SYSTEM 001 / DG03 / 19 SEPTEMBER 2026

Prototype design & workshop build guide



MURMUR

COWL + MOLT CORE

One architectural shell.
One removable carrier.
Separate, testable electronics.

DG03 extends the approved guide with build-order checkpoints, executable input diagnostics and evidence-led tracking. Original construction pages retain their page numbers.

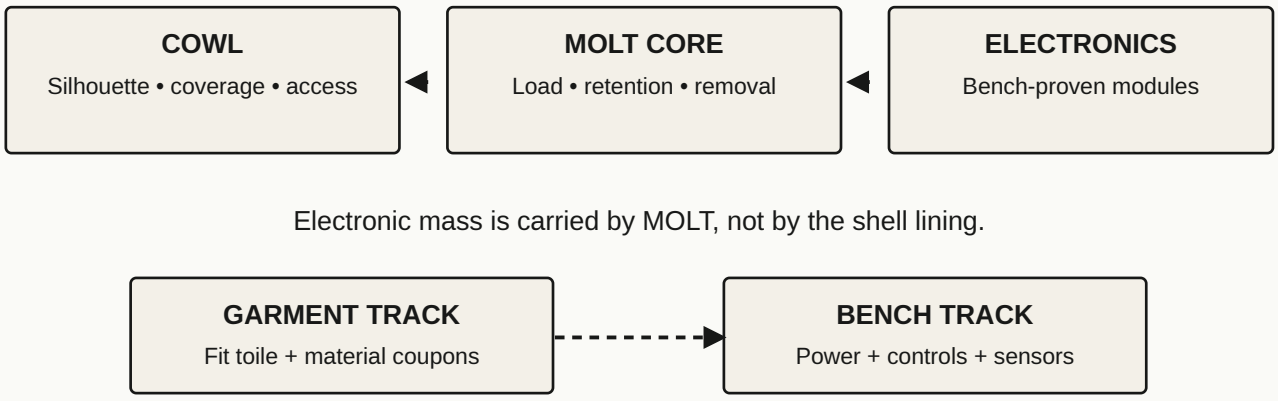
Sample M remains the inherited development reference, not a confirmed wearer size. Native cutting geometry is still a separate required input.

Visual: V01, original reference crop. Design image, not a completed physical sample.

REF 01 / BUILD DEFINITION

Keep the three jobs separate

COWL determines how it looks and moves. MOLT carries the hardware. The bench proves what the electronics actually do.



Track	First useful output	What it must not be mistaken for
COWL fit sample	An inexpensive fabric toile that preserves the reference silhouette and service access.	A graded production garment or proven weather barrier.
MOLT fit sample	A removable carrier with measured dummy modules, real closures and service routes.	A promise that full-size evaluation boards fit inside the final clothing.
Bench system	Recorded power, controls, sensor and observer behaviour using identified boards.	A wearable product or an anti-surveillance performance result.

How to use the guide

Use the DG03 index on page 5. Retained reference sections define the product; the following DG03 work cards expand execution. Garment and inert-carrier work can proceed independently of the staged bench programme.

DG02-ROUTE / WORKSHOP METHOD

Read it as a build sequence

The reference pages define the product. The new work cards explain how to perform the next operation and what to inspect before continuing.

Workstream	Read / do	Useful completed output
Prepare	Confirm the 25-piece inventory; mark fabric faces; make seam and closure coupons.	A labelled cut ticket and a repeatable sewing setup.
COWL	Walk native seams, make the full toile, then execute flat-panel operations before closing the shell.	A fitting sample with the original cowl, layers and free edges intact.
MOLT	Measure complete modules; make inert envelopes; fit carrier and six interfaces to the wearer.	A carrier that supports its load without pulling COWL into shape.
Bench	Identify each board; start with controls; add one powered block at a time.	Recorded wiring, boot, current and subsystem response.
Join	Use the measured removable loom and compact modules only after the relevant electrical and mechanical tests.	A serviceable prototype, not electronics sewn into an untested garment.

What can start without the missing native pattern

Material coupons, hardware identification, module measurements, cable-route mock-ups and an isolated core/service-pod bring-up can start now. Garment contour cutting still needs the actual C5A/C.4 master; work-card illustrations do not replace it.

Stable operation IDs are preserved across revisions. The PDF bookmarks, page index and companion tracker refer to the same activities. A workshop method is an instruction, not a physical PASS record.

DG03-CHANGE / WORKSHOP METHOD

A build release, not another redesign

DG03 retains the approved COWL and MOLT CORE references. Pages 1–75 keep their original positions; new execution cards are on pages 76–88.

Retained	Improved in DG03
Approved design pixels	The same embedded reference images, 25-master inventory and inherited Sample M development reference. No new silhouette or guessed cutting master.
Construction sequence	New last-access checks, zipper landmark transfer, seam-edge control and final closure inspection.
Measured carrier fit	Connected-envelope measuring jig, six-point registration and witness marks before an inert movement trial.
LAB-0 pin allocation	A five-input MicroPython diagnostic uses MODE GP14, UP GP15, DOWN GP16, ACTION GP22 and NC tamper GP9. It does not drive external outputs.
No invented physical results	Tracker requires sample, operator, configuration, result and evidence references before a new manual Passed state. Earlier DG02 passes require review on migration.
Separate development and commerce	The store build page is the document entry point. A documentary release is not a physical acceptance certificate or a finished-garment shipment.

Start at page 76

Then return to the relevant operation in pages 6–75. Stable DG02 operation IDs remain valid so existing records and photographs do not need renaming.

DG02-INDEX / NAVIGATION

Find the next operation

Read each retained reference page with its following workshop cards. Page numbers and PDF bookmarks refer to this DG03 edition.

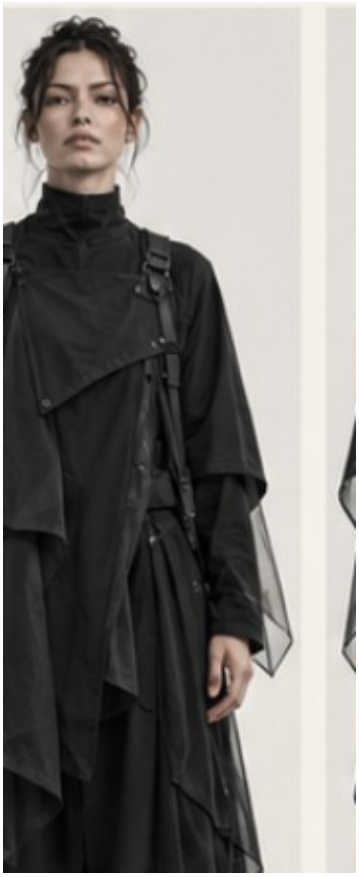
Section	Content	Pages
Start / control	Build route, revision boundary and index	1–5
Design / fit	Approved views, POMs, orientation and load path	6–9
Inventory / preparation	63 textile layers; material, coupons, seam walk and toile	10–20
Front / back / sleeves	Pockets, separating zip, Q/W, yoke, shields and tabs	21–29
Cowl / shell	D–E–D / F, set-in sleeves, hem and adjustment	30–34
Inner architecture	Service frames, K/L/N, channels, cuffs, lining and sealing	35–42
Carrier / harness	MOLT fit, six RA interfaces, inert modules and leads	43–49
Bench / electronics	Hardware ID, inputs, screen/radio, isolation, rails and logs	50–65
Test / service	Loaded movement, removal, fault isolation and bench targets	66–70
Outstanding / records	Actionable dependencies and offline build tracking	71–73
Sources	Inherited source register and DG03 readback	74–75
DG03 execution cards	First session, sewing checkpoints, caddies, diagnostic and release records	76–88

A dimension needs a meaning

Envelope ≠ cut shape. Blank ≠ clear aperture. Board size ≠ complete caddy. Supply rating ≠ measured draw. Target ≠ test result. Keep these distinctions in every build record.

REF 02 / DESIGN CONTINUITY

This is the silhouette to preserve



FRONT / existing V01 image crop



REAR / same V01 image crop

Visible design cue	Construction consequence
High, generous cowl and hood	Proof the head opening, collar join, head rotation and closure together; do not replace it with a standard hoodie.
Layered shoulder and upper-sleeve coverage	Retain independent cover layers and articulated long sleeves; do not simplify into a plain jacket.
Asymmetric front and rear movement	Maintain the intended handedness and free edges. Do not mirror the complete garment or sew every layer down.
Long hanging and translucent elements	Their complete geometry is not established by the 25-piece inventory alone. Reconcile each visible layer to the native master and toile before cutting final fabric.
Quiet, restrained hardware	Every strap, snap and opening must have an attachment, adjustment or service function.

Reference pixels have not been redesigned. The crops show design intent, not orthographic measurements or verified panel boundaries.

V01; S03 pp.2, 4–6. DG01 comparison: visual-to-pattern mapping still requires the native geometry.

REF 03 / FIT BASIS

Measure the sample, not the picture

The inherited C5A programme uses **Sample M**. The separate System Coat Rev C uses **men’s L** and a different construction reference. This guide does not combine their dimensions or size labels.

Point of measure	Programme target (cm)	How to measure the closed, relaxed sample
Target body chest	94–102	Wearer reference range only; not a measured fit result.
Garment chest	116 ± 2	Circumference; equivalent flat half-chest target 58.
Hem	114 ± 2	Circumference; equivalent flat half-hem target 57.
Centre-back length	70 ± 0.8	Use the native neckline/hem measurement endpoints.
Front HPS length	69 ± 0.8	High-point shoulder to the defined front hem.
Shoulder seam	16 ± 0.5	Along the shoulder seam.
Armhole depth	27 ± 0.5	Use the pattern’s vertical measurement definition.
Sleeve length	64 ± 0.7	Along the native sleeve measurement line.
Bicep circumference	44 ± 1	At the defined upper-arm level.
Cuff circumference	26 ± 0.7	At the finished cuff opening.
Collar height	11 ± 0.5	At the defined finished collar point.

> **Do not shorten the approved silhouette to force a number**
>
> The 70 cm centre-back target does not, by itself, explain the long layered appearance in V01. The missing native pattern must establish whether it measures the base shell rather than the lowest cover layer. Record both the base-shell length and the longest visible layer during the toile review; do not invent a conversion.

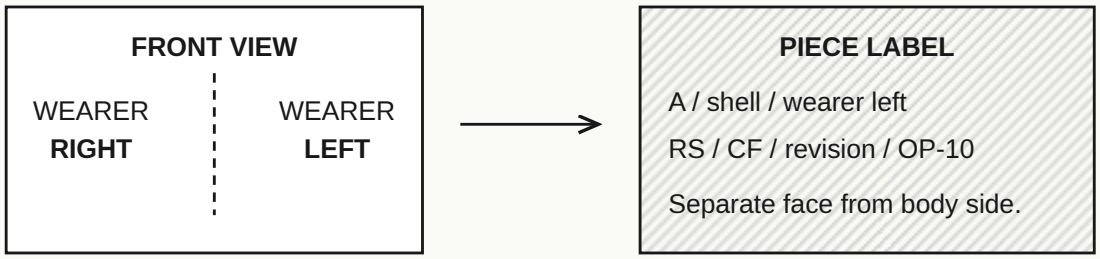
Before changing size, record body chest, waist, hip, shoulder width, arm length and intended underlayers. Fit the shell with the actual carrier mock-up. A size label is not sufficient to determine ease or hardware clearance.

S01 p.8; S06 pp.1–2; V01. Measurement procedure expands the source targets without claiming a fitted result.

DG02-MEASURE / WORKSHOP METHOD

Orient the wearer and the cloth

“Left” means the wearer’s left. “Right side” means the intended exterior face of the fabric. These are different instructions.



01 **Record the fit context**

Measure chest, waist, hip, shoulder span and arm length over the intended underlayer. Record posture, tape position and whether the carrier mock-up is present. Do not infer the wearer’s measurements from Sample M.

02 **Establish repeatable garment endpoints**

Lay the closed sample flat without pulling it. Mark the native POM endpoints on the work copy. Measure chest and hem as half-widths only where the original circumference is defined as twice that flat measure.

03 **Measure base and drape separately**

Record the source centre-back length to its intended base-shell endpoint. Also record the lowest free layer from a clearly photographed reference point. A 70 cm base-shell target is not an instruction to trim a hanging layer to 70 cm.

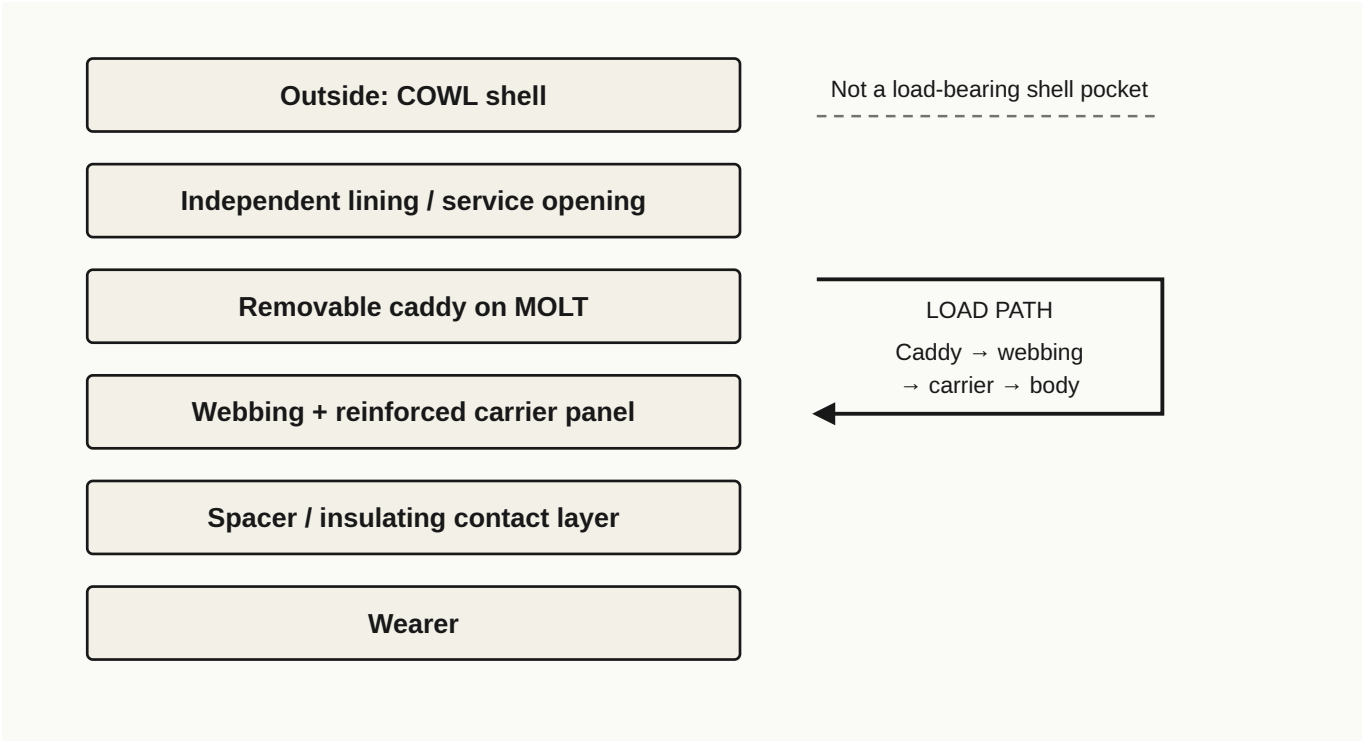
04 **Use removable labels**

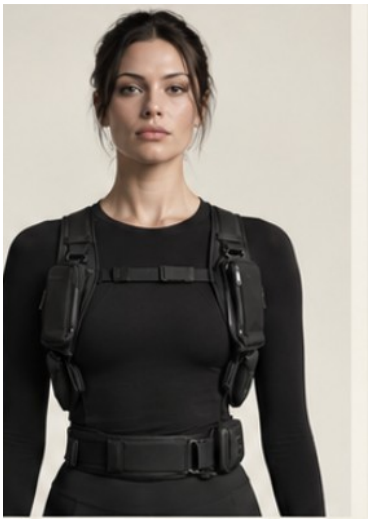
Label each piece with code, fabric, RS/WS, wearer side, revision and next operation. Keep marks out of the visible surface and sensor openings. On coated material, test the marking method on an offcut first.

> **Photograph the same state each time**
>
> Use front, rear and both profiles with the same zip position, hood position, underlayer and camera height. Take separate carrier-only and shell-over-carrier views so a fitting problem can be located.

REF 04 / GARMENT–CARRIER INTERFACE

Keep the load off the shell





MOLT front reference / V02

Placement rules

BLACK: wearer’s inner-left, behind reinforcement and spacer.

RED: wearer’s outer-right / upper-arm service area.

Power: two independent sources low on opposite flanks.

Optical and antenna zones: clear of conductive textile; locate from actual hardware.

Left and right always mean the wearer’s left and right

A front photograph reverses those sides for the viewer. Do not use the poster’s decorative module labels to locate final electronics. The service opening registers to the carrier; it is not the primary suspension for a heavy caddy.

S03 p.6; S01 pp.20–25; Shopify MOLT readback; V02. Layer diagram is functional, not a section through a released seam.

REF 05 / PATTERN INVENTORY / 1 OF 2

COWL outer pieces

All dimensions below are **vector bounding envelopes in millimetres**. They identify a pattern piece. They are not instructions to cut a rectangle.

Code	Piece	Garment total / layer	Envelope, mm
A	Front shell	2 mirrored / shell	310 × 745.71
B	Back shell	1 on fold / shell	300 × 755.02
C	Sleeve	2 mirrored / shell	460.17 × 660
D	Hood side	2 mirrored shell + 2 mirrored lining	310.59 × 438.93
E	Hood centre gusset	1 shell + 1 lining	125 × 668.23
F	Stand collar	1 shell on fold + 1 lining on fold	262.57 × 130.01
P	Front zip facing	2 mirrored / shell	75 × 720
Q	Asymmetric storm flap	1 shell + 1 lining; same handedness	176.08 × 670
R	Back shoulder yoke	1 on fold / shell	284.71 × 255.10
S	Upper sleeve shield	2 mirrored / shell	340.48 × 352.50
T	Cuff tab	4 shell pieces → 2 finished tabs	170 × 60
U	Hand-pocket bag	4 lining pieces → 2 bags	210 × 290
V	Pocket zip facing	2 shell + 2 local 210D backing	230 × 65
W	Rear quiet cover	1 shell + 1 lining	160.53 × 440

> **Confirmed correction: P = two mirrored facings**
>
> The P source specifies 75 × 720 mm, main shell fabric and 10 mm seam allowance included. Do not add another allowance or default fusible layer. All other allowances, contour cuts, notches and overlap marks must come from their native masters.

D, E, F, Q and W have more than one material layer. Keep their shell and lining copies labelled separately. Q's layers must match in handedness; "one of each" is not an instruction to mirror them.

REF 06 / PATTERN INVENTORY / 2 OF 2

Lining, access and interface pieces

Code	Piece	Garment total / layer	Envelope, mm
LA	Front lining	2 mirrored / lining	310.36 × 705.81
LB	Back lining	1 on extended fold / lining	310 × 715.02
LC	Sleeve lining	2 mirrored / lining	460.17 × 630
G	BLACK service frame	1 reinforcement + 1 lining	220 × 160
H	RED service frame	1 reinforcement + 1 lining	230 × 170
J	Power service frames	2 reinforcement + 2 lining	185 × 115
K	Optical patch	1 reinforcement + 1 clear TPU blank	80 × 80
L	Microphone patch	1 reinforcement + 1 open mesh blank	70 × 70
N	Haptic contact pad	1 spacer + 1 lining	70 × 70
M	Cable channel	4 TOTAL / lining	45 × 500
RA	MOLT anchor patch	6 TOTAL / 210D reinforcement	80 × 100

M = four in the whole garment

A “CUT 4 TOTAL” label repeated on four layout instances does not mean sixteen channels.

RA = six in the whole garment

The six service attachment zones need six reinforcement patches, not six per repeated template.

Service-frame size is not usable caddy capacity

G/H/J dimensions are flat pattern envelopes. Seams, turns, closures, aperture margins, enclosure thickness and the withdrawal direction reduce usable space. Do not order a 220 × 160 mm box because G has that envelope.

Cut-ticket discipline

Keep every piece in a labelled bundle: system, revision, code, material, wearer side, quantity and operation. Shell and lining twins must stay paired. Record replacements and toile redlines on a separate work copy; preserve the untouched master.

These two pages account for **25 named COWL pattern masters**. They do not constitute a separate MOLT carrier pattern release.

S01 pp.5–6; S03 pp.5–7; S05 pp.20–21.

DG02-COUNT / WORKSHOP METHOD

Count cut layers, not repeated labels

This reconciliation is derived from the inherited COWL inventory. It counts physical textile pieces—not pattern masters, metres or MOLT carrier parts.

Material group	Piece allocation	Total
Main shell	A2 + B1 + C2 + D2 + E1 + F1 + P2 + Q1 + R1 + S2 + T4 + V2 + W1	22
Lining	D2 + E1 + F1 + Q1 + U4 + W1 + LA2 + LB1 + LC2 + G1 + H1 + J2 + N1 + M4	24
210D reinforcement	V2 + G1 + H1 + J2 + K1 + L1 + RA6	14
Spacer / TPU / mesh	N1 spacer; K1 clear TPU; L1 open mesh	3
Total textile layers	COWL only, excluding additional process coupons and separate MOLT geometry.	63

01 **Build operation bundles**

Fronts: A/P/Q/V/U and the two pocket zips. Back: B/R/W. Sleeves: C/S/T. Hood: D/E/F. Inner architecture: LA/LB/LC with G/H/J/K/L/N/M/RA.

02 **Check pairs before stacking**

A, C, P and S need deliberate wearer-side pairing. Q shell and lining must produce the same finished handedness after turning; their fabric faces oppose during sewing.

03 **Keep count and geometry separate**

Mark quantities complete only when the actual correctly shaped pieces exist. A folded piece counts as one cut component; do not split B/R/F/LB into two simply to make the tally look symmetric.

> **Two corrected quantities remain fixed**
>
> M = 4 total channels. RA = 6 total anchor patches. Four instances of a “CUT 4 TOTAL” label do not authorise sixteen channels.

REF 07 / MATERIALS

Buy for the sample, not a production run

Quantities are inherited **integrated-sample allowances**, shared where applicable with MOLT. Actual marker yield, shrinkage, usable width and final article selection still need checking.

ID	Material reference	Sample allowance	Use / check
T02	Calico for a full fit toile	6 m planning	Separate from final fabric; include lining/access proof.
F01	70D TPU-laminated nylon ripstop	3.2 m	COWL; match drape and real laminate to the design. Exact article not accepted.
F02	75–120 g/m² polyester tricot / warp-knit	2.0 m	Comfort lining shared across shell and carrier. Confirm stretch, recovery and usable width.
F03	210D nylon packcloth	0.75 m	Load/service reinforcement; grain and layer allocation matter.
F04	3 mm polyester spacer mesh	0.45 m	Carrier comfort and stand-off; not electrical insulation by itself.
F05	Shieldex Nora RS 1400101130	0.35 m	Local engineering patches only. No blanket shielding claim.
F06	Clear TPU film, 0.2–0.4 mm candidate	0.20 m stock	Optical window; test purchased film with the sensor.
F07	Open microphone mesh	100 × 100 mm stock	L uses a 70 × 70 mm blank; preserve the open acoustic path.

Identify every fabric

Write supplier article, colour, lot, width and face/back orientation on a retained offcut. Mark the right side with removable tape. The rendering's black tone is not a supplier colour standard.

