

Sensorium™ SmartBolt — Instrumented Fastener

Datasheet · [sensorium-smart-bolt-datasheet](#) · Revision Draft (Preliminary) · 2026-07-18

PRELIMINARY — PROPOSED VALUES. Values marked ‡ are proposed, industry-typical figures for this product class, provided so no specification is left blank. They are **not measured and not final**, and no value in this document is a certification claim. Engineering must confirm every ‡ value before this datasheet is released as final. The SmartBolt provides **monitoring support — it is not a certified structural-health-inspection system**. See §12 for change control.



SENSORIUM™

Sensorium™ SmartBolt

Sensorium™ SmartBolt — the instrumented fastener of the Sense layer.

Figure FIG-001 — Sensorium™ SmartBolt, the instrumented Sense-layer fastener of the Sensorium™ family.

1. At a glance

The **Sensorium™ SmartBolt** is a *Sense* module of the 5Tech Sensorium™ family, built on the BLE smart sensor-node platform: an instrumented structural fastener that installs in place of a standard bolt. A preload-sensing element in the **instrumented head cavity**‡ measures the axial **clamping force (preload)** directly, alongside **temperature, vibration, and looseness signals**, and streams that data over **Bluetooth Low Energy** to the **Sensorium™ Gateway**. On the **5Tech Platform**, the data supports **condition monitoring, trend visibility, and maintenance alerts** — monitoring support, **not** a certified structural-health inspection or a substitute for scheduled inspection.

Product	Sensorium™ SmartBolt (Instrumented Fastener)
Family / role	Sensorium™ · Sense
Function	In-fastener monitoring of preload/clamping-force, temperature, vibration & looseness (monitoring support)
Sensing	Preload-sensing element in the instrumented head cavity‡; MEMS accelerometer; head-temperature sensor
Size / grade	M12–M24‡ family · property class 8.8 / 10.9 / 12.9‡ per ISO 898-1
Strength	Load-bearing shank not machined — retains the full rated strength of its property class‡
Connectivity	Bluetooth Low Energy 5.x to the Sensorium™ Gateway
Enclosure / IP	Sealed hex head with head-integrated antenna; IP67‡ (IEC 60529)
Power	Sealed-for-life Li-SOCl ₂ primary cell‡; ≥ 10 yr‡ service life (not field-replaceable)

Key features

- **Direct mechanical replacement** for an equivalent-grade structural fastener: all electronics, the primary cell, and the antenna live in an **instrumented head cavity**, and the load-bearing **shank is not machined or bored**, so the bolt retains the **full rated strength (proof load, tensile, and fatigue)** of its ISO 898-1 property class (see §5).
- **Direct preload measurement** — a sensing element in the head cavity reports axial clamping force to **±2 %‡ of reading**, so joints are tensioned to a *measured* clamp load instead of an inferred torque value.

- **Temperature, vibration, and looseness sensing** at the fastener to flag preload loss and abnormal joint condition over time.
- **BLE 5.x** streaming to the Sensorium™ Gateway — no per-bolt wiring runs; antenna in the exposed head.
- **Sealed-for-life Li-SOCl₂ cell, ≥ 10 yr†** service life; not field-replaceable — end-of-life removal and **hazardous-waste disposal** route in §8.
- Feeds the **5Tech Platform** for condition monitoring, trends, and maintenance alerts — monitoring **support**, not a replacement for periodic manual torque / inspection checks.

Typical applications

- Structural and equipment joints where fastener preload / looseness should be monitored.
 - Construction-site and asset monitoring (alongside Zone Awareness) via the 5Tech Platform.
 - Condition-based maintenance programmes that want fastener preload / looseness trends alongside inspection.
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2. System context

The SmartBolt is a **Sense** device: it originates data. Its measurements flow up through the **Sensorium™ Gateway** (Connect) to the **5Tech Platform** (Decide), where monitoring, automation, and AI assistance turn preload and looseness trends into alerts, trends, and maintenance recommendations.

