# Technical Note

*TN-03-Satevis Monitoring Mode*

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# Contents

# 1 LIST OF ABBREVIATIONS AND ACRONYMS

- **AES** – Advanced Encryption Standard
- **AMRR** – Alarm Monitoring Refresh Rate
- **CA** – Critical Alarm
- **DL** – Downlink
- **EUI** – Extended Unique Identifier
- **GPS** – Global Positioning System
- **I2C** – Inter-Integrated Circuit
- **IR** – Infrared
- **JSON** – JavaScript Object Notation
- **LLC** – Logical Link Control
- **LNS** – LoRaWAN® Network Server
- **LVDT** – Linear Variable Differential Transformer
- **MA** – Minor Alarm
- **MAC** – Media Access Control
- **OTAA** – Over-The-Air Activation
- **PER** – Packet Error Rate
- **RF** – Radio Frequency
- **RH** – Relative Humidity
- **RSSI** – Received Signal Strength Indicator
- **SA** – Severe Alarm
- **SNR** – Signal-to-Noise Ratio
- **SPI** – Serial Peripheral Interface
- **THOLD** – Threshold
- **TTI** – The Things Industries
- **TTN** – The Things Network
- **UI** – User Interface
- **UL** – Uplink
- **USB** – Universal Serial Bus
- **WDT** – Watchdog Timer
- **WSN** – Wireless Sensor Network

## 1.1 VISUAL SYMBOLS DEFINITION

**<u>Tip / Information:</u> Provides helpful advice and suggestions that may be useful when installing and configuring Satevis® sensors.**

***<u>Caution:</u> Alerts the user to important information regarding Satevis® sensors. If these instructions are not followed, the equipment or software may fail or malfunction.***

***<u>Danger:</u> Indicates critical information that MUST be followed. Failure to comply may result in permanent damage to the equipment or bodily injury.***

# 2 PURPOSE & SCOPE

## 2.1 PURPOSE

The purpose of this document is to provide system integrators, network operators, and field engineers with a comprehensive guide on the operational modes, configuration logic, and data transmission behaviors of the Satevis® monitoring device. It is designed to help users understand how to optimize the device for ultra-low power consumption, configure accurate telemetry data acquisition, and set up advanced, logic-based alarm thresholds (Minor, Severe, Critical) to ensure reliable structural, environmental, and industrial monitoring over a LoRaWAN® network.

## 2.2 SCOPE

This document specifically covers the firmware functionalities and logical configurations of the Satevis® device. The scope includes:

- **Monitoring Modes:** Detailed operational workflows for Slow Monitoring Mode (periodic data collection) and Alarm Monitoring Mode (real-time event tracking and Keep-Alive status).
- **Data & Payload Handling:** Explanations of payload structures, batch transmissions, and automated timestamp calculations within the LoRaWAN® Network Server (LNS).
- **Alarm Configuration & Logic:** Instructions on configuring Single, High, Low, and Mixed thresholds, as well as applying Logical 'AND' / 'OR' rules for multi-sensor event detection (e.g., correlating temperature with inclination).
- **Timing Parameters:** Guidelines for setting Refresh Rates (MRR, AMRR, KARR, SDRR) while adhering to system restrictions.
- **Sensor-Specific Settings:** Configuration profiles for onboard or external sensors, including specific measuring ranges for the Satevis® Inclinometer (Tri-axis and Bi-axis versions).

*(Note: This document assumes the user has a basic understanding of LoRaWAN® network architecture. Hardware installation, physical mounting instructions, and third-party cloud software development are outside the scope of this manual).*

# 3 MONITORING MODE ( DATA ACQUISITION & TRANSMISSION)

Two types of Monitoring modes are available:

- **Slow Monitoring Mode** for an ultra-low power operation
- **Alarm Monitoring Mode** for Alarm tracking

## 3.1 SLOW MONITORING MODE

Slow Monitoring Mode is designed for standard, periodic data collection. In this mode, the device records measurements at regular intervals and transmits them in batches to optimize battery life and network bandwidth.

### 3.1.1 User-Configurable Settings

Operators can customize this mode via Downlink commands using the following parameters:

• **Monitoring Refresh Rate (MRR):** The time interval (in seconds) between each sensor measurement.

• **Maximum Data Samples (NB_MON_DATA_SAMPLES):** The maximum number of data samples, per

sensor channel, bundled into a single LoRaWAN® transmission message.

### 3.1.2 Payload Structure & Timestamp Calculation

To minimize payload size, the device does not attach a timestamp to every individual measurement. Instead, the payload includes a single base timestamp and the MRR. The data sequence is structured as follows:

1. **Number of Data Samples** (Total samples in the message)
2. **DATE_FIRST_SAMPLE** (Absolute timestamp of the very first measurement)
3. **MRR** (Monitoring Refresh Rate in seconds)
4. **Number of Sensor Channels**
5. **First Measurement Sample** (Corresponds exactly to DATE_FIRST_SAMPLE)
6. *... [N Subsequent Samples] ...*
7. **Last Measurement Sample (N)**

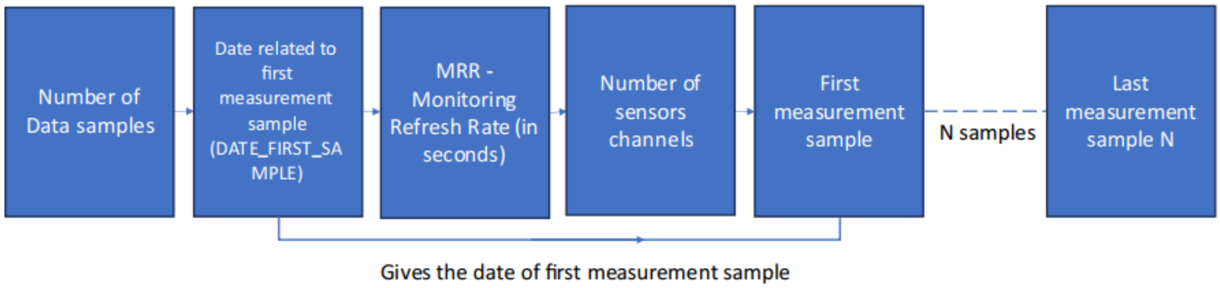
**How to calculate the date of any subsequent sample:** Because the LNS knows the time of the first sample and the refresh rate, the timestamp for any subsequent sample (Sample *N*) can be calculated sequentially by adding the MRR to the previous sample's time.

