Sensorium™ SmartBolt — User & Operation Manual

Correct installation and torque, BLE pairing to the Gateway, reading monitoring data, and maintenance of the SmartBolt connected fastener.

`sensorium-smart-bolt-manual` · Revision Draft (Preliminary) · 2026-07-18 · Status: **PRELIMINARY**

> **PRELIMINARY — PROPOSED VALUES.** This manual describes intended operation. Product figures are maintained in the datasheet; where quoted here they carry the ‡ mark, meaning **proposed, industry-typical, not measured and not final** — engineering must confirm them before release. Values that are deployment-specific (the joint's target torque/preload and tightening sequence) are set **per the responsible engineer's joint specification**, not by this manual. **Do not rely on this document for live structural or safety-critical work until it is released.**

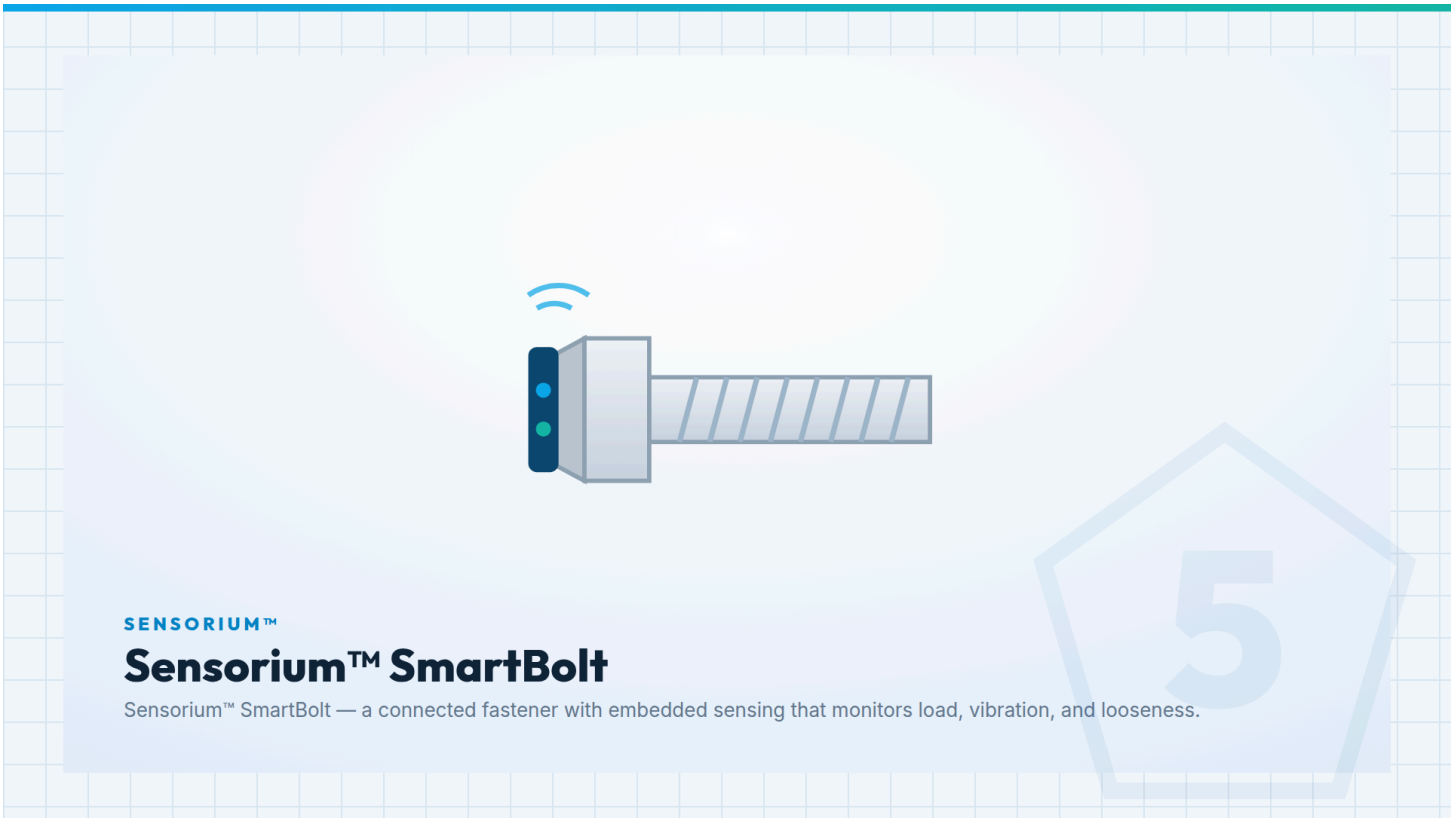

Figure FIG-001 — Sensorium™ SmartBolt, the connected fastener of the Sensorium™ family, with preload, temperature, vibration, and looseness sensing housed in the instrumented head.