Prove the process on scraps

Use the real shell, backing, lining and thread in the same order as the final seam. Check puckering, needle marks, fold bulk, closure peel and any heat-seal response before committing large panels.

> **Keep the material stack honest**
>
> A waterproof coating does not establish breathability. Conductive cloth does not establish attenuation through a finished seam or opening. Clear film is not automatically neutral to a spectral sensor.

S02 Costed BOM T02, F01–F07; S03 pp.3–4; S01 pp.7, 9. No supplier prices or availability re-quoted.

DG02-FABRIC / WORKSHOP METHOD

Prepare fabric without changing its behaviour

The sample allowances are a purchasing estimate. Actual usable width, orientation and the accepted marker determine consumption.

01 **Identify the roll**

Record supplier article, lot, colour, usable width and coating/face orientation on a retained sample. Note whether the lining stretches most across or along the roll; do not assume both directions behave alike.

02 **Follow the actual preparation instructions**

Use the supplier’s prescribed care or relaxation process. Do not hot-wash or iron an unidentified laminate. Let the material rest flat, then measure the usable area again.

03 **Test marks and temporary holding**

Try chalk, removable tape, clips and any seam-stick on scraps. Remove them after the expected work time. Reject a method that stains, pulls the coating or leaves adhesive in a visible or sensor area.

04 **Lay the complete marker**

Use the native outlines with their grain/fold directions, the correct face orientation and any directional surface effect. Keep mirror pairs deliberate. Weigh pieces down; do not stretch cloth until it reaches the edge of the table.

05 **Reserve process material**

Keep enough identified offcut for the actual seam, pocket, binding, window and fixing stack. Mark these as coupons, not spare garment pieces. Record actual used length after cutting, including losses.

Observed problem	Change before cutting
Tricot curls or shifts	Re-lay relaxed and use a tested stabilisation/holding method. Do not pull to flatten.
Coating sticks to the presser foot	Trial an appropriate feed/foot setup on the coupon; do not lubricate the final surface casually.
Marker exceeds usable width	Re-plan placement respecting grain and handedness. Do not rotate critical pieces to force the allowance to work.

REF 08 / TRIMS + TOOLS

The small parts that finish the system

ID	Controlled trim / working quantity	Construction purpose
N01	1 × YKK #5 two-way separating zip, 700 mm	Main front. Exact order code and finish remain to be selected.
N02	2 × #3 pocket zips, 180 mm	Hand pockets, not electronics service hatches.
N03	25 mm nylon load webbing, 2.5 m total	MOLT load path. This is not an individual strap cutting schedule.
N04	20 mm sew-on hook + loop, 1.5 paired m	1.5 m of each mating side under the cost model.
N05	10 mm elastic cable-retention tape, 1 m	Retain cable runs without loading the connector.
N06–07	2 mm shock cord, 1.5 m; 4 low-profile locks	Hem/cowl adjustment where marked.
N08–09	Bonded polyester Tex 40; Microtex 80/12 baseline	Verify on the machine and material coupon; 5 needles budgeted.
N10	15–20 mm laminate-compatible seam tape, 12 m	Only with a compatible, tested process. Not basting tape.
N11	25 mm edge binding, 8 m working allowance	Actual edge takeoff required after pattern and coupon checks.
N12–14	4 × 25 mm buckles; 4 × triglides; 6 × gatekeepers	Carrier adjustment and six garment interfaces.
N15–16	8 service-closure sets; 4 cord-exit sets	Planning quantities; final style, fixing and diameter are not frozen.
N17	4 brand/size/care/serial labels planned	Use actual composition/care information; not retail-release evidence.
N18	Seam-stick basting tape, 8 m working usage	Assembly aid only; test residue on the coating. Not seam-seal tape.

Set up the work surface

Use a cutting mat, fabric shears or rotary cutter, pattern weights, removable marking tools, a millimetre ruler, tape measure, seam gauge, clips, seam ripper, zipper foot and a machine suited to the tested material stack. Add digital calipers and a scale for the carrier mock-ups. Keep electronics off the cutting and pressing surface.

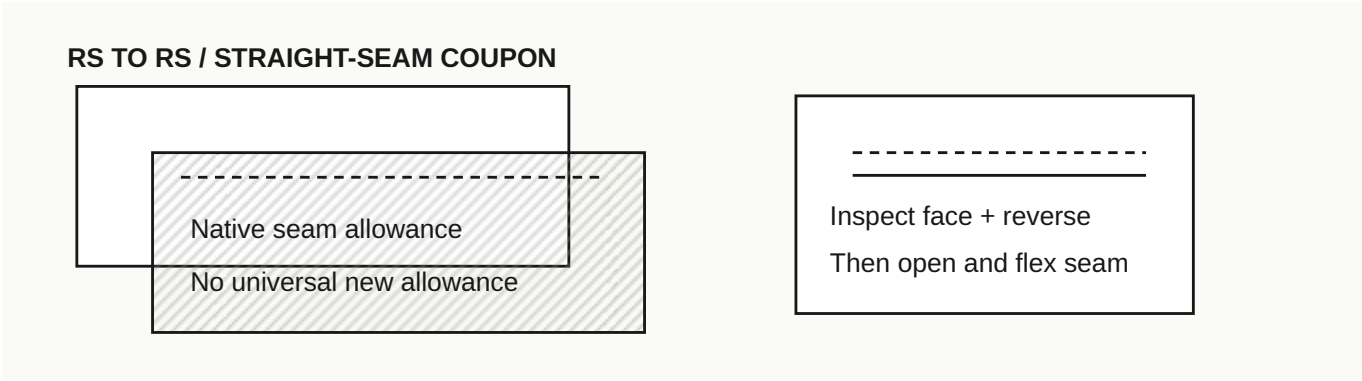
> **Baseline stitch**
> The inherited shell baseline is a straight lockstitch at 2.8–3.2 mm. Use the native seam allowance, not a universal new 10 mm rule. Test thread tension, feeding and needle size on the complete stack.

S02 Costed BOM N01–N18; S01 pp.7, 9; S03 p.7. Tool setup is DG01 workshop guidance.

DG02-COUPON / WORKSHOP METHOD

Set the machine on a real seam stack

Make the sewing setup repeatable before working on a large shell panel. Test thin seams and reinforced seams separately.



01 **Make a traceable test**

Use two 150 × 200 mm offcuts for a straight-seam practice coupon, aligned in the direction of the planned seam. These are DG03 test rectangles, not garment patterns. Use the actual seam allowance from the relevant native piece.

02 **Start from the inherited baseline**

Use the machine-compatible needle system, with the source Microtex 80/12 and Tex 40 only as the initial material trial. Start at 2.8–3.2 mm straight lockstitch. Record needle, thread, foot, stitch length, tension and feed settings.

03 **Inspect both sides**

Sew without pulling front or rear. Check that the interlock sits within the stack, feeding is even and there are no skipped stitches, pulled coating or permanent ripples. Change one setting at a time and keep the rejected coupon.

04 **Repeat with reinforcement**

Build the actual V backing, webbing anchor or bound service edge as a separate stack. A successful two-layer shell seam does not prove the thicker assembly.

05 **Flex and compare**

Open the seam, bend it repeatedly in both directions and compare before/after photographs. Record gaping, thread cutting, perforation growth or layer separation. Accept the setup only for the stack actually tested.

> **Do not cure a material failure with more stitches**
>
> Repeated dense stitching can create a perforation line. Anchor geometry and stitch density must come from the accepted attachment coupon, not a decorative Box-X copied from a rendering.

S01 p.9; S00 DG01 pp.8–9. DG03 150 × 200 mm practice coupon and inspection method; not a seam-strength certification.

DG02-CLOSURE / WORKSHOP METHOD

Prove closures, binding and seam tape

A closure can look neat on the bench yet tear the supporting textile or block module removal. Test the complete stack.

Coupon	Build it like the real part	Inspect / record
Bound service edge	Actual lining, reinforcement and 25 mm binding; include a straight section and the tightest intended corner.	Finished clear opening, missed underside, puckering, edge roll and the tool/foot setting.
Gatekeeper / webbing anchor	Actual hardware, 25 mm webbing, reinforcement and accepted stitch pattern.	Direction of load, marked tail position, seam movement and local tearing. No rated strength is inferred.
Snap / cord exit	Actual article, washer/backing and setting tool on the planned stack.	Hole/setting size, rotation, edge damage and whether the cord or closure pulls on unsupported laminate.
Hook and loop	Actual mating strips on the channel/support fabrics.	Open/close force, edge lift, snagging and distortion after repeated access.
Seam tape	Actual stitched shell seam, compatible tape and supplier process window.	Tape lot, temperature, pressure, time or speed; adhesion, flex, coating damage and visible distortion.

01 **Select the process before the garment**

Keep one reference coupon with the finished sample and photograph both sides. The successful article/stack/settings—not the generic material name—control the next operation.

02 **Measure edge consumption**

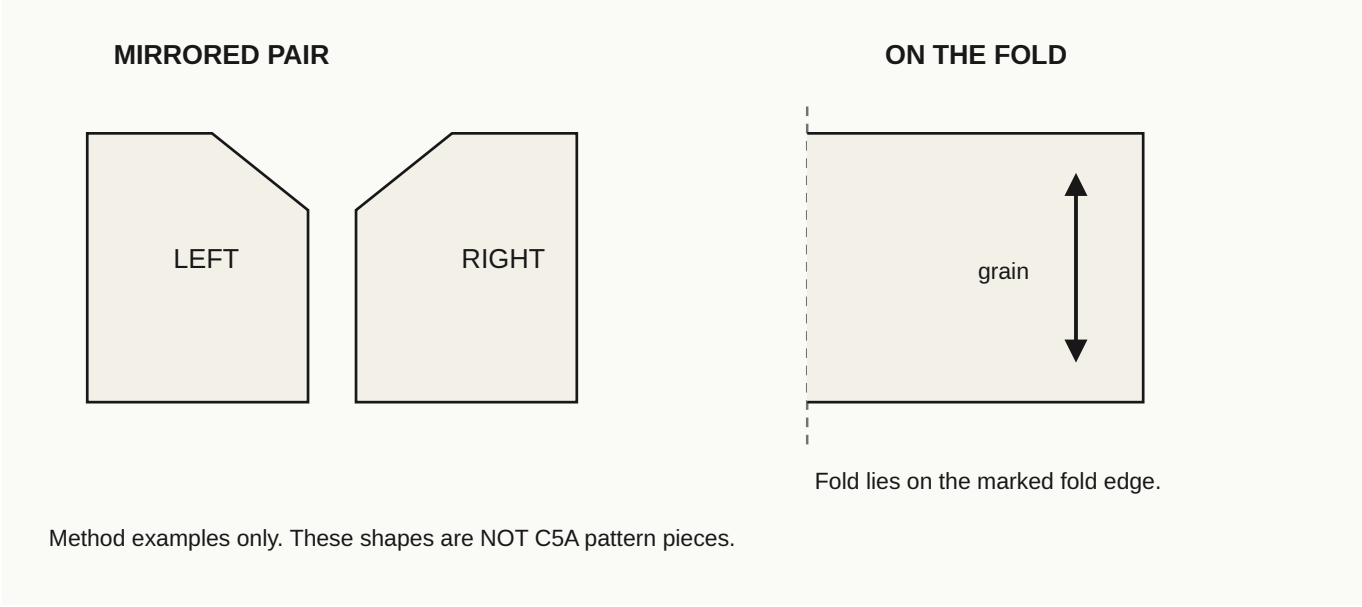
Run binding around the accepted test edge, mark its consumed length before cutting the tail and record any overlap. Use the real finished perimeter for final takeoff; the 8 m allowance is not proof of enough stock.

> **Keep two tapes distinct**
>
> Seam-stick holds layers temporarily during sewing. Laminate-compatible seam-seal tape covers selected stitched seams after its process is proven. They do not serve the same job.

S00 DG01 pp.8–9, 18; S01 pp.7, 9, 19, 26. DG03 coupon procedure; final articles/settings remain measured inputs.

REF 09 / PREP + CUTTING

Cut only from a checked native master



01 **Match the revision**

Use the native C.4/C5A outlines with the corrected inventory. Keep the separate men’s L System Coat Rev C packet out of the cutting set.

02 **Verify physical scale**

Print each native sheet at Actual size / 100%, with Fit and Shrink disabled. Measure its 50 mm square in both directions. Confirm the paper’s native size before tracing.

03 **Walk and label the seams**

Mark seamlines, notches, drill points, grain and fold instructions. Walk each intended seam pair on the paper, including hood/gusset/collar and sleeve/armhole joins. Resolve mismatches before fabric.

04 **Prepare and lay out the fabric**

Follow the actual fabric care/preparation instructions. Let fabric lie flat without stretch. Align grainlines to the measured grain, place fold pieces on the correct fold and pair mirrored pieces deliberately.

05 **Cut the toile, then reconcile**

Cut inexpensive fabric first. Transfer registration marks within the allowed area. Count every material layer against pages 10–11 and bag by operation. Final laminate cutting follows fit and coupon acceptance.

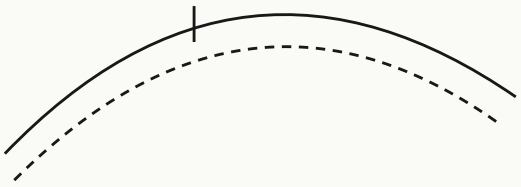
S01 p.10; S03 pp.4–6; S05 pp.5, 20–21. Diagram teaches handling only; no C5A cutting contours are drawn.

DG02-SEAMWALK / WORKSHOP METHOD

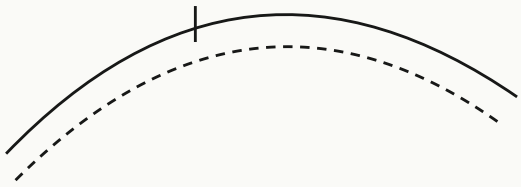
Verify the paper before the scissors

A contour envelope cannot reveal a seam curve, intended ease, a fold extension or a notch location. Use the actual native file.

WALK THE STITCH LINES, NOT THE CUT EDGES



Piece 1: notch-to-notch seamline



Piece 2: matching interval

01 **Check scale on every native sheet**

Print at the specified paper size and 100%, without fit/shrink. Measure the native 50 mm square in both directions. Investigate any discrepancy before using that sheet.

02 **Separate cut line and seamline**

Identify which outline includes allowance, then mark the stitch line on a work copy. For P, the source already includes 10 mm. Do not add an extra allowance to all pieces by habit.

03 **Walk one interval at a time**

Start at a shared seam intersection. Pivot one paper piece along the other stitch line without stretching or sliding past the curve. Mark where each notch lands. Record the interval lengths, not only the total perimeter.

04 **Explain every mismatch**

Compare the correct wearer sides and revisions. Check whether the master assigns ease, a fold or a turn-back. Sleeve-cap ease is not automatically a drafting error; an unexplained difference is not permission to trim.

05 **Transfer only verified marks**

Mark grain/fold, CF/CB, match points, pocket/service outlines and free-edge limits. On final fabric, use the accepted mark method and keep notches within the permitted allowance.

Pairs to walk first

A ↔ B shoulder and side seams; C cap ↔ assembled armhole; D ↔ E on both sides; hood ↔ F; F ↔ body neckline; P ↔ front opening; lining registrations ↔ shell. Preserve the native order where it defines an interface.

DG02-TOILE / WORKSHOP METHOD

Make the first sample easy to correct

The toile must prove the full silhouette and access, not just a sleeveless torso that cannot reveal the real problem.

01 **Cut and label the whole system of layers**

Use the native COWL master in inexpensive cloth. Include the cowl, sleeves, Q/W covers and representative inner service construction. Keep all material and wearer-side labels visible.

02 **Use alterable construction**

Use a removable basting setup on the toile for uncertain joins; secure enough to wear for the fitting. Mock the real zipper and closures at their actual attachment lines. Do not substitute a pinched centre front for the separating zip test.

03 **Fit shell alone first**

Check shoulder balance, front closure, sleeve pitch, hood movement and free-layer fall. Photograph drag lines before changing anything. Mark the proposed alteration on both sides of the affected seam.

04 **Fit with the inert carrier**

Use measured dummy shapes and mass. Check whether a problem exists only with the carrier: a bulge or collar pull should not automatically be “fixed” by enlarging the shell.

05 **Transfer one change, then recheck**

Record the cause, original line and revised line. Walk adjacent seams again and update matching lining/facing/cover pieces. Keep the untouched master and identify the physical toile revision.

Symptom	First distinction to make
Front zip waves	Is the tape stretched, the facing too short, or the torso fit pulling the closure?
Sleeve spirals	Wrong side/notch pairing versus genuine sleeve-pitch change.
Cowl drags at the throat	Collar/hood registration versus carrier bulk behind the neckline.
Rear layer pulls upward	Cover edge trapped in a seam versus load entering the shell.

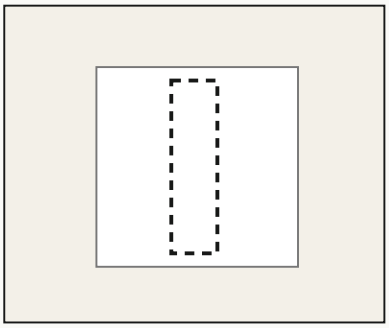
S01 pp.10, 18, 27; S00 DG01 pp.3–4, 15, 19. DG03 toile workflow.

REF 10 / SEW / OP-10 + OP-11

Make both front pockets while flat

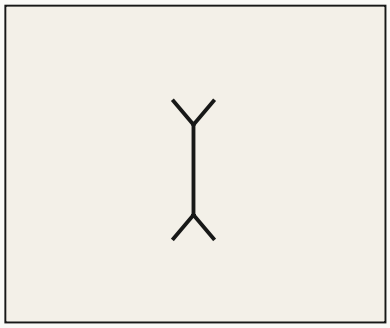
INPUTS: A × 2 • V × 2 shell + 2 reinforcement • U × 4 lining • N02 × 2

1. STITCH OPENING



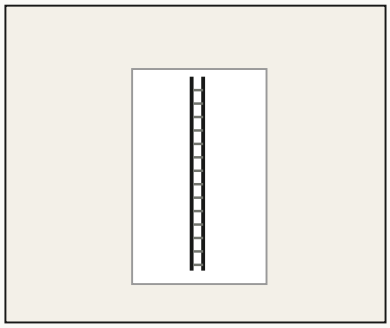
Facing V on A; marked seam only.

2. SLASH + TURN



Do not cut through the stitches.

3. SET ZIP + BAG



N02 behind; U forms the bag.

01 **Prepare the mirrored fronts**

Lay the two A pieces right side up and identify wearer left/right. Transfer the native pocket opening, zipper and flap registration marks. Place the V backing where specified; do not add unapproved fusible layers.

02 **Sew before slashing**

Place the matching V facing right sides together with A. Stitch the marked opening accurately. Check both fronts for height and alignment before cutting either opening. Slash and clip toward the corners without severing the seam.

03 **Turn and position the zipper**

Turn the facing inward and flatten using a method already accepted on the fabric coupon. Centre the 180 mm zipper behind the opening. Baste, check the exterior and secure without puckering or catching the opposite side.

04 **Build and close the pocket bags**

Attach the two U bag halves to the intended edges/zipper-tape arrangement, keeping the shell out of the bag-closing seam. Close and finish the bag perimeter. Keep the bag clear of MOLT anchors and channels.

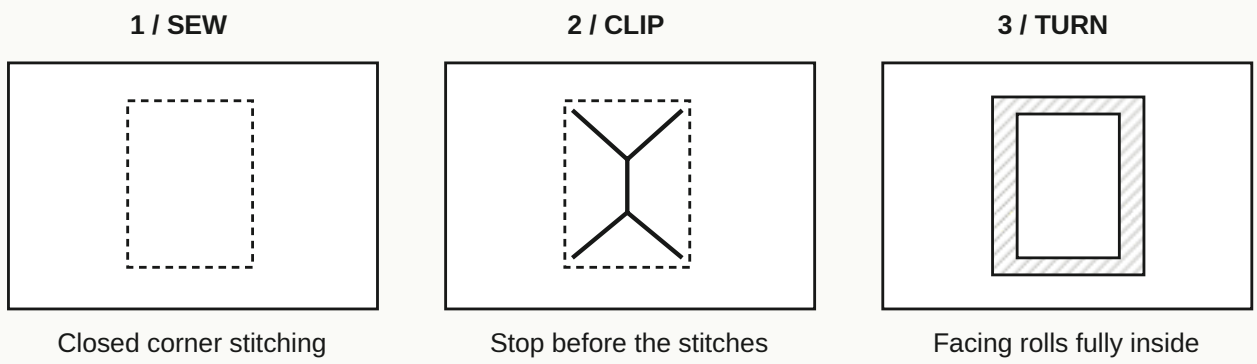
> **Check before the next seam**
>
> Cycle each zipper 10 times. Both openings should be level and flat; neither bag may show through or pull the shell. Hand access must not interfere with a later carrier module.

DG02-POCKET1 / WORKSHOP METHOD

Sew the pocket opening before cutting it

Work on one flat front at a time, but compare both fronts before slashing either opening.

A front • V shell facing • V local backing • native opening marks



01 **Build the correct sandwich**

Place local 210D backing on the wrong side of A at the native pocket location. Put V shell facing right sides together with A. The backing remains behind A; it is not the face that turns through the opening.

02 **Sew the marked opening**

Use the native opening shape and the accepted stitch setup. At each corner, stop with the needle down, lift the foot and pivot without dragging the cloth. Do not sew across zipper teeth: the zip is not installed yet.

03 **Inspect before slashing**

Check closed stitching at every corner, level/angle against the other front and sufficient intact facing beyond the seam. Correct a sewing error now rather than trying to hide it after the hole exists.

04 **Slash and turn**

Cut the centre of the stitched opening, then clip toward its corners without severing a stitch. Feed V through to the inside. Ease the corner tabs flat with a blunt tool; do not push a sharp point through the laminate.

05 **Stabilise the opening**

Roll the seam to the intended side and flatten with the accepted coupon method. Do not force heat or hard creases into an unidentified coating. Proceed only when the opening lies flat without exposed facing.

S01 OP-10/11 pp.11–12; S00 DG01 p.11. DG03 layer orientation and turning detail. Generic opening diagram, not a cut template.

DG02-POCKET2 / WORKSHOP METHOD

Install the zip and build the bag

The zipper controls hand entry. The two U pieces form the pocket volume behind it; the outer shell must stay free of the bag-closing seam.

01 **Place the pocket zipper**

Centre N02 behind the finished opening. Check the planned slider direction on both sides, tooth clearance and the native end positions. Baste without stretching the tape or pocket mouth.

02 **Secure the opening**

Use a zipper foot and the native attachment/topstitch path. Stop and move the slider with the needle down when necessary. Check from the front after sewing each long side.

03 **Attach each bag half separately**

Place the first U half at its corresponding zipper tape/facing edge with the bag's right side facing into the future pocket cavity. Move A aside while sewing. Attach the second U to the opposite edge without closing the entry.

04 **Close the pocket perimeter**

Bring the two U halves right sides together, align their native notches and sew the perimeter only. Keep A, Q placement and future MOLT interfaces outside this seam. Finish the exposed bag edge using the accepted method.