For example, to find the timestamp of the very next sample: Date_Sample_2 = DATE_FIRST_SAMPLE + MRR (in seconds)

*(To calculate the exact timestamp of the final sample in a batch of N samples, your LNS parser would use: DATE_FIRST_SAMPLE + ((N - 1) * MRR)).*

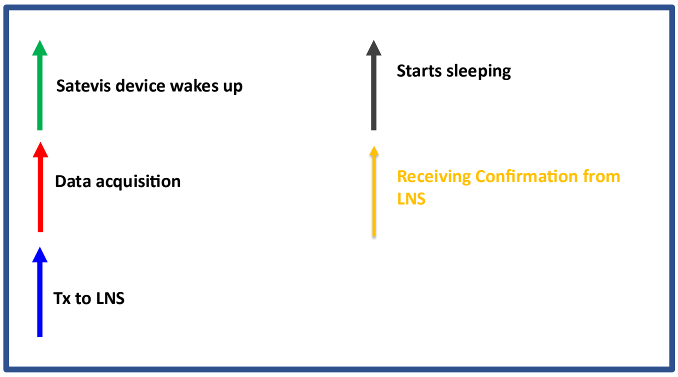
**How to get the date of Last Measurement sample:**

Date_Sample_N = DATE_FIRST_SAMPLE + MRR (seconds)



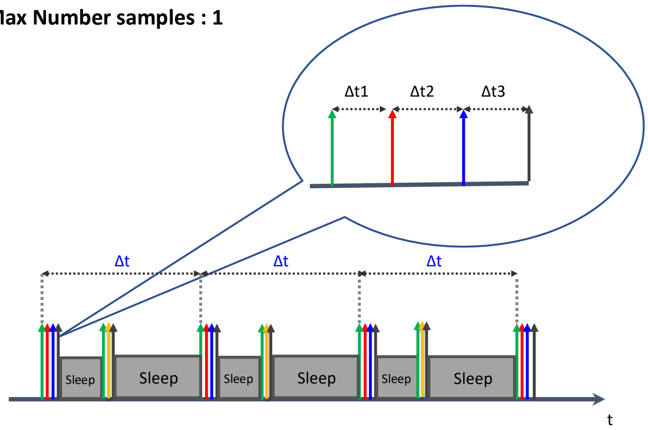
### 3.1.3 Device operation : case of 1 data sample in a message

***Captions***




***Slow Monitoring Mode***

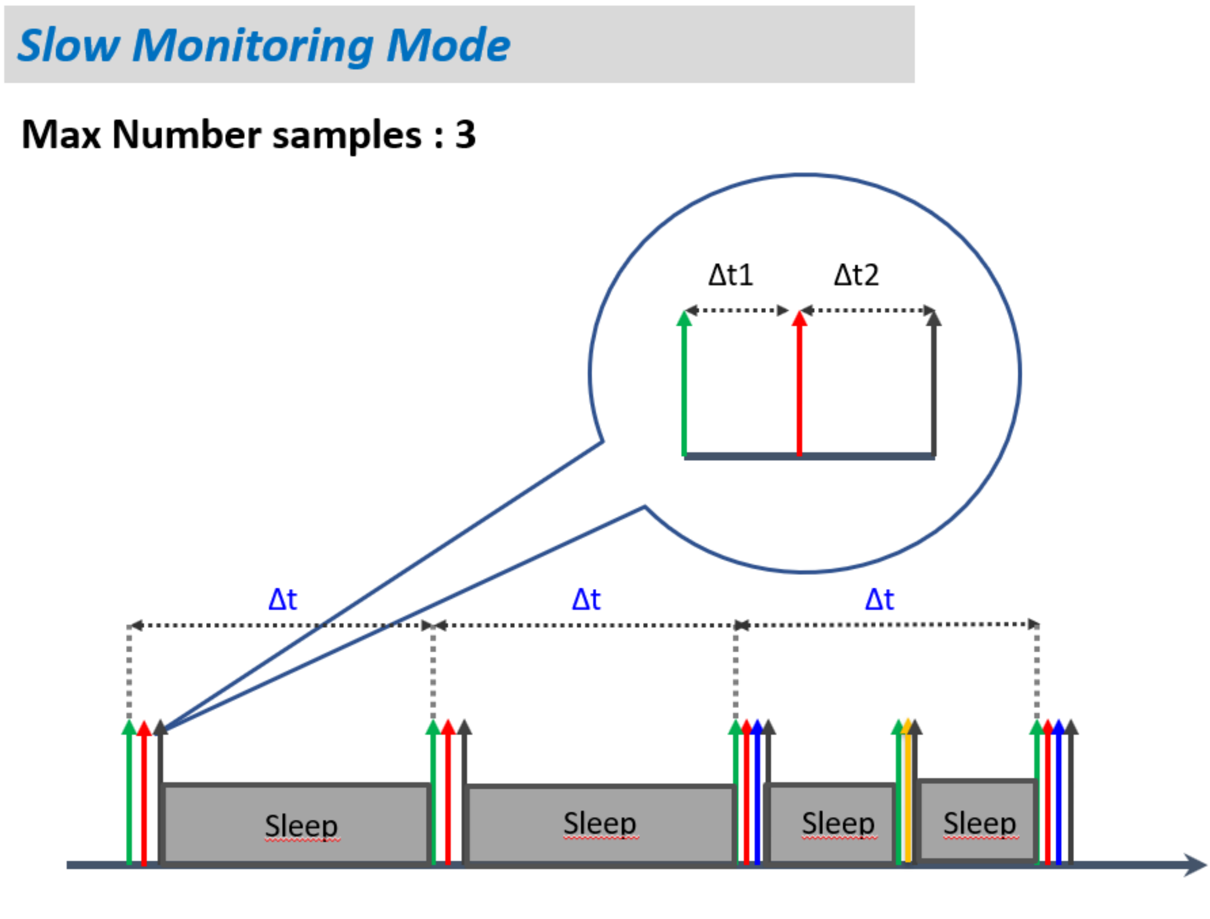
**Max Number samples : 1**




In Slow Monitoring Mode, when the device is configured to send just one data sample per message, the Satevis® device operates in the following chronological sequence:

