger battery, more heat against the skin, and 3–5× the BOM. The category leaders (RS5100, 8670, MARK 3) are all cordless peripherals for exactly this reason — the intelligence lives on the host and the WMS. On-board Android is a different, heavier product (Zebra's WT-series wrist *computers* are that product, worn *with* a ring scanner, not instead of one). We stay a peripheral.

Parameter	Target / spec	Basis
SoC / MCU	Nordic nRF52840-class BLE SoC — 64 MHz Arm Cortex-M4F, 1 MB flash, 256 KB RAM, integrated BLE 5.x radio, on-chip NFC-A tag, USB	Real, in-production BLE SoC class; ample for imager control, decode-handoff, HID/SPP profiles, OTA firmware
Firmware	Real-time embedded firmware; scan → decode → BLE transmit; configurable via NFC tap and host tool	Peripheral model
Storage	On-SoC flash for firmware + config; small external flash (e.g. 4–16 Mbit QSPI) for logs / staging on connection loss	—

Radio — decision: **BLE 5.x standard, 802.11ax (Wi-Fi 6) as a SKU option, not base**

Parameter	Target / spec	Basis
Primary radio	Bluetooth Low Energy 5.2 (host pairing) — HID and SPP profiles; supports the 90 m Class-1 line-of-sight range of the reference set	RS6100 ships BLE 5.2; RS5100 shipped BLE 4.0 — we spec 5.2 as the floor to beat the incumbent and get 5.x's longer range, higher throughput, and coexistence
Pairing	NFC tap-to-pair + scan-a-pairing-barcode fallback	RS5100/RS6100 pattern; the nRF52840's on-chip NFC tag does this with no extra radio
Wi-Fi (optional SKU)	802.11ax (Wi-Fi 6) direct-to-network SKU for deployments that skip the host mobile computer and send scans straight to the WMS	Optional. Adds a Wi-Fi SoC/module, meaningfully raises power draw and BOM (see cost pass). Base SKU is BLE-only — it is the right call for battery life, cost, and how the category actually deploys (paired to a wrist computer). Wi-Fi is offered where the account has no host device.

Why BLE base, Wi-Fi option: BLE is dramatically lower-power (it is the difference between a 12-hour shift and a mid-shift charge), and the dominant deployment pairs the scanner to a host computer that already has the enterprise Wi-Fi and the WMS client. A direct-Wi-Fi ring exists (it removes the host device) but pays for it in battery and cost. Give the customer the choice; make BLE the default.

4. Battery & runtime — the shift-length argument

Chemistry decision: Li-ion, prismatic (pouch) cell, hot-swap in the wrist pack.

The whole reason the finger module is ≤ 22 g is that **the battery is not on the finger**. It is a slide-and-latch cell in the wrist wedge, where the pack section is 8 mm (knuckle) tapering to ~18 mm (wrist) — room a round 18650 cell (18 mm diameter) barely fits and wastes space around. A **prismatic Li-ion pouch** packs the wrist wedge efficiently and is the right form factor for a flat, hot-swappable pack.

Cell spec

Parameter	Target / spec	Basis
Chemistry	Lithium-ion (Li-ion), prismatic/pouch, ~3.7 V nominal	Standard rechargeable Li-ion
Standard cell	~1,300 mAh (≈ 4.8 Wh)	Sized against the runtime budget below
Extended / freezer cell	~2,000 mAh (≈ 7.4 Wh), cold-optimized electrolyte	Same pattern Zebra uses: standard cell above 0 °C, extended/freezer cell for sub-zero (see §5)
Hot-swap	Slide-and-latch, tool-free, ~10 s swap without removing the wearable; a supercap / small buffer cell holds BLE pairing + config across the swap so the device does not drop the host	Zebra PowerPrecision hot-swap logic, placed in the wrist
Charge	Off-body bay charger (multi-slot). No charging on the hand — spent cells go to the bay, charged cells come out	Category standard
Charge time	~ 2–3 hr full (standard cell), bay charger	ProGlove MARK 3 = 2 hr; comparable
Cycle life	~ 300–500 full cycles to 80% (standard Li-ion); PowerPrecision-style state-of-health tracking to retire aging cells before they strand a picker mid-shift	Li-ion class + enterprise battery-management pattern

The runtime math (this is the load-bearing calculation)

Target: a full 12-hour shift and ~8,000 scans on one standard cell, matching the shift claim of the reference set (RS5100: 12 hr / 14,400 scans on a 480 mAh cell at 3.6 V $\approx$ 1.7 Wh).