1. Safety

Correct installation and torque of the SmartBolt is **safety-relevant**: the SmartBolt is a load-bearing structural fastener, and an incorrectly installed or under/over-torqued joint can lose clamping force and fail. Read this chapter in full before handling, installing, or servicing the product.

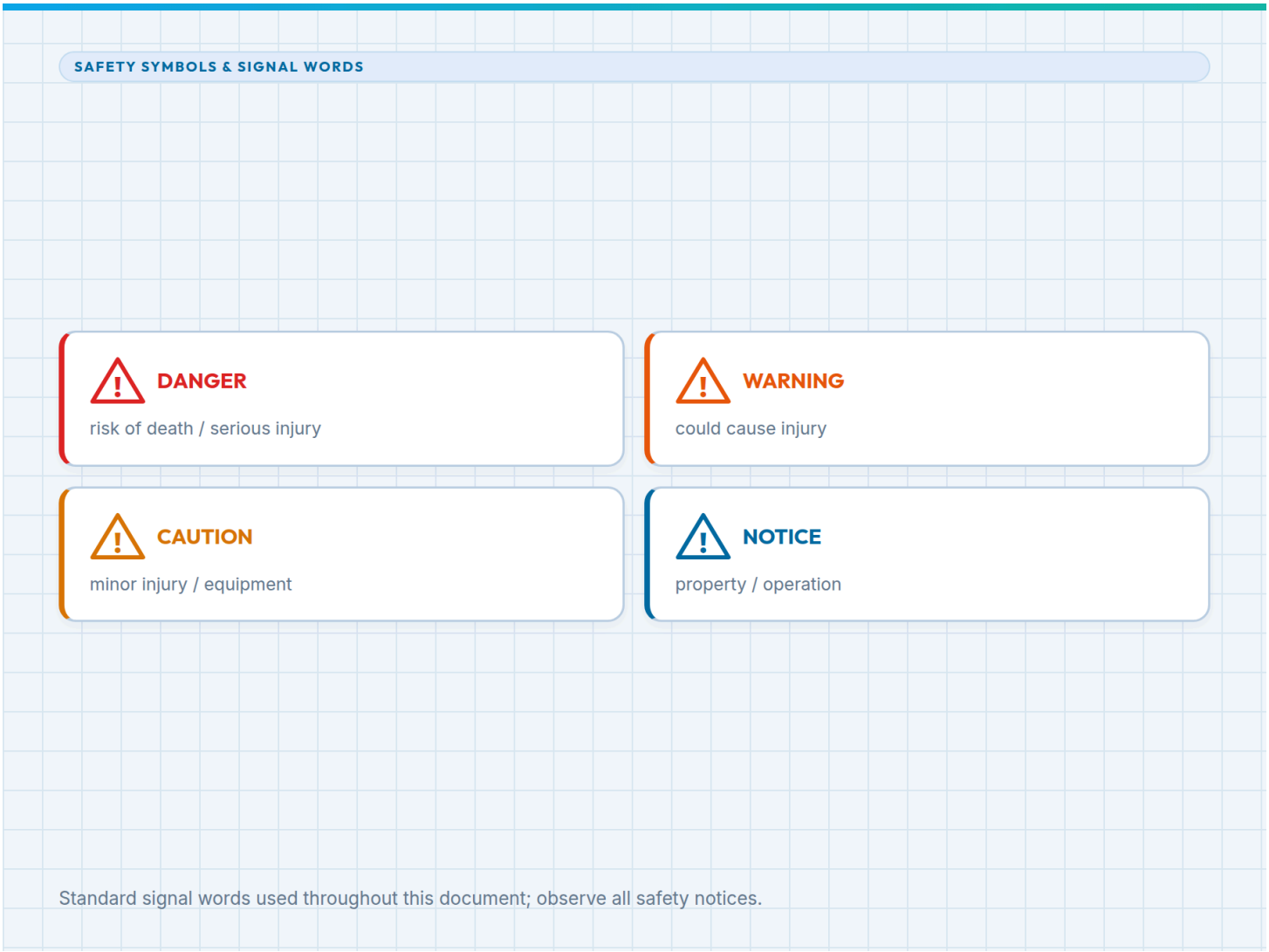

Figure FIG-002 — Signal words and the structural-integrity and torque hazard pictograms used throughout this manual.

1.1 Signal words

SIGNAL WORD	MEANING
DANGER	Hazardous situation which, if not avoided, **will** result in death or serious injury.
WARNING	Hazardous situation which, if not avoided, **could** result in death or serious injury.
CAUTION	Hazardous situation which, if not avoided, could result in **minor or moderate** injury.
NOTICE	Practice not related to personal injury; risk of **property or equipment damage** or invalid data.

1.2 Intended use

The Sensorium™ SmartBolt is a connected structural fastener intended to **replace a standard fastener of the equivalent specified grade and size** in critical infrastructure, while monitoring load, vibration, and looseness. It is intended to be installed by qualified personnel, tightened to the specified torque (per joint design), and monitored wirelessly through the Sensorium™ Gateway and the 5Tech Platform. Any other use — in particular substituting it for a fastener of a different grade, size, or class than specified — is misuse.