- **Step 1 (Wake-up & Acquisition):** The device wakes up (indicated by the green arrow) and performs a data acquisition based on the configured Monitoring Refresh Rate (MRR). The measurement is immediately timestamped. Because the buffer capacity is set to a maximum of 1 sample, the data is instantly ready for dispatch.
- **Step 2 (Data Transmission):** The device immediately transmits the acquired data payload to the LoRaWAN® Network Server (LNS) (indicated by the blue arrow).
- **Step 3 (Receive Window / Confirmation):** Following the transmission, the device wakes up during its scheduled receive window to listen for a confirmation message or Acknowledgment from the LNS (indicated by the yellow arrow).
- **Step 4 (System Diagnostic):** Depending on the configured System Diagnostic Refresh Rate (SDRR), a system diagnostic report is generated and transmitted (typically 20 seconds after the initial data acquisition).
- **Step 5 (Sleep Mode):** Once all data processing, transmissions, and receive windows are complete, the Satevis® device enters a low-power sleep state (indicated by the black arrow) to conserve battery life until the next MRR interval begins (assuming the "sleep" power mode is enabled).

### 3.1.4 Device operation : case of 3 data samples in a buffer




In Slow Monitoring Mode, when the device is configured to bundle multiple data samples (in this case, a maximum of 3 samples per message), the Satevis® device operates in a battery-optimized batching sequence:

- **Step 1 (Data Buffering - Samples 1 & 2):** At the scheduled Monitoring Refresh Rate (MRR, shown as ), the device wakes up (**green arrow**) and performs a data acquisition (**red arrow**). The absolute timestamp for the first measurement is recorded. Because the buffer capacity (3 samples) has not yet been reached, the device bypasses transmission and immediately enters a low-power sleep state (black arrow). This short "wake-acquire-sleep" cycle is repeated for the second sample.

- **Step 2 (Buffer Full & Transmission - Sample 3):** At the third MRR interval, the device wakes up and acquires the 3rd data sample. With the buffer now full, the device transmits the fully bundled payload to the LoRaWAN® Network Server (LNS) (blue arrow). This single message contains the base timestamp, the MRR, and all 3 data samples, significantly reducing network airtime.

- **Step 3 (Receive Window / Confirmation):** Following the bundled transmission, the device wakes up during its scheduled receive window to listen for a confirmation message or Acknowledgment from the LNS (**yellow arrow**).

- **Step 4 (System Diagnostic & Sleep):** If the System Diagnostic Refresh Rate (SDRR) aligns with this cycle, a diagnostic report is transmitted (typically 20 seconds after the data transmission). Once complete, the device clears its data buffer and enters sleep mode (black arrow), ready to begin the next 3-sample collection cycle.

## 3.2 ALARM MONITORING

In Alarm Monitoring Mode, the Satevis® device proactively transmits an Alarm notification whenever a pre-configured Alarm Threshold is breached.

When no alarm conditions are present, the device ensures continuous system visibility by periodically transmitting a Keep-Alive notification. This keeps the user informed of the ongoing monitoring status. The Keep-Alive message payload provides a statistical summary of the monitored period, containing the **maximum, minimum, and average values**, as well as the **latest measurement** recorded during that Keep-Alive interval.

To provide granular alerting and facilitate targeted incident response, three severity levels of Alarm notifications can be transmitted to the LoRaWAN® Network Server (LNS):

- **Minor Alarm (MA)**
- **Severe Alarm (SA)**
- **Critical Alarm (CA)**

### 3.2.1 User-Configurable Settings

To ensure precise and tailored alarm management, operators can customize several configuration parameters:

- **Alarm Monitoring Refresh Rate (AMRR):** When an Alarm Threshold is breached, the data acquisition frequency can be automatically accelerated to provide real-time tracking, governed by the Alarm Monitoring Refresh Rate (AMRR).
- **Standard Monitoring & Keep-Alive (MRR & KARR):** During normal operation (when no thresholds are breached), data is acquired at the standard Monitoring Refresh Rate (MRR). Instead of transmitting every sample, a Keep-Alive message summarizing the data is transmitted based on a defined duty cycle, known as the Keep-Alive Refresh Rate (KARR).
- **Logical Rules:** Multi-condition Alarm Notifications can be generated by applying logical **'OR'** or **'AND'** combinations across different triggers.
- **Channel-Specific Configurations:** For each individual sensor channel, users have the flexibility to:
  - Enable or disable alarms entirely.
  - Define exact values for the three threshold severity levels: Minor Alarm (MA), Severe Alarm (SA), and Critical Alarm (CA).
  - Configure the threshold directional logic as **Low** (triggers when dropping below a value), **High** (triggers when exceeding a value), or **Mixed** (windowed alarms).