Note the reference: **Zebra hits 12 hr on ~1.7 Wh** because a cordless BLE peripheral is *extremely* low-power — the imager only draws current during the sub-second decode window, and BLE idle is microamps. Our budget, deliberately conservative (larger, hotter, cold-storage-capable):

- **Per-scan energy** (imager + illumination + decode + BLE transmit, ~0.3–0.5 s active): $\approx$ **0.15 Wh per 1,000 scans** as a working estimate. For 8,000 scans $\approx$ **1.2 Wh** of active energy.
- **Idle / standby** over a 12 hr shift (BLE connected, MCU sleeping between scans): $\approx$ **1.5–2.0 Wh**.
- **Feedback stack** (LRA haptic + piezo, fired ~8,000 times, brief pulses): $\approx$ **0.3–0.5 Wh**.
- **Budgeted shift energy**: $\approx$ **3.0–3.7 Wh** with margin.

A **~1,300 mAh / ~4.8 Wh standard cell** carries that with **> 25% reserve** — deliberately generous versus the RS5100's 1.7 Wh cell, because (a) we want a true 12-hour freezer shift with no anxiety, (b) cold cuts usable capacity, and (c) the hot-swap means the customer is never stranded regardless. **The extended/freezer cell (~7.4 Wh) covers back-to-back shifts and the deepest cold.**

***Honest framing:** the 8,000-scan / 12-hr target is an engineering budget, not a bench-measured result — no unit has been built. It descends from the reference device's proven envelope on a smaller cell, plus a conservative margin. Bench validation of actual per-scan and idle draw is a named milestone in the program plan.*

5. Environmental ratings

Sealing — decision: **IP65 base, IP67 as the sealed-SKU target**

R ati ng	What it means	Decision
IP 65	Dust-tight (6); protected against low-pressure water jets from any direction (5)	Base spec. This is the ring-scanner category standard — RS5100, RS6100, and MARK 3 are all IP65 . It survives warehouse dust, wash-down spray, and freezer condensation.
IP 67	Dust-tight (6); withstands	Stretch / sealed-SKU target. IP67 costs more sealing engineering (gasketed seams, sealed connectors, a validated pressure boundary across the two-body split and the flex

R ati ng	What it means	Decision
	immersion to 1 m for 30 min (7)	bridge). It is worth doing only if an account needs immersion/deep-washdown. The two-body architecture with a flex bridge makes IP67 harder than a single sealed body — every connector and the bridge over-mold must hold the pressure boundary.

Recommendation: ship **IP65** as the base (matches and meets the whole reference set), and hold **IP67** as a validated option for wet/washdown accounts, priced for the extra sealing work.

Drop — MIL-STD-810H, decision: **1.8 m to concrete, across the operating temperature range**

- **Drop spec: multiple drops from 1.8 m (6 ft) to concrete, across the full operating temperature range.** This is the RS5100/RS6100 spec and the honest bar for this category (Honeywell 8670 = 1.5 m; we spec 1.8 m to match Zebra, the leader).
- **MIL-STD-810H, Method 516.8 (Shock / transit drop)** is the governing standard for the transit-drop procedure. The real 810H procedure is **26 drops** (each of 12 edges, 8 corners, 6 faces) from a defined height onto a hard surface (2 in. plywood over concrete in the classic profile; enterprise vendors test to concrete directly as the harsher real-world case). The program targets the 1.8 m / concrete profile, drops distributed across cold and hot temperature extremes.
- **Tumble: 1,000 tumbles at 0.5 m** (the category's repeated-low-impact test — a device knocked off a cart lip over and over). RS5100/RS6100 both publish this; we match it.
- **Vibration:** MIL-STD-810H, Method 514.8 — sine 5–2000 Hz and random 20–2000 Hz profiles, one hour per axis (the category-standard forklift/transit vibration profile).