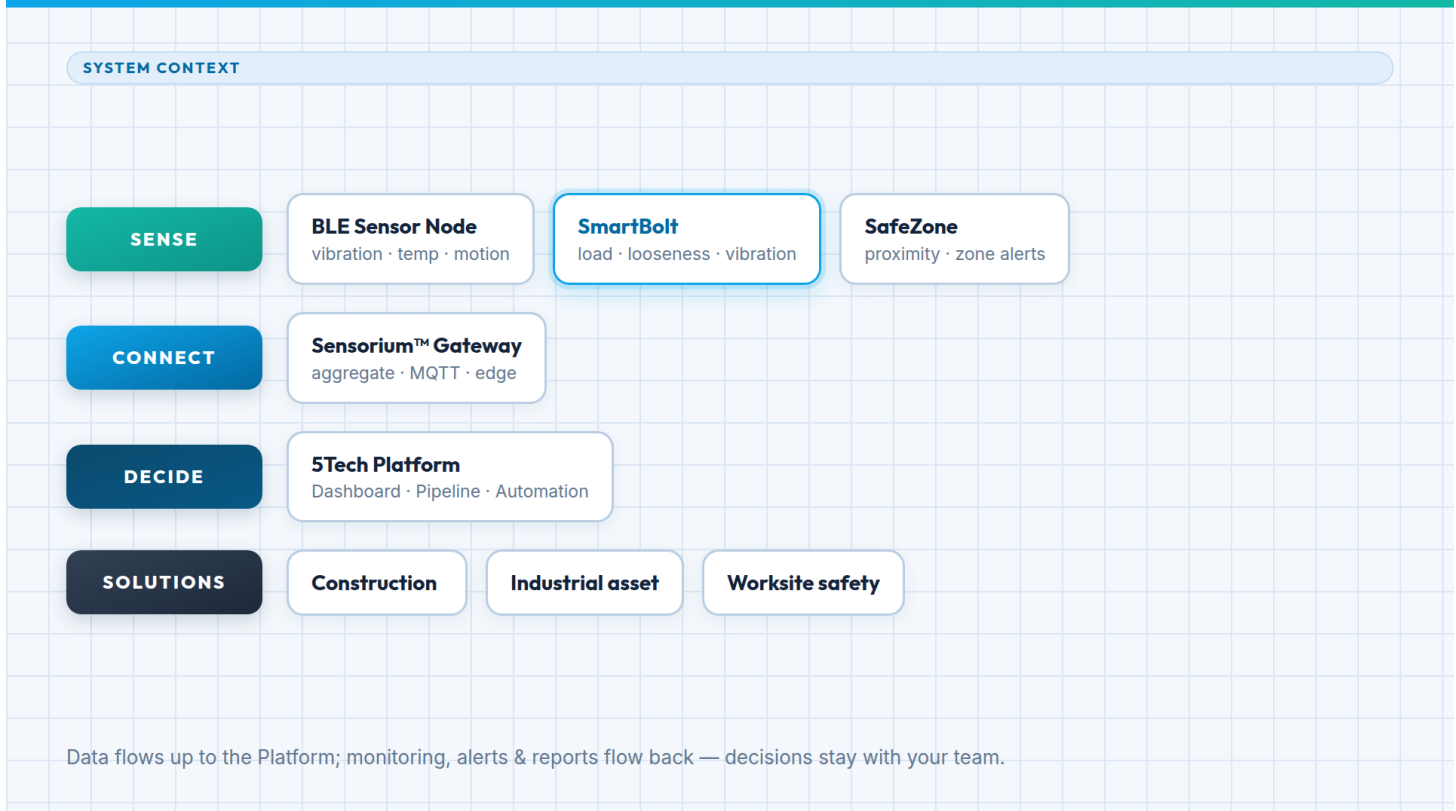


Figure FIG-002 — Sense → Connect → Decide. The SmartBolt is a Sense device streaming over BLE to the Gateway.

- **Sense** — the **Sensorium™ SmartBolt** (preload / vibration sensing) and Zone Awareness devices.
- **Connect** — the Sensorium™ Gateway aggregates and pre-processes SmartBolt data.
- **Decide** — the 5Tech Platform (Monitoring · Automation · AI assistance) turns data into trends and maintenance alerts.
- **Solutions** — Construction Sites Monitoring is built on this chain.