### 3.2.2 Alarm Notification Rule

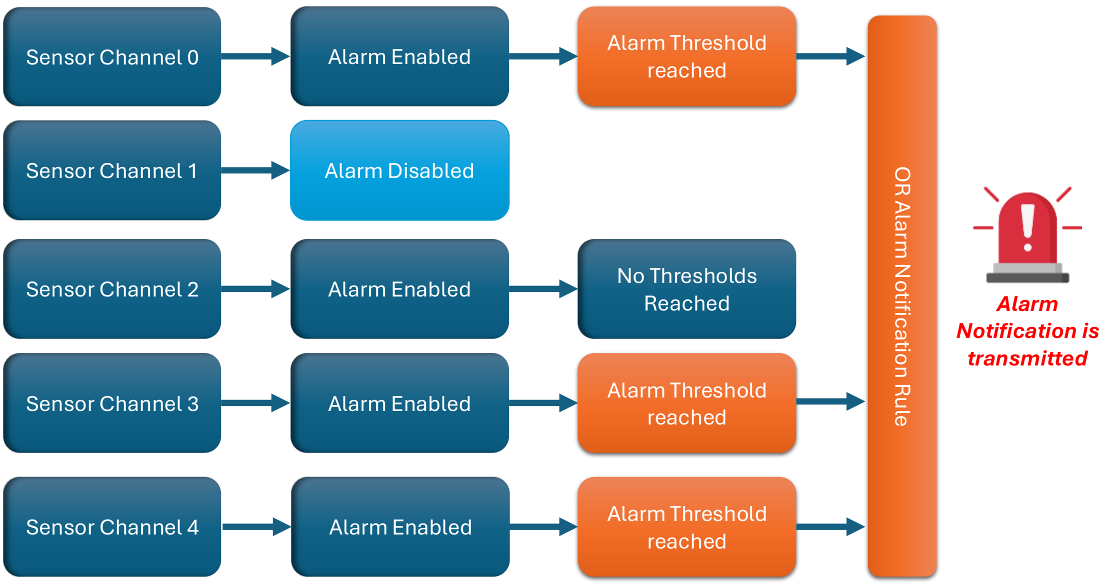
To provide precise monitoring and prevent false positives, the Satevis® device allows system integrators to define logical conditions for how alarms are triggered across multiple sensor channels. There are two primary notification rules: **Logical 'OR'** and **Logical 'AND'**.

*(Note: For either rule to apply to a specific sensor channel, Alarm Notifications must be individually* ***enabled*** *on that channel via the device configuration. Disabled channels are bypassed and ignored by the logical rules).*

#### 3.2.2.1 Logical 'OR' Alarm Notification Rule

The 'OR' rule is designed for broad event detection. Under this rule, an alarm notification is transmitted to the cloud software if a Minor, Severe, or Critical threshold is reached on **any single enabled sensor channel**.

**How it works (Flowchart Example):** Suppose channels 0, 2, 3, and 4 are enabled, while channel 1 is disabled. If channels 0, 3, and 4 breach their thresholds, but channel 2 remains normal, the device will **transmit the alarm** to the cloud. Because the '**OR**' logic is active, only one channel needs to cross a threshold to trigger the system-wide notification.

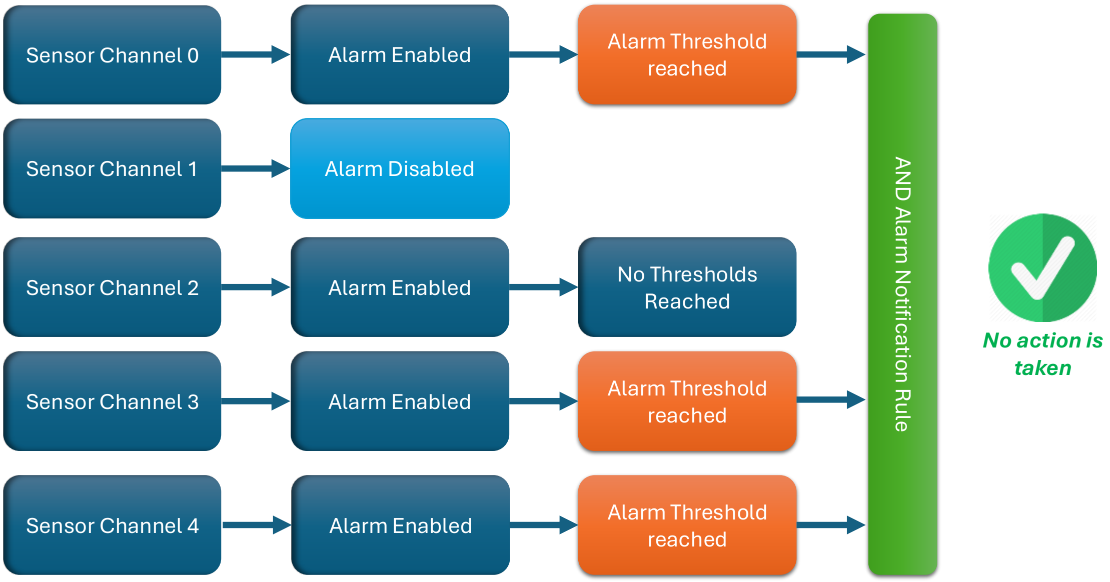



#### 3.2.2.2 Logical 'AND' Alarm Notification Rule

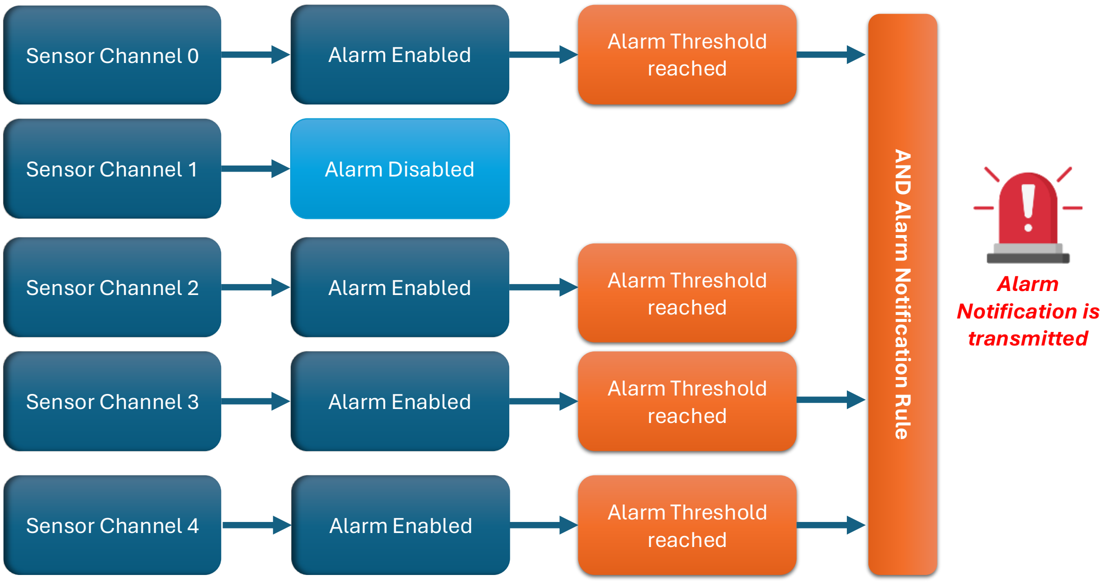
The 'AND' rule is designed for complex event detection where multiple physical conditions must correlate to validate an alarm. Under this rule, an alarm notification is sent to the cloud software only if all enabled sensor channels reach their thresholds simultaneously.