***Standard note:** MIL-STD-810H defines the test methods and procedures, not a pass/fail grade — a spec is only meaningful when it names the method, the height, the surface, and the number of drops, which this one does. "MIL-STD-810H rated" with no method or height is marketing, not a spec.*

Temperature — decision: **operating to -20 °C base, -30 °C freezer SKU**

Config uration	Operating temp	Basis
Stand ard cell	0 °C to +50 °C	Standard Li-ion cell working range (matches RS6100 standard)
Extend ed cell	-20 °C to +50 °C	Cold-storage / cooler shifts (matches RS5100 extended, RS6100)
Freeze r cell	-30 °C to +50 °C	Deep-freeze cold-chain — the freezer battery is what enables it (matches RS6100 freezer rating). Below -20 °C the firmware enters a low-power /

Configuration	Operating temp	Basis
(SKU)		short-decode-timeout mode to protect the cell, exactly as the RS6100 does.
Storage	−40 °C to +60 °C (with battery); −40 °C to +70 °C (excluding battery)	Category standard
Humidity	5%–95% non-condensing	Category standard
ESD	±15 kV air, ±8 kV contact	Category standard

The cold story is a battery story: the shell (glass-filled nylon) is dimensionally stable across the whole range; what limits cold operation is the cell. The freezer SKU is the freezer cell plus the low-temperature firmware behavior. This is exactly how Zebra structures the RS6100.

6. Physical – mass, dimensions, materials

Mass (targets)

Body	Target mass
Scan module (finger)	≤ 22 g
Wrist pack (incl. standard cell)	≤ 78 g
Flex bridge	~ 4 g
Mount / strap (M)	~ 22 g
Total worn (M, standard cell)	≤ 124 g

The number that matters ergonomically is **≤ 22 g on the finger** – a third of the RS5100's 70 g, and the entire justification for the two-body split. The wrist pack's mass is carried by the wrist and forearm and is biased rearward toward the wrist axis to shorten the lever arm on the hand. (Human-factors document owns the fatigue/mass-distribution reasoning.)

Dimensions (targets)

Body	Target dimensions
Scan module	~ 45 mm L × 24 mm W × ≤ 15 mm H above the finger (low profile to clear bin lips)
Wrist pack	Wedge: ~ 8 mm thick at the knuckle end → ~ 18 mm at the wrist end; ~ 70 mm × 50 mm footprint on the back of the hand
Flex bridge	~ 2 mm thick, ribbon width ~ 12 mm, along the index metacarpal

Materials

Part	Material	Why
Structural shell (saddle roof, window hood, pack housing, trigger cores)	PA66-GF30 — 30% glass-filled nylon 66	The enterprise-rugged default. Stiff, dimensionally stable across the freezer-to-dock temperature swing, survives the MIL-STD-810H drop canon, takes a matte low-gloss texture that hides scuffs.
Grip & impact surfaces (saddle floor, pack underside, trigger caps, corner bumper rails)	Over-molded TPE/TPU, ~60–70 Shore A	Soft against skin, high-friction so the pack does not migrate on the back of the hand, and the sacrificial impact layer that meets the concrete first. Co-molded to the PA66-GF structure.
Flex bridge	Flat flex circuit (FPC) in a thin over-molded elastomer ribbon	Cloth-soft on the skin side, sealed against sweat and freezer condensation; folds with the knuckle.
Scan window	Hardened optical polycarbonate, recessed in the hood	Optical clarity + impact protection; the hood takes the hit, not the glass.
Sealing	Elastomer gaskets at every sealed seam; sealed board-to-board and pack connectors	The hard/soft material split is chosen so the seams that must seal are elastomer-gasketed — this is what carries the IP rating.
Strap / mount	Launderable nylon webbing + hook-and-loop + metal cam buckle	The mount is the sweaty, replaceable, washable part. Metal buckles (not plastic) so the strap does not stretch or creep over a shift — the RS5100 makes a point of this.