3. Functional overview

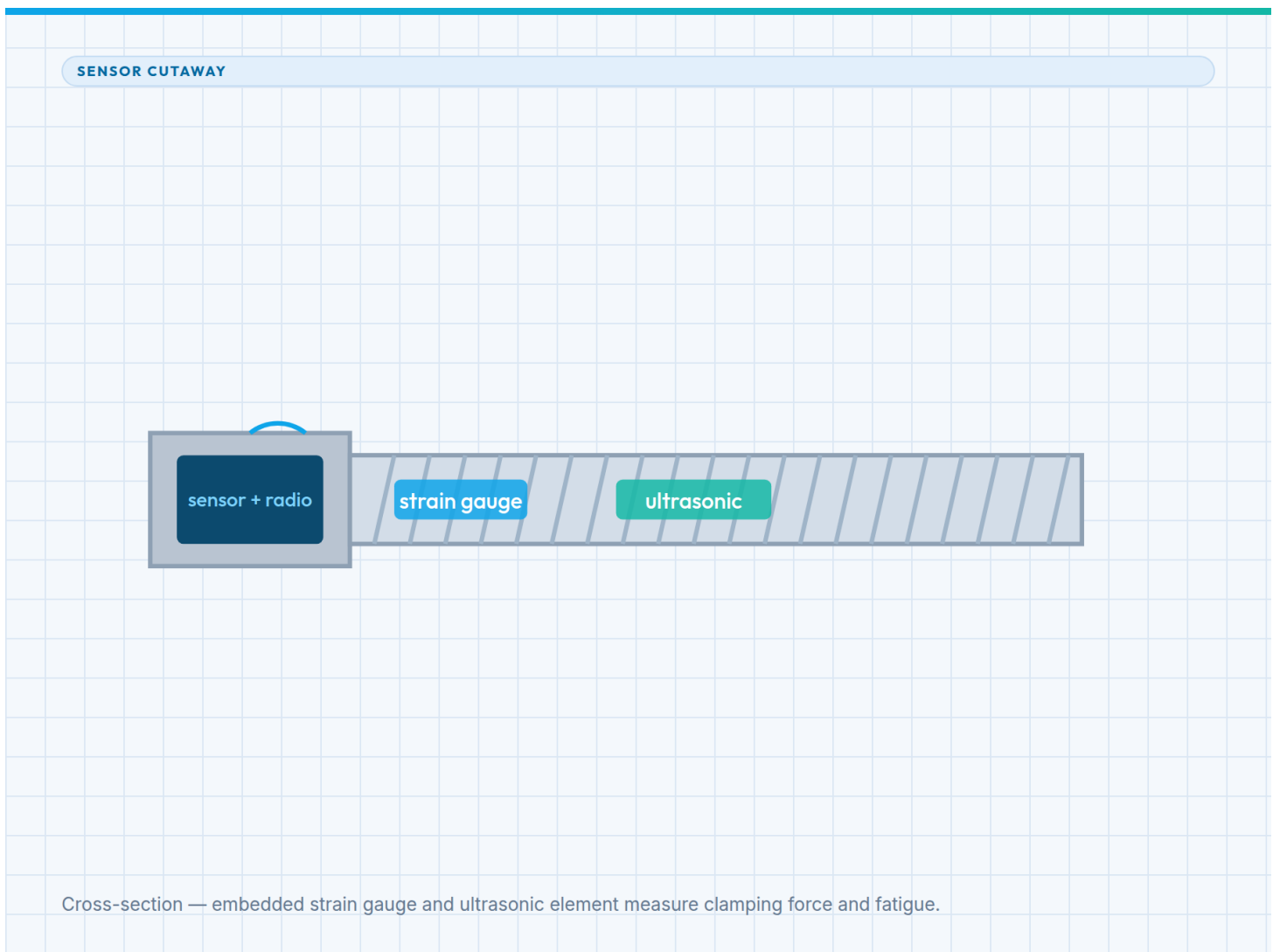


Figure FIG-003 — Longitudinal cross-section: preload-sensing element, electronics, primary cell, and antenna housed in the instrumented head cavity; the load-bearing shank is unmodified.

The SmartBolt integrates sensing and radio inside an **instrumented head cavity**, so the mechanical joint and the measurement point are one and the same, **without weakening the load-bearing shank**:

1. **Preload sensing** — a sensing element in the head cavity ($\pm$, method under engineering confirmation) responds to the axial clamp load carried by the bolt, giving a **measured clamping / preload force** in service rather than an inferred torque value.
2. **Temperature sensing** — a temperature sensor at the bolt head reports fastener temperature, both as a joint-condition signal and to compensate the preload reading over temperature.
3. **Vibration & looseness sensing** — a MEMS accelerometer monitors vibration and movement-related signals over time to flag **looseness and preload loss**.
4. **Wireless streaming** — the in-head electronics transmit measurements over **Bluetooth Low Energy** to the Sensorium™ Gateway via an antenna in the exposed head.