1.3 Qualified personnel

> **WARNING — Structural failure.** Installation, torqueing, and removal of structural fasteners must be performed only by qualified personnel (a trained millwright, structural bolting technician, or equivalent) working to the responsible engineer's joint specification. Incorrect installation can cause loss of clamping force and joint or structural failure.

Qualified personnel must be trained on this product, on the applicable structural bolting procedure, and on the use of a **calibrated** torque tool.

1.4 Key safety warnings

> **DANGER — Falling / collapsing load.** Never loosen, remove, or re-torque a SmartBolt in a loaded joint unless the structure has been de-loaded, supported, or made safe per the site's lift/rigging and lock-out procedures. A joint releasing under load can cause a falling load or structural collapse and death.
> **WARNING — Incorrect torque.** Do **not** exceed or fall short of the specified torque (per joint design). Over-torque can yield the fastener and reduce its fatigue life; under-torque can leave the joint loose. Always use a calibrated torque tool.

WARNING — Fatigue life. Do not reinstall a SmartBolt that has reached the end of its rated fatigue life (**≥ 2 × 10^6 cycles‡**, per **VDI 2230** S-N — see the Datasheet §5) or that the Platform has flagged for replacement. Replace it with a new fastener of the specified class.
WARNING — Embedded lithium cell: fire and explosion. The SmartBolt contains a **sealed, non-replaceable lithium thionyl chloride (Li-$SOCl_2$) primary cell** inside the head. Do **not** weld on, apply heat to, incinerate, drill, grind, re-machine, crush, or short-circuit the fastener: the embedded cell can vent, ignite, or explode and can release toxic gas. Do **not** attempt to open the head or replace the cell — it is sealed for life. At end of life, remove the fastener **intact** (§5.5) and dispose of it as **hazardous waste / a lithium-battery-containing device** per local regulations; do **not** place it in general or scrap-metal waste. Battery transport is subject to UN 38.3 (Datasheet §9).
CAUTION — Sharp threads / pinch points. Machined threads and hex flats can cut; assembling joints creates pinch points. Wear appropriate PPE.
NOTICE — Do not deface the identity marking. Do not paint over, re-stamp, or obscure the laser-etched device identity or property-class marking on the head; doing so can prevent pairing and corrupt the load/preload record. (For the fire/explosion and structural hazards of machining or heating the fastener, see the WARNING above.)

1.5 Residual risks

Even when installed and used correctly, residual risks remain: sensor drift or loss of wireless link can delay a fault indication; a fastener can still be damaged by an out-of-specification overload event between reporting intervals; and predictive-maintenance alerts from the Platform are decision-support, **not** a guarantee against failure. The SmartBolt provides **monitoring support, not a certified structural-health inspection** — retain independent structural inspection and safety measures. The detailed residual-risk register is maintained in the product risk assessment held with engineering.

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2. About this manual

Scope. This manual covers correct installation and torque, wireless pairing/commissioning to the Sensorium™ Gateway, reading and interpreting monitoring data, and maintenance of the Sensorium™ SmartBolt. It does **not** cover joint design, bolt-pattern engineering, or Gateway and Platform installation — see *Related documents*.

Audience. Qualified structural bolting technicians, maintenance/reliability engineers, and commissioning personnel.

Conventions.

- Numbered lists are **procedures** — perform the steps in order, one action per step.
- Signal words (§1.1) precede the hazard they refer to.
- **‡** marks a proposed, industry-typical product value that is **not yet measured or final**; full specifications and every **‡** value live in the datasheet.
- "Per the joint specification" marks a deployment-specific value (target torque/preload, tightening sequence) set by the responsible engineer — not a fixed product figure.
- Monospace text denotes an order code, device identifier, or Platform field.

Related documents.

- **Datasheet (full specifications):** `sensorium-smart-bolt-datasheet`
- **Aggregated by:** `sensorium-gateway-manual` and its datasheet.
- **Platform:** 5Tech Platform — monitoring, automation, and AI-assisted reporting (monitoring dashboards and alerts).

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3. Product overview & theory of operation

The Sensorium™ SmartBolt is the *Sense*-category connected fastener of the Sensorium™ family. It is a bolt that installs like a conventional fastener but carries sensing, a sealed primary cell, and a BLE antenna in an **instrumented head cavity** — the **load-bearing shank is not machined**, so the fastener keeps the full rated strength of its property class (Datasheet §5). It monitors:

- **Load / clamping force (preload)** — measured directly by a sensing element in the head cavity, so the system can indicate whether a joint was tensioned into its expected range and flag a loss of preload (loosening) over time.
- **Temperature** — head temperature is reported as a joint-condition signal and used to compensate the preload reading over temperature.
- **Vibration and movement-related signals** — tracked over time to surface changes in joint condition.

