

# SENS-MOTION-V1 - Operating Instruction

## 1. Purpose and Principle of Operation

### 1.1 Purpose

SENS-MOTION-V1 is a dual-mode LTE-M/NB-IoT telemetry module for motion and tilt tracking with integrated 3-axis accelerometer.

The module is intended for: - motion event detection - tilt and orientation monitoring - asset integrity and handling audit trails - optional GPS position metadata

### 1.2 Scope of Application

- Anti-theft and unauthorized movement alerts
- Mobile asset deployment verification
- Structural or platform movement trend monitoring
- Process-state inference from vibration and tilt signatures in industrial assets

### 1.3 General Operating Algorithm

1. Device samples accelerometer channels on configured schedule and trigger thresholds.
2. Events are classified and stored.
3. Event summaries and telemetry are transmitted via LTE-M/NB-IoT.
4. Data is buffered when connectivity is unavailable.

## 2. Specifications

Parameter	Value / Notes
Device type	SENS-MOTION-V1
Connectivity	LTE-M (Cat-M1), NB-IoT (Cat-NB1/NB2)
Network transport	LTE-M/NB-IoT with fallback and retry policies
Operating temperature	-20 to +85 °C
Standby current (battery mode)	150mk
Dimensions	250 x 30 x 30 mm

Weight	183 g
Motion sensing	Integrated high-performance 3-axis accelerometer
Positioning	GPS profile supported
External interfaces	No external sensor interfaces in standard profile
Service interfaces	Hall sensor trigger
Firmware updates	OTA supported

### 3. Device Elements and Connections

#### 3.1 Main Elements

1. LED indicators
2. Hall sensor zone

#### 3.2 Installation Notes

- Record device orientation reference at commissioning.
- Use rigid mounting to avoid false vibration events.

### 4. Hall Sensor Actions

Magnet hold time	Action
1-2 s	Show last diagnostics code
2-4 s	Trigger measurement cycle
4-6 s	Trigger cloud communication
6-8 s	Trigger GPS-only cloud communication
15-20 s	Enter warehouse mode
>25 s	Reset storage and device model

Note: A hall sensor interaction also opens the BLE service window for the configured settings timeout.

## 5. LED Indication

Indicator	Meaning
INFO	State and error code patterns
STATUS	Cloud connection stage heartbeat

Firmware LED patterns:

LED	Pattern	Meaning
INFO	1 blink	Device wake-up/initialization complete
INFO	3 blinks (every 60 s)	Warehouse mode active
INFO	5 blinks [1 long + 2 shorts]	Entering warehouse mode
INFO	10 blinks [3 long + 1 short]	Exiting warehouse mode
STATUS	1 blink heartbeat every 3 s	Initialization and SIM/APN checks
STATUS	2 blinks heartbeat every 3 s	Requesting full functionality ( CFUN=1 )
STATUS	3 blinks heartbeat every 3 s	Network registration
STATUS	4 blinks [1 long + 1 short] heartbeat every 3 s	DNS resolution
STATUS	5 blinks [1 long + 2 shorts] heartbeat every 3 s	MQTT open
STATUS	6 blinks [2 long + 0 shorts] heartbeat every 3 s	MQTT connect
STATUS	7 blinks [2 long + 1 short] heartbeat every 3 s	MQTT subscribe

STATUS	8 blinks [2 long + 2 shorts] heartbeat every 3 s	Data publish
STATUS	9 blinks [3 long + 0 shorts] heartbeat every 3 s	GNSS-only flow

Blink encoding for values above 3 uses mixed long and short blinks:

- short blink: 20 ms ON, 100 ms OFF
- long blink: 100 ms ON, 300 ms OFF

## 6. Installation and Commissioning

### 6.1 Installation Sequence

1. Confirm module SKU and expected asset orientation.
2. Route the supplied zip ties through the top and bottom mounting slots.
3. Fix the enclosure to the target pole, stick, or asset support in the field.
4. Verify stable mounting and clear LED visibility.
5. Trigger wake and diagnostic cycle using the Hall sensor.
6. Confirm event telemetry and baseline orientation in backend tools.

### 6.2 Commissioning Recommendations

- Tune threshold values per asset type.
- Base operational decisions on repeated events or sustained movement, not on one isolated spike.
- Configure quiet periods if expected handling windows exist.

### 6.3 Baseline Configuration for Industrial Deployments

Set initial values and then tune after 2-4 weeks of observed telemetry:

Parameter	Initial value	Adjustment signal
Sampling interval	1-5 s (moving assets), 10-60 s (stationary assets)	Increase frequency when short shocks are missed
Motion threshold	0.08-0.15 g	Raise when false positives dominate; lower when missed events dominate

Tilt alarm threshold	5-10 degrees from baseline	Lower for high-stability equipment, raise for flexible mounts
Event aggregation window	30-120 s	Reduce for faster alarms, increase for noise-heavy sites
Uplink cadence	5-15 min summaries + immediate critical events	Increase cadence for incident investigations

## 7. Data Interpretation and Process Actions

### 7.1 Core Telemetry to Track

- Peak acceleration: highest vibration or motion spike in period
- RMS acceleration: stable indicator of vibration intensity over time
- Tilt on X/Y axes: orientation drift relative to baseline
- Motion event count: number of above-threshold movement events
- Event duration: continuous movement interval

### 7.2 KPI Examples for Process Optimization

- False movement alarm rate (% of alarms with no field-confirmed event)
- Mean time to detect abnormal movement
- Repeated-impact count per asset per week
- Tilt drift rate (degrees per month)
- Unplanned downtime correlated with motion anomalies

## 8. Industrial Use Cases

Use case	Sensor signal value	Optimization outcome
Mission-critical pump station monitoring	Vibration trend + tilt anomalies + GPS position consistency	Early fault detection and faster field response before process interruption
Mobile compressor fleet dispatch control	Movement events + route trace + dwell-time by site	Improved utilization, reduced idle time, and tighter dispatch planning

High-value container tamper and diversion detection	Unexpected shocks + orientation change + geofence breach	Faster theft/diversion detection and improved chain-of-custody compliance
Temporary infrastructure asset assurance	Baseline motion profile + GPS checkpoints along deployment route	Verification of correct installation sequence and reduced commissioning delays
Remote utility cabinet stability surveillance	Long-term tilt drift + intermittent impact events + location context	Earlier intervention on structural risk and fewer emergency outages
Critical spare equipment readiness tracking	Inactivity patterns + unauthorized movement + out-of-zone positioning	Better readiness control and reduced unplanned asset loss

## 9. Operation and Maintenance

- Check mounting integrity on each maintenance cycle.
- Review false-positive and missed-event ratio monthly.
- Re-baseline orientation after any remounting or structural work.
- Update thresholds after seasonal/operational changes.
- Apply OTA updates through approved release process.
- Validate KPI trends quarterly with maintenance and operations teams.