5. **Monitoring** — on the 5Tech Platform, preload, temperature, and looseness trends are visualized and drive maintenance **alerts and recommendations** (monitoring support, not certified structural-health inspection).

Data path: *bolt sensing (head cavity) → in-head BLE radio → Sensorium™ Gateway → 5Tech Platform (monitoring & alerts)*. Exact sensing-element design, sampling, and measurement ranges are ‡ proposed and subject to engineering confirmation.

4. Ordering information

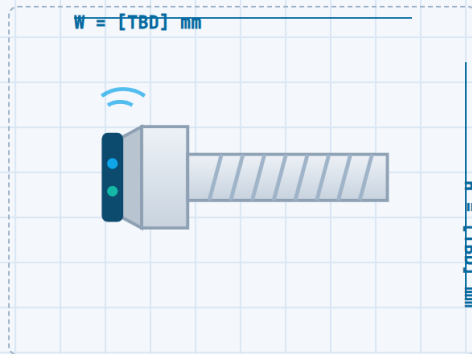
Order codes below are the proposed scheme; the base identifier and suffixes are ‡ pending confirmation. Configure = base size + property class + length/coating option. One thread size and one property class per order code.

ORDER CODE	CONFIGURATION	NOTES
SEN-SB-100 ‡	Base SmartBolt	Preload / temperature / vibration sensing, BLE to Gateway; size + class per suffix
SEN-SB-100-L ‡	Alternate length variant	Same instrumentation, different shank length / grip
SEN-SB-100-X ‡	Extended / special variant	Alternate property class or coating variant

Size (M12–M24‡) and property class (8.8 / 10.9 / 12.9‡) are selected per order code; accessories in §10.

5. Mechanical specifications

DIMENSION DRAWING



Orthographic outline with principal dimensions and mounting pattern — values indicative, confirm before use.

Figure FIG-005 — Elevation with overall length, thread, and across-flats dimensions (mm). Values $\neq$ proposed.

PARAMETER	VALUE	CONDITION / NOTE
Nominal thread size family	M12–M24‡ (ISO metric coarse)	One size per order code; direct replacement for an equivalent-grade standard bolt
Property class	8.8 / 10.9 / 12.9‡	Per ISO 898-1 ; selectable per order code; class marked on head
Strength integration	Instrumented head cavity ; shank not machined ‡	Retains full rated strength of the property class (see strength note below)
Overall length	60–200‡ mm	Per variant / joint grip length
Thread length	Per ISO 4014 / 4017‡	Partially or fully threaded per variant
Head type / across-flats	Hex, DIN 931 / 933 profile‡	Head enlarged to house instrumentation; across-flats per size
Weight	e.g. 70 g (M12) ... 480 g‡ (M24)	Instrumented head adds mass vs a plain bolt
Coating / finish	Zinc-flake per ISO 10683‡ (Cr(VI)-free)	Salt-spray class in §8
Ingress protection	IP67‡ (IEC 60529)	Sealed-for-life head assembly; see §8
Fatigue life	$\geq 2 \times 10^6$ ‡ load cycles	Alternating stress amplitude $\sigma_A \leq 50$ MPa‡ on the stress area about the installed preload, per VDI 2230 S-N; equal to an unmodified fastener of the same class

Strength & derating. All electronics, the primary cell, and the antenna are housed in an **instrumented head cavity**; the **load-bearing shank is not machined, bored, or fitted with a strain-gauge bore**. The SmartBolt therefore retains the **full rated proof load, tensile strength, and fatigue life** of its ISO 898-1 property class, and is a **defensible direct replacement for an equivalent-grade fastener** — there is **no strength derating factor** applied to the shank. (Were a future variant to machine a shank strain-gauge bore, a derating factor on proof/tensile load would be stated here instead.)