The exact sensing-element design is proposed (**‡**) and maintained in the datasheet. The SmartBolt reports these measurements **wirelessly over BLE to the Sensorium™ Gateway**, which aggregates the data and forwards it to the **5Tech Platform**. On the Platform, monitoring dashboards show joint condition over time, and AI-assisted analysis highlights trends and flags joints that may need attention, so maintenance can be planned. This is **monitoring support, not a certified structural-health inspection**, and does not guarantee against failure.

The SmartBolt has **no operator-facing display**; its state is observed on the Platform, not on the device. This places it in the Sense → Connect → Decide chain: *SmartBolt (Sense) → Gateway (Connect) → Platform (Decide, human-in-the-loop)*.

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4. Controls & indicators

The SmartBolt is a fastener, not a panel device: it has minimal on-device interaction and reports its status wirelessly. Exact hardware details are proposed (‡) and confirmed in the datasheet.

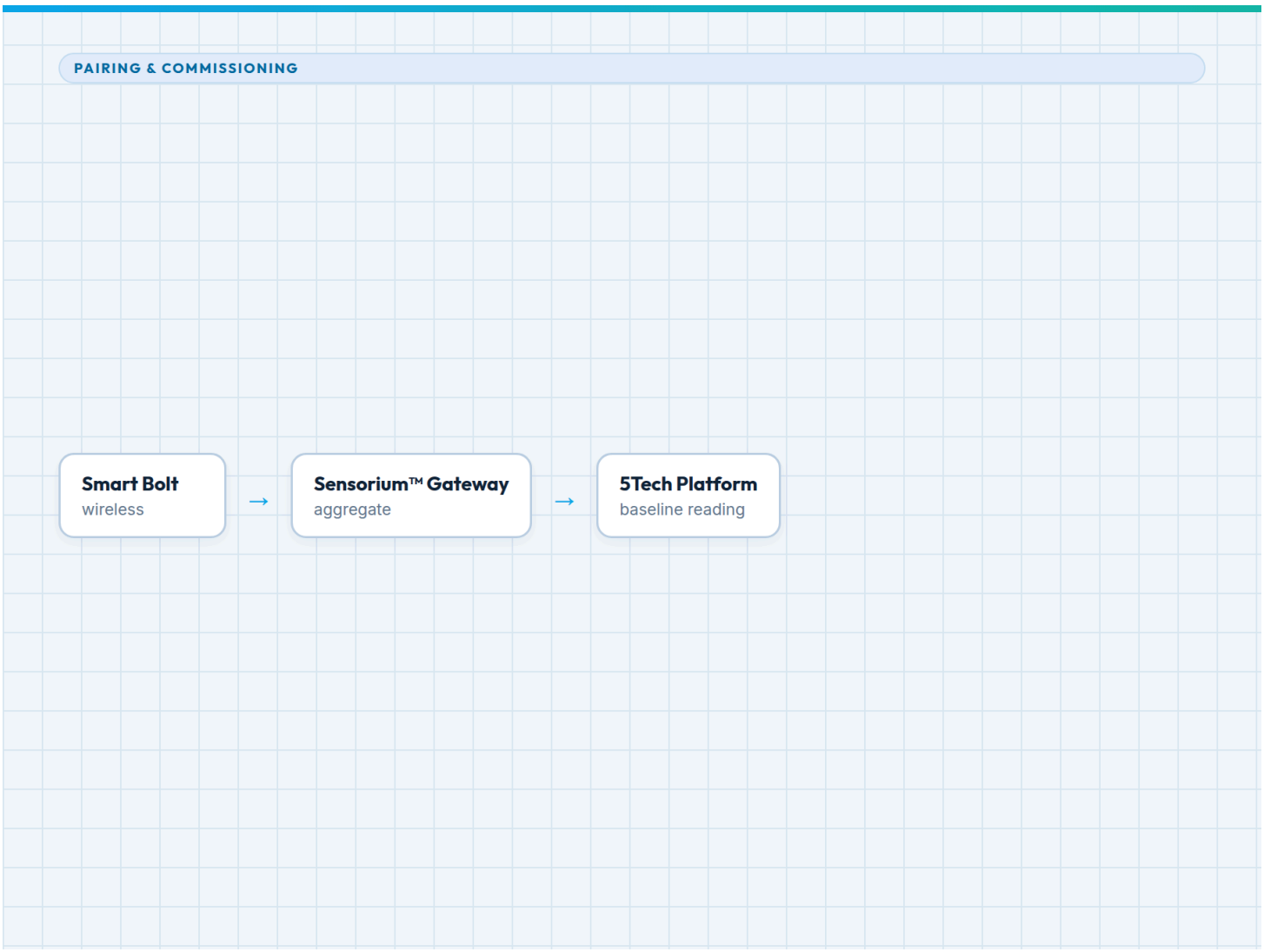

Figure FIG-004 — The SmartBolt pairs wirelessly with the Sensorium™ Gateway, which reports device status up to the 5Tech Platform.