05 **Prove the completed pocket**

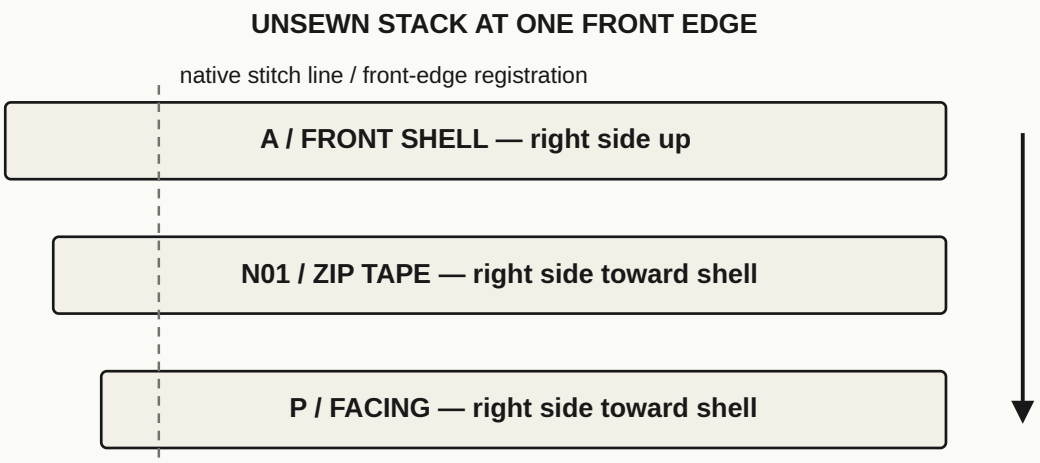
Turn the bag into its wearing position and cycle the zip 10 times. Insert the hand, remove it and sit/reach in the toile. The bag must not show, lift the hem or foul the centre-front zip.

Fault	Repair the cause
Corner puckers	Check clipping depth and trapped allowance; do not cut beyond the seam to make the pucker disappear.
Bag is sewn shut	Separate the attachment and perimeter seams; verify the entry route before re-closing.
Zip bows the front	Release stretched basting/tape alignment and re-baste flat. Do not shorten the opposite front to match.

REF 11 / SEW / OP-12 + OP-13

Front zipper, facing and asymmetric flap

INPUTS: prepared A fronts • P × 2 mirrored • N01 × 1 • Q × 1 shell + 1 matching lining



Baste and check the closed zip before catching the stack in its final seam.

01 **Balance the closed front**

Close the 700 mm two-way separating zipper. Align both front hems and the collar/reference notches. Baste one tape to its A front without stretching the tape or laminate, then align and baste the other side.

02 **Install the facings**

Use the corresponding P facing right sides together over each zipper tape. Sew the native front-edge seam, turn the facing inward and secure/understitch only where the construction allows. Keep the separating box and both sliders usable.

03 **Build Q in the correct handedness**

Pair Q shell and lining so their outline and finished side agree. Sew the specified perimeter, retain its attachment/turning opening and turn without rounding away the intended corners. Match its marked attachment path to the designated front.

04 **Preserve independent access**

Check the closed flap, both slider positions and the service route underneath. Q is a cover layer, not the suspension strap for a module. Finish its free edges without accidentally catching the zip or an inner channel.

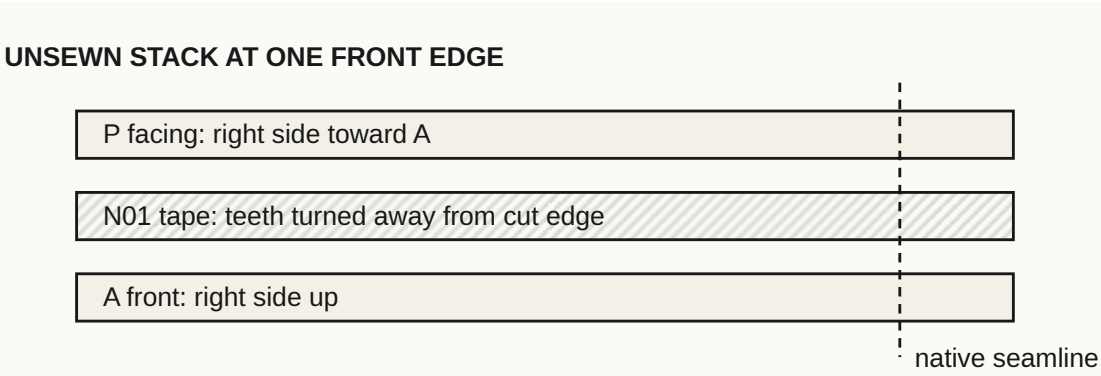
> **Facing allowance**
>
> P already includes its stated 10 mm seam allowance. Keep it in the shell fabric. Do not double the allowance or add an untested stiffener to force a sharper rendering-like shape.

S01 pp.13–14; S05 p.20. Exploded stack is a sewing relationship, not a dimensioned pattern.

DG02-ZIP / WORKSHOP METHOD

Balance a two-way separating front zip

The closed zip is the alignment jig. Use it to compare the two fronts before the final seam fixes their relationship.



After sewing: turn P inside; retain free travel for both sliders.

01 **Mark shared references**

Close N01 and align both front hems, upper collar reference and all native balance points. Transfer small removable marks to both tapes. Confirm that the separating box will remain accessible.

02 **Baste one tape, then match the second**

Attach the first tape to A without pulling. Close the zipper again and pin/clip only in the accepted areas to align the second side at the same references. Lay the whole front flat.

03 **Sew each facing stack**

Place the corresponding P over its tape, right sides toward A. Sew the native front-edge line with the zipper foot. Turn P inside and roll the edge without pulling the tape. Understitch or topstitch only where the native construction calls for it.

04 **Finish the ends deliberately**

Keep upper stops from pressing on the wearer and leave the lower box/insertion pin usable. Contain tape ends within the facing construction; do not fold them across slider travel.

05 **Check before adding the flap**

Close the garment flat, compare hem and collar reference heights, then operate both sliders and fully separate/rejoin the zip. Q must not be needed to hide a twisted or mismatched front.

> **Do not “correct” by stretching**
>
> P’s 10 mm allowance is already included. A facing, zipper or front that does not match at native stitch lines requires diagnosis, not extra allowance or stretched tape.

DG02-Q / WORKSHOP METHOD

Turn Q without reversing the design

An asymmetric piece can be cut in the right quantity and still end up on the wrong side. Confirm its finished orientation before sewing.

01 **Lay out the finished view**

Place the Q shell right side up beside the corresponding A front, in the way it will appear when worn. Mark attachment edge, free edge and top. Place the lining in its eventual underside orientation and check that the outlines match.

02 **Pair for sewing**

Bring Q shell and lining right sides together, preserving the correct correspondence. The pieces may look mirrored on the table because their faces oppose; the finished overlay must not change handedness.

03 **Sew only the controlled perimeter**

Retain the designated attachment/turning edge. At corners, pivot accurately. Grade or clip only where the allowance and material trial permit, without weakening the attachment seam.

04 **Turn and shape**

Turn through the intended opening and ease out corners without piercing. Flatten using the accepted material process. Close the turning edge only in the way the native construction allows.

05 **Baste, hang, then attach**

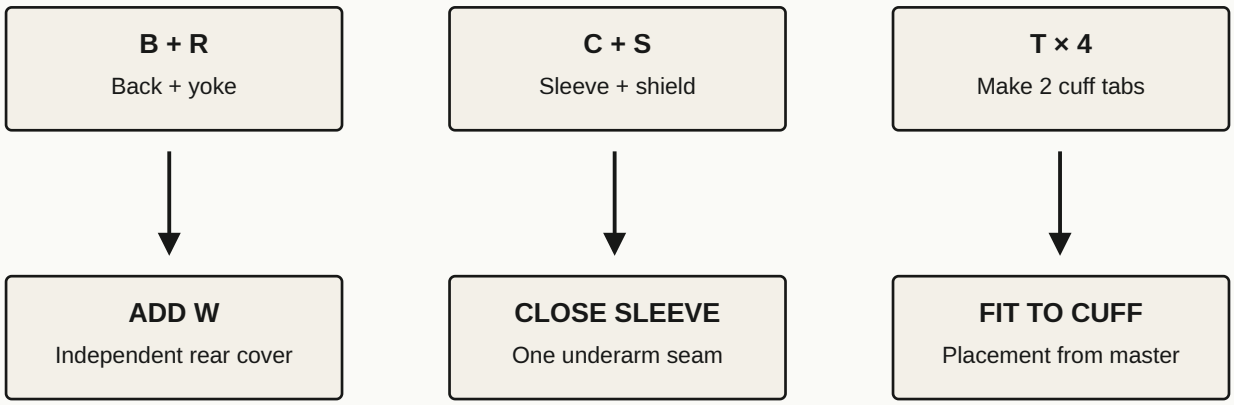
Baste along Q's marked attachment path on A. Close N01 and check standing and seated drape, hand-pocket entry and service access. Sew permanently only after the layer hangs independently.

Before the final seam	Required observation
Zip fully closed and lower slider raised	Neither slider catches Q or its lining.
Hand reaches both pockets	The overlay does not distort or obstruct the openings.
Shell worn over inert carrier	No caddy or power pod is suspended from Q.
Free edges inspected inside and outside	No stray stitch captures Q into a side seam, channel or lining join.

REF 12 / SEW / OP-14 + OP-15

Back covers, sleeve shields and cuff tabs

INPUTS: B • R • W shell + lining • C × 2 • S × 2 • T × 4



Assembly relationships only. Native contours, overlaps and seam marks govern.

01 **Prepare the back/yoke group**

Place B and R using the native registration marks and specified seam/overlap relationship. Check centre back and shoulder balance. Leave the intended layer edges free rather than flattening the yoke into a decorative topstitch.

02 **Assemble the rear quiet cover**

Pair W shell and lining, finish the designated perimeter and attach on its native path. Check the cover’s swing and access before closing surrounding layers. It must not obstruct an RA anchor or a service extraction route.

03 **Prepare each sleeve flat**

Apply each S shield to its matching C sleeve while the sleeve is flat. Preserve wearer-side labels and front/back sleeve notches. Make T as two paired, finished cuff tabs from four shell pieces.

04 **Close each sleeve once**

Fit the tab attachment at the native cuff location, then close the sleeve underarm seam. Retain the cuff/lining construction access. Finish the two sleeves as a mirrored pair ready for insertion.

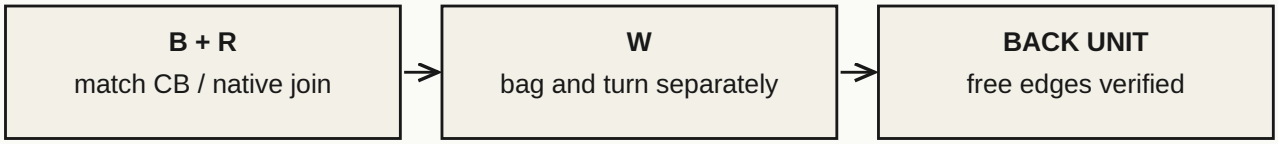
> **DG01 resolves the assembly-order ambiguity**
>
> This guide uses a closed-sleeve, set-in insertion route: close each sleeve here, close the body side seams on page 32, then insert the sleeve. Do not close the underarm a second time. This is a process clarification, not a change to the sleeve cap.

S01 pp.15–16, 18. DG01 specifies one consistent sleeve assembly route.

DG02-BACK / WORKSHOP METHOD

Assemble the back without trapping W

R and W contribute to the layered back. Their native attachment paths determine which edges join and which edges must move.



01 **Preserve centre back**

Open the fold-cut B without creating a new centre seam. Mark CB and its grain reference. Match R's fold and registration marks to B before sewing.

02 **Join the specified yoke seam**

Walk the actual R/B stitch lines. Baste at notches, then inspect the seam from the exterior. Do not add a perimeter topstitch simply because the reference image shows a crisp edge.

03 **Bag W as a separate cover**

Match its shell and lining faces for sewing. Leave the designated turn/attachment opening; finish the controlled perimeter, turn and shape. Keep any planned closure out of the future sensor and withdrawal path.

04 **Check W before fixing it**

Baste W on its native line, hang the back assembly and lift the cover through its full movement. Check against the carrier mock-up rather than placing arbitrary new hardware on the body panel.

05 **Keep the next seams clear**

Before shoulders or sides close, trace the free edge with a finger. Clip W away from unrelated seams and identify where each RA/service area will remain accessible.

> **Find the source of a pulled back layer**
>
> Check a captured free edge, a twisted lining or a strap bearing on the shell before changing the cover length. A rear drape defect is not automatically a pattern-length defect.

DG02-SLEEVE / WORKSHOP METHOD

Prepare both sleeve assemblies while flat

Finish the shield and cuff-tab attachment before closing the underarm. The sleeve is then inserted as one closed unit.

01 **Pair C with S**

Match wearer side and native cap/forearm references. Lay each sleeve right side up and place S at its actual marks. Baste and compare the two sleeves before stitching.

02 **Attach the shield on its marked path**

Keep free edges free. Do not sew every shield edge to the sleeve or add dense decorative stitching that prevents the layered section moving.

03 **Make two tabs from four T pieces**

Pair two pieces right sides together for each tab. Sew the native perimeter, preserving its attachment/turning opening. Turn with a blunt tool and finish only the specified edges.

04 **Register the tabs**

With the sleeve still flat, mock the cuff in its finished state. Check tab direction and mating closure position. Attach through the intended cuff reinforcement; hardware style and fixing follow the accepted coupon.

05 **Close the underarm once**

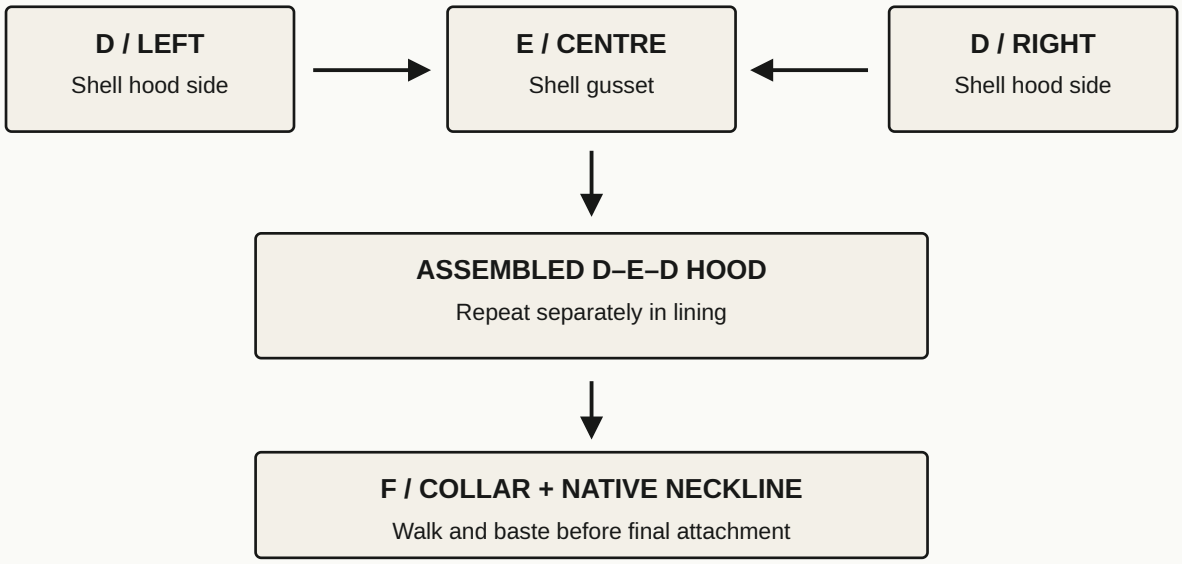
Bring the sleeve right sides together, match underarm stitch lines and sew. Preserve native articulation. Leave the cuff/lining interface accessible. Mark front, back, cap and underarm references for insertion.

Check	What to look for
Paired units laid beside one another	C/S wearer-side labels correct; tab lengths and intended finished cuffs correspond.
Sleeve held from the cap mark	No unexplained spiral caused by swapped notches or offset underarm edges.
Cuff folded into final position	Tab can operate without entering the lining seam or catching a cable route.

REF 13 / SEW / OP-16

Build the hood and collar as a matched set

INPUTS: D × 2 shell + 2 lining • E shell + lining • F shell on fold + lining on fold



01 **Join the hood shell**

Match the left D to one side of E using the native notches and stitch line; join the right D to the other side. Distribute only the ease defined by the master. Do not stretch one piece until the ends happen to meet.

02 **Repeat in lining**

Construct the lining hood separately. Identify its face opening and lower attachment edge. Keep the shell and lining corresponding centre, front and lower registration marks visible.

03 **Prepare F and verify the neckline**

Prepare the collar layers on their true fold lines. Walk the hood/collar/body connections in the sequence specified by the native pattern. No verified seam length is supplied by this reading guide.

04 **Baste and test the coverage**

Baste the hood/collar group to the shell before permanent attachment. Close the front and turn the head both ways; test looking down, raising the hood and opening the front. Confirm that the high-coverage shape does not bind at the throat.

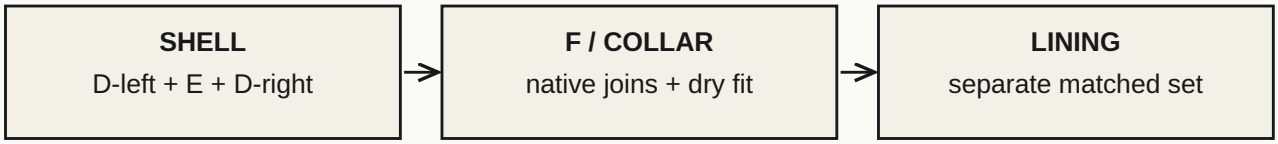
> **No guessed neck conversion**
>
> Do not import the System Coat Rev C's 48.1 cm neck or its sleeve-cap figures into this C5A build. Different piece sets cannot be reconciled by copying a convenient dimension.

S01 p.17; S06 p.2. Diagram maps piece relationships only; the exact collar/hood interface awaits the native master.

DG02-HOOD / WORKSHOP METHOD

Walk, baste and turn the cowl assembly

Treat D–E–D and F as one fit problem. A neat hood seam does not prove that the finished collar and neck opening work together.



01 **Label all six hood layers**

Keep shell D-left/D-right/E separate from their lining equivalents. Mark the same centre, front and lower match points on both sets.

02 **Join each D to E**

Sew one native notch interval at a time on the shell. Support the curve rather than stretching it. Repeat in lining with allowances oriented to avoid a hard ridge against the head.

03 **Match to the collar**

Prepare the shell and lining F on their true folds. Use the native hood-to-collar and collar-to-neck stitch lines. Baste the shell hood to shell F and lining hood to lining F where the native construction specifies.

04 **Trial the finished opening**

Before concealing allowances, place the assembly on the body neckline. Close the zip, raise/lower the hood, look down and rotate the head. Confirm the high collar clears the carrier mock-up and does not load the throat.

05 **Finish in the accessible order**

Join/turn the shell and lining around the controlled opening. Keep any cord exit and lower attachment seam accessible until their coupons and registration are settled. Attach to the body only after the dry fit works.

> **Curve handling**
>
> Clip concave allowances only where needed to let them open; remove bulk from convex allowances only where required to turn. Neither action should touch the stitch line or redefine the contour. Test on the toile first.

REF 14 / SEW / OP-17 + OP-18

Assemble the shell and test movement

01 **Join the shoulders**

Match front/back shoulder registration without stretching the seam. Check the yoke and storm-flap free edges remain free. Inspect the neckline before attaching the hood/collar group permanently.

02 **Close the body side seams**

With the sleeves still separate, join the shell side seams in the native order, keeping pocket bags, channels and cover layers out of the seam. Confirm hem levels and wearer-side labels.

03 **Set in the closed sleeves**

Insert each completed sleeve into its correct armhole, right sides together. Match underarm, shoulder and all front/back cap notches. Baste and check rotation. Sew only after the paper/toile seam walk explains the intended ease.

04 **Complete the hood/collar attachment**

Use the verified registration from page 30. Recheck the front-zip top, high collar, cowl fall and available head movement before finishing inaccessible seam allowances.

05 **Prepare hem adjustment**

Use the marked hem/casing and reinforced exits. Fit the 2 mm shock cord and locks without trapping carrier attachment points or electronics. Use only the fixing/eyelet treatment accepted on the coupon; do not infer hole diameter from the stock listing.

06 **Try the shell before concealing the inside**

Close the front, sit, reach forward, raise each arm and rotate the torso. Compare front, rear and profile to V01. Record drag lines, sleeve twist and any layer caught in a seam, then correct the toile rather than pulling harder on the closures.

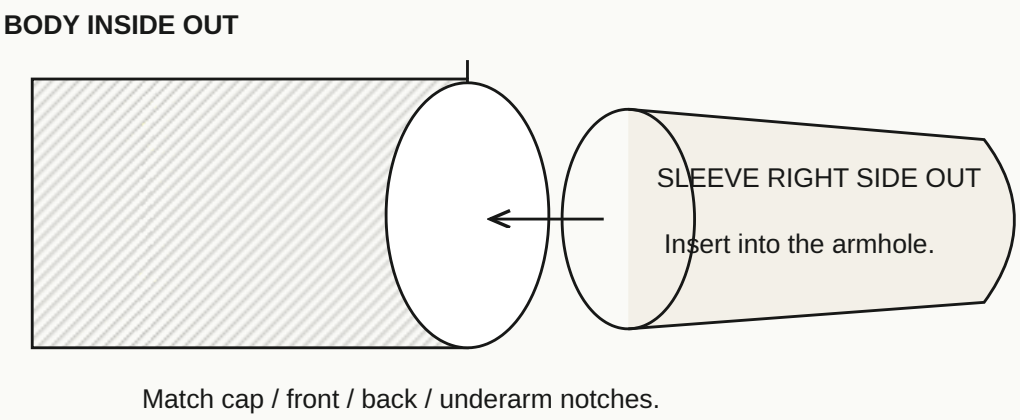
> **Exit check**
>
> The shell hangs as intended without MOLT carrying it into shape. The pockets and zipper work, the hood moves, and the cord adjustment can be cycled 20 times without a pulled exit or snagged cover layer.

S01 pp.18–19; S01 p.27 for loaded movement; DG01 closed-sleeve/set-in process route.

DG02-SETIN / WORKSHOP METHOD

Set the closed sleeve into the closed body

This edition uses one consistent method: prepare and close the sleeves; close the body sides; then set in each sleeve.



01 **Complete the body opening**

Join shoulders and body side seams using native registrations. Keep bags, overlays and channels out of the seam. Check that the armhole still carries all original match points.

02 **Nest right sides together**

Turn the body inside out and the matching sleeve right side out. Insert the sleeve into the armhole so shell right sides touch. Keep wearer-side labels visible.

03 **Match fixed points first**

Align the sleeve underarm, cap/shoulder and front/back notches. Distribute only the ease established by the native seam walk between its assigned points. Do not gather the entire cap or stretch the body opening.

04 **Baste and inspect rotation**

Baste the full seam, turn the shell right side out and fit it. Check that the cuff faces the intended direction and the sleeve moves without spiralling. Correct rotation before permanent stitching.

05 **Sew and finish the seam**

Return to the sewing orientation. Sew the native allowance, checking that no opposite sleeve or shield edge is caught beneath. Finish/inspect while accessible; do not close the underarm a second time.

S00 DG01 pp.13, 15; S01 OP-15/17. DG03 execution of the retained closed-sleeve route. Diagram is a sewing orientation, not armhole geometry.

DG02-HEM / WORKSHOP METHOD

Build adjustment without damaging the edge

Use the native hem line and casing layout. Intentional asymmetry is not a defect to trim away.

01 **Check the relaxed hem**

Hang the shell in its fitting state, then compare the base hem and each free layer to the recorded toile. Mark only accepted redlines. Keep COWL independent of carrier strap tension.

02 **Prepare the casing**

Turn or face the hem exactly as the native pattern specifies. Baste the casing while checking its continuity and clearance from service frames, pocket bags and attachment points.

