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Skalli Handbook



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REVISION HISTORY

Ver.	Date	BACKGROUND (Reason for change)	Description of change	Sections changed	Approver	Author
0.1	2021/06/08	Create document	Add charts and description	All		MaSa
0.2	2021/06/16	Clarification of the description	Clarified behavior during "Unmounted" state, changed figure 4 "Transition state diagram in an activation context". "Long drive scenario" selected in the separate section – 2.3.2	2.2, 2.3.2		MaSa
0.3	2021/06/24	Fix remarks from review	Change title image. Remove "Release overview" section. Add text to the "Introduction" section. Remove "Components" section. Change caption of the images. Other minor changes	1, 2		MaSa
0.4	2021/06/29	Fix remarks from meeting with Sensolus	Widespread changes, new sections added.			MaSa
0.41	2021/06/30	Corrections	Chapt. 13.2, Figure 7, Solved comments deleted Chapt 1.8 & 1.9 added			T.Kiefer
0.42	2021/07/05	Corrections based on review with Sensolus	Chap. 1 Chap. 1.1.3 Chap. 1.3 Chap. 1.5 Chap. 5			T.Kiefer
0.5	2021/07/09	Document name changed Feedback from Sensolus In Flight detection added				T.Kiefer
0.51	2021/07/14	Additional info	Debugging added Disposal added			T.Kiefer
0.6	2021/07/23	Feedback from Sensolus				T.Kiefer
0.62	2021/08/10	Disclaimer added Final alignments with Sensolus				T.Kiefer
1.00	2021/08/11	First official release				T.Kiefer
1.01	2021/09/13	Typos, Customer appearance, Chpt. For parser added	Some typos corrected Abbreviations avoided			T.Kiefer
1.02	2021/09/24	FW Update Mounting position Disclaimer	Info about restart criteria was added More precise info Forbidden to open the device (IP69)			T.Kiefer
1.03	2021/10/01	OTM Settings Magnet info	Changed OTM to default 4hrs (>=FW1.13) Some information added, for OTM Info added	2.3		T.Kiefer
1.04	2021/10/05	Positioning based on Sigfox network Hardware content	Description changed, based on Sigfox feedback Graphical overview added			T.Kiefer
1.05	2021/10/07	Dimensions	dimensions updated	9		T.Kiefer
1.10	2021/11/23	Info on START event Mounting Firmware DL Settings	Note 5 added Face-down mounting position forbidden Info for standard settings added DL settings description	2.4.1 10 4 6		T.Kiefer

REFERENCES

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DEFINITIONS AND ABBREVIATIONS

Abbreviation/Term	Definition
BT	Bluetooth
DL	Downlink
D.I.	Data Integrity
UL	Uplink
OTM	On-The-Move

RELATED DOCUMENTS

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1. INTRODUCTION

“Skalli” is the name for a High-End Asset Tracker. This device has following capabilities:

- GPS Tracking
- WiFi
- Worldwide Usage (different Region Codes possibility) / 1-for-all [RegionCode 1-5]
- In-Flight Detection
- Sigfox® Network Verified
- Tamper detection
- BLE Bluetooth® Low Energy (optional)
- Data Integrity (optional)
- External sensors supported (i.e. temp., humidity) (optional)
- Firmware Update (optional)
- Beacon detection (optional)
- Graphical User Interface / Statistics via Sensolus Backend (optional)

Skalli is co-developed by AlpsAlpine and Sensolus. This product is especially designed for long lifetime. Depending on the Use-Case, it's running up to 8 years. TRUMI motion detection algorithm is integrated to achieve long lifetime.

This document was created to have a condensed overview of Skalli's capabilities and specification.

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1.1. Description

Skalli is an asset tracking device that enables the user to track the different locations of a moving asset, such as containers and trollies. It's an industrial grade device, where it is maintenance-free and can reach a life-time up to 8 years, depending on the customer Use-Case (i.e. daily amount of messages).

Based on a sophisticated motion algorithm, Skalli is capable to send the relevant GPS location of the asset locations or - as a fallback - Wifi BSSIDs address. The GPS / WiFi location message will be transmitted via Sigfox® network.

The core competence of the Skalli is its motion algorithm, which allows sending messages only when the motion event occurs. In other words, as long as the asset does not move, it will enter kind of a power saving mode. In case of no motion detected, the Skalli could be set to send once a day an 'alive message', with the current GPS location. Detecting motion happens when certain thresholds such as speed and distance are exceeded, once this occurs, the device waits till motion stops, then transmit the corresponding GPS Data. During motion, the device sends only Status messages. Data transmission happens only via Sigfox® protocol, no transmission through GPS (Wifi). Motion algorithm parameters and others can be configured via downlink message.