CONTROL / INDICATOR	FUNCTION	STATES
Device identity marking (laser-etched on the head)	Unique ID used to pair, place on the joint map, and track the fastener	Fixed; human/tool-readable — alphanumeric ID‡
Commissioning / wake interface	Wake and enroll the fastener during pairing	Handheld wake/enroll tool‡ (Datasheet §7)
On-device status indicator (if fitted)	Local commissioning feedback	Optional‡ — the primary status source is the Platform
Reported device status (via Gateway → Platform)	Health and link state shown on the Platform	Discovered · Paired · Online · Alert · Offline‡
Condition state (via Platform)	Interpreted joint condition	Nominal · Watch · Alarm — thresholds per the joint specification

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5. Operation

> **WARNING — Structural work.** Every procedure in this chapter is structural bolting work. Perform it only as qualified personnel, only to the responsible engineer's joint specification, and only with a **calibrated** torque tool. Confirm the joint is de-loaded or supported as required before working on it.

5.1 Pre-installation inspection

1. Confirm the SmartBolt **property class and size** (M12–M24‡; class 8.8/10.9/12.9‡ per ISO 898-1, marked on the head — Datasheet §5) match the joint specification. Do not substitute a different class.
2. Read the device identity marking (§4) and record it against the joint/position on the site bolt map.
3. Inspect the fastener for shipping or handling damage. **Do not install** a bolt with damaged threads, a damaged head, or a damaged sensor recess.
4. Verify the mating faces, washer, and nut are clean, correct, and free of debris, burrs, or corrosion.

Expected state: fastener verified as the correct part, undamaged, logged, and ready to install.

5.2 Installation and torque

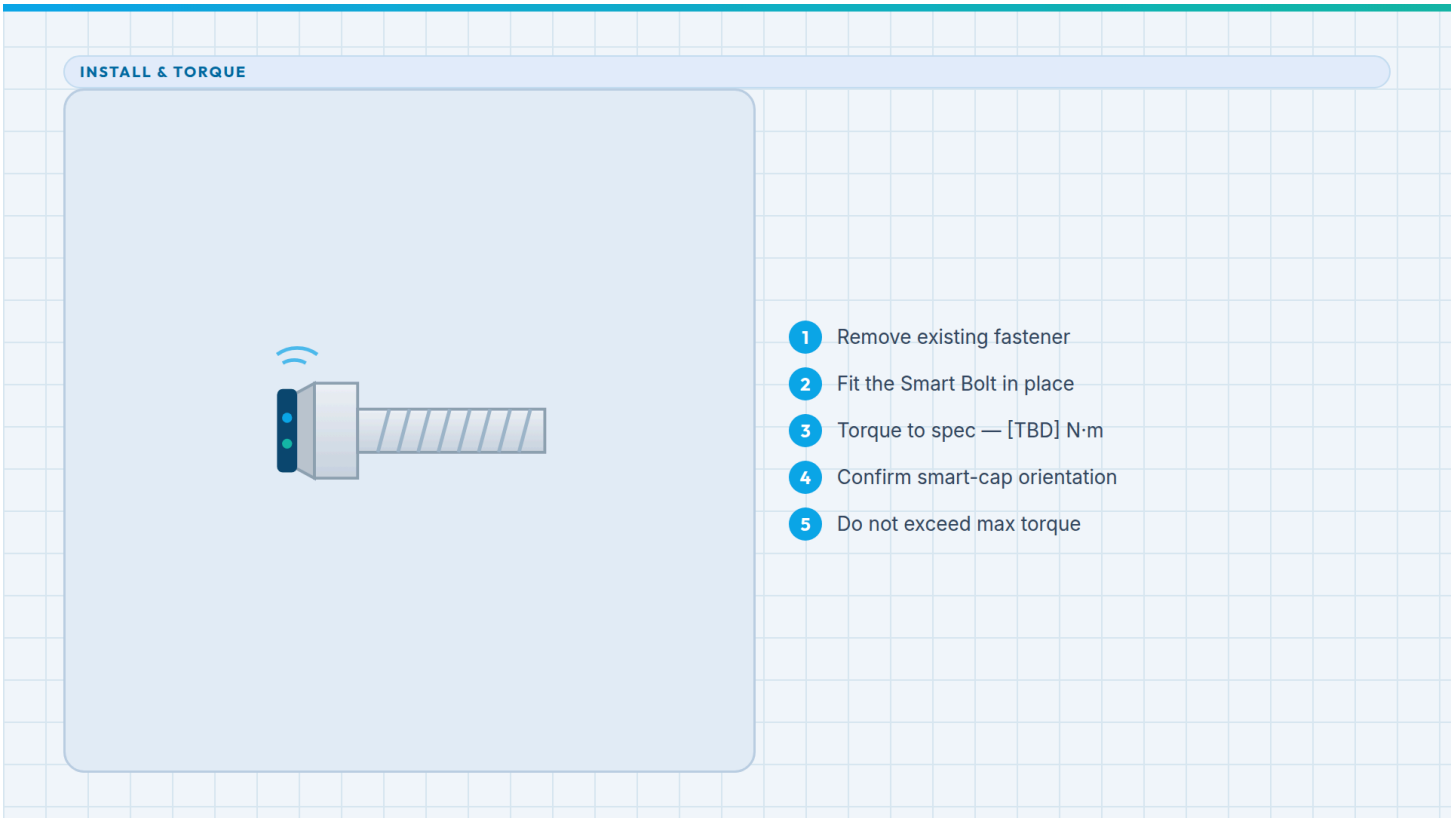

Figure FIG-003 — Correct joint stack-up, calibrated torque-wrench engagement, and the controlled tightening sequence.