03 **Make the cord exits on a coupon first**

Use the actual 2 mm cord, fixing article and tool. Establish the hole/setting and reinforcement stack on scraps before punching the garment. The cord diameter does not determine the eyelet hole diameter.

04 **Thread and retain the cord**

Route N06 through the intended channel and N07 locks. Secure ends by the approved construction so they cannot disappear into the casing. Do not tie an oversized improvised knot where it presses on the body or blocks the slider.

05 **Check the full travel**

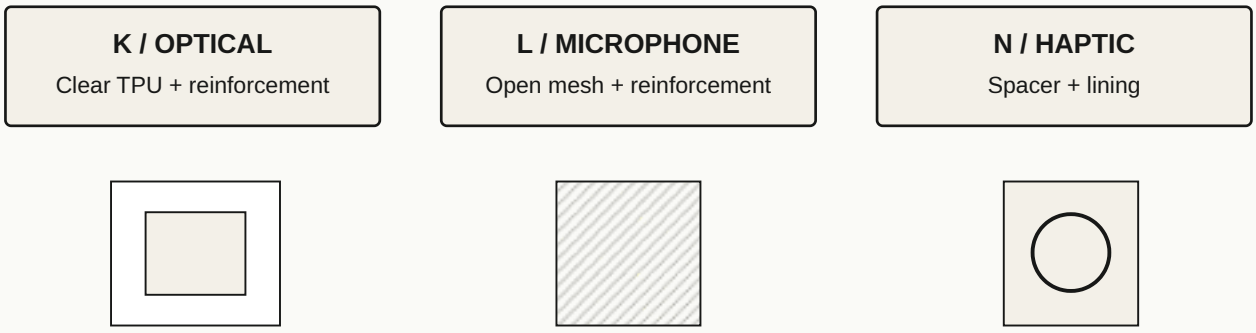
Operate adjustment 20 times, from relaxed to the intended fitted state. Inspect both exits, casing joins and locks. The cord must not abrade the laminate, lift a free layer or tighten around a connector.

Fault	Check before repair
Cord will not pull	Trapped seam crossing, narrow join or incorrectly assembled lock.
Hem ripples even when relaxed	Casing shortened during stitching or cord ends retained under unintended tension.
Exit rotates or whitens the coating	Fixing/backing mismatch. Rework the coupon; do not set the hardware harder in the same damaged hole.

REF 15 / SEW / OP-20 + OP-21

Build the inner service zones while flat

INPUTS: LA / LB / LC • G / H / J • RA × 6 • K / L / N material pairs



Keep stitch / glue out of aperture.

Blank size ≠ clear opening. Locate the actual sensor / actuator first.

01 **Register the service frames**

Use the native placement marks on the lining flats for G, H and both J frames. Fit their reinforcement before cutting a service opening. Confirm wearer left/right and the carrier’s future extraction direction.

02 **Fit the six RA reinforcement zones**

Transfer all six anchor marks from the approved master or a fully documented carrier/toile fitting. Reinforce the intended interface. Do not choose arbitrary shoulder/waist coordinates from a photograph.

03 **Make K and L around the actual sensing path**

Register the optical aperture to the AS7343 and the microphone opening to the real microphone port. The 80 mm and 70 mm blanks are not aperture sizes. Keep stitching, opaque adhesive and conductive fabric out of the working openings.

04 **Make N serviceable**

Use the 70 × 70 mm spacer/lining pair for the single reference haptic actuator. Prove contact, retention and removal with an inert or unpowered module before closing the support layers.

Check before joining lining panels

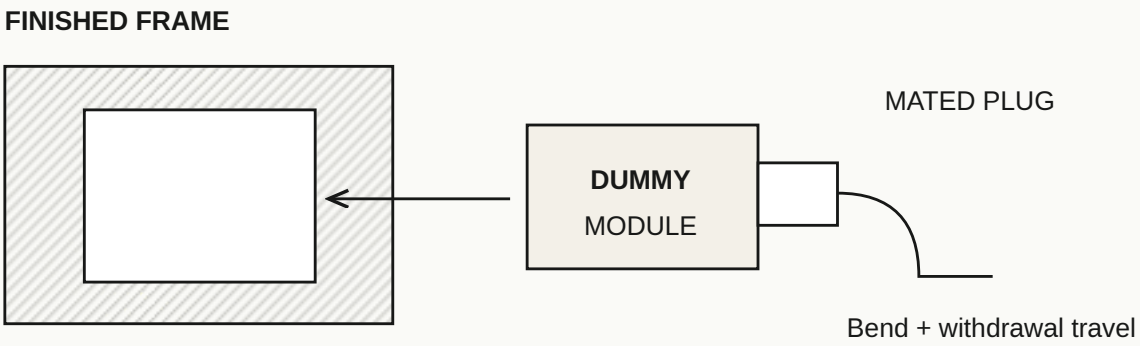
Every service zone should open from the intended side, preserve its sensor path and transfer no unsupported module load into the comfort lining. Bind or finish repeated-access edges using the accepted material coupon.

S01 pp.20–21; S03 pp.5–6. Aperture shape, closure and exact placement are not released by blank dimensions.

DG02-SERVICE / WORKSHOP METHOD

Prove the service opening at its finished size

G, H and J are flat pattern envelopes. Neither the rectangle nor its label proves that the complete caddy can pass through it.



Test the clear opening after binding, closure and body curvature.

01 **Transfer the real opening**

Use native marks and the fitted carrier location. Register G to wearer inner-left, H to the right/upper service zone and J to opposite low flanks. Do not cut an aperture from the envelope dimensions.

02 **Reinforce before opening**

Apply the specified reinforcement to the wrong side of the support layer. Mark closure and extraction direction while flat. Keep the future load path independent of unsupported comfort lining.

03 **Finish a representative aperture**

Use the real edge finish and closure on a coupon or toile opening. Include all layers that will consume space, including a flap or binding turn. Measure the resulting clear opening.

04 **Pass the whole assembly**

Insert the inert module with its plug, retention hardware and representative cable bend. Test removal in the intended orientation while the opening follows body curvature, not only flat on the table.

05 **Register the working interface**

Only after this trial should the garment-side opening and MOLT mating position be finalised. Record clear width/height, module orientation, unplugging travel and the failure that any redline corrects.

> **Do not enlarge first and ask later**
>
> Identify whether the obstruction is the frame, closure, plug, route or caddy. The smallest mechanical correction should preserve the shell’s design and native seam allowances.

S00 DG01 pp.7, 16, 20; S01 OP-20/31. DG03 clearance method; diagram has no cutting scale.

DG02-SENSORWINDOW / WORKSHOP METHOD

Build K, L and N around their actual jobs

The optical window, acoustic port and haptic contact pad require different structures. Keep their blanks and tests separate.

Zone	Assembly method	Functional check
K / optical	Use the 80 × 80 mm reinforcement/TPU blank inventory. Locate the actual sensing aperture, keep stitching/opaque adhesive out of it and retain the film by the accepted coupon method.	Compare sensor readings with and without the final film in unchanged illumination, angle and sensor settings. Record the difference; clear is not automatically neutral.
L / microphone	Use the 70 × 70 mm reinforcement/mesh blank inventory. Match the real microphone port and keep the acoustic path open. Finish mesh edges without pulling the weave closed.	Record quiet baseline and the same controlled sound before/after the completed port. Check rubbing noise during movement separately.
N / haptic	Use the 70 × 70 mm spacer/lining pair. Retain the one reference actuator so it can be removed, while avoiding hard edges and strain on its leads.	Check deliberate activation, mute/off state and contact in the fitted carrier. A padded enclosure that prevents contact can make a working actuator feel ineffective.

01 **Record the stack**
Photograph each part outside and inside. Enter film thickness, mesh article and spacer/contact arrangement alongside the actual module marking.

02 **Keep servicing possible**
Before lining closure, remove and reinstall the sensor/actuator without cutting or unpicking textile. Protect the sensor face from tools and adhesive residue.

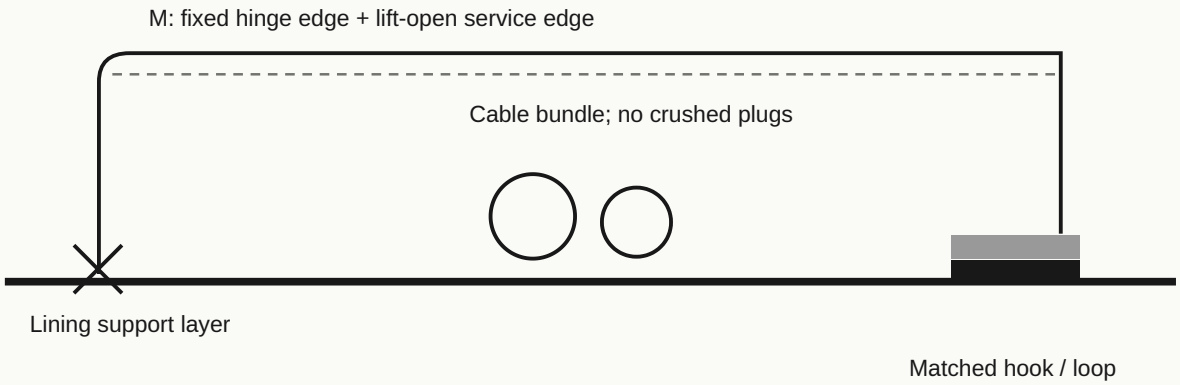
03 **Repeat after a material change**
A different film, mesh, adhesive, position or nearby conductive patch changes the tested arrangement. Repeat the affected baseline rather than carrying forward a previous result.

REF 16 / SEW / OP-22

Route cables so the system can come out

INPUTS: M × 4 total • N04 mating closure • N05 retention • labelled dummy leads

SERVICEABLE CHANNEL — CROSS-SECTION, NOT TO SCALE



DG01 construction proposal: validate the closure and usable width on a coupon.

01 **Trace the route on the fitted lining**

Use a dummy cable of the actual bundle diameter and connector size. Keep the path away from flexing joint creases, sharp hardware, pocket entry and moving zippers. Match the intended G/H/J extraction direction.

02 **Prove one channel before making four**

Use one M piece in the 45 × 500 mm source envelope. Prototype the edge finish and service closure. DG01 proposes a fixed hinge edge and lift-open opposite edge so a pre-terminated harness is removable. Its usable width must be measured on the coupon.

03 **Retain the cable, not the electrical contact**

Add retention and strain relief before the cable reaches the connector and at moving transitions. Leave a measured service loop; the plug must not be the first point taking a pull. Respect the cable manufacturer’s bend requirements.

04 **Perform the withdrawal test**

Open the channel and withdraw the full dummy loom with connectors attached. Repeat at each service frame. Correct any narrow throat or trapped junction before closing the lining.

> **Do not convert a removable loom into sewn-in electronics**
>
> A channel stitched shut at both long edges can trap a large connector. Do not copy the 45 mm blank width as proof that a finished 20 mm closure plus the bundle will fit.

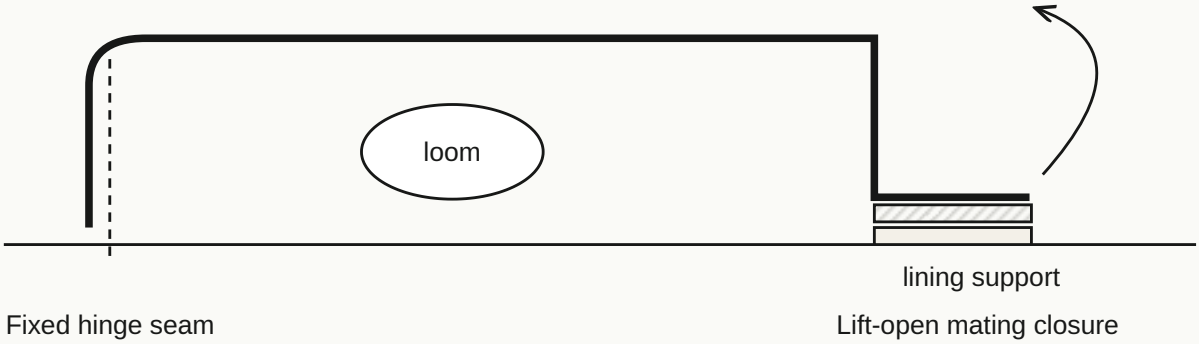
S01 p.22; S02 N04/N05; S03 p.6. Openable flap construction is a DG01 proposal requiring a closure coupon, not a claimed released pattern.

DG02-CHANNEL / WORKSHOP METHOD

Make one lift-open channel coupon first

DG01 proposes a fixed hinge edge and a lift-open opposite edge. Validate that construction before making the four garment channels.

OPENABLE CHANNEL / METHOD SECTION



01 **Use a short practice strip**

Cut a 45 × 180 mm lining offcut for the trial. Its width matches M's envelope; its length is a DG03 practice length, not a new garment pattern. Use the actual closure, edge finish and support fabric.

02 **Build the two edges differently**

Finish both long edges using the candidate method. Stitch the fixed edge to the support as a hinge. Attach the mating closure to the opposite edge and support, leaving enough wrap for the real bundle without forcing the closure shut.

03 **Add the representative loom**

Use the real cable diameter and its largest pre-terminated plug. Close the flap over the cable without flattening it. Keep the connector at an accessible service point rather than forcing it beneath a narrow sewn throat.

04 **Open, remove and replace**

Lift the flap completely, remove the whole loom with plugs attached and replace it. Repeat with the support bent as it will be worn. Check that the closure does not peel open under normal bending.

05 **Record usable width**

Measure the finished channel and identify edge-turn, hinge and closure consumption. If 45 mm cannot accommodate the stack, raise a recorded M revision. Do not silently increase the width or stitch the channel shut.

S00 DG01 p.17; S01 OP-22 p.22. DG03 practice coupon implementing the DG01 openable-flap proposal; not a released M contour.

REF 17 / SEW / OP-23 + OP-24 + OP-40

Finish the shell without trapping the system

01 **Assemble the lining**

Join LA, LB and LC according to the native construction, preserving the extended-back fold/ease and every marked service opening. Keep frames, channels, pocket bags and free cover edges out of unrelated seams.

02 **Complete any approved seam sealing while accessible**

After fit and material coupons pass, seal only the specified weather seams with the exact compatible tape/process. Do it after the relevant stitch operations and before the lining hides them. Do not use a universal temperature or treat seam-stick tape as waterproofing.

03 **Connect lining to shell**

Register neck, front facings, cuffs and hem without pulling the lining taut. Maintain the native lining ease. Leave the specified turning and service access until the complete assembly is checked.

04 **Check every opening and moving part**

Cycle front and pocket zippers, cord locks, cuff adjustment and service closures. Confirm that no tape, lining stitch or label covers K/L, closes a cable channel or traps an RA attachment.

05 **Perform the shell-only separation test**

Remove every carrier module, power source and detachable loom. The shell must remain a complete wearable garment. Nothing requiring electronic service should force a seam to be unpicked.

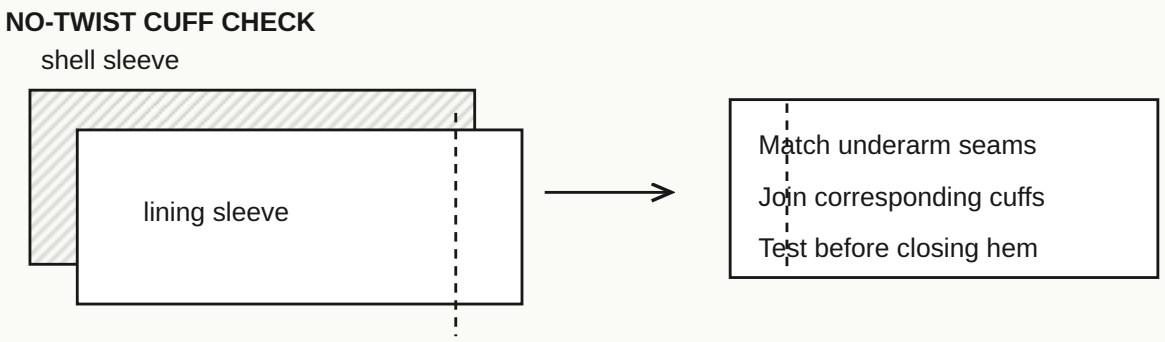
> **Sewing finish is not a weather-performance pass**
>
> Inspect skipped stitches, exposed raw edges, puckering, pulled coating and closure snagging. Any later stitch through a sealed zone needs a documented local reseal and recheck. Retain the tested material-stack coupon with the sample.

S01 pp.23–24, 27. DG01 sealing-before-concealment clarification retained; native construction controls attachment seams.

DG02-LINING / WORKSHOP METHOD

Join the lining without twisting the cuffs

Keep enough construction access to verify the lining before the final turning opening or hem edge is closed.



A hand must pass shoulder → sleeve → cuff with no twisted lining tube.

01 **Make the lining body consistently**

Join LA/LB shoulders and sides, close each LC underarm, then set in its closed sleeve with the correct notches. This is the DG03 matching closed-sleeve process; preserve native lining ease and the extended LB fold.

02 **Nest the completed layers**

Place the lining within the shell in its wearing orientation. Match neck, facings, shoulders, underarms and hem registrations. Clip service flaps and channels clear of the seams.

03 **Pair each cuff before turning through**

Reach through the retained construction opening, match the correct shell and lining sleeve ends and bring their corresponding seam allowances together. Mark the underarm correspondence. Verify the sleeve tube has not been rotated.

04 **Baste the cuff join and test**

Return the sample to its wearing orientation and pass a hand through each sleeve. Check sleeve extension and that lining does not drag the cuff upward. Sew the native cuff join only after the path is correct.

05 **Close progressively**

Finish the native facing, neckline, cuff and hem attachments while retaining the last planned turning/service access. Inspect all four cable channels and G/H/J openings before the final edge closes.

> **No invented bagging opening**
>
> The position and length of the turning opening must suit the native lining construction and the finished garment bulk. Mark it on the work copy; a service hatch is not automatically a suitable turning hole.

S01 OP-23/24 pp.23–24; S00 DG01 p.18. DG03 lining process clarification and cuff twist test; native joins/ease unchanged.

DG02-SEAL / WORKSHOP METHOD

Seal while you can still reach the seam

Plan access seam by seam. A finished lining must not prevent the tape process, inspection or any later correction.

01 **Confirm the accepted stack**

Use the exact shell lot, thread, tape article and settings from the coupon record. Keep unrelated windows, cord locks and hard components away from the heated process.

02 **Mark the intended weather seams**

Use the source/native seam scope. Identify joins hidden by facings, covers or the lining. Do not assume every seam should be taped or every open service aperture has become waterproof.

03 **Complete the relevant stitching first**

Inspect the actual seam before applying tape. Resolve skipped stitches, trapped allowances and puckers. Do not tape over a sewing defect or a seam that still needs fitting changes.

04 **Apply and inspect before concealing**

Use the approved temperature/pressure/time or speed, with proper support for corners and intersections. Let the seam return to its inspection state before flexing and checking adhesion or distortion.

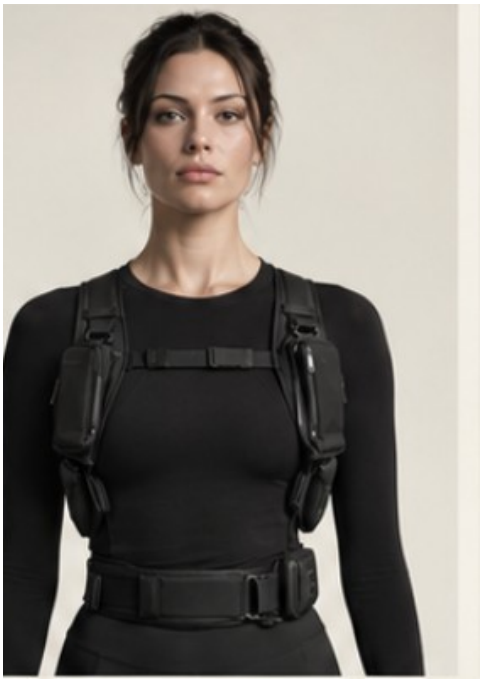
05 **Control subsequent needle holes**

Any later stitching through the sealed zone changes the seam. Record and locally reseal/recheck using the accepted process before closing the lining.

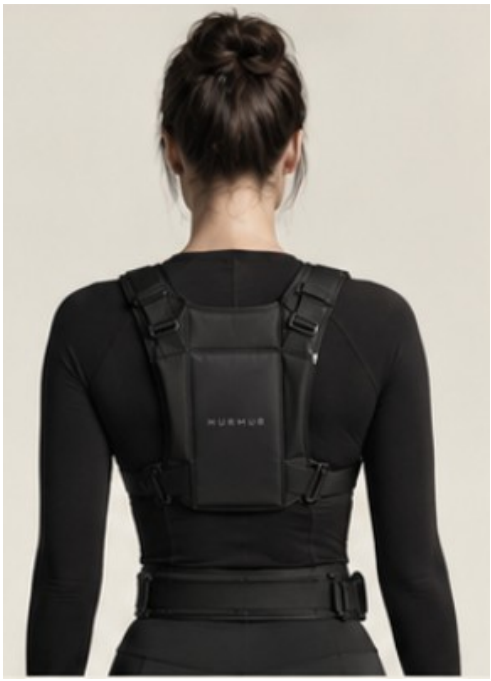
Access decision	Practical order
Pocket/facing join will conceal the back of a seam	Complete the required local seam work while the front remains flat.
Shoulder or sleeve seam needs tape	Finish that seam and inspect/tape before the lining blocks access.
Final attachment crosses an already taped area	Include local reseal and reinspection in the operation; do not count the earlier tape check twice.
Exact tape/process not accepted yet	Keep the toile or coupon work moving; leave final laminate sealing unclaimed.

REF 18 / MOLT / OP-30 + OP-31

Build and fit the removable carrier



Front reference / V02



Back reference / V02

01 **Use the carrier’s own pattern**

Do not use G/H/J service-frame envelopes as caddy-pocket patterns. Assemble the spine, shoulder support and lower stabilisation from the carrier master, with its real reinforcement and contact layers.

02 **Fit the webbing before final trimming**

Use the 25 mm nylon webbing, four buckles and four triglides in the intended adjustment layout. The 2.5 m material allowance is not a cut list. Fit over intended underlayers, retain adjustment tails, and record each strap’s actual length.

03 **Attach measured dummy modules**

Use the same external envelope and mass as the planned assembled modules, including cables and plugs. Support caddies through webbing/reinforced carrier panels, with insulating and spacer layers where specified.

04 **Register the six garment interfaces**

Fit the carrier on the wearer, then register its six detachable interfaces to RA without distorting the shell. Confirm that the carrier stays stable under load independently of the shell’s zipper and cover layers.

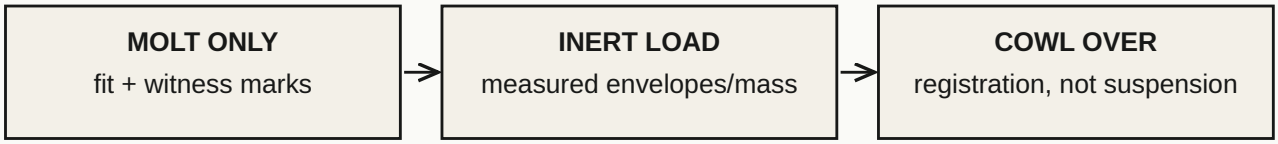
> **Mechanical acceptance is a real test**
>
> Perform the 30-minute loaded movement and module-removal tests on page 66. A drawing of a compact pouch is not evidence that the electronics fit or remain comfortable.