**Real-World Use Case:** This is highly useful when correlating an inclinometer sensor with structure/equipment temperature. For instance, a rise in ambient temperature can lead to thermal expansion and temporary structural deformation. By applying the 'AND' rule, you can configure the system to only alert you if the structure tilts *and* the temperature spikes at the same time.

**Example 1: Condition Not Met** Suppose channels 0, 2, 3, and 4 are enabled (channel 1 is disabled). Channels 0, 3, and 4 breach their configured Minor/Severe/Critical thresholds. However, channel 2 has *not* reached its threshold. Because the 'AND' requirement is not completely fulfilled across all enabled channels, **no alarm notification is transmitted** to the cloud software




**Example 2: Condition Met** Using the same configuration, the physical environment shifts, causing channels 0, 2, 3, and 4 to *all* reach their respective Minor/Severe/Critical thresholds simultaneously. Because every enabled channel has now triggered an alert state, the 'AND' condition is fulfilled, and the **alarm notification is transmitted** to the cloud software.



### 3.2.3 Alarms thresholds configuration

To provide granular monitoring and facilitate automated incident response, the Satevis® device categorizes threshold breaches into three distinct severity levels. This tiered approach allows system integrators to configure their LoRaWAN® Network Server (LNS) or cloud software to execute specific actions based on the severity of the event—such as routing notifications to different maintenance teams (via email or SMS) or automatically activating physical relays (e.g., flashing lights, sirens, or shut-off valves).

The three alarm notification levels are defined as follows:

• **Minor Alarm:** The lowest level of severity. This serves as an early warning indicator that a physical measurement has deviated from the expected baseline. Breaching this threshold immediately triggers the accelerated **Alarm Monitoring Refresh Rate (AMRR)**, ensuring the device closely tracks the physical evolution of the event.

• **Severe Alarm:** The medium level of severity. This indicates a significant measurement anomaly that requires preliminary investigation by an operator, while the device continues to transmit highresolution data points via the active AMRR.

• **Critical Alarm:** The highest level of severity. This indicates an extreme breach of operational thresholds, meaning the structure or equipment is outside of safe operating parameters. Immediate field intervention is requested.

**High or Low Threshold Configurations** Depending on the specific physical parameter being monitored, users can configure the alarm logic to operate as either a High Threshold Alarm (triggered when measurements rise above expected limits) or a Low Threshold Alarm (triggered when measurements drop below expected limits). The specific mechanics of how these directional thresholds interact with the Minor, Severe, and Critical tiers are detailed in the following subsections.

| | *Low Alarm Threshold* | *High Alarm Threshold* |
|---|---|---|
| Alarms thresholds Level | MA (Minor Alarm) > SA (Severe Alarm) > CA (Critical Alarm) | MA (Minor Alarm) < SA (Severe Alarm) < CA (Critical Alarm) |
| Example for Temperature Sensor | MA = -5°C , SA = -7°C, CA = -10°C<br><br>MA notification is transmitted to LNS, if temperature goes below -5°C.<br><br>SA notification is transmitted to LNS, if temperature goes below -7°C<br><br>CA notification is transmitted is temperature goes below = -10°C<br><br>See Figure 6 | CA = +30°C , SA = +34°C, MA = +36°C<br><br>Alert level notification is transmitted to LNS, if temperature goes higher than +30°C.<br><br>Action level notification is transmitted to LNS, if temperature goes higher than +34°C.<br><br>Alarm level notification is transmitted to LNS, if temperature goes higher than +36°C.<br><br>See Figure 7 |
| Example for Humidity Sensor | MA = 45%RH , SA = 35%RH, CA = 30%RH<br><br>MA notification is transmitted to LNS, if humidity goes below 45%RH. | CA = 85%RH, SA = 80%RH, MA = 70%RH<br><br>MA notification is transmitted to LNS, if humidity goes higher than 70%RH |

| | | |
|---|---|---|
| | SA notification is transmitted to LNS, if humidity goes below 35%RH.<br><br>CA notification is transmitted to LNS, if humidity goes below 30%RH. | SA notification is transmitted to LNS, if temperature goes higher than 80%RH<br><br>CA notification is transmitted to LNS, if temperature goes higher than 85%RH |
| Example for Inclination Sensor | MA = +5°Angle , SA = +3°Angle, CA = -6°Angle<br><br>MA notification is transmitted to LNS, if inclination goes below +5°Angle<br><br>SA notification is transmitted to LNS, if humidity goes below +3°Angle<br><br>CA notification is transmitted to LNS, if humidity goes below -6°Angle | CA = +3°Angle, SA = +4°Angle, Alert = +6°Angle<br><br>MA notification is transmitted to LNS, if inclination goes higher than +3°Angle<br><br>SA notification is transmitted to LNS, if temperature goes higher than +4°Angle<br><br>CA notification is transmitted to LNS, if temperature goes higher than 85%RH |

#### 3.2.3.1 High Threshold Alarms

High Threshold Alarms are configured to trigger when a physical measurement is *rising* above a safe baseline. As the value increases, it crosses sequentially through the severity tiers.

**Example (Temperature Sensor):** To prevent overheating in an industrial environment, the device can be configured so that normal operation is below 30°C ("No Alarm Zone"). As the temperature rises, it triggers the Minor Alarm (e.g., at 30°C), which immediately accelerates the sampling rate (AMRR). If the temperature continues to rise, it will trigger the Severe Alarm (e.g., at 34°C) and finally the Critical Alarm (e.g., at 36°C).