> **WARNING — Incorrect preload.** Under- or over-tensioning compromises the joint. Tension to the **target preload set by the joint specification**, in the specified tightening sequence, only. The SmartBolt is **preload-controlled**: use its **live preload reading** on the Platform to verify the achieved clamp load, rather than relying on a torque value alone.

1. Assemble the joint with the correct stack-up: place the washer under the turned element and seat the mating members as specified.
2. Insert the SmartBolt and fit the nut/washer per the joint drawing.
3. Engage a **calibrated** torque tool square-on to the hex head or nut. If a reference torque is used, apply the value from the joint specification (class- and lubrication-dependent; a lubricated k = 0.14‡ reference is given in Datasheet §5).
4. Bring the joint to the **snug-tight** condition per the joint procedure.
5. Tension to the **target preload** set by the joint specification, following the specified tightening sequence for multi-bolt patterns, and confirm the achieved clamp load on the SmartBolt's **live preload reading** (Platform, §5.4).
6. Where a witness/match mark is required, apply it across the fastener and joint after final tensioning.

Expected state: the fastener is tensioned to the specified preload (confirmed by its live reading) and marked; the joint is mechanically complete.

5.3 Pairing / commissioning to the Gateway

Perform this after the fastener is installed and torqued, with a Sensorium™ Gateway commissioned and online on the site.

1. Confirm the target **Gateway is powered and online** (see the Gateway manual).
2. In the 5Tech Platform, open the site's device-commissioning view and start enrollment for a new SmartBolt.
3. Wake/enroll the SmartBolt using the handheld commissioning tool‡ and its device identity (§4).
4. Verify the Gateway **discovers** the fastener and it advances to **Paired**, then **Online**.
5. Assign the device to its joint/position on the site map and confirm it reports a first **load/preload reading**.

Expected state: the SmartBolt is Online in the Platform, mapped to its joint, and streaming data through the Gateway.

5.4 Reading and interpreting monitoring data

Monitoring data is read on the **5Tech Platform**, not on the fastener.

1. Open the Platform monitoring dashboard for the site and select the joint or fastener.
2. Read the **load / preload** value and compare it against the installed preload range set by the joint specification.
3. Read the **temperature** value and the **vibration / movement** trend and check them against their baselines.
4. Read the interpreted **condition state** (Nominal · Watch · Alarm — thresholds per the joint specification).
5. If the Platform raises a predictive-maintenance alert, follow your site's maintenance-alert response procedure — do **not** dismiss it without engineering review.

Expected state: joint condition understood; any Watch/Alarm state actioned per site procedure.

5.5 Removal / decommissioning

> **DANGER — Loaded joint.** Do not loosen a SmartBolt in a loaded joint. De-load, support, or make the structure safe first.

1. Confirm the structure is de-loaded/supported and the work is authorised.
2. In the Platform, mark the fastener for removal/decommissioning so its going-offline is expected, not an alarm.
3. Loosen and remove the fastener **intact** with the appropriate tool. Do **not** cut, grind, heat, or crush it — it contains a sealed lithium cell (see the WARNING in §1.4).
4. Record the fastener's ID as removed and quarantine it — a used SmartBolt must not be reinstalled unless the responsible engineer approves it (see §7).
5. At end of life, dispose of the SmartBolt as **hazardous waste / a lithium-battery-containing device** per local regulations (Datasheet §8) — do **not** place it in general or scrap-metal waste.

Expected state: fastener removed intact, logged, and quarantined or routed to hazardous-waste disposal; Platform updated.

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6. Configuration

SmartBolt behaviour is configured centrally on the **5Tech Platform** (there are no field-set switches on the fastener). Change parameters only with the appropriate role and change-control approval.

PARAMETER	PURPOSE	NOTES
Joint / position mapping	Ties the device ID to a physical joint	Set at commissioning (§5.3)
Installed preload / clamping-force target & tolerance	Defines the correct-installation window	Values from the joint specification
Condition thresholds (Watch / Alarm)	When the Platform flags a joint	Thresholds from the joint specification
Reporting / sampling interval	How often the fastener reports	1 min – 24 h‡, default 1 h‡ (Datasheet §6)
Alert routing	Who is notified and how	Per site policy
Units	Force / torque display units	Per site preference

> **NOTICE — Data integrity.** Changing thresholds or units affects how joints are judged and how alerts fire. Record every change under change control so monitoring history stays

auditable.