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1.2. Hardware content

Skalli's Hardware basically contains following components

- 1 PCB
- GPS Receiver
- WiFi Transceiver (solely used as receiver)
- Sigfox® Transceiver
- Bluetooth® Low Energy (BLE) [optional]
- Acceleration Sensor
- Pressure Sensor
- Temperature Sensor
- Magnetic Switch
- LED (1)
- Battery (non replaceable*)
- Tamper rubber button (2)
- Plastic Enclosure, Industrial Strength (3)
- Vent (4)



*Warranty lost, if device is opened

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2. OPERATION

2.1. Device Activation

There are two ways to activate the device: using a magnet or using the back-side button.

2.1.1. Magnet activation



Figure 1 - Location of the indicator for magnet switch (detector)

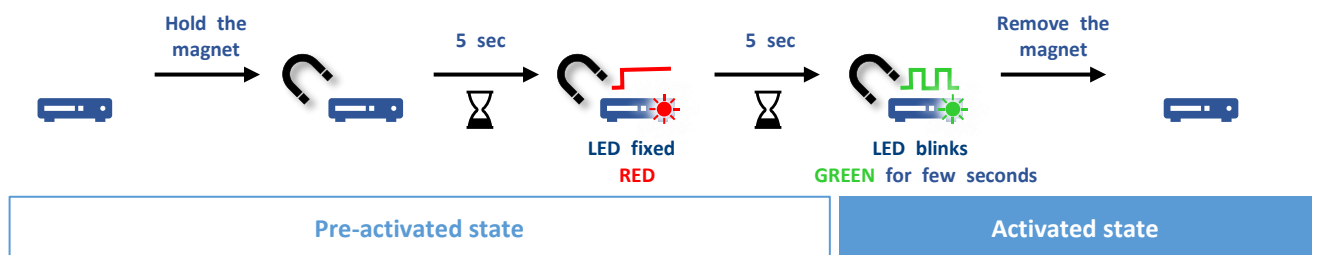


Figure 2 - Magnet activation, continuously hold magnet for 10sec

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2.1.2. Button activation

The button is a rubber component on the backside, that is continuously pressed, when device is properly mounted.



Figure 3 – Location of the button

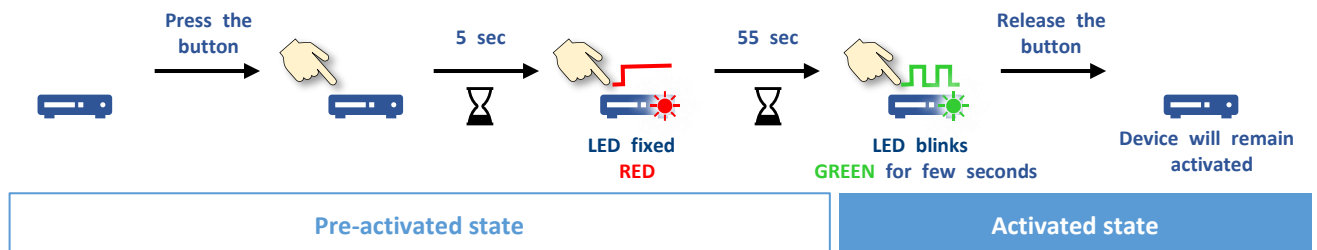
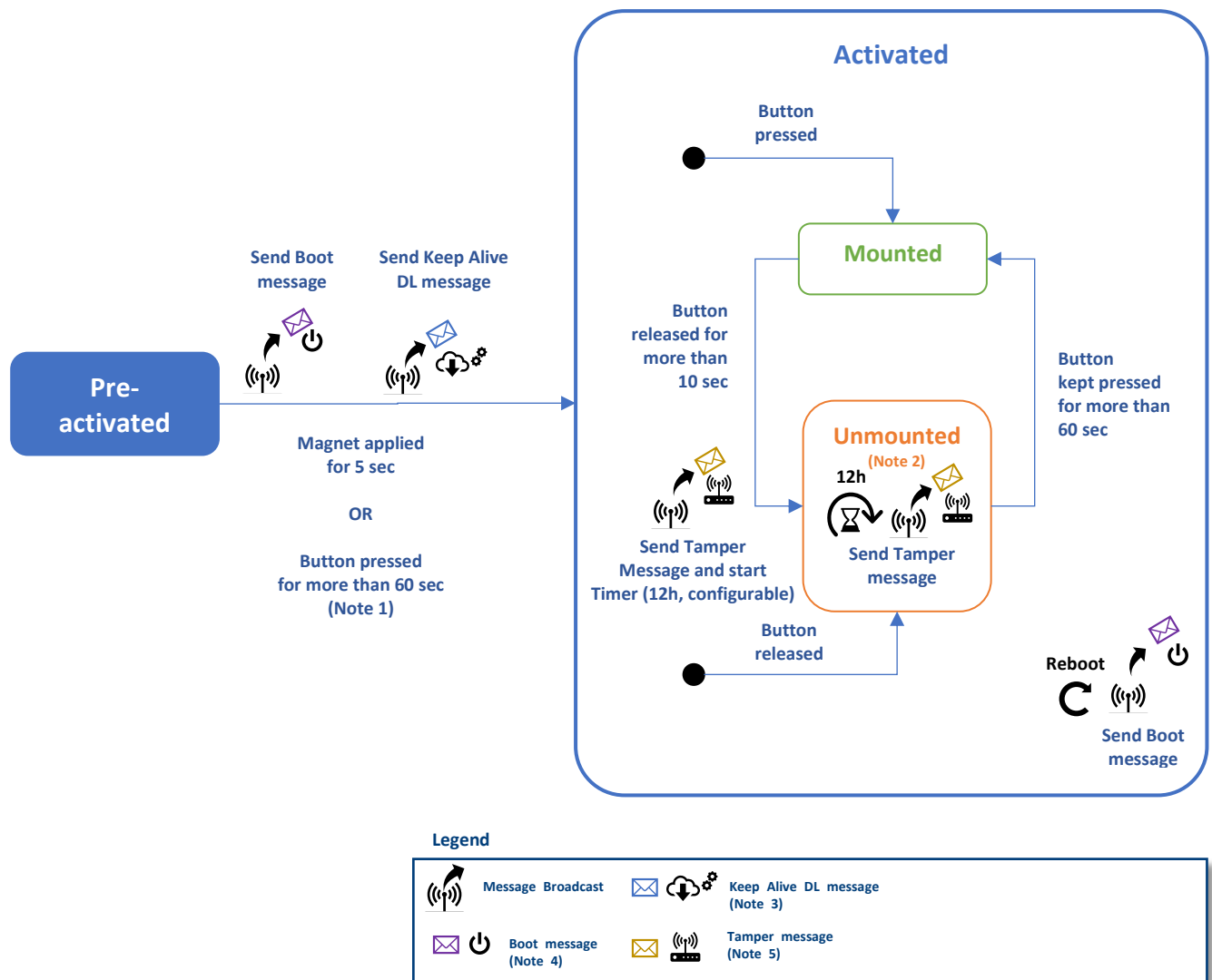


Figure 4 – Button activation

Note: If activation process is interrupted within the 60 seconds, the whole process is cancelled and device will remain in pre-activated state.

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2.1.3. Activation state machine



Notes.

1. After continuous press for 60 sec, the state of the button does not matter as the device stays activated. The state of the button is then used to define the "mounted" or "unmounted" states.
2. **Unmounted state** - state with limited functionality, in which every 12 hours a message with GPS or WiFi data is sent. The motion tracking mechanism is not active.
3. **Keep alive DL message** – is not a location message, uplink part contains various status information: uptime, consumed energy etc.
4. **Boot message** - Sent after activation or after rebooting in the activated state. It is not sent in a pre-activated state (even reboot happened).
5. **Tamper message** – is a location message with Event Type Tamper. Location message type can be GPS (1st Prio) or WiFi (2nd Prio). If both fails, then an empty SigFox location message will be sent (GPS message without any latitude/ longitude data).
6. If the device was activated by the Magnet, the device will still react to the state of the button and switch from the state "Mounted" to "Unmounted" and back.
7. If pressing of Tamper button is interrupted within 60sec, the device will remain in unmounted state and timer will restart at 0 once the button is pressed again.

Figure 5 – State diagram in an activation context

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2.2. Device deactivation

The device cannot be deactivated either with a magnet or with a button. The only way is through a Downlink command. (For DEV-Purpose, it can be deactivated by BT command). When being deactivated, it's pushed back into pre-activated state. That's basically the meaning of being deactivated.

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2.3. Magnet capabilities

Magnet can be used for activation, ref. to previous chapters. Yet, it can also be used to perform following actions:

- Get device status
- Force a request for a new configuration

Regular small magnet is fine. No special one required.

2.3.1. Get device status

To get the device status, just hold the magnet for less than 5 seconds. The LED will indicate accordingly, indicating the current state of the device.

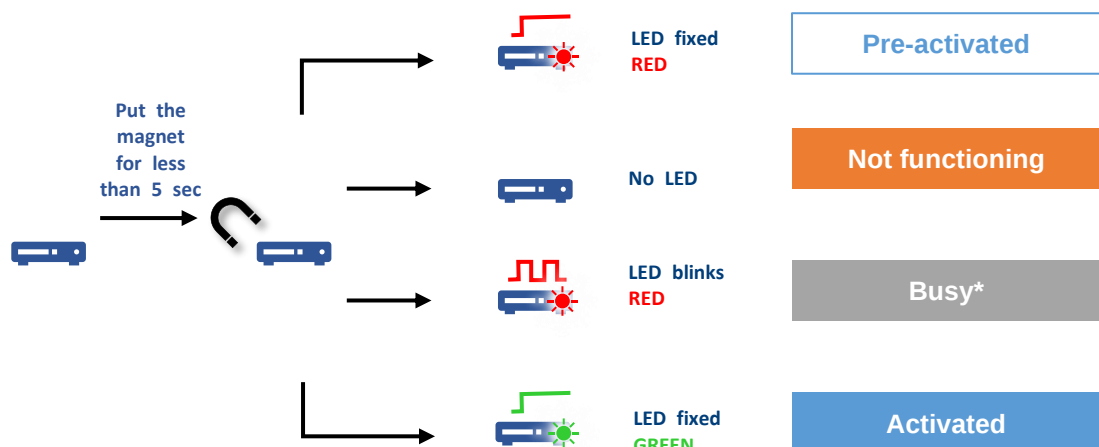


Figure 6 – Status determination of device

* Reasons for Busy state:

- Device is within first 60 seconds after (re-)boot
- Daily amount of DL requests (max. 8) is reached. (ref. to chpt. 2.3.2)

Note: If the device is in the activated state, it is impossible to know whether it is in the "Mounted" or "Un-mounted" sub-state.

Note: On a reboot, it will blink green, for a short time (16 blinks, 4sec). Same for activation by Magnet or Tamper Switch.

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2.3.2. Force a request for a new configuration

There is another category of messages that will be transmitted immediately without any message budget restriction (MSG_PRIORITY_URGENT) - when initiated using magnet for more than 5 seconds on an already activated device (restriction is we have to wait 1 minute after activation before triggering the DL) - keep alive message with DL flag set.

Device can generate only a max of up to 8 keep-alive messages with DL flag set using magnet within a 24 hour period so as not to exceed the threshold of permissible use of SigFox radio and cause a drain of battery.

Following graphic explains procedure of forcing DL request.

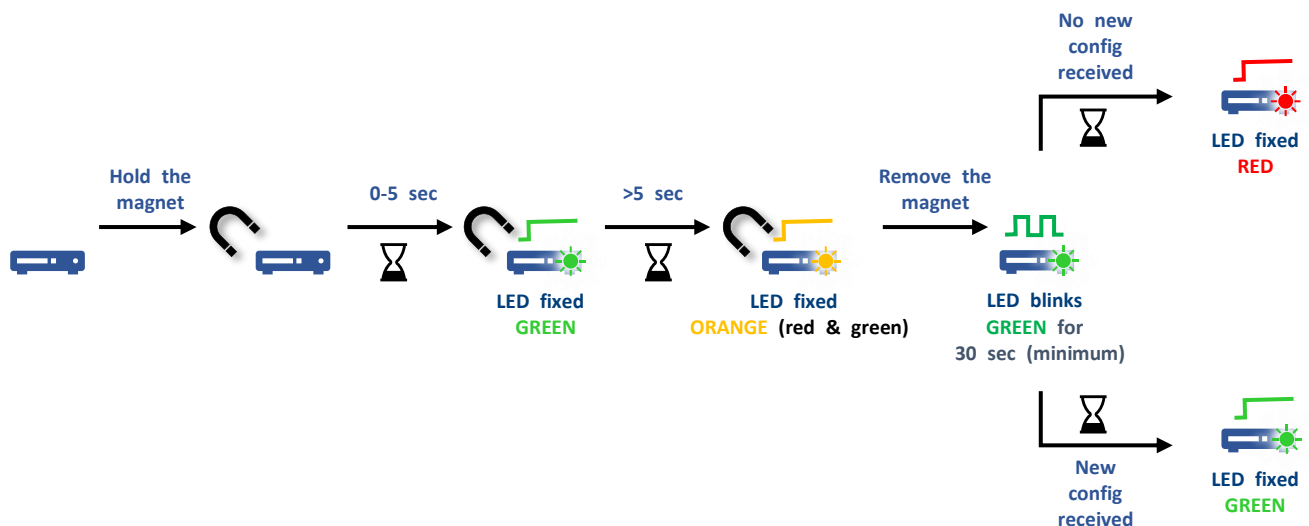


Figure 7 – Force new configuration download by Magnet (device already activated)

Important: Same request for DL Settings can also be initiated by pressing the Tamper Button for >5 sec and <60sec, while device is in unmounted state.