**Rule:** For High Thresholds, the configuration must follow the logic: Minor Threshold < Severe Threshold < Critical Threshold

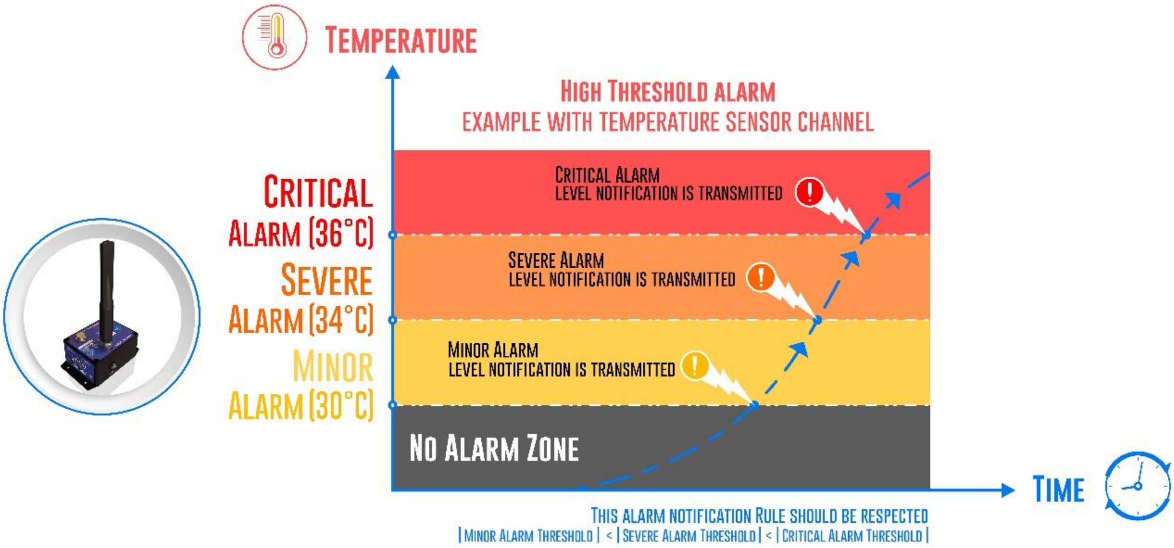



*Figure 1 : Example of High Threshold Alarm on external Temperature sensor*

3.2.3.2 Low Threshold Alarms

Low Threshold Alarms are configured to trigger when a physical measurement is *falling* below a safe baseline. The alarm escalates as the value drops further away from the expected norm.

**Example (Temperature Sensor):** To prevent freezing in sensitive infrastructure, the device operates normally at higher temperatures ("No Alarm Zone"). As the temperature drops, it first crosses the Minor Alarm threshold (e.g., at -5°C), activating the AMRR. Continued drops will breach the Severe Alarm (e.g., at -7°C) and Critical Alarm (e.g., at -10°C) thresholds.

**Rule:** For Low Thresholds, the configuration must logically follow the descending progression: Minor Threshold > Severe Threshold > Critical Threshold