7. Maintenance

WARNING — Structural work. Treat every maintenance action on an installed fastener as structural bolting work (§5). De-load/support the joint as required and use a calibrated tool.

INTERVAL	TASK	NOTES
Per site inspection schedule‡	Visual inspection of the fastener, head marking, washer, and joint faces	Check for corrosion, gap, or a shifted witness mark
Per site inspection schedule‡	Verify the device is **Online** and reporting in the Platform	Investigate any Offline/Alert device
Per site inspection schedule‡	Re-torque check with a calibrated tool	Only to the joint specification; do not exceed
On Platform alert	Investigate Watch/Alarm or predictive-maintenance alerts	Follow site maintenance-alert procedure
End of fatigue life (≥ 2×10^6 cycles‡, Datasheet §5)	**Replace** the fastener; dispose of the old one as hazardous waste (§5.5)	Do not reinstall a life-expired bolt

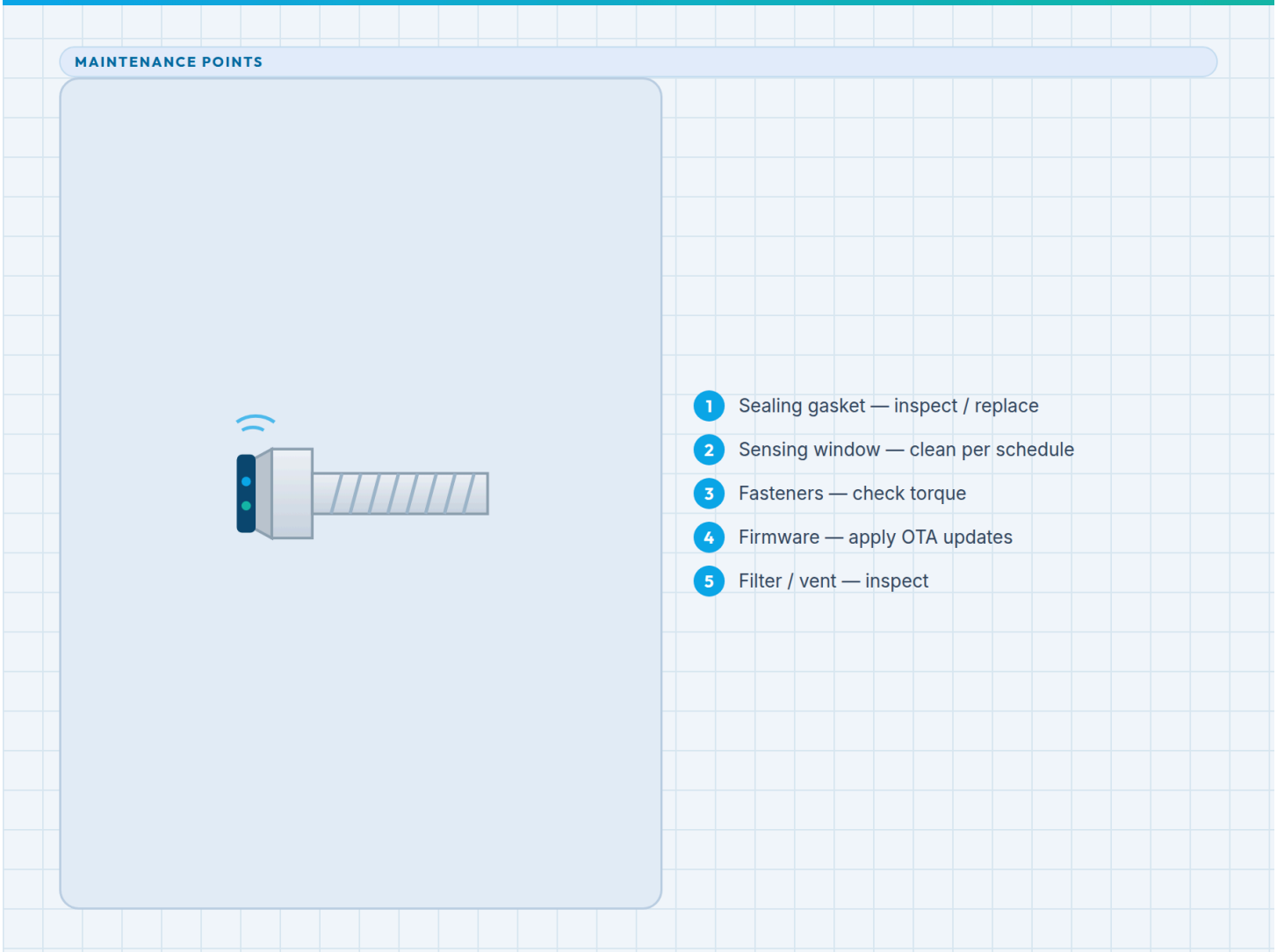

Figure FIG-005 — Maintenance points: inspect the head marking and joint, re-torque with a calibrated wrench, and replace at end of fatigue life.