Proof load & tensile per size (computed for representative class **10.9**; values scale per selected class per ISO 898-1 and are ‡ until a conformance report is on file):

SIZE	STRESS AREA A _S	PROOF LOAD F _P ‡ (10.9, S _P = 830 MPA)	MIN. TENSILE F _M ‡ (10.9, R _M = 1040 MPA)	TYP. INSTALL PRELOAD‡ (≈ 0.7 F _P)
M12	84.3 mm ²	70 kN	88 kN	49 kN
M16	157 mm ²	130 kN	163 kN	91 kN
M20	245 mm ²	203 kN	255 kN	142 kN
M24	353 mm ²	293 kN	367 kN	205 kN

Tightening & preload control. Installation is **preload-controlled**: the SmartBolt's **live preload reading** is used to tension the joint to its target clamp load, rather than relying on a torque value. Where a *reference* tightening torque is published, it assumes class 10.9 with a lubricated thread/underhead condition (**tightening factor k = 0.14‡**) via $T = k \cdot F \cdot d$ — e.g. an M20 class-10.9 joint tensioned to ≈ 142 kN corresponds to ≈ **398 N·m‡** at k = 0.14. Torque is a cross-check only; the actual clamp load is set by the **measured** preload, per **VDI 2230** joint design. Clamping-force measurement range and accuracy are in §6.

6. Electrical & sensing specifications

All values are ‡ proposed and stated with their measurement condition. The SmartBolt is a self-powered wireless node; there are no external electrical connections.

PARAMETER	MIN	TYP	MAX	UNIT	CONDITION
Preload / clamping-force measurement range	0	—	290‡	kN	Family span M12–M24; per size = 0... proof load of the selected class (§5)
Preload-measurement accuracy	—	±2‡	—	% of reading	–20 ... +80 °C, referenced to a calibrated load cell (ISO 376‡)
Preload resolution	—	0.1‡	—	kN	@ 25 °C
Temperature measurement range	–40‡	—	+85‡	°C	At the bolt head
Temperature accuracy	—	±2‡	—	°C	–20 ... +80 °C
Vibration / looseness sensing	—	—	±16‡	g	MEMS accelerometer, 0–2 kHz‡; movement-related signals
Sampling / reporting interval	1‡	60‡	1440‡	min	Configurable via Platform; default 60 min‡
Radio	—	+4‡	—	dBm	BLE 5.x, 2.4 GHz conducted TX power; see §7
Power source	—	—	—	—	Sealed-for-life Li-SOCl ₂ primary cell‡; not field-replaceable (see §8 disposal)
Battery service life	10‡	—	—	yr	@ 60 min‡ reporting interval, 25 °C; exceeds typical monitored fatigue life (§5)