S01 pp.25, 27–28; S03 p.7; Shopify MOLT readback; V02. Carrier master geometry not replaced with a new drawing.

DG02-MOLT / WORKSHOP METHOD

Fit the carrier before trimming straps

The MOLT pattern remains a separate required input. These instructions explain fitting and load-path checks, not a newly invented carrier shape.



01 **Prepare the actual carrier structure**

Use its own spine, shoulder and stabilisation geometry. Identify where load-bearing webbing joins reinforcement and where the softer textile only provides contact or coverage. Keep a hard module edge off the body.

02 **Thread the real hardware**

Use the buckle/triglide manufacturer’s threading arrangement for the purchased article. Mock each strap with enough adjustment range and retained tail. Do not divide the 2.5 m webbing allowance into equal pieces.

03 **Fit carrier alone over the underlayer**

Adjust shoulder and lower stabilisation so the intended dummy load remains supported without COWL. Mark strap reference positions with removable witness marks.

04 **Install measured inert modules**

Start unloaded, then add the representative BLACK, RED and opposite-flank power masses in their intended positions. Keep any ballast fixed inside the dummy, not loose against the wearer.

05 **Record before cutting**

Record each strap ID, finished path length, folds through hardware, attachment overlap and retained adjustment tail. Trim only after both neutral and moving fit remain stable and the accepted construction can retain the ends.

> **New hardware means a new threading check**
>
> A generic “25 mm buckle” name does not establish bar spacing, tail retention or direction of loading. Keep a clear photograph of the actual threading and repeat after the first loaded movement test.

S00 DG01 pp.5, 19–20; S01 OP-30 p.25. DG03 fitting method; no carrier contour, strap cut length or rated load invented.

DG02-ANCHORS / WORKSHOP METHOD

Register all six interfaces on the wearer

RA reinforces the garment-side interface. The six attachments register COWL to MOLT; they must not turn the shell into the main suspension system.

01 **Establish the carrier position**
Fit the inert MOLT independently first. Photograph its BLACK-left, RED-right and lower power arrangement. Keep the garment relaxed around it.

02 **Match one interface at a time**
Locate the native RA zone and corresponding carrier interface on the dressed wearer. Bring the mating parts together without pulling the shell upward, sideways or into a module corner.

03 **Mark the actual attachment**
Mark each interface centre and orientation on a work copy or toile. Give it a unique ID RA-01 to RA-06; these IDs identify the six existing zones, not new guessed coordinates.

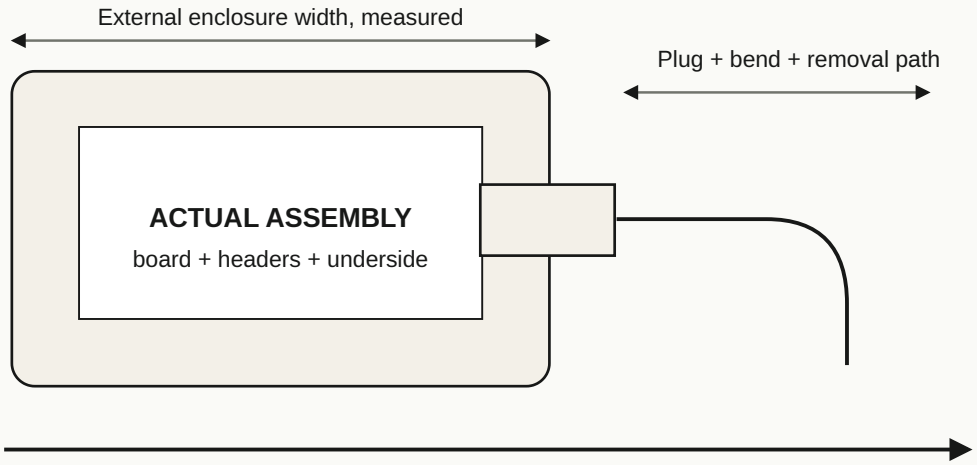
04 **Check movement before fixing**
Walk, sit, reach and rotate. Open the shell while the carrier stays loaded. An interface that only closes under high tension needs position/path diagnosis, not more strap tightening.

05 **Install and retest**
Use the accepted reinforcement/fixing coupon. Recheck after final fabric construction because stretch, bulk and bound-edge thickness can change registration.

For each RA ID record	Why it matters
Native zone / work-copy mark + photograph	Makes a later adjustment reproducible without guessing from an image.
Mating hardware and orientation	Prevents an inaccessible or reversed release.
Engagement standing and seated	Reveals tension introduced by posture.
Carrier remains supported with shell open	Separates registration from load suspension.
Release order and time	Feeds the complete system-removal procedure.

REF 19 / MECHANICAL FIT

Measure the whole module, including the plug



Measure or test	What the record must include
Assembled envelope	Maximum length, width and height including underside parts, solder joints, headers, antenna connector, mounting hardware and enclosure.
Power/module mass	Complete unit with enclosure, cable and its share of retention hardware; weigh rather than estimating from a board photograph.
Connection envelope	Mated plug length, unplugging travel, required tool/finger access and cable bend envelope.
Service aperture	Clear opening after seams, binding and closures; test extraction at the actual orientation and curvature.
Attachment	Mating interface, reinforcement stack, permitted movement, retained adjustment tail and observed slippage.
Sensor/antenna clearance	Actual optical/acoustic path, antenna keep-out and any conductive material nearby. Recheck after final textiles are installed.

The earlier carrier plan budgets seven caddies: one BLACK, three S3, one Nordic and two power pods. That is a planning inventory, not demonstrated packaging. The CC1101 and screen mounting arrangement must also be accounted for in the actual module assemblies.

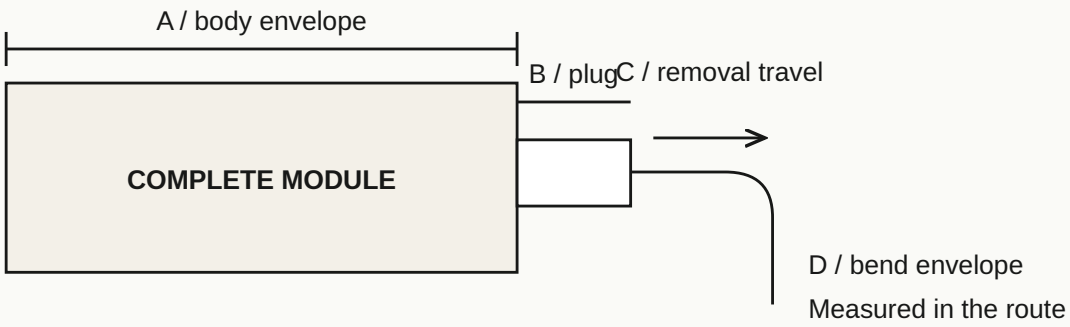
> **Separate evaluation equipment from the wearable**
>
> AD8318 evaluation boards, filters, coax and lab stimulus fixtures stay on the bench. Do not enlarge the clothing to carry the entire calibration setup. Prototype electronics may need a later compact PCB/carrier without altering the outer design.

S02 M01/M03/M05; S03 p.7; S04 pp.14–17; Shopify MOLT readback. Measurement method is DG01 engineering guidance.

DG02-DUMMY / WORKSHOP METHOD

Make an inert module that represents reality

Measure the complete assembly, not the bare PCB. Then build a mock-up that includes the parts most likely to foul a service opening.



An enclosure dimension does not include the space needed to unplug it.

01 **Define the assembly boundary**

Include enclosure, board, underside parts, headers, mounting hardware, antenna connector and the attached share of cable/retention hardware. List anything excluded from the measured mass.

02 **Measure four different spaces**

Record body length/width/height; mated plug projection; travel to unplug; and cable bend/finger/tool access. Use calipers/ruler for geometry and a scale for mass.

03 **Build a rigid-enough dummy**

Reproduce the measured outside form in card, foam board or another inert material that holds its shape. Round or cover sharp edges. Secure ballast to match measured mass; do not make a light empty box and call it representative.

04 **Add the awkward details**

Fit real spare plugs or accurately measured inert substitutes. Add the route-sized dummy cable and any retained antenna projection. Mark orientation, mass and module ID on the outside.

05 **Test the whole service motion**

Insert, retain, unplug and remove at body curvature. Repeat three times, then photograph the limiting clearance. Change the caddy/interface only through a recorded dimension or fitting correction.

S00 DG01 pp.19–20, 29; S01 OP-30/50. DG03 measurement/dummy construction. No enclosure dimensions inferred.

REF 20 / HARNESS

Name every lead and preserve the boundary

A wiring colour is not a pin assignment. Use one connector schedule tied to the actual board revision and label both ends of every removable lead.

Lead / group	Ends to identify	Required check
BLACK power	Source → BLACK disconnect/protection → BLACK input	Correct polarity and keyed connector; separate return.
RED power	Source → RED disconnect/protection → RED distribution	Cannot mate into BLACK. No shared supply return.
Sensor I²C	BLACK bus-isolation output → each sensor SDA/SCL	Power domain, pull-up rail and dead-rail behaviour.
PDM microphone	Clock + data + sensor supply/return	Clock/data power-off path and actual carrier pin labels.
Storage + BLACK OLED	Switched rail and isolated digital lines	All signal paths isolated when the device rail is off.
RED display / CC1101	S3-C shared SPI, separate chip selects	Actual module pinout, voltage and backlight interface.
One-way link	RED LED side → optical boundary → BLACK receiver	No conductive signal return across the boundary.
Carrier loom	Module connector → channel → strain relief	Whole pre-terminated harness removable without unpicking.

Record connector pins explicitly

For every connector, capture its family, contact count, mating view, pin 1 mark, pin number, net name, wire gauge, endpoint and domain. A generic JST family name or an “8-entry” allowance does not define a wiring schedule. Photograph the mating view before crimping a batch.

> **Bench wiring is not wearable wiring**
>
> Short logic jumpers make testing observable; they are not strain-relieved garment wiring. The source’s 24–26 AWG power / 28 AWG signal allowances do not certify current capacity, flex life or voltage drop for a finished route. Size the final loom from measured current and route length.

S02 H01–H19; S04 pp.12–13, 17–19. Connector schedule remains dependent on measured hardware and loom route.

DG02-LOOM / WORKSHOP METHOD

Make a harness from a pin schedule

Freeze each connector’s actual family and mating view before cutting a batch of wires. A colour or a housing name is not an electrical definition.

01 **Create the endpoint record**

For every lead, record lead ID, domain, connector part/contact type, cavity number, net, source board pin and destination pin. Photograph the mating face with pin 1 and latch orientation identified.

02 **Fit a dummy route first**

Use the actual connector size and cable bundle on the dressed carrier. Mark strain-relief points, moving transitions and the service loop. Measure route length with the loop present, not as a straight line across the body.

03 **Make one complete lead**

Cut to the accepted length; use the contact maker’s strip length and compatible crimp tool. Keep conductor strands within the conductor crimp and insulation support in its intended position. Inspect before inserting the contact.

04 **Check retention and pin order**

Perform the contact maker’s prescribed inspection/retention test. Seat the contact fully and compare the mating view to the schedule. Do not invent a universal crimp pull force or use a loose contact in the garment.

05 **Test before connecting boards**

With both ends unplugged and power absent, verify end-to-end continuity for each scheduled net and absence of unintended connections to adjacent pins. Label both ends, then photograph the finished lead and route.

> **Keep domains mechanically distinct**
>
> BLACK and RED power connectors must not permit a service mix-up. A shared battery return or USB shield is still an electrical bridge even when coloured wires look separate. Route and test the full system, not only individual leads.

S00 DG01 pp.21, 25; S04 pp.12–13, 17–19. DG03 harness fabrication method; connector, wire and contact ratings remain actual-part dependent.

REF 21 / ELECTRONICS / SCOPE

Preserve the features without pretending they are all wearable

Domain	Reference components	Role in this guide
BLACK	Pico 2 non-W; DT100104 secure-element board; DRV2605L + one ERM; local controls	Trusted control, identity operations, alerts and local input. Verify exact secure-element device/position.
FIELD	AS7343 SEN-23220; LIS2DU12 STEVAL-MKI222V1; SPH0641LU4H-1 on carrier	Spectral, motion and PDM acoustic measurements. Final sensor windows need their own tests.
Storage / UI	SPI microSD; 1.3-inch 128 × 64 SPI OLED	BLACK's switchable local logging and service display.
Power / boundary	3 BLACK TPS22919 rail switches; 3 SN74CB3Q3245 bus switches; inversion logic; TLP2361 + Schmitt inverter	Switched loads and the one-way RED → BLACK summary interface. The older cost list's two bus switches is not the LAB-0 count.
RED	3 × S3 reference boards; 1 × nRF52840 DK; band-correct CC1101 module(s)	Three fixed Wi-Fi observers plus local radio observation and service. No fourth display controller is implied.
RED UI	1.69-inch ST7789 240 × 280 candidate; four buttons	Latest LAB-0 reference. Actual board pinout must be identified before wiring.
LAB-0 additions	BME280; BPW34 + OPA381 fast optical path; MCP3208	Bench characterization additions, not automatic new garment inclusions.
RF metrology / stimulus	One then four AD8318 channels; band filters; enclosed optical / acoustic / RF fixtures	Bench programme. Not hidden wearable emitters or a claim of recognition defeat.

Capability and release are different

A CC1101 IC's tuning range does not identify its module matching network. Wi-Fi/BLE presence and RF energy are observations, not proof of a threat or its identity. Active RF/adversary workflows in LAB-0 are separate laboratory instrumentation, not garment controls.

S04 pp.2–3, 9–15; S02 B04/R07; S03 p.7; Shopify MOLT readback.

DG02-BENCHPREP / WORKSHOP METHOD

Make the bench readable before adding parts

Use named boards and net labels. Do not assign breadboard row numbers until the actual board and rail continuity have been checked.

01 **Identify every board**

Photograph front/back, module marking and revision. Label Pico as BLACK core and S3-C as RED service pod. Record display resolution/backlight interface, CC1101 band matching and the exact sensor adapters.

02 **Inspect the breadboard unpowered**

Use continuity mode to identify connected rows, split power rails and any rail breaks. Seat boards across the correct gap without shorting opposite headers. Mark the verified rails rather than trusting coloured stripes.

03 **Separate domains physically**

Build BLACK core/switched sections and RED service section separately. Reserve space for the optical boundary. Keep RF coax/detectors on their bench tray and laboratory source/high-current wiring off solderless breadboards.

04 **Establish one power route per first test**

For the Pico-only control check, use its USB supply alone. For the S3-C-only check, use its own documented supply route alone. Do not add external rail feeds at the same time merely because the header is available.

05 **Add measurements before peripherals**

Provide labelled ground and rail test points in the correct domain. Record no-load/idle state and inspect polarity before each new block. Add one subsystem, test it, then keep the passing record.

Board / module uncertainty	Resolve before wiring
S3 N8R8 versus owned N16R8	Exact board/module marking and assigned GPIO availability.
ST7789 board labelled “BL”	Logic input, onboard driver or raw LED load; active level and supply.
Mic / secure-element adapter	Physical pin labels, supply requirements and selected device position.
CC1101 module	RF matching band, antenna and documented power/logic connections.

REF 22 / BLACK / PIN REFERENCE

Pico 2: GPIO name and header pin

The table preserves the LAB-0 allocation. It is a **net reference**, not a full circuit release for unidentified adapters. Pico physical pin numbers are not ESP32 GPIO numbers.

GPIO	Pico header	Net / function	Connection rule
GP0	1	PDM clock	Sensor-side isolation strategy required
GP1	2	Isolated RED RX	After BLACK-side Schmitt inverter
GP2	4	PDM data	Actual microphone carrier to identify
GP3	5	MCP3208 CS	Always-on ADC branch
GP4 / GP5	6 / 7	Sensor I²C SDA / SCL	Through sensor bus isolation
GP6 / GP7	9 / 10	Trusted I²C SDA / SCL	Secure element + DRV2605L
GP8	11	Sensor rail enable	Also RF enable logic; no direct RF load
GP9	12	Tamper switch input	NC to ground + pull-up; see page 58
GP10 / GP11 / GP12	14 / 15 / 16	SPI1 SCK / MOSI / MISO	ADC direct; SD branch isolated
GP13	17	SD CS	Through storage bus isolation
GP14 / GP15	19 / 20	MODE / UP buttons	Each button to BLACK ground
GP16	21	DOWN button	Button to BLACK ground
GP17	22	OLED CS	Through storage/UI isolation
GP18 / GP19	24 / 25	OLED SCK / MOSI	SPI0 through isolation
GP20 / GP21	26 / 27	OLED DC / RESET	Through storage/UI isolation
GP22	29	ACTION button	Button to BLACK ground
GP26	31	Service jumper	Jumper to BLACK ground
GP27	32	Storage/UI rail enable	Control input, not peripheral power
GP28	34	Diagnostic analog spare	Respect BLACK analog input limits

Power / orientation	Exact reference
3V3 output	Pico header 36. Do not confuse it with 3V3_EN on header 37.
VSYS / VBUS	VSYS = header 39; VBUS = header 40. Do not treat these as interchangeable rail names.
Board view	Component side, USB connector uppermost: header 1 upper-left; 40 upper-right. Ground points must be identified from the official pinout.

Local button input is HIGH at rest with its pull-up enabled and LOW when pressed to BLACK ground. All powered-down peripheral signal paths need checking; GPIO allocation alone does not prevent back-power.

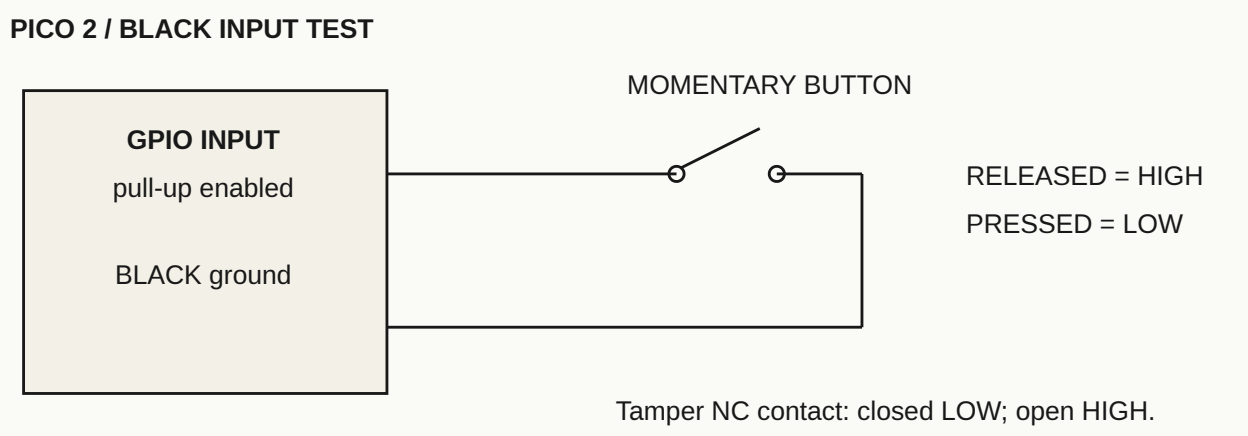
S04 pp.5–7, 18–19; T01 official Pico 2 datasheet, mechanical pin numbering and power pins.

DG02-CONTROLS / WORKSHOP METHOD

Wire and verify the first five inputs

Start with Pico 2, four momentary buttons and the NC tamper contact. Leave sensors, radios, motors and external power feeds disconnected.

Component-side view, USB at top: pin 1 upper-left / pin 40 upper-right



Lead	Pico GPIO / physical pin	Other end
MODE	GP14 / 19	Button contact → BLACK GND
UP	GP15 / 20	Button contact → BLACK GND
DOWN	GP16 / 21	Button contact → BLACK GND
ACTION	GP22 / 29	Button contact → BLACK GND
TAMPER	GP9 / 12	NC contact → BLACK GND
Common return	GND / 18 (one verified option)	Return side of each contact

01 **Check the switch before connecting**

A four-leg tactile switch may contain two internally joined pairs. With no power, identify the two separate contacts and use one from each pair. Do not assume diagonals from an unknown footprint.

02 **Test with pull-ups enabled**

Read inputs as HIGH at rest and LOW when pressed. For the NC tamper contact, closed is LOW/normal and open or broken wire is HIGH/event. Record each physical action and observed input state.

DG03 executable companion: pages 82–84 and firmware/black_input_check.py. This is a USB-only, input-only diagnostic, not the complete LAB-0 runtime.

REF 23 / RED / PIN REFERENCE

Build the S3-C service pod first

S3-A observes channel 1. S3-B observes channel 6. S3-C observes channel 11 and hosts the display, CC1101 interface and one-way summary transmitter.

S3-C GPIO	Connect to	Important detail
GPIO13	ST7789 SCK + CC1101 SCK	Shared RED SPI clock
GPIO11	ST7789 MOSI/SDA + CC1101 SI	Display “SDA” is SPI data on this reference, not I²C
GPIO12	CC1101 SO	MISO; display not assumed to provide MISO
GPIO9	ST7789 CS	Separate display chip select
GPIO8	ST7789 DC	Display data / command
GPIO7	ST7789 RST	Display reset
GPIO6	Backlight control input	Only if the actual module provides a compatible control input
GPIO10	CC1101 CSn	Separate radio chip select
GPIO14	CC1101 GDO0	Interrupt/status
GPIO15	CC1101 GDO2	Optional status path
GPIO4 / GPIO5	K1 / K2 to RED ground	Enable pull-ups
GPIO16 / GPIO18	K3 / K4 to RED ground	Enable pull-ups
GPIO17	Optocoupler LED path	680 Ω source reference; no BLACK ground wire

> **Identify the board and display before connecting power**
>
> LAB-0 names ESP32-S3-DevKitC-1-N8R8. An owned N16R8 board is a substitution requiring its actual revision and exposed-pin check. The current 240 × 280, 1.69-inch display is not interchangeable by name alone with the earlier 240 × 320 costing reference.

Do not connect an LED backlight power load directly to GPIO6. First establish whether the display exposes a logic enable, an onboard driver, or raw LEDs. Use the module’s documented drive arrangement.

Missing from L0.1: the electrical links carrying S3-A/S3-B/Nordic summaries into S3-C. Their GPIOs, voltage/interface, connector and firmware transport must be defined. This table does not pretend those aggregation links already exist.

For Octal-memory variants covered by Espressif’s guide, GPIO35–37 are not available for external use. This map does not use them. The original DevKitC and v1.1 also differ in the onboard RGB LED assignment.

S04 pp.9–10, 19; T02 Espressif official user guide. Intra-RED aggregation gap verified against the complete L0.1 netlist.

DG02-RED / WORKSHOP METHOD

Bring up screen, buttons, then the radio

S3-C is the service pod. The source assigns its display and CC1101 to a shared SPI bus with separate chip selects.

01 **Identify the display before power**

Confirm actual ST7789 module voltage, pin order, active resolution and backlight circuit. Connect only its documented logic/power interface. GPIO6 is a control allocation, not an instruction to power raw LEDs from a GPIO.

02 **Test the screen by itself**

Use the controlled GPIO map on the preceding reference page. Draw a one-pixel border and corner labels within the actual active area, then a full-screen fill. Check offsets, rotation and visible last row/column; “it lights up” does not prove the profile.

03 **Add all four controls**

Wire K1/K2/K3/K4 to GPIO4/5/16/18 and RED ground, with pull-ups. Verify each independently. An integrated four-button module may not expose that wiring directly; inspect its actual schematic/pins first.

04 **Add a band-identified CC1101**

Power off before wiring. Share SCK/MOSI as allocated; route SO to MISO and use the dedicated CSn. Keep radio/display chip selects inactive when their device is not addressed. Add status pins as documented.