Re-torque check procedure

1. Confirm the joint is safe to work on (§5) and the work is authorised.
2. Note the current **load/preload reading** in the Platform for the fastener.
3. With a **calibrated** torque tool, verify the fastener holds the preload set by the joint specification. Do **not** exceed it.
4. Re-apply the witness mark if it was disturbed, and record the check in the maintenance log.

Expected state: preload verified against the joint specification and logged; Platform reading confirmed.

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8. Troubleshooting

Perform only the operator-level checks below. For anything indicating an actual loss of joint condition or preload, follow your site's maintenance-alert procedure and involve the responsible engineer.

SYMPTOM	POSSIBLE CAUSE	ACTION
Fastener will not pair / not discovered by the Gateway	Gateway offline or out of range; wrong device ID; enrollment not started	Confirm the Gateway is Online; verify the ID (§4); restart enrollment (§5.3)
Device shows **Offline** in the Platform	Lost wireless link; obstruction; steel joint attenuating the head antenna; end of service life	Confirm Gateway link; check range/obstruction (installed BLE range ≈ 10 m‡, Datasheet §7); if persistent, escalate to 5Tech support (§10)
Load/preload reading below the installed range	Loss of preload / loosening, or incorrect installation	Do not ignore; inspect and re-check preload per §7 **only after** making the joint safe; involve engineering
Vibration / movement trend drifting or **Alarm**	Changing joint condition or overload event	Follow maintenance-alert procedure; schedule inspection/replacement per engineering
Predictive-maintenance alert from the Platform	AI-assisted analysis flags a joint for attention	Treat as actionable; do not dismiss without engineering review
Readings implausible or missing after service	Sensor recess or marking damaged during handling	Do not rely on the data; quarantine and replace the fastener

If a symptom is not listed or persists after these checks, contact 5Tech support (§10).

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9. Specifications

This manual does **not** duplicate the full specification. All exact values — property class and sizes, dimensions, clamping-force and torque figures, fatigue life, wireless characteristics, environmental ratings, and certifications — are maintained in the datasheet, where they carry the ‡ proposed-value convention until engineering confirms them.

Full specifications: see the Sensorium™ SmartBolt Datasheet.

ITEM	SUMMARY	SOURCE
Product / family	Sensorium™ SmartBolt (Instrumented Fastener) · Sensorium™ · category **Sense**	Datasheet §1
Sensing	Head-cavity sensing of preload, temperature, vibration, and looseness‡	Datasheet §3, §6
Connectivity	BLE 5.x to the Sensorium™ Gateway → 5Tech Platform	Datasheet §7
Bolt property class / size	M12–M24‡ family; class 8.8/10.9/12.9‡ per ISO 898-1	Datasheet §5
Strength / fatigue life	Shank not machined — full rated strength of class; ≥ 2×10^6 cycles‡ (VDI 2230)	Datasheet §5
Preload / tensioning	Preload-controlled (live reading); range 0…proof load per size‡, ±2 %‡ accuracy	Datasheet §5–6
Environmental & ingress rating	−40 °C to +85 °C‡; IP67‡ (IEC 60529)	Datasheet §8
Power	Sealed-for-life Li-$SOCl_2$ cell‡; ≥ 10 yr‡ service life; not field-replaceable	Datasheet §6, §8
Compliance & certifications	**No certification currently held**; radio type-approval required before sale	Datasheet §9

10. Warranty & support

Warranty terms are issued with the product datasheet and order documentation, and will state coverage, duration, and exclusions (including damage from modification, over-tensioning, misuse, or reinstallation of a life-expired fastener — see §1).

Support

- **5Tech** — Vancouver, BC, Canada
- Email: **info@5tech.ca** · Web: **https://5tech.ca**

To obtain service, have ready: the fastener's device identity, the site/joint mapping, the Platform **load/preload history**, and a description of the symptom (§8).

Figures

ID	TITLE	STATUS	FILENAME	PURPOSE
FIG-001	Industrial Hero Render	Missing	`renders/hero_sensorium_smart_bolt.png`	Cover / hero image
FIG-002	Safety Symbols & Signal Words	Missing	`figures/safety_symbols.png`	Signal words and hazard pictograms for the safety chapter
FIG-003	Correct Installation & Torque	Missing	`figures/install_and_torque_callout.png`	Correct joint assembly, tool engagement, and controlled tightening
FIG-004	Pairing & Commissioning to the Gateway	Missing	`diagrams/pairing_to_gateway.png`	Wireless pairing/commissioning flow and expected status
FIG-005	Inspection, Re-torque & Maintenance Points	Missing	`figures/maintenance_points.png`	Locate inspection, re-torque, and service points

Content is preliminary and subject to change. Figure prompts and metadata: `figures.json`. Full specifications: `../../datasheets/sensorium-smart-bolt-datasheet/document.md`. Web publication target: `/resources/manuals/smart-bolt`.