7. Interfaces & protocols

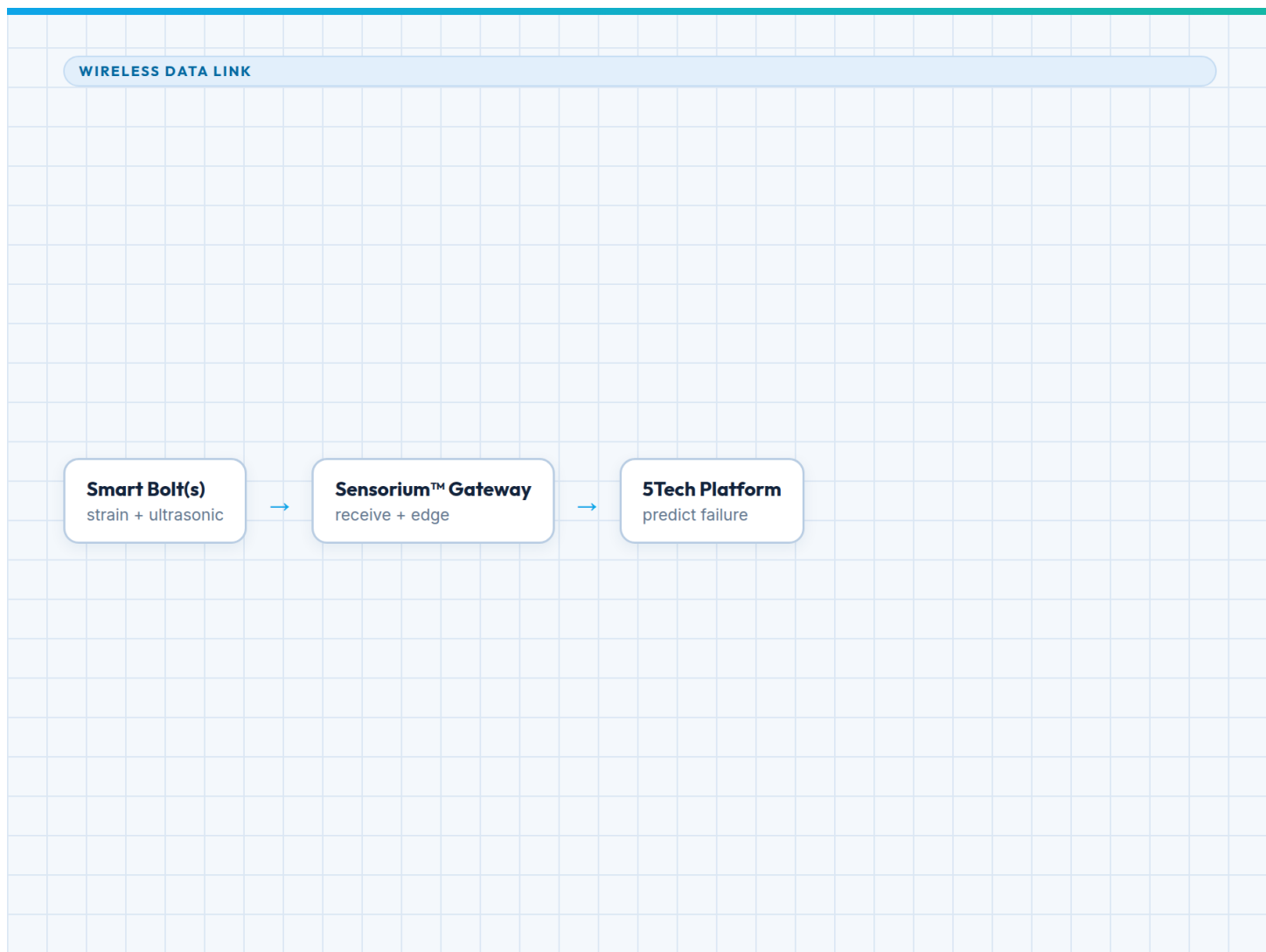


Figure FIG-004 — Multiple SmartBolts stream preload, temperature, and vibration data over BLE to a single Sensorium™ Gateway.

INTERFACE	SPECIFICATION	NOTES
Wireless uplink	Bluetooth Low Energy 5.x, 2.4 GHz	To the Sensorium™ Gateway
Antenna	Integrated in the exposed hex head ‡	Radiates from the head above the joint face; the shank and joint steel sit below the antenna
Wireless range	10 m ‡ installed / 30 m ‡ free-air	+4 dBm‡ TX, BLE, line-of-sight; installed = bolt torqued into a steel joint (steel attenuates), free-air = unobstructed
Bolts per Gateway	Up to 50 ‡ Sensorium nodes/Gateway	SmartBolts share the Gateway's BLE node budget with Zone Awareness nodes
Provisioning / commissioning	Handheld wake/enroll tool + device ID‡	Field association to a Gateway
Payload	Preload/clamping-force, temperature, vibration & looseness signals	Streamed to the 5Tech Platform via the Gateway

Security. The SmartBolt ↔ Gateway BLE link uses **BLE LE Secure Connections** pairing‡; the authenticated, encrypted uplink to the 5Tech Platform (MQTT over TLS) is provided by the Gateway. The SmartBolt does **not** connect to the Platform directly.

8. Environmental & ratings

Structural fasteners operate in outdoor, loaded, and vibrating environments. All figures below are ‡ proposed targets, not yet verified by test.

PARAMETER	VALUE	STANDARD / CONDITION
Ingress protection	IP67‡	IEC 60529; sealed-for-life head assembly
Operating temperature	−40 °C to +85 °C‡	Ambient, under load
Storage temperature	−40 °C to +85 °C‡	Li-SOCl ₂ cell storage limit
Humidity	5–100 % RH‡	Condensing permitted (sealed head, IP67)
Vibration	10–500 Hz, 10 g‡, 20 sweeps/axis	IEC 60068-2-6, installed in a representative joint
Shock	50 g‡, 11 ms half-sine, 3 shocks/axis/direction	IEC 60068-2-27
ESD immunity	±8 kV contact / ±15 kV air‡	IEC 61000-4-2
Radiated RF immunity	10 V/m, 80 MHz–2.7 GHz‡	IEC 61000-4-3
Corrosion resistance	≥ 720 h‡ neutral salt spray, no red rust	ISO 9227 (NSS); zinc-flake coating per ISO 10683

End-of-life & disposal. The primary cell is **sealed inside the head for life and cannot be replaced**. At end of service, remove the fastener **intact** (do not open, machine, heat, or incinerate it — see the manual Safety chapter) 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** (see §9).