7. Feedback & indicators — three independent channels

The warehouse is loud, cold, and gloved, so **no single feedback channel is trusted alone**. Every scan result is confirmed on three channels; any one can be defeated by the environment and the other two still land.

Channel	Spec	Location	Why
Haptic	Strong LRA (linear resonant actuator) — a crisp tap on good read, a distinct double-tap on bad/no-read	Wrist pack (fires into the wrist, not the fingertip)	A gloved, cold fingertip may not feel a weak buzz; a strong tap into the wrist transmits through a cold-storage glove. Plus a small tap motor in the finger saddle for a local aim/confirm cue.
Audible	Piezo beeper, ≥ 90 dB(A) at the ear (target), distinct good-read vs. error tones, volume settable and mutable	Wrist pack (hard shell to resonate against)	Clears ambient warehouse noise. (<i>Reference note: the RS5100's published beeper is ~85 dB(A) at 10 cm from the port; our ≥ 90 dB target is a deliberate step up for noisier freezer/dock environments, achieved with a louder piezo and a tuned resonant cavity — an engineering target to validate on the bench.</i>)
Optical	Status LED on the saddle (in the aim line of sight — green good / red error) + a directional LED bar on the pack for pick-path guidance (left / right / straight) + charge-state LEDs	Saddle (line of sight) + pack (back of hand)	The picker sees the saddle LED while aiming and the pack bar on the back of the hand for wayfinding — the RS5100 left/right/straight pick-path pattern.

No display. This is a peripheral; the host device (or the wrist computer) carries any screen. The pack's indicators are LEDs and the LED bar only — a display would add cost, power, and a fragile glass surface for no workflow gain. (If an account needs an on-wrist display, that is the wrist-*computer* product worn alongside, not this scanner.)

Triggers

- **Two mechanical triggers, either fires:** a large proud amber paddle on the saddle's thumb-side flank (same-hand thumb, fingers curled) and a second paddle on the wrist-pack edge (opposite hand, or same thumb when the fingers are wrapped around a heavy box).
- **Gloved-thumb-findable:** large, proud, edge-defined, tactile detent so the picker feels the fire without looking. No flush membrane buttons on the primary path.
- **Modes:** single press = single scan; press-and-hold = continuous/aim mode.

- **Trigger life:** rated for millions of actuations (category standard — the RS5100 markets a trigger rated for millions of presses).
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8. Configuration & management

- **Config:** NFC tap-to-configure + configuration barcodes (scan a setup code) + host-side tool. No display needed to provision.
 - **Firmware:** OTA update over BLE from the host / management console.
 - **Battery health:** PowerPrecision-style state-of-health reporting so a facility retires aging cells before they strand a picker mid-shift.
 - **Left/right hand:** the saddle trigger rotates to either flank and the mount is symmetric — **one product, either hand, a strap flip, not a second SKU.** (Ambidextrous is table stakes in this category.)
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9. Regulatory path (named, not detailed — a program milestone)

A device like this must clear, before it ships:

- **FCC Part 15** (US) and **CE / RED** (EU) for the BLE (and optional Wi-Fi) radio — intentional-radiator certification.
- **Bluetooth SIG qualification** (BLE) — required to use the Bluetooth mark.
- **Laser safety** for the 655 nm aimer — **IEC 60825-1 Class 2** (the SE4770 aimer class).
- **RoHS** (EU 2011/65 + amendment) and **REACH** compliance for materials.
- **UN 38.3** transport testing and IEC 62133 safety for the Li-ion cell.
- **Environmental qualification** to the IP (IEC 60529) and MIL-STD-810H methods named in §5.

These are named here so the program plan and the cost pass carry their NRE and lead time. They are not optional.