05 **Exercise the shared bus**

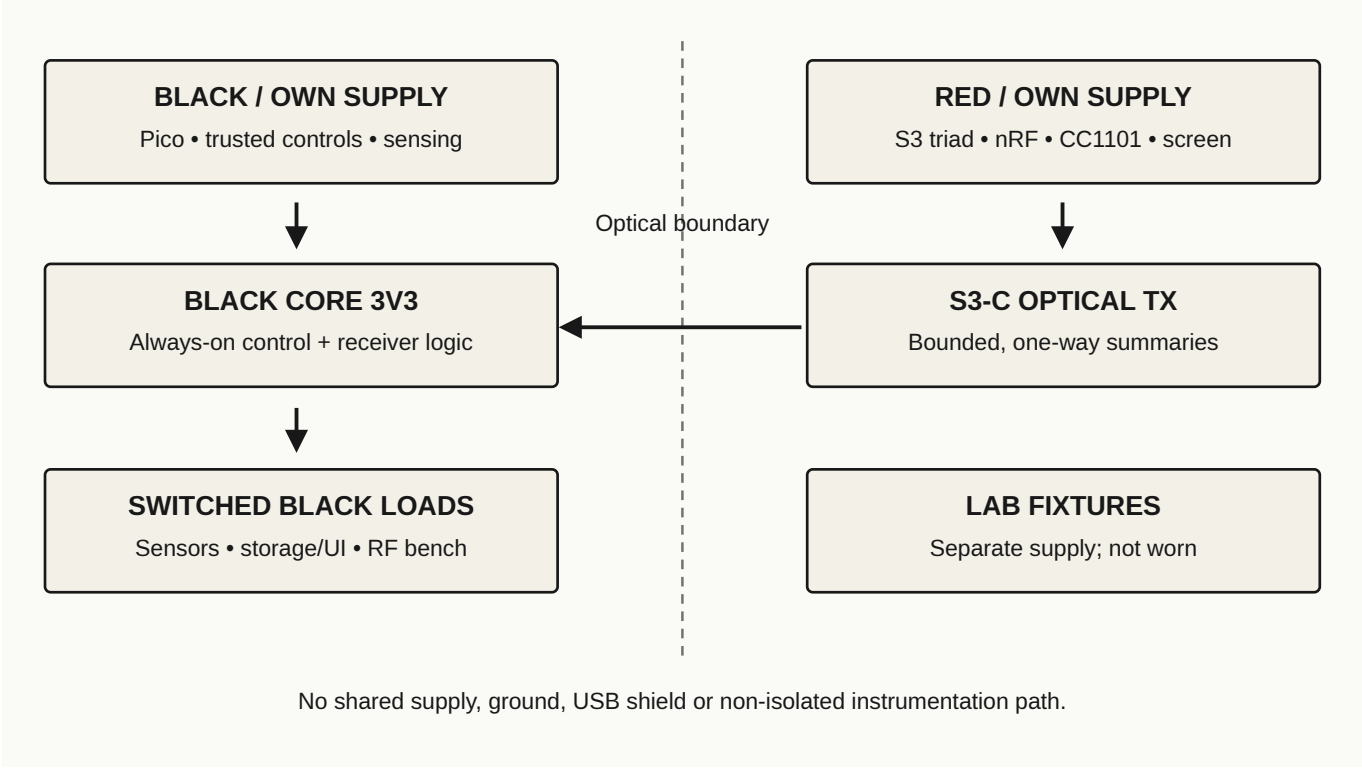
Alternate display updates and bounded receive/status reads. Check for flicker, frozen input, corrupt reads or a device driving the bus when unselected. Record bus speed, display profile and exact radio module.

Observed fault	Likely area to isolate first
Partial / shifted display	Active dimensions, controller offsets and rotation settings—not random GPIO reassignment.
Screen fails only after radio is added	Chip-select handling, MISO contention, power headroom or SPI-mode switching.
One button holds another active	Contact pairing or shared module routing; inspect unpowered continuity.
No credible receive response	Actual band matching, antenna and receive configuration; a tuning range alone is not module qualification.

S00 DG01 p.24; S04 pp.9–10, 19; T02 Espressif official guide. DG03 service-pod test method; no tested firmware supplied or aggregation link implied.

REF 24 / POWER + ISOLATION

Only the summary crosses the boundary



No shared supply, ground, USB shield or non-isolated instrumentation path.

Optical path: S3-C GPIO17 → the RED-side LED/resistor path of TLP2361 → RED ground. On BLACK, TLP2361 receiver power/ground belong to CORE_3V3/BLACK ground; its output passes through SN74LVC1G14 to Pico GP1. Physical IC pins must be matched to the purchased package/adapter, not a generic drawing.

Source protocol: UART 115200, 8N1; bounded frames no longer than 32 bytes; nominal cap 50 frames/second. The parser must enforce length, type, rate and integrity checks without starving local controls.

> **Separate supplies means separate conductive returns**
>
> A shared PC, USB hub, oscilloscope ground or logic-analyser ground can bridge the two domains. Verify the complete instrument setup, not only the visible power wires. Do not add a return command wire to make configuration easier.

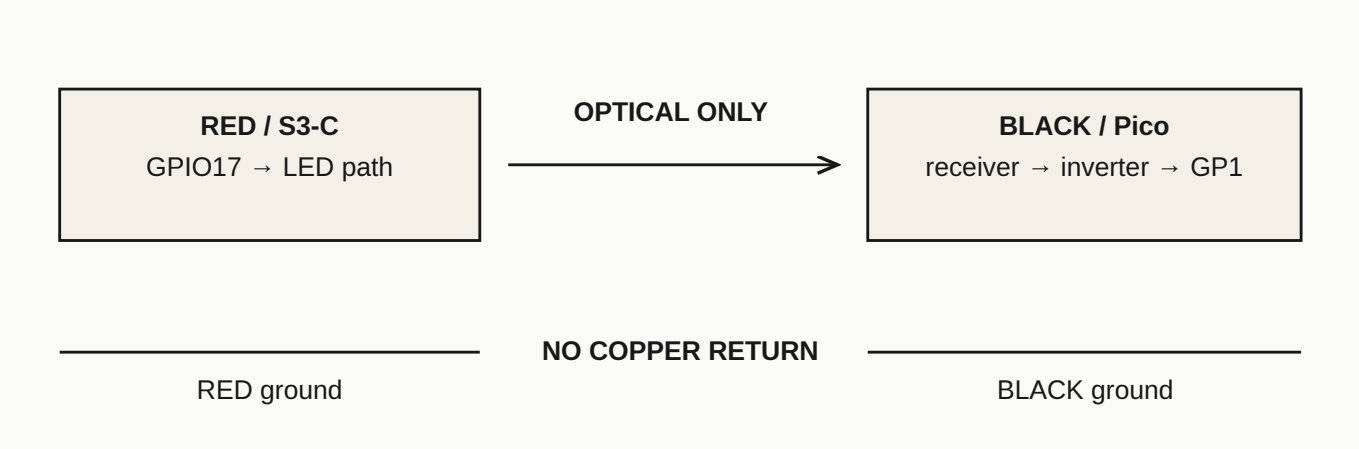
The source's 5 V / 2 A BLACK and 5 V / 4 A RED supplies are bench capacity recommendations, not measured consumption, battery capacity or a released wearable fuse selection.

S04 pp.2, 4, 8, 12–13, 18–21. Functional diagram; not a new schematic or instrument-isolation certification.

DG02-OPTICAL / WORKSHOP METHOD

Test the one-way link in a visible sequence

Use a bounded RED-side test source before live observer traffic. Measure signals only with an instrumentation setup that preserves the two domains.



01 **Wire only the specified path**

Use S3-C GPIO17 through the 680 Ω source-reference resistor and actual TLP2361 LED pins to RED ground. Power the receiver and Schmitt inverter from BLACK. Route conditioned output to Pico GP1. Match IC/adapter pins to the purchased package.

02 **Check for hidden bridges**

With supplies disconnected, inspect and test the complete setup: USB shields, hubs, programmers, oscilloscope and logic-analyser connections. A continuity check alone does not certify isolation, but any unexpected conductive path must be removed.

03 **Verify the idle and bit waveform**

On each side with suitable isolated/separate measurement, check the actual polarity and UART idle state. Confirm the receiver/inverter produces a valid 115200 8N1 waveform, not only toggling voltage.

04 **Send bounded valid frames**

Use the implemented protocol definition, maximum 32 bytes and nominal limit 50 frames/s. Record frame types, length, checksum/CRC definition and parser counters. This guide does not invent a missing packet layout.

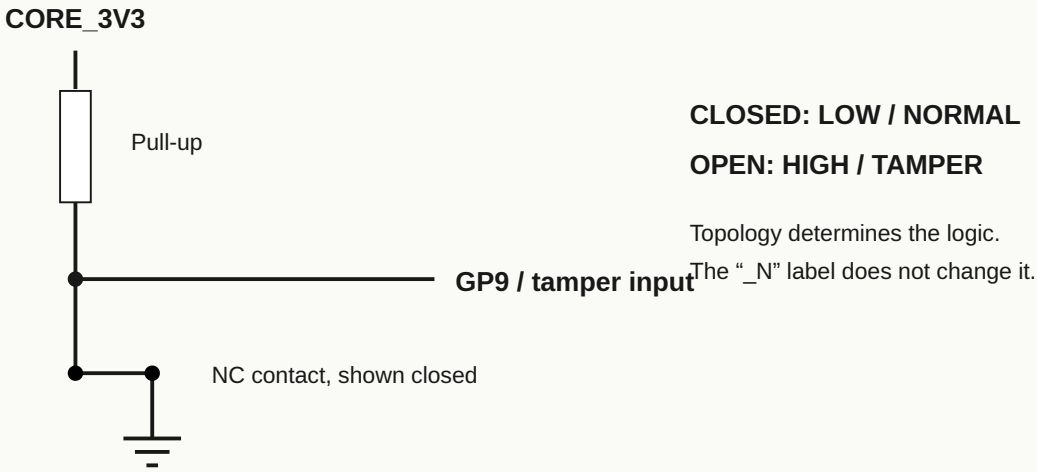
05 **Inject faults one at a time**

Test stuck level, damaged integrity field, oversize frame and excessive traffic. Check local controls remain responsive and stale RED state is explicit. Source E-B6 requires local response below 100 ms under its fault tests.

S00 DG01 pp.25, 30; S04 pp.8, 15, 19, 21. DG03 execution method. Exact package pins and packet encoding remain implementation-controlled.

REF 25 / CORRECTION / TAMPER + DEAD RAILS

Correct the logic before testing it



The source specifies an NC tamper switch to BLACK ground and a pull-up at GP9, but its TP13 description reverses the normal/event polarity. For that specified circuit, **closed = LOW / normal; open or broken wire = HIGH / event**. The firmware and test record must use the actual contact state.

Switched group	Paths that need a defined power-off state
Sensor I²C	SDA, SCL and their pull-ups. A pull-up to an always-on rail can defeat a switched peripheral rail.
PDM microphone	Both GP0 clock and GP2 data. L0.1 calls these "short direct" runs while placing the microphone on a switched rail; the power-off strategy is unresolved.
microSD	SCK, MOSI, MISO and CS; the source uses bus isolation on the storage branch.
BLACK OLED	SCK, MOSI, CS, DC and RESET; all five must obey the storage/UI-off state.
RF analog output	Detector output into ADC while either side is off; voltage division does not establish safe power sequencing.

The measurement decides whether OFF is real

The inherited test target is a switched rail no higher than 0.30 V after 250 ms, with no peripheral response or signal back-power. Do not mark the circuit passed because the enable pin is LOW. Confirm pull-ups, bus-switch enables and the full load current budget.

S04 pp.4, 6, 13, 15, 18–19. Tamper polarity follows the specified circuit; PDM direct-run conflict remains an implementation issue.

DG02-DEADRAIL / WORKSHOP METHOD

Prove that a disabled rail is really off

An enable signal going LOW is not the result. Measure the switched supply and each signal path under realistic off-state conditions.

Group	All relevant paths to inspect
Sensor domain	SDA/SCL, pull-ups, PDM clock/data and any interrupt or other connected lead. The L0.1 direct PDM run remains an unresolved power-off path.
Storage domain	SD SCK/MOSI/MISO/CS and their pull-up rails. Keep the always-powered ADC branch distinct.
BLACK OLED	SCK/MOSI/CS/DC/RESET and supply. Leaving DC/reset direct can defeat isolation even when SPI is disconnected.
Analog domain	RF detector output/divider and every ADC connection when either supply is absent.

01 **Check the switching circuit unloaded**

Verify the actual load-switch input/output/control and bus-switch enable truth table against the selected adapters. For SN74CB3Q3245, /OE high disconnects; /OE low connects. Use a defined inactive state at startup.

02 **Measure the rail transition**

Use the correct domain reference and suitable capture to measure voltage versus time. Source target: the disabled rail is at or below 0.30 V after 250 ms. A late handheld-meter reading cannot establish the 250 ms decay.

03 **Repeat with peripheral signals present**

With the rail disabled, exercise the implemented bus states and inspect for rising rail voltage or peripheral response. Identify the injecting line by disconnecting branches with power removed between rewiring steps.

04 **Fix the path, then retest**

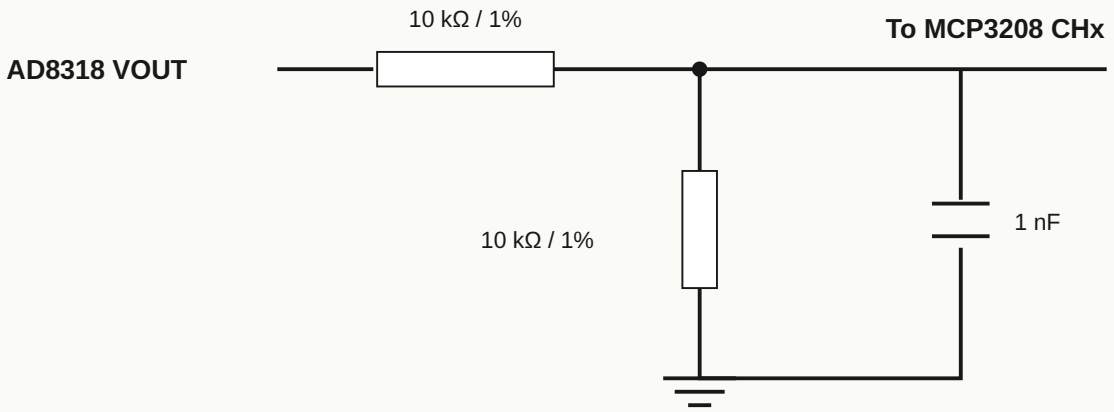
Correct pull-up rail ownership, missing isolation, enable sequencing or analog leakage. Re-run with the full wiring restored. A software sleep call is not a substitute for the physical-off requirement.

> **PDM resolution is not silently assumed**
>
> Both clock and data need an explicit powered-down strategy in the schematic and firmware. DG03 supplies the check procedure, not a guessed adapter circuit or a PASS for the unresolved L0.1 path.

REF 26 / CORRECTION / RF ANALOG INPUT

The old divider has too little headroom

L0.1 places 10 kΩ in series and 20 kΩ to ground. At 4.9 V detector output, the ideal ADC node is **4.9 × 20 / 30 = 3.267 V**. That already exceeds the same document's 3.20 V low-end CORE/VREF target. Resistor tolerance further reduces the margin.



Proposed bench revision only. Confirm input range, settling and power-off behaviour.

DG01 bench candidate — not a physical pass	Result under the stated design envelope
Change to 10 kΩ series / 10 kΩ shunt, each 1%	Worst high ratio = 10.1 / (9.9 + 10.1) = 0.505.
Assume detector output bounded to 5.50 V	Worst divider node = 2.7775 V; 0.4225 V below a 3.20 V reference.
Retain 1 nF only as a provisional filter value	Nominal divider source resistance is 5 kΩ. Verify ADC acquisition/settling at the selected SPI clock and channel scan rate.

Before attaching the ADC: verify the actual output envelope and transients, measure the divider node, prove valid readings across the intended input range, and test loss of either rail. Add a properly designed buffer/protection stage if the measured source/settling or power-off behaviour requires it. Recalibrate after changing the divider.

> **Do not confuse over-range with damage**
>
> Exceeding VREF violates the ADC's specified single-ended conversion range; it does not by itself prove that an absolute-maximum rating was exceeded. The detector's voltage is a calibrated measurement input, not an identity or threat detector.

S04 pp.4, 7, 10, 17; T03 AD8318 official product/evaluation information; T04 MCP3208 datasheet §§1, 4, 6. Calculations are DG01 analysis.

DG02-RF / WORKSHOP METHOD

Verify the divider before connecting the ADC

DG01's 10 kΩ / 10 kΩ candidate adds conversion-range headroom. It still needs a measured source envelope, settling check and power-off test.

01 **Build and label the candidate**

Use 10 kΩ series and 10 kΩ shunt resistors, each 1%, to BLACK ground. Retain the provisional 1 nF at the divider node only for the characterization trial. Do not connect the MCP3208 input yet.

02 **Apply a known bounded source**

Use a controlled voltage/reference setup or the identified detector under controlled stimulus. Record actual source voltage and divider node voltage. Compare with the nominal half-scale transfer and resistor-tolerance envelope.

03 **Measure extremes and transitions**

Capture the highest credible source voltage and power transitions. Check the divider remains within the intended ADC conversion range. Separately verify the ADC's absolute limits; VREF and absolute maximum are not the same test.

04 **Attach and compare ADC readings**

Only after the node test, connect the ADC in the defined power state. Record actual VREF, channel, clock and sample sequence. Compare stable DMM input with conversion results and check channel switching/settling.

05 **Calibrate one RF path**

Keep antenna/filter/coax configuration fixed and record reference levels. Fit the chosen calibration method, retain residuals and test the source E-B7 span/error targets before duplicating detector channels.

Calculation retained from DG01	Value / consequence
Worst high divider ratio, 1% parts	10.1 / (9.9 + 10.1) = 0.505.
At the stated 5.50 V source envelope	Node ≤ 2.7775 V in the resistor-only calculation.
Relative to 3.20 V VREF	0.4225 V calculated headroom; no transient or rail-off pass implied.
Nominal divider source resistance	5 kΩ. Check ADC acquisition and channel settling rather than guessing an allowable sample rate.

S00 DG01 p.27; S04 pp.7, 10, 15; inherited T03/T04 device references. DG03 measurement procedure; candidate remains unvalidated.

REF 27 / FIRST BENCH BUILD

Bring up one observable block at a time

01 **Pico core and local controls**

Use the identified Pico 2 alone first. Connect MODE, UP, DOWN and ACTION to their page 52 GPIOs and BLACK ground, with pull-ups. Record the flashed binary version, successful boot, idle current and deterministic button states.

02 **Trusted bus and haptic**

Add the identified secure-element board and DRV2605L to GP6/GP7, using their documented supply/adapter connections. Verify the device identity before any irreversible provisioning. Add the single ERM only after the driver is communicating.

03 **Switched rails and complete isolation**

Prove load-switch enable/discharge and every digital path before adding sensors or storage. Resolve the PDM power-off path and rail budget. GPIO tables are not a replacement for a complete switch/adapter schematic.

04 **S3-C screen and four controls**

On its own RED supply, bring up the actual ST7789 using the verified display profile and page 54 mapping. Check rotation, full active pixel area, all buttons and backlight control. Then add one identified, band-matched CC1101 module.

05 **Sensors and boundary**

Add sensors individually and record baseline data. Test the optical link with a bounded simulator before live RED traffic. Define and test the still-missing observer-to-aggregator transport before claiming a working triad.

06 **RF metrology and full integration**

Validate one corrected RF/ADC path before copying it. Keep lab stimulus equipment separate. Only package modules for the garment after the relevant power, fault, thermal and service tests have actual records.

> **A compile is not a demonstration**
>
> This guide supplies no claimed-tested firmware binary or fabricated flash log. Build hash, flash completion, successful boot, actual sensor response and loaded garment fit are separate records. Preserve the first working version before adding another subsystem.

S04 pp.15–18, 21; S05 p.19. DG01 sequence retains staged bring-up and makes unresolved interfaces explicit.

DG02-TRUST / WORKSHOP METHOD

Add the trusted bus and haptic in stages

Keep the first working core record. Add communication first, then the load that can disturb its supply.

01 **Confirm the actual secure-element board**

Identify the DT100104 revision, selected device and physical supply/SDA/SCL pins. The GPIO allocation GP6/GP7 does not identify a socket or package position on an unknown board.

02 **Check the unpowered wiring**

Use CORE_3V3 and BLACK ground as specified. Inventory any onboard pull-ups and their rail. Verify no 5 V pull-up or second supply path has been introduced through an adapter.

03 **Read identity without permanent provisioning**

Use a device-aware routine to read supported identity/configuration status and execute the source's non-destructive operations. Do not issue irreversible locking commands as a communication test. A generic I²C scan is not a complete secure-element test.

04 **Add the DRV2605L without the motor**

Connect to the same trusted bus using the actual breakout labels. Apply the source local decoupling arrangement where required by the board implementation. Confirm communication before connecting the actuator.

05 **Test the actual ERM**

Connect it only to the driver's documented output pair, not a GPIO. Configure for the identified actuator. Measure rail droop during each controlled pattern and verify mute/off is quiet. Repeat with a different actuator only as a new tested configuration.

> **Keep the two tests separate**
>
> E-B1 requires 100 non-destructive secure-element operations without bus fault. E-B3 requires 10 haptic patterns, no reset and less than 150 mV droop from the pre-event baseline. Passing one does not pass the other.

S00 DG01 pp.22–23, 28, 30; S04 pp.6, 15. DG03 staged bring-up detail; no irreversible provisioning or measured result assumed.

DG02-SENSORS / WORKSHOP METHOD

Add one sensor, then prove storage isolation

Begin with the identified switched-rail circuit working. Leave unresolved interfaces disconnected instead of using them to mask a failure elsewhere.

Block	Bring-up method	Evidence to retain
AS7343	Check actual board supply/pull-ups and connect through sensor isolation to GP4/GP5. Use a device-specific acquisition configuration.	Dark/neutral baselines, gain/integration settings, actual window state and response to the same controlled illumination.
LIS2DU12	Verify the actual adapter and SA0 setting for the source 0x19 address. Keep the first test independent of an interrupt path.	Six static orientations with axis labels. Check gravity moves to the expected axis/sign; do not assume a mounted orientation from a photo.
BME280	Confirm the actual breakout supply and supported SDO/address strap. Add after the other bus device tests remain stable.	Ambient baseline, acquisition settings and module ID. This is context sensing, not a threat label.
PDM microphone	Resolve the power-off path for both clock and data before switched-domain integration. Verify carrier pins/channel strap.	60-second baseline, controlled response, clipping/dropped-block record and actual clock.
SD + BLACK OLED	Use their identified 3.3 V interfaces and complete storage/UI isolation. Prove true-off with the actual signal wiring.	Log rotation/recovery records, off-state measurements and core response during storage failure.

01 **Change one variable**

Record which board, lead and firmware setting was added. Save a short known-good trace before attaching the next device.

02 **Fault-test disposable data**

For abrupt storage rail-off tests, use test logs rather than the sole copy of build evidence. Cut only the controlled storage rail in the intended test; keep BLACK core monitoring active. Archive results elsewhere after the run.

S00 DG01 pp.22–23, 26, 28, 30; S04 pp.7, 15, 21. DG03 stage execution, with source addresses conditional on the actual adapters.