9. Compliance & standards

No certification is currently held. The table lists the intended certification programme; no mark below may be shown on the product, packaging, or marketing until certified with a report on file (recorded in [references.md](#)).

AREA	INTENDED STANDARD	STATUS
Radio / telecom (per region)	FCC Part 15 / ISSED RSS-247 / RED (EU) for the 2.4 GHz BLE radio‡	Planned — not yet submitted
Fastener mechanical property class	ISO 898-1 (proof load, tensile, hardness)‡	Planned — conformance testing not yet on file
EMC (radio)	EN 301 489-1 / -17‡	Planned — not yet tested
Environmental (materials)	RoHS (EU 2011/65) / REACH‡	Planned — declaration pending
Battery transport	UN 38.3 (Li primary cell)‡	Planned — assessment pending

Radio type-approval is required before the product may be sold in any market; it is not yet held. The SmartBolt is monitoring support and is not a certified structural-health-monitoring (SHM) or structural-inspection system; no such claim is made or implied.

10. Accessories & related products



SENSORIUM™

Accessories & lineup

SmartBolt size/type variants alongside matched nuts, washers, and field tooling.



Figure FIG-006 — SmartBolt size/type variants alongside matched nuts, washers, and field tooling.

ITEM	ORDER CODE	PURPOSE
Matched nut	SEN-SB-ACC-NUT ‡	Correct mating hardware (class-matched)
Hardened washer set	SEN-SB-ACC-WSH ‡	Load distribution under head/nut
Field commissioning tool	SEN-SB-ACC-CMT ‡	Wake/associate a bolt to a Gateway
Length / thread variants	SEN-SB-100-L ‡	Joint-specific sizing

Related documents

- **Aggregated by:** Sensorium™ Gateway datasheet — the Connect layer that receives this data.
- **Manual:** [manuals/sensorium-smart-bolt-manual/](#) — installation, commissioning, service.
- **Installation:** [installation/sensorium-smart-bolt-installation/](#) — torque, association, checks.

- **Sensed alongside:** Sensorium™ Zone Awareness datasheet.
- **Works with:** 5Tech Platform (Monitoring · Automation · AI assistance) — Construction Sites Monitoring.