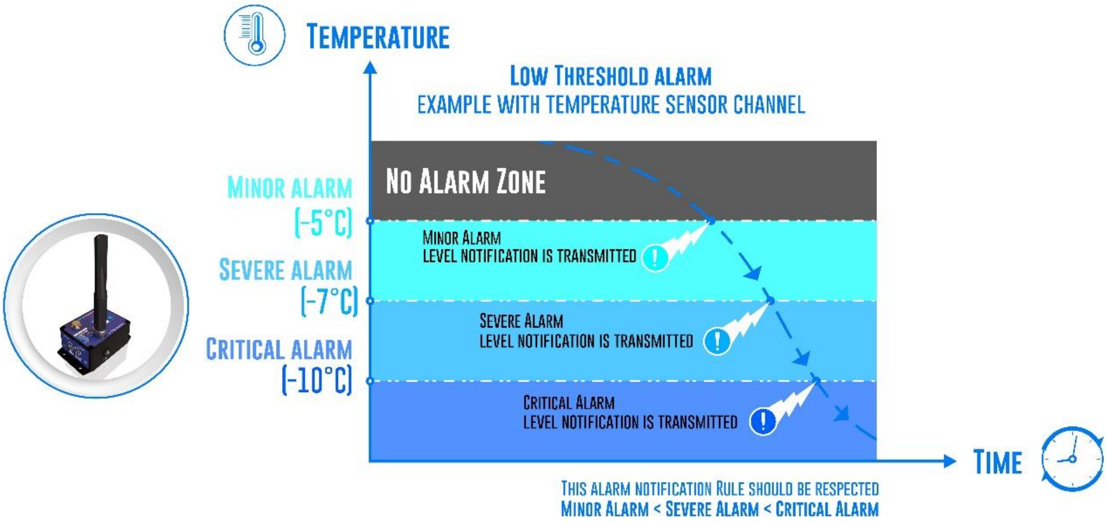



*Figure 2 : Example of Low Threshold Alarm on external Temperature sensor*

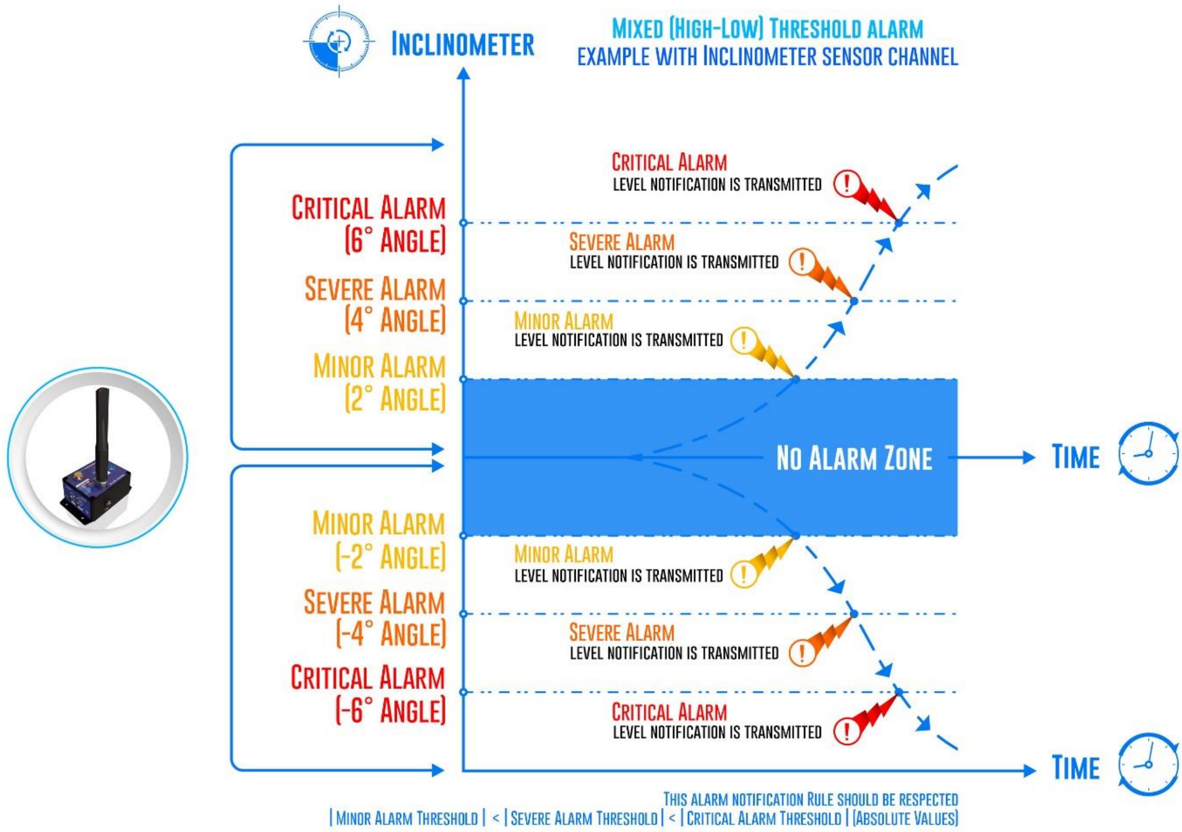
#### 3.2.3.3 Mixed High-Low Thresholds alarms

Mixed High-Low Alarms provide bi-directional monitoring. They are designed for applications where a structure or equipment has a central "No Alarm Zone" (a safe baseline) but can unsafely shift, tilt, or move in *either* opposite direction.

**Example (Inclinometer):** A vertical pillar might be perfectly safe at 0°. If it leans forward (positive angle) or backward (negative angle), it poses a risk. The device monitors the absolute value of the movement. Moving away from 0° in either direction will sequentially trigger the Minor (accelerating to AMRR), Severe, and Critical alarms.

**Applicability:** This specific alarm mode is **only available for Inclinometer and Displacement sensor channels**.

**Rule:** The alarm notification rule evaluates the absolute deviation from the baseline: | Minor Alarm Threshold | < | Severe Alarm Threshold | < | Critical Alarm Threshold |.




#### 3.2.3.4 Alarm Persistent

During an active alarm event, the transmitted Alarm message payload encapsulates specific status indicators to provide precise tracking of the event's lifecycle. Depending on the current sensor readings, the device will flag the transmission with one of the following statuses:

- **New Alarm Notification:** Indicates the initial breach of a defined alarm threshold.
- **Alarm Status Update:** Indicates a change in the severity level of an ongoing alarm (e.g., escalating from a Severe Alarm to a Critical Alarm, or de-escalating).
- **Alarm Persistent:** Indicates that the device remains within the exact same alarm threshold zone as the previous transmission.
- **Last Alarm Notification:** Indicates that the measured values have returned to normal operating ranges and the device has fully exited the alarm zone.

**External Integration & Automation:** Providing these distinct, granular alarm states allows cloud platforms and IoT applications to accurately manage automated responses. Users can leverage these specific statuses to reliably trigger (or deactivate) external systems, such as physical strobe lights and sirens, or to dispatch targeted SMS and email notifications tailored to the exact stage of the alarm event.

#### 3.2.3.5 Keep-Alive message

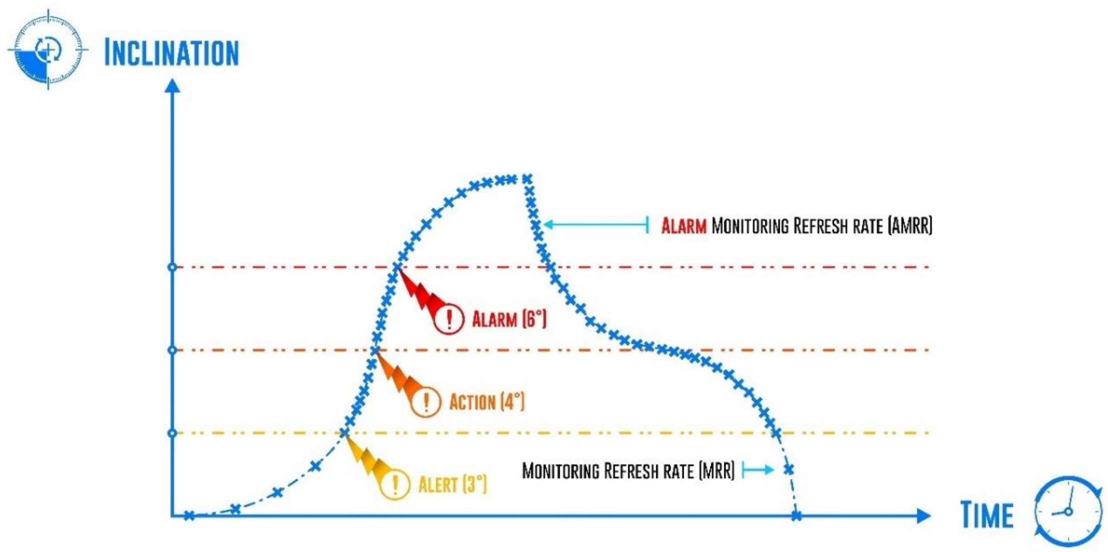
To ensure that cloud platforms and Network Servers know the device remains online and is monitoring successfully during extended periods without threshold breaches, the Satevis® device transmits a periodic Keep-Alive message.