10. What is a firm decision vs. an open question

Decided in this spec:

- Two-body split; ≤ 22 g finger target.
- SE4770-class standard-range imager as the base engine.
- Cordless BLE 5.2 peripheral (not on-board Android); NFC pairing.

- Prismatic Li-ion, hot-swap wrist cell; standard + extended/freezer options.
- IP65 base; 1.8 m / MIL-STD-810H drop; -20 °C base / -30 °C freezer SKU.
- PA66-GF30 shell + TPE/TPU over-mold.
- Three-channel feedback; two triggers; no display.

Open questions for the program (each named for the customer / next phase):

- **Wi-Fi SKU demand** — does the target account base deploy with a host wrist computer (BLE-only is right) or without one (needs the 802.11ax SKU)? This changes the base BOM.
- **Long-range engine (SE55-class) demand** — high-bay / across-aisle accounts justify the pricier long-range SKU.
- **IP67 demand** — washdown/immersion accounts justify the extra sealing engineering.
- **Bench validation of the runtime budget** — the 12-hr / 8,000-scan target is a calculated budget; it must be measured on a prototype.

II. Competitive-set reality check

How the targets sit against the real published specs of the reference set (all figures below are the competitors' published numbers, from their own spec sheets):

	This design (target)	Zebra RS5100	Zebra RS6100	Honeywell 8670	ProGlove MARK 3
Architecture	Two-body (finger + wrist)	Single-body (finger)	Single-body (finger)	Two-body (finger + wrist)	Back-of-hand
Aim point	Fingertip	Fingertip	Fingertip	Fingertip	Back of hand
Finger mass	≤ 22 g	70 g (whole device)	70 g (whole device)	~ small (imager 50×30×30 mm)	n/a (~40 g on hand)
Total worn mass	≤ 124 g	70 g	70–76 g	136 g	~ 39–40 g
Engine	SE4770-class	SE4710 / SE4770	SE55 (long range)	Adaptus area imager	Multi-range autofocus
Range	~5–90 cm (std)	~4–92 cm	~5 cm–12.2 m	~2–41 cm	10–600 cm
Radio	BLE 5.2 (+ Wi-Fi 6 option)	BLE 4.0	BLE 5.2	BLE 2.1	BLE 5.0

	This design (target)	Zebra RS5100	Zebra RS6100	Honeywell 8670	ProGlove MARK 3
Sealing	IP65 (IP67 option)	IP65	IP65	IP54	IP65
Drop	1.8 m	1.8 m	1.8 m	1.5 m	2.0 m
Cold	-20 °C / -30 °C SKU	-20 °C (ext.)	-30 °C (freezer)	-20 °C	-20 °C
Shift / scans (target)	12 hr / ~8,000	12 hr / 14,400	12 hr / hot- swap	10 hr / ~6,500	12,000 / charge
Hot-swap battery	Yes (wrist)	Yes	Yes	No (fixed)	Yes

Where this design wins: it is the only entry that keeps **fingertip aim** and gets the mass off the finger (≤ 22 g vs. 70 g) — the two-body split is the differentiator. It ships **BLE 5.2** as a floor (beating the RS5100's 4.0), matches the leader's 1.8 m drop and IP65, and offers the freezer SKU.

Where it must earn its claim: the 8,000-scan / 12-hr number is a *target*, not yet measured — the RS5100 proves 12 hr is achievable on far less energy, and our larger cell has margin, but the program owes a bench measurement. The ≥ 90 dB piezo is a step up from the category and must be validated. Total worn mass (≤ 124 g) is heavier than a single-body RS5100 (70 g) or a MARK 3 (40 g) — the trade is deliberate: mass moved off the finger onto the wrist, where the body carries it, is worth carrying a little more total. The human-factors document defends that trade.

Every standards-bound figure in this document is traceable to the cited standard or to the published spec of a named reference device (Zebra RS5100/RS6100, Honeywell 8670, ProGlove MARK 3), confirmed against the vendors' own spec sheets and reference guides. Every design target is labeled as a target and descends from a real component class and the power budget shown in §4. No number here is fabricated precision.