11. Monitored signals & alert behaviour (illustrative)

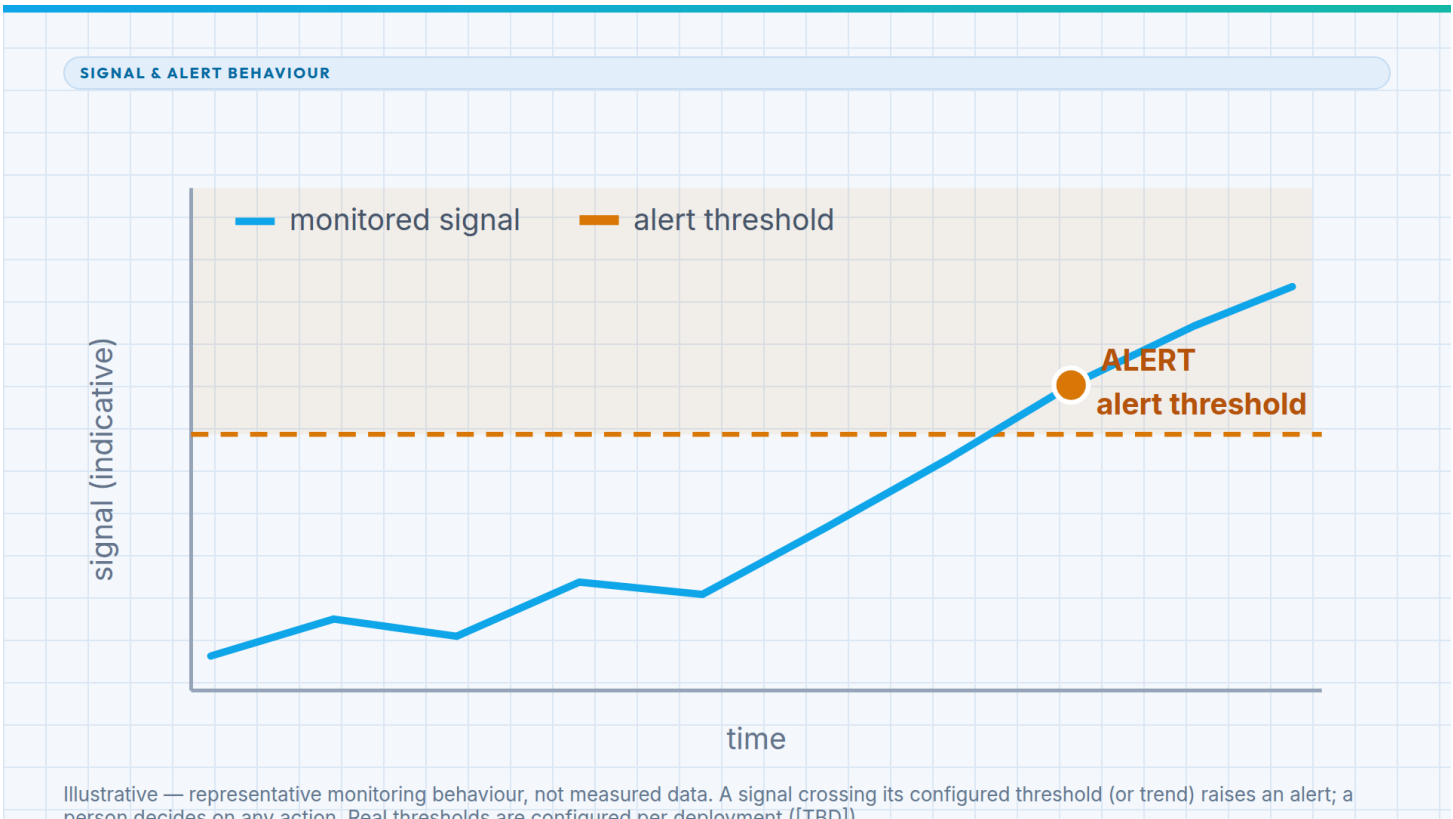


Figure FIG-007 — Illustrative — a monitored signal crossing its configured alert threshold (or an abnormal trend) raises an alert; a person decides on any action. Representative behaviour, not measured data.

The SmartBolt reports its monitored signals — **load/preload, temperature, and vibration** — over BLE (via the Gateway) to the 5Tech Platform; when a signal crosses a configured threshold or shows an abnormal trend, the Platform raises an **alert** and a person decides on any action. These are illustrative condition indications only — the SmartBolt is **not a certified structural-health- monitoring (SHM) system**. Thresholds are configured per deployment.

SIGNAL	EXAMPLE ALERT TRIGGER‡	RESPONSE
Preload / load (looseness)	Bolt preload drops below its configured band (looseness)	Alert + notify (person decides)
Vibration	Vibration rises above a configured threshold or trends abnormally	Alert + notify (person decides)
Temperature	Head temperature crosses a configured limit	Alert + notify (person decides)

Illustrative — representative, not measured; trigger values ‡ proposed and configurable.

12. Revision & change control

REVISION	DATE	CHANGE	AUTHOR
Draft (Preliminary)	2026-07-07	Initial authored content; values <code>[TBD]</code> .	Documentation
Draft (Preliminary, PROPOSED)	2026-07-18	Adopted head-cavity/unmachined-shank strength design (no derating); added real size family (M12–M24) and ISO 898-1 property class with proof-load/tensile table; added preload measurement range/accuracy/resolution, temperature sensing, fatigue-life basis (VDI 2230), preload-controlled tensioning with $k = 0.14$; set IP67 (IEC 60529); head-integrated antenna with installed/free-air BLE range and bolts-per-Gateway; sealed-for-life Li-SOCl ₂ cell with disposal route; rewrote compliance as "no certification held" + planned programme; filled all <code>[TBD]</code> with conditioned ‡ values and specific test standards; standardized SmartBolt naming; added revision block.	Documentation

Full change history: `revision.md`. Sources and cited standards: `references.md`.

Specifications are preliminary; ‡ values are proposed and subject to engineering confirmation and change. See `revision.md` for change control, `references.md` for sources, and `image_prompts.md` for the figure/prompt index. Web publication target: `/resources/datasheets/smart-bolt/`.