This message is *only* transmitted when the device operates in Alarm Monitoring mode and no active alarms are currently triggering an immediate notification.

- **Automated Keep-Alive Period (KARR):** The frequency of this transmission is governed by the user-defined Keep-Alive Refresh Rate (KARR). During this quiet period, data is still being acquired internally at the baseline Monitoring Refresh Rate (MRR).
- **Aggregated Telemetry:** Instead of sending an empty network ping, the Keep-Alive payload provides a rich statistical summary of the monitored period. For every active sensor channel, the payload encapsulates the **Latest, Minimum, Maximum, and Average** values calculated since the previous Keep-Alive message, reducing network traffic while maintaining data integrity.

**Example Scenario: Inclination Monitoring** As illustrated in the accompanying graph, consider an inclination sensor channel operating under the following configuration:

- **Alarm Thresholds (High Threshold Mode):**
  - **Minor Alarm (Alert):** Triggered at 3°
  - **Severe Alarm (Action):** Triggered at 4°
  - **Critical Alarm (Alarm):** Triggered at 6°
- **Alarm Logic:** Configured with an **'OR'** Alarm Notification Rule.
- **Refresh Rates:**
  - **Monitoring Refresh Rate (MRR):** Configured to 2 minutes. (Used during normal, non-alarm states; data is gathered every 2 minutes for the Keep-Alive statistics).
  - **Keep-Alive Refresh Rate (KARR):** Configured to 10 minutes. (A statistical summary is sent every 10 minutes if inclination remains below 3°).
  - **Alarm Monitoring Refresh Rate (AMRR):** Configured to 40 seconds.




**Operational Flow based on the Graph:**

While the inclination remains below the 3° Minor threshold, the device samples data every 2 minutes (MRR) and sends a Keep-Alive summary every 10 minutes (KARR).

Once the inclination breaches the 3° (Minor), 4° (Severe), or 6° (Critical) thresholds, the device immediately transmits an alarm notification. At this point, normal MRR is suspended, and data acquisition accelerates to the **AMRR of 40 seconds**, providing high-resolution, real-time tracking of the event curve. Once the event subsides and drops back below the thresholds, the device reverts to its standard MRR and Keep-Alive (KARR) schedule.

### 3.2.4 STOP Monitoring Mode

Stop Monitoring Mode is not an active data acquisition state. When placed in this mode, the Satevis® device completely halts all data sampling and network transmissions.

**Best Practice:** To prevent the generation of false or irrelevant alarm transmissions, it is highly recommended to place the device in Stop Monitoring Mode during physical installation, field deployment, and initial configuration. Once the setup and calibration are complete, the device can be safely transitioned into either Slow or Alarm Monitoring Mode.

**Important Note on Device Configuration: Because the device only opens a receive window for Downlink commands immediately following an Uplink transmission, any command sent from the cloud to change the monitoring mode will be queued. To successfully switch the device out of Stop Monitoring Mode, the user must wait for the next scheduled System Diagnostic message. The device will receive and execute the mode-change downlink command immediately after this diagnostic uplink is sent.**

### 3.2.5 All the Timings parameters

| *Timing setting* | *Acronym* | *Unit* | *Minimum* | *Maximum* | *Default Factory Settings* |
|---|---|---|---|---|---|
| Monitoring Refresh Rate | MRR | seconds | 20s | 86400s | 300s |
| Alarm Monitoring Refresh Rate | AMRR | seconds | 20s | 86400s | 60s |
| Keep Alive Refresh Rate (KARR) | KARR | seconds | 20s | 86400s | 300s |
| System Diagnostic Refresh Rate | SDRR | seconds | 60s | 86400s | 600s |

All the Timing restrictions (min, max values, multiple values) are directly managed by Satevis® device:

- **System Diagnostic Refresh rate (SDRR)** must be a multiple of **Monitoring Refresh Rate** (MRR);
- **Alarm Monitoring Refresh Rate (AMRR)** should be lower than **Monitoring Refresh Rate** (MRR);
- **Keep Alive Refresh Rate (KARR)** must be a multiple of **Monitoring Refresh Rate** (MRR);

# 4 INCLINOMETER CONFIGURATION

The Satevis® inclinometer can be configured to operate within specific measuring ranges depending on the device hardware version and the precision requirements of your deployment.

## 4.1 HARDWARE RANGE SPECIFICATIONS

The available physical measuring limits depend on the sensor model (Tri-Axis or Bi-Axis):

- **Tri-Axis Version (10T):**
  - **Low Range:** ±10°
  - **High Range:** ±85°
- **Bi-Axis Version (30B):**
  - **Low Range:** ±30°
  - **High Range:** ±55°

## 4.2 MEASURING RANGE MODES

To optimize the balance between measurement precision and the expected range of structural motion, the inclinometer can be configured into one of four operational modes:

- **Static Low Range:** The measuring range is strictly locked to the Low Range limit. This mode restricts the maximum measurable angle but provides the highest possible measurement precision.
- **Static High Range:** The measuring range is strictly locked to the High Range limit. This mode accommodates larger structural movements but operates at a lower precision compared to the Static Low Range mode.
- **Automatic Low Range:** The sensor initializes in the high-precision Low Range. If the structure's inclination exceeds the Low Range limits, the device dynamically auto-scales into the High Range. This is highly recommended for dynamic structures prone to occasional large movements (e.g., drawbridges, folding bridges, or marine vessels).
- **Automatic High Range:** The sensor initializes in the High Range to capture large initial movements or extreme baseline angles. If the structural inclination settles within the Low Range thresholds, the device dynamically auto-scales down to the Low Range to maximize measurement precision.