DG02-FIRMWARE / WORKSHOP METHOD

Record what actually ran

The guide is an assembly document, not a supplied full-system firmware release. A compiled sketch, a successful flash and a stable hardware run are different evidence.

Record	Required content
Source identity	Repository or source archive actually used, commit/version where available, uncommitted change description and build configuration.
Hardware profile	Pico board, exact S3 module/revision, display controller/profile and all selected pin mappings. Do not substitute the older BLACKNODE/C3 profile silently.
Build	Compiler/framework and library versions; complete success/failure output; binary filename and checksum.
Flash	Actual board/port, flashing method, completed write/verify result and power-cycle boot observation.
Run	Start/end times, board IDs, connected blocks, supply arrangement, observed current/rails, reset count and test operation ID.
Fault/recovery	What was interrupted, when, actual effect on local controls and recovery state. Preserve failed runs, not only the clean one.

01 **Photograph the as-built state**

Capture both board labels and every removable lead endpoint. The photo should agree with the netlist and the hardware profile used for that run.

02 **Resolve the missing aggregation contract separately**

S3-A, S3-B and Nordic summaries need a defined physical transport into S3-C, connector/GPIO allocation and bounded firmware interface. A working S3-C screen does not prove these links exist.

03 **Archive a known-good checkpoint**

Keep source/binary identity, wiring record and short baseline together before changing another subsystem. Store the record under its operation ID in the companion tracker and export a backup.

DG03 supplies a five-input diagnostic and host-side logic tests (pages 82–84). It does not supply the complete BLACK/RED application, watchdog acceptance, RF calibration or observer aggregation.

REF 28 / GARMENT ACCEPTANCE

Test the sample as something a person wears

These are source-derived acceptance targets and DG01 recording instructions. **No test is represented as completed.**

Test	Method	Record / intended result
Fit and silhouette	Photograph front, rear and both profiles with closures in the same state as the reference. Measure the page 7 POMs.	No unexplained length/shape drift. Keep base-shell and lowest-layer measurements distinct.
Loaded movement	At least 30 minutes: walk, sit, crouch, reach and rotate with measured inert module envelopes/masses.	Observe pressure, shifting, snagging, cable pull and restricted movement; record failures rather than smoothing them out in pictures.
Carrier independence	Open/remove the shell while the fitted carrier supports its load.	No concentrated module load suspended from unsupported shell textile or comfort lining.
Module extraction	Remove/reinstall the modules three times through the real openings.	No unpicking; no forced cable bend, blocked plug or frayed opening.
Full strip	Remove power, modules and detachable harness.	Source target: complete system removal within 5 minutes. Time the actual process.
Mass	Weigh the mechanically representative inert carrier assembly.	Inherited ≤1.2 kg target; record the exact contents weighed. It is not an achieved weight claim.
Closure durability	Cycle the pocket zips 10 times and cord controls 20 times; operate all service closures.	No pulled fixings, binding snag, distorted laminate or blocked adjustment.
Sensor access	Use final window/mesh and nearby textile arrangement in the sensor test.	Retain the before/after baseline; no assumed neutral film or RF-transparent conductive patch.

One repeatable integrated interaction

After the relevant bench tests pass, demonstrate one useful local interaction, such as a deliberate local input producing a controlled haptic response and a bounded log entry. Record the exact configuration, power state and failure behaviour; do not describe the whole programme as finished because one interaction works.

S01 pp.12, 19, 27–29; S05 p.19; S04 p.17. No physical acceptance evidence was supplied for this review.

DG02-WEAR / WORKSHOP METHOD

Run a repeatable 30-minute fitting test

Use the measured inert carrier first. The schedule below operationalises the source's 30-minute movement target; it is not a claimed completed test.

Time	Action	Observe
0–5 min	Stand neutrally, close/open the shell, turn head and raise/lower cowl.	Initial strap witness marks, collar pressure and service access.
5–10 min	Walk normally with natural arm swing.	Module bounce, shell migration, rubbing and cable movement.
10–15 min	Sit, stand and bend forward within comfortable movement.	Lower power-pod edges, waist-wing pressure, front zip and hem behaviour.
15–20 min	Reach forward and raise each arm; rotate torso.	Sleeve restriction, shield/free-edge snagging and cable strain at joints.
20–25 min	Crouch and return to standing; repeat normal walking.	Retention slip, hard corners and new pressure points after movement.
25–30 min	Return to neutral, open shell and inspect carrier witness marks.	Changed strap positions, actual displacement, heat/contact observations and garment distortion.

01 **Record the starting condition**

Weigh the exact inert assembly; list the contents and masses. Photograph all four garment views and carrier placement before the timer starts.

02 **Stop to document a fault**

Do not endure pressure or keep moving to finish a clean-looking log. Record the time, posture and location. A repaired sample needs a repeat of the relevant movement sequence.

03 **Compare the final state**

Recheck witness marks, module orientation and all six RA interfaces. Distinguish a shell-fit change from a carrier-retention change; alter the component that caused the problem.

> **Separate target from result**
>
> The inherited inert-carrier target is ≤1.2 kg, not an achieved weight. A 30-minute comfort trial is not a certified load rating or a lifetime durability test.

DG02-REMOVE / WORKSHOP METHOD

Write and test the removal sequence

A serviceable prototype must come apart without unpicking. Time the real sequence with the garment in its actual wearing arrangement.

01 **Make the system inactive**

For powered later-stage trials, use the documented shutdown and disconnect both sources before unplugging signal leads. For inert trials, identify the dummy source positions and rehearse the same reach/access order.

02 **Open the intended service routes**

Open G/H/J and the four M channel closures. Keep free shell layers clear. Release strain relief before pulling on any lead; never use the cable to extract the plug or caddy.

03 **Disconnect and withdraw modules**

Follow the labelled connector schedule. Remove plugs along their designed axis with the required clearance, then release caddy retention. Keep BLACK and RED parts in separately identified trays.

04 **Release the six interfaces**

Open RA-01 to RA-06 in the recorded order while supporting the carrier. Remove the loom and carrier without letting a module hang from the lining or shell.

05 **Inspect and rebuild**

Check for trapped leads, damaged binding, loosened contacts and moved witness marks. Reinstall in reverse only where that gives the intended service access. Verify every connection before restoring power.

Timed trial	Record
Module extraction: three repetitions	Which module, actual withdrawal route, obstruction and any changed clearance.
Complete strip: target ≤5 minutes	Define start/finish, exact included components and actual elapsed time.
Reinstallation	Correct connector/keying, strain relief, closures and return to the recorded starting position.
Shell alone	Complete wearable shell remains; no seam was unpicked to release electronics.

S00 DG01 pp.18–21, 29; S01 OP-31/50. DG03 service procedure; source removal target is not a measured result.

REF 29 / BENCH ACCEPTANCE

Use distinct names for garment and electronics tests

The files reuse “B0” for different things. In this guide, **G-** means garment and **E-** means electronics. These prefixes prevent confusion; they do not create or certify a new test result.

LAB-0 test	Source target / evidence required
E-B0 / Core	60-minute powered core run, deterministic controls, active watchdog, no unexplained reset; record idle/active current.
E-B1 / Trust	Identify the actual secure element; 100 non-destructive operations without a bus fault. No permanent configuration lock during this stage.
E-B2 + B2A / Power	On-rail measurements and OFF ≤0.30 V after 250 ms; no dead-rail back-power or peripheral response.
E-B3 / Haptic	10 patterns; no reset and less than 150 mV supply droop. Record actual waveform and load.
E-B4 + B4A / Sensors	30-minute sensor acquisition; motion orientation check and optical baselines; 60-second PDM baseline plus controlled stimulus.
E-B5 / Storage	100 log rotations and 10 abrupt storage rail-off cycles; core remains responsive and recovery is explicit.
E-B6 / Boundary	Stuck levels, corrupted/oversize frames and 10× nominal traffic do not freeze BLACK; local response target <100 ms.
E-B7 + B7A / RF	One calibrated channel first: ≥40 dB stimulus span, residual target ≤2 dB. Then compare the duplicated paths over common test points.
E-B8 / Observers	Remove/power-cycle each observer independently; BLACK continues local operation and missing observers are reported.
E-B9 / Fixtures	Each interlock independently disables the relevant lab stimulus; measure the actual timer/output response.
E-B10 / Soak	8-hour mixed run + 100 controlled power cycles; no unexplained BLACK reset; retain hashes, rail, thermal and fault records.

Only repeat affected work after a change

Record the changed board, module, cable, material or firmware revision and identify which results it invalidates. A changed optical window needs a new optical check; a changed power rail needs the relevant current, true-off and fault tests.

S04 pp.15–17; S01 pp.2–3. Prefixes are DG01 editorial disambiguation; all listed tests remain unverified here.

DG02-DIAGNOSE / WORKSHOP METHOD

Find the failed block before adding another

Keep a reproducible baseline. Disconnect or substitute one known part at a time with power removed before rewiring.

Symptom	First isolation step	Recheck before progression
BLACK resets during haptic	Compare core rail before/during activation; inspect actuator configuration, driver supply and returns.	Repeat E-B3 and the affected core/rail checks with the real load.
Disabled rail remains high	Inspect pull-up ownership and every connected digital/analog path, including PDM and OLED reset/DC.	Repeat E-B2/B2A with all signals restored.
Sensor bus stops responding	Remove latest added device, verify its supply/address and stuck-low lines; test bounded recovery.	Repeat baseline acquisition and true-off after the correction.
Storage test freezes local UI	Check unbounded waits, shared SPI/CS ownership and missing isolation.	Core controls stay responsive while storage is failed/off.
RED traffic freezes BLACK	Bound frame size, parser work and queue depth; check reject counters and local response.	Repeat E-B6 at the defined fault load.
RF code clips or shifts	Measure input node, actual VREF, supply state and ADC settling before changing calibration.	Repeat node/range checks and one-channel calibration.
Screen works alone, fails with radio	Check separate CS states, shared-bus settings and actual RED rail headroom.	Repeat alternating display/radio activity and controls.
Carrier fits flat, not worn	Check opening curvature, plug travel and changed cable route under movement.	Repeat dummy extraction and loaded movement at the actual posture.

Record failures as useful evidence

Keep the failed condition, changed variable and corrected run together. A new board revision or firmware build does not inherit a previous PASS automatically.

REF 30 / WHAT STILL NEEDS REAL INPUT

The remaining work is specific

These are the gaps found in the retrieved design/build evidence, not a generic launch checklist. None is filled with an invented measurement or a copied PASS label.

Item	What is already established	What resolves it
Native COWL geometry	25-piece inventory; C.4/C5A authority; P/M/RA corrections.	Retrieve the actual 12-sheet native master, check seamlines/scale, and map all long/free reference layers to pieces.
Wearer and fit	Sample M programme targets, not a measured wearer.	Actual body measurements plus the complete toile and carrier fitting record.
MOLT pattern and packaging	Carrier role, six interfaces, service-frame envelopes and seven-caddy plan.	Carrier master + actual assembly envelopes/masses + extraction and retention tests.
Final fabric/process	Material family, working quantities and seam baseline.	Exact articles/lots, usable widths and accepted seam/closure/window coupons.
Board and module revisions	LAB-0 GPIO allocations and reference board types.	Front/back board identification; display/backlight, microphone carrier, secure-element position and CC1101 band records.
Incomplete electrical details	Tamper logic corrected; safer divider candidate calculated; dead-rail issue identified.	Complete switch/adapter/PDM power-off and power budget implementation; verify divider range/settling/off-state.
RED aggregation	Fixed channels and S3-C role.	Specify S3-A/S3-B/Nordic transport, GPIOs/connectors and bounded firmware interface; prove link loss recovery.
Measured performance	Source test methods and targets, with no physical passes retrieved.	As-built netlist, firmware hashes, power/thermal traces, sensor/RF results and loaded-wear observations.

Work that can start now

Organise the 25-piece cut ticket, identify owned hardware, prepare real material coupons, measure complete modules and bring up an isolated core/service pod with an appropriate existing firmware build. Do not buy final yardage from the allowance alone or fabricate caddies from the service-frame bounds.

> **One missing file matters more than another rendering**
>
> The native C5A/C.4 cutting master was not retrieved. The D0 source itself says no native-size pattern file was certified in that release. This guide deliberately does not present the reading-copy diagrams as replacement patterns.

S01; S02; S03; S04; S05 pp.64–66. This is the reconciled state of the sources reviewed, not an assertion that no other file exists.

DG02-NEXT / WORKSHOP METHOD

Turn the open items into concrete records

The remaining dependencies are narrow. Keep work moving on the independent tasks while recording exactly what each blocked operation needs.

Dependency	Produce this next	Affected work
Native C5A/C.4 cutting master not retrieved	Actual native-size sheets/files; verify scale, seamlines, notches and free-layer mapping.	Contour cutting, seam lengths and native placement coordinates.
Carrier geometry and actual modules	Carrier master plus measured assembled envelopes, masses, plug travel and dummy extraction record.	MOLT cut shapes, strap schedule, caddies and service clearances.
Final textile / trim articles	Identified lots and accepted seam, binding, closure, window and sealing coupons.	Final laminate sewing, fixings and material takeoff.
Board / adapter identification	Front/back photographs and documented pin/voltage profile for each actual module.	Package-level wiring, backlight drive and supply budget.
Power-off and aggregation implementation	Complete PDM/switch sequencing schematic; defined observer-to-S3-C links and firmware transport.	True-off tests and full observer-system claim.
Physical evidence	As-built wiring, firmware identity, rail traces, baseline/calibration and loaded-wear records.	Progression to powered integrated sample.

01 **Start the nondependent work**

Use DG02-COUPON, DG02-CLOSURE, DG02-DUMMY, DG02-BENCHPREP and DG02-CONTROLS now with identified materials/components. They produce useful records without inventing the missing contours.

02 **Record a change at its operation**

State original condition, proposed change, reason, affected drawing/part and repeated tests. Leave the original geometry/data untouched and create a new revision for the accepted work copy.

S00 DG01 p.31; S01 p.2; S04 pp.16–18. DG03 actionable record list; repeat Library search did not retrieve the native cutting master.

DG02-TRACK / WORKSHOP METHOD

Keep the build state outside the chat

The DG03 tracker preserves the 54 DG02 activity IDs and adds 13 execution cards. It contains no prefilled physical results.

01 **Open the local tracker**

Extract the toolkit, then open BUILD_TRACKER.html in a JavaScript-enabled browser. Keep the DG03 PDF beside it. Search by operation, piece or test ID; page links still match the retained guide.

02 **Import your previous record**

Use Import for a DG02 or DG03 JSON export. DG02 results, revisions and evidence references are carried forward. Any previous Passed state becomes Review required; its former status is retained in the record.

03 **Record the actual build**

Enter sample and operator, actual configuration, measurements/result and evidence filenames. Selecting Passed is blocked until these fields are present. File references are not proof that the files exist or that a criterion was met.

04 **Keep evidence outside the browser**

Export at the end of the session. Browser storage may be cleared or unavailable. The JSON stores text and references, not the original photos, traces, CAD files or firmware binary.

05 **Reopen affected checks after a change**

Changing configuration, results or evidence on a Passed record moves it to Review required. Mark related affected activities Rework yourself. The tracker does not automatically infer all engineering dependencies.

> **Review is a human action**
>
> No activity becomes Passed automatically. Retained source tests E-B0 to E-B10 remain separate from successful host-software tests or a five-input diagnostic. See the change-impact card on page 87.

REF 31 / SOURCE RECORD

What this guide is based on

ID	Retrieved source	Use
S01	MURMUR_SYSTEM001_FACTORY_ASSEMBLY_BUILD_PACK_F01_2026-09-17.pdf	29 pp. Assembly, 25-piece inventory, POMs and garment tests.
S02	MURMUR_COST01_RELEASE_GATE_PACKAGE_REVIEWED_2026-09-16.xlsx	Costed BOM and reviewed release controls. Quantities are allowances, not measured yield.
S03	MURMUR_PRODUCT_SYSTEM_TECH_PACK_E0_2026-09-14.pdf	23 pp. Product boundaries, C5A inventory and carrier planning.
S04	MURMUR_LAB0_HARDWARE_BLUEPRINT_REV_L0_1.pdf	21 pp. Latest bench scope/net allocation; reviewed here, not assumed physically proven.
S05	MURMUR_FINAL_BRAND_AND_BUILD_BIBLE_REV_D0_PRINT.pdf	66 pp. C.5 corrections; pp.64–66 explicitly limit native-source validation.
S06	MURMUR_SYSTEM_COAT_REV_C_BUILD_MANUAL.pdf	Separate men’s L route. Read to identify conflict, not merged into this build.
V01	MURMUR Visual Consistency System / Board 01	Existing user reference, file_00000000caf081f58fb5bbbb3b484c5f.png. Crops only.
V02	MOLT CORE / SYSTEM 01 reference board	Existing user reference, file_00000000e41481fda18c2c8f5883c4e8(1).png. Crops only.

Manufacturer cross-checks

T01 Raspberry Pi Pico 2 datasheet

T02 Espressif ESP32-S3-DevKitC-1 v1.1 user guide

T03 Analog Devices AD8318 product / evaluation reference

T04 Microchip MCP3204/MCP3208 datasheet DS21298E

Live Shopify COWL and MOLT CORE records were read to check product boundaries and physical placement. No store, price, product image or publication setting was changed. The reference crops used in this guide are the retrieved user design boards, not a newly generated collection.

> **Inherited baseline: DG01**
>
> DG01 is the approved source-reconciled baseline dated 19 September 2026. DG03 retains its inventory, design references and corrections, then expands practical methods. Neither edition supersedes missing native cutting geometry or claims unrun bench/wear tests.

DG02-SOURCES / WORKSHOP METHOD

Inherited and freshly checked evidence

The 75-page DG02 file is the controlled baseline for this edition. The source register on page 74 remains the authority map for the retained manufacturing and hardware references.

Reference	DG03 use / access
S00 / DG01	The original 32-page approved guide remains archived. DG03 edits the DG02 HTML/PDF package, not the native garment master.
DG02 / approved baseline	MURMUR_SYSTEM001_DESIGN_BUILD_GUIDE_DG02.pdf and its editable guide, image pages, inventory, operations and tracker were reviewed. The six embedded reference-image occurrences are retained byte-for-byte.
S01–S06 / internal sources	Retained requirements and targets are attributed through DG02. This edition does not claim a fresh complete review of every earlier source file, a certified native pattern or a measured prototype.
Shopify / 19 Sep 2026	Live product and page content was read for publication alignment. The build guide is separate from the Founder's Reservation terms; no design image, price or product availability needs to change for this release.
T01 / Pico 2	Official Raspberry Pi Pico-series pinout and MicroPython setup references checked for the input-only diagnostic. The LAB-0 allocation remains on page 52.
T06 / MicroPython	Official Pin and time APIs support Pin.IN / Pin.PULL_UP, input reads and wrap-aware elapsed-time handling. Current download page identifies the non-wireless Pico 2 build.
DG03 methods / software	Pages 76–88 and the diagnostic are new execution aids. Host software tests are reported separately in SOFTWARE_QA.json. No physical test is reported as passed.

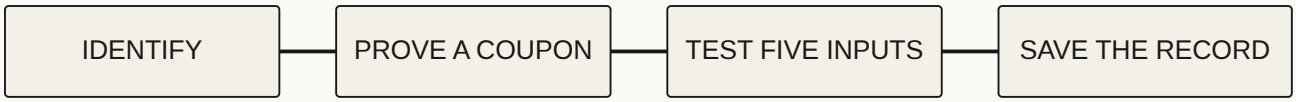
Original page and operation references survive

DG02-prefixed IDs on retained cards are intentional. They identify stable activities, not a claim that the file is still edition DG02. DG03 new source links and release instructions are on page 88.

DG03-START / WORKSHOP METHOD

Finish a useful first work session

Start with work that produces evidence now. Do not let the missing native pattern stop electrical identification, seam coupons or measured module mock-ups.



Separate cloth, carrier and powered bench work. Combine records before combining assemblies.

01 **Make the work record first**

Open the tracker; enter the actual sample identifier and operator. Photograph the present materials and each board face. Identify the Pico as non-wireless Pico 2 and record its markings. Record unknowns as unknowns, not inferred part numbers.

02 **Complete one seam-stack coupon**

Use the intended shell, backing and thread. Follow pages 16–17. Record needle, stitch settings, face direction and whether the coating marks, puckers or leaks through needle holes. Label the physical coupon so the photo and result refer to the same specimen.

03 **Wire only the five inputs**

Follow pages 53 and 82. With the board unplugged, continuity-check each lead and the contacts. Leave all other electronics disconnected. Run the diagnostic on page 83 and complete the event sequence on page 84.

04 **Measure one connected module**

Follow page 80 with the actual enclosure, antenna connector and cable installed. Make an inert mock-up and record mass separately. Do not cut a caddy from an unconnected PCB dimension.

05 **Close the session with a record**

Export the tracker JSON. Save the real photographs and USB log beside it. Enter a specific next action for every block: missing board identity, native pattern, connector dimension or test instrument.

> **A useful finish line**
>
> A labelled coupon, five-input event log, identified board and measured connected envelope are progress. None is a substitute for a completed garment, full core acceptance or a finished native pattern.

DG03-LASTACCESS / WORKSHOP METHOD

Check the work before access disappears

Perform these inspections while the panel is flat or the assembly is still open. Do not discover a trapped part after topstitching or bagging the lining.

Before this action	Inspect now	Proceed only when
Slash a pocket opening	Both stitch rows, corner triangles, zip orientation and all loose cloth clear of the cut path.	The marked opening matches the native piece and the previous stitching is secure; see pages 21–23.
Topstitch the main zip	Hem balance, native collar seamline, both sliders and no caught facing.	The closed fronts match without stretching; see pages 25 and 78.
Close a sleeve underarm	Shields, cuff tab direction and any native internal reinforcement.	Left/right assignments and free edges are photographed; see pages 29 and 33.
Close shell or cowl seams	D/E orientation, Q/W free edges and any seam that needs access for sealing.	No design layer is accidentally captured; the seam order is checked against the native master.
Join lining cuffs	Sleeves are not twisted; hatches and channel openings function.	A hand can pass through each sleeve and all required openable interfaces remain open.
Close the lining turn opening	Rails/harness absent from needle path, six interfaces accessible and complete textile strip possible.	The inspection on page 86 is recorded. Baste this opening until the service check is complete.

01 **Photograph the hidden stack**

Place a removable piece-code label next to the assembly. Photograph face, back and the seam allowance before covering it. Keep the needle zone free of electronics, wires and rigid fixtures.

02 **Use basting to test uncertain order**

Where the native sequence or access remains unresolved, assemble reversibly. Test the real motion, zipper or module removal before committing to a seam that hides the interface.

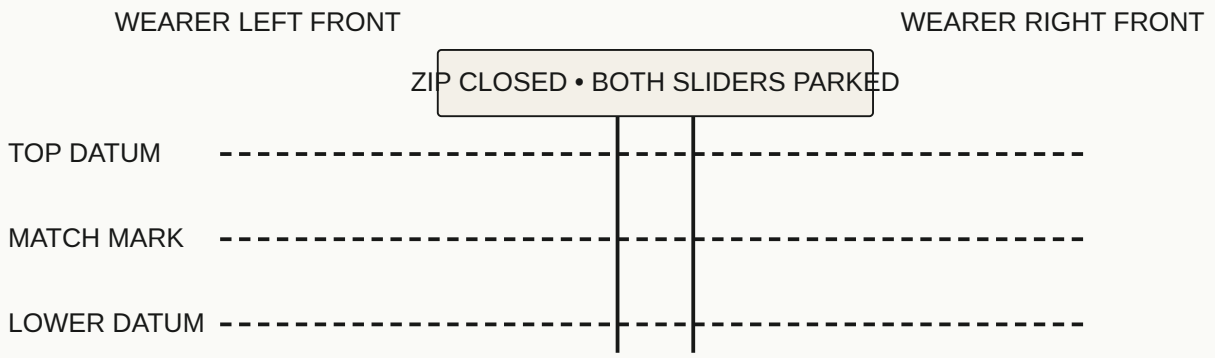
03 **Repair the affected seam, not the silhouette**

If a layer is trapped, identify the shortest accessible seam that releases it. Remove stitches without slicing the coated textile. Reject damaged cloth at a load point rather than covering the fault with decoration.

DG03-ZIPDATUM / WORKSHOP METHOD

Transfer zipper landmarks as a pair

Use the actual #5 two-way separating zip and the matched native front/facing pieces. The inherited 700 mm trim length is not a new finished seamline measurement.



Transfer native match points; diagram positions are not cutting coordinates.

01 **Establish the native start and finish**

On the paper work copy, identify the zipper attachment line, upper collar intersection, lower facing/hem transition and the box/insertion-pin clearance. Do not position the top stop from a rendering.

02 **Mark while the zip is closed**

Lay both fronts flat without tension. Close the zip fully with both sliders correctly parked. Transfer matching landmarks across both tapes from the native seamline. Label the wearer’s left and right tape outside the sewn area.

03 **Baste and cycle before permanent stitching**

Baste the first side, close the zip and align the opposite landmarks before basting the second. Exercise the complete opening and both slider positions. The box and insertion pin must remain accessible and the facing must not enter the teeth.

04 **Attach facings in the same registered state**

Use P with its inherited allowance, not a second added allowance. Follow page 25. Recheck the collar/hem landmarks after turning; topstitch only after the closed fronts hang without a forced offset.

> **Correct a mismatch at its cause**
>
> Release the relevant basting and redistribute neither stretch nor unwanted ease into the zip. Do not trim the collar, shorten a hanging layer or cut off the lower separator to make the fronts appear level.

DG03-EDGES / WORKSHOP METHOD

Write an edge ticket before cutting

A piece envelope describes storage space. A seamline describes the join. A cut line includes the specified allowance. Keep all three distinct on the work copy.

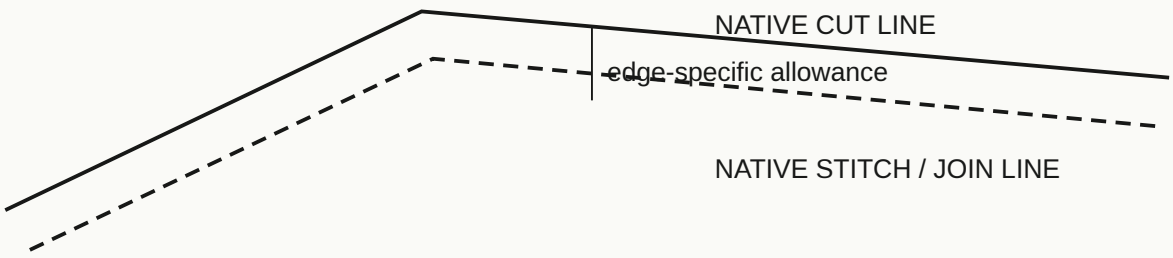


Illustration only. No offset shown here is a measurement or pattern.

Record for each edge	What to verify
Piece / material / side	Code, work-copy revision, shell/lining/reinforcement, RS/WS and wearer handedness. Count the layers from pages 10–12.
Edge purpose	Join seam, fold, binding, zip attachment, free drape edge or service opening. Do not bind or stitch a free edge simply because an illustration has a border.
Native allowance	Write the allowance from the actual master for that edge and whether it is already included. P's stated 10 mm is inherited; it is not a blanket allowance for every other piece.
Matched edge and landmarks	Record the partner piece and walk their stitch lines, not their outer bounding boxes. Preserve the intended sleeve ease and all genuine balance marks.
Operation and inspection	List what must be attached or checked while flat, what stays free, and the next irreversible cut or seam.

01 **Resolve conflicting annotations before cutting**

Keep both source references. Measure the relevant native master rather than choosing the smaller dimension or averaging the two. Mark that edge Blocked until one revision is selected.

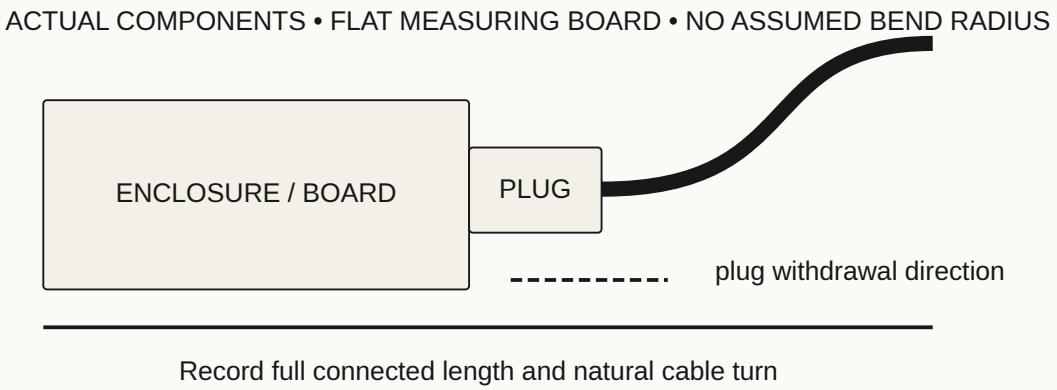
02 **Transfer only a verified edge**

Mark on the wrong side or in an expendable allowance using the tested method from page 14. Never add allowance twice to an already inclusive pattern.

DG03-ENVELOPE / WORKSHOP METHOD

Measure the module in its connected state

A caddy must fit the complete module and allow its removal. The disconnected board dimensions are only one input.



01 **Build the measuring fixture**

Place the module on a flat sheet beside a ruler. Connect the intended cable, strain relief and antenna connector. Rest the cable naturally; do not force it flat to reduce the drawing. Trace the assembly outline and mark body-side orientation.

02 **Record three different envelopes**

Measure the closed physical envelope, the connected operating envelope and the swept space needed to remove each plug or open the case. Include switch travel, card removal, ventilation and service access. Record mass with its actual cable share separately.

03 **Make and label an inert equivalent**

Use page 47. Replicate the connected volume and representative mass without a live battery or powered radio. Label dummy, module identity, measured dimensions, mass and measurement date. A placeholder cuboid is not evidence of fit.

04 **Check every planned module, not only seven boxes**

Reconcile the actual module list with the carrier. Explicitly account for the display/service pod, CC1101 and antennas, sensors, power, connectors and cable slack. Existing seven-caddy imagery is a layout reference, not proof that all later hardware fits.

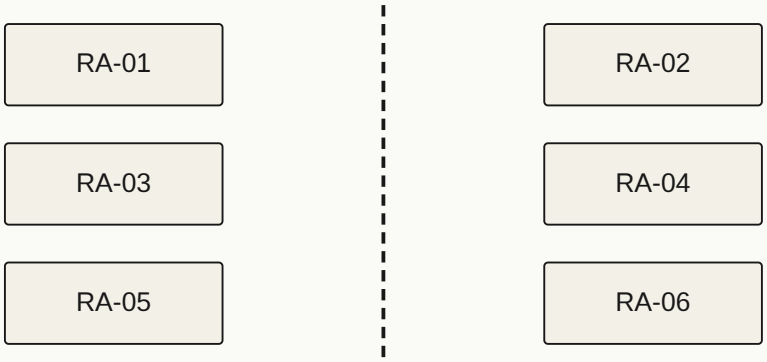
05 **Fit the loaded carrier before making final caddies**

Confirm that the carrier supports the mass and connectors remain reachable. Reserve room for measured harness turns without forcing the shell away from the approved silhouette.

DG03-REGISTER / WORKSHOP METHOD

Make six interfaces return to the same place

Register COWL to the fitted, inert-loaded carrier. The interface coordinates come from the actual pattern and fitting, not positions measured from a front-view image.



Worksheet numbering only: not anatomical placement or cutting coordinates.

01 **Stabilise the wearer state**

Use the intended underlayer and an inert-loaded carrier fitted as on pages 44–45. Close COWL to the chosen inspection state. Record strap settings and photograph front, rear and both sides before transferring any mark.

02 **Number the existing six interface pairs**

Use removable RA-01 to RA-06 labels on the shell-side patch and matching carrier interface. Follow the native placement and page 45. This numbering aids registration; it does not define new patch positions.

03 **Transfer centre, rotation and face**

Mark the mating centre and direction on a work copy while the assembly is correctly aligned. Specify which face receives the fastener and which side carries reinforcement. Check that the attachment does not turn an intended free drape into a load strap.

04 **Add removable witness marks**

Place a small tape witness across each strap/adjuster boundary and near each fitted interface. Photograph it before movement. After page 67’s inert trial, record any movement in millimetres against the same reference; do not call unmeasured motion “stable”.

05 **Repeat removal and replacement**

Unmate and refit using the six labels. Check alignment, strap marks, accessible hatches and connector slack. Correct registration or load support before permanently closing the lining.

> **Acceptance is about the assembled sample**
>
> Retain the inherited fit and service targets; no new load rating or strap tolerance is invented here. A witness mark is an observation method, not a certified strength test.

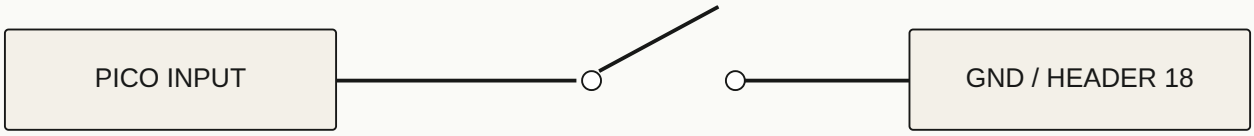
DG03-INPUTWIRE / WORKSHOP METHOD

Connect five inputs without ambiguity

Use only the bare non-wireless Pico 2 and passive contacts. This card expands page 53; it does not revise the LAB-0 allocation on page 52.

Lead	Pico GPIO	Header pin	Far end
MODE	GP14	19	Momentary contact → BLACK GND
UP	GP15	20	Momentary contact → BLACK GND
DOWN	GP16	21	Momentary contact → BLACK GND
ACTION	GP22	29	Momentary contact → BLACK GND
TAMPER	GP9	12	Normally closed contact → BLACK GND
Common return	GND	18	Other side of every contact

ONE CONTACT PER INPUT • INTERNAL PULL-UP ENABLED IN THE DIAGNOSTIC



Button: open HIGH, pressed LOW. Tamper: closed LOW, open HIGH.

01 **Confirm board orientation unpowered**

View the component side with USB uppermost: header 1 is top left, header 40 top right. Use the official pinout, not the row number on a breadboard. Check the middle power-rail breaks on the actual breadboard.

02 **Identify the contacts with continuity**

On a four-leg tactile switch, find the two internally joined pairs and choose one terminal from each different pair. Check released/pressed states before attaching a GPIO wire. An NC tamper contact must conduct in its normal closed state.

03 **Wire and inspect one lead at a time**

Label both ends by net and physical pin. Verify no continuity from a contact to 3V3, VSYS or VBUS. Verify adjacent GPIOs are not shorted. The external 3.3 V and 5 V rails are not needed for this test.

> **USB-only test boundary**
>
> Disconnect every peripheral, RED board, external supply and wearable harness. A successful input log does not prove watchdog operation, fail-off hardware or electrical isolation.

DG03-INPUTRUN / WORKSHOP METHOD

Run the supplied bench diagnostic

The toolkit includes two complete MicroPython files: input_logic.py and black_input_check.py. This program reads contacts and prints JSON lines over USB; it does not command external outputs.

01 **Preserve existing firmware before installing**

Use an identified spare/bare Pico 2 for this diagnostic. If the board already contains project code, retrieve and archive it first. Installing a MicroPython UF2 replaces the installed runtime; do not overwrite the only existing build.

02 **Install the board-correct runtime**

Use the official non-wireless Pico 2 download page linked on page 88. Hold BOOTSEL while connecting USB; the RP2350 volume appears. Copy the chosen stable RPI_PICO2 UF2 to it and wait for reboot. Record the exact UF2 filename and its hash.

03 **Copy the two source files**

In Thonny, select the MicroPython (Raspberry Pi Pico) interpreter and the actual USB serial port. Save input_logic.py and black_input_check.py to the board root. Do not name this diagnostic main.py; run it deliberately, not on every power-up.

04 **Run black_input_check.py**

Open that file from the board and press Run. The USB shell first reports the diagnostic version/runtime and an initial snapshot. It then reports debounced button changes, raw tamper changes and periodic heartbeat snapshots. Use Stop/Ctrl-C to end it.

05 **Capture the actual shell output**

Copy the real JSON lines into a UTF-8 log, not the illustrated text below. Save board photos, both source hashes and the runtime identification with the record. Complete the physical sequence on page 84.

```
Actual output types to look for:
{"type":"boot", ...}
{"type":"snapshot", "reason":"initial", ...}
{"type":"button", "name":"MODE", "level":0, ...}
{"type":"tamper", "level":1, "state":"OPEN", ...}
{"type":"snapshot", "reason":"heartbeat", ...}
```

> **Diagnostic scope**
>
> The displayed lines are a field guide, not captured evidence. No GPIO is configured as an output. The program has no watchdog acceptance test, secure-element driver, storage power test, RF driver, remote control or garment activation.

DG02 pp.53, 65; T01/T06 official Raspberry Pi and MicroPython setup/API. Diagnostic source included; physical execution not performed here.

DG03-INPUTTEST / WORKSHOP METHOD

Test the events, not just the screen

Use a real shell log from page 83. Compare each contact action with its corresponding field; simultaneous contacts must not masquerade as one button.

Physical action	Expected diagnostic observation	Record
Boot with all four buttons released; tamper closed	Initial MODE/UP/DOWN/ACTION = 1; tamper = 0 / CLOSED.	Initial snapshot and board orientation photo.
Press then release MODE, UP, DOWN, ACTION one at a time	Only the corresponding button reports level 0 / PRESSED, then 1 / RELEASED after software debounce.	Ten full cycles per button as a DG03 wiring check, not E-B0.
Hold two buttons together, then release separately	Two independent button states and two independent releases.	Names and order in the real log.
Open the NC tamper loop, then reconnect	Raw tamper 1 / OPEN, then 0 / CLOSED. Contact bounce may produce several raw events.	Actual events; no inferred reset/re-arm action.
Run with one button held at startup	The initial snapshot shows that button at 0; it is not silently assumed released.	Restart identity and initial snapshot.
Stop, unplug and reconnect the test board	USB session stops and the diagnostic is not auto-started unless explicitly configured elsewhere.	Check board-root main.py/boot.py if behaviour differs.

01 **Explain a stuck LOW before replacing the board**

Unplug power. Disconnect that button lead and inspect whether both wires used the same internally joined switch pair, a bridge shorts to ground or the breadboard row is wrong. Recheck with continuity before applying USB power.

02 **Explain a stuck HIGH at the contact**

Unplug power. Verify the common ground, selected physical header pin and contact closure. A button that visibly clicks is not proof its selected terminals conduct.

03 **Separate software test from system acceptance**

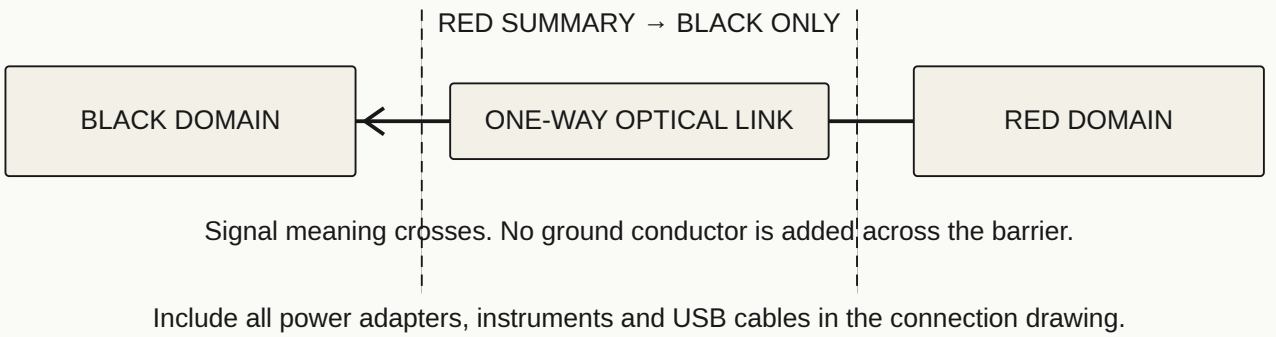
Host tests check event logic and file syntax. Physical input tests check this wiring. Neither proves E-B0’s 60-minute core run, active watchdog or any E-B2 true-off target.

> **Tamper is observed, not implemented as a protection system**
>
> Raw polling and USB logging are not a hardware interlock. Reconnecting the contact does not mean the complete MURMUR system has been safely reset or re-armed.

DG03-INSTRUMENTS / WORKSHOP METHOD

Keep instruments from joining the domains

A separated BLACK/RED circuit can be joined accidentally through USB shields, oscilloscope ground clips or a computer. Draw the measurement connections as part of the test fixture.



Include all power adapters, instruments and USB cables in the connection drawing.

01 **Record every conductive path while unpowered**

Draw both supplies, board grounds, host USB connections, shields, debug probes and instruments. Check the instrument manuals for shared grounds and earth references. Two ports on one computer are not automatically separate domains.

02 **Use the fixture from pages 56–57**

Keep the intended optical transmitter on RED and the receiver/inverter on BLACK. The specific board/module pin assignment still needs identification; an isolation IC in a parts list does not validate a wired breadboard.

03 **Measure on one side with a suitable arrangement**

Choose instrumentation whose documented input/reference arrangement fits the measurement. Never lift protective earth to manufacture isolation. Disconnect or replace a measurement connection that joins the domains.

04 **Make loss of power part of the test**

Record observed receiver behaviour when RED power disappears and when BLACK power disappears. Check that local BLACK operation continues under the defined fault sequence. Retain the connection drawing with the captures.

05 **Distinguish continuity screening from certification**

A meter indicating open circuit on an unpowered fixture is a useful check for obvious unintended wiring. It does not establish barrier withstand voltage, creepage, leakage, transient immunity or certification.

> **Keep the source’s true-off criterion exact**
>
> For the retained LAB-0 switched-rail check, use ≤0.30 V after 250 ms plus no back-power/peripheral response (pages 58–59 and E-B2A), not a different target copied from an old store page.

DG03-CLOSEOUT / WORKSHOP METHOD

Close the garment only after service works

Do this with inert modules. The last lining opening is an inspection route until the whole carrier and all electronics can be removed without cutting a seam.

Inspection route	Check with the sample open
Front → hem → cowl	Cycle the separating zip; inspect both facings, Q's handedness, collar seam and the intended free drape. Confirm the cowl opening has not changed while attaching the lining.
Both sleeves	Check the lining is untwisted and the cuff/underarm allowance is not caught by a channel, strap or adjuster. Repeat reach and bend with inert carrier load.
All six interfaces	Check reinforcement, correct mating face and accessible fastener release. Photograph the interface before it becomes concealed.
Each module route	Insert the full connected dummy; disconnect it and withdraw through its actual opening. Check plug latch access and natural cable bends.
Complete textile strip	Remove carrier, electronics, leads, removable sensors and every source-defined detachable element. Count them against the measured module and harness inventory.

01 **Reinstall from the record, not memory**

Use the removal order on page 68 in reverse where mechanically appropriate. Check connectors and orientation against the net schedule before power is considered. No hot-plug permission is implied.

02 **Inspect hidden work before final closure**

Check the tested seam tape where specified, no dangling conductor or sharp rigid edge, no needle damage at load-bearing points and no loose thread in zipper teeth. Photograph the final accessible state.

03 **Baste, refit, then close**

Baste the remaining lining opening. Repeat service and inert movement checks. After they are acceptable against the inherited criteria, close with the specified finish and recheck access once more. Leave a documented service opening if the design requires one.

> **Washing is a separate release**
>
> Successful removal does not validate a wash programme or textile durability. Use tested material/process results before publishing care instructions for a finished product.

DG03-RETEST / WORKSHOP METHOD

Know what a change invalidates

Use this matrix to reopen the affected records. The tracker keeps evidence; it cannot decide that an old result is still representative of changed hardware or cloth.

Change	Recheck at minimum
Shell cloth, thread, needle or stitch	DG02-FABRIC / COUPON / CLOSURE; seam strength/finish and tape process for that stack. Revisit fit when behaviour changes.
Native contour, allowance or zip	DG02-SEAMWALK / TOILE / ZIP; DG03-EDGES / ZIPDATUM; affected POMs and movement.
Carrier strap, anchor or module mass	DG02-MOLT / ANCHORS / DUMMY / WEAR; DG03-ENVELOPE / REGISTER; G-FIT and G-SERVICE.
Window, sensor orientation or covering	DG02-SENSORWINDOW / SENSORS; E-B4 / B4A; optical baseline through the actual final stack.
Rail, regulator, pull-up or harness	DG02-DEADRAIL / LOOM; E-B2 / B2A and relevant fault/current tests. Repeat haptic/storage checks where their load path changed.
RF divider, detector, ADC scan or antenna path	DG02-RF; E-B7 / B7A; settling, calibration, signal envelope and power-off behaviour. A changed scale invalidates old calibration.
Firmware, packet parser or observer transport	DG02-FIRMWARE; affected controls/sensor/storage functions; E-B6 / B8 and final E-B10 after integration.

01 **Name the actual delta**

Record old and new part/revision, exact affected net or seam and why the change was made. Keep the superseded result rather than editing it to look as if it applied to the new sample.

02 **Set status intentionally**

Editing a Passed tracker record moves that record to Review required. Set related activities to Rework when the matrix indicates they may be affected. There is no automatic complete dependency graph.

03 **Close with evidence and a reviewer**

Record the actual new measurement, configuration, evidence filenames and operator. A manual Passed state means the operator attests that the cited criterion is met; the tracker cannot inspect the evidence files.

DG03-RELEASE / WORKSHOP METHOD

Use one controlled build package

DG03 combines the guide, executable diagnostic and portable build records. Keep source facts, workshop methods and measurements in separate evidence classes.

File / evidence class	Use
DG03 PDF + editable HTML	88-page controlled document with stable first 75 page positions. Original approved images retained. Illustrations are not native patterns.
BUILD_TRACKER.html + operations JSON	67 activities: original 54 plus 13 DG03 cards. Initial state is unrecorded. Exports contain record text, not photo/trace binaries.
firmware/ and host tests	Five-input USB diagnostic, portable event logic and automated host tests. No complete BLACK/RED firmware or on-board physical pass is claimed.
DG03_CHANGE_RECORD.json / QA files	Document/image integrity, layout and software checks. Physical acceptance remains separate and is not populated from software tests.
Your build evidence	Actual native master, marked work copy, coupon photos, measurements, board identity, USB/instrument logs and operator-reviewed results.

Current public technical references

T01: Raspberry Pi Pico-series documentation and pinout.
T06: MicroPython for non-wireless Pico 2; Pin API; time / ticks_diff API. Checked 19 September 2026.

Store document entry point

murmur.qd.je / pages / system-001-build-guide. The publication record identifies the uploaded file and page readback. Store images are design-development visualisations, not photographs or physical acceptance evidence.

> **The next physical bottleneck is still specific**
>
> Obtain and verify the native C5A/C.4 contour master and actual carrier geometry before final garment cutting. Meanwhile the identified-board input test, material coupons, measured caddy work and wiring records can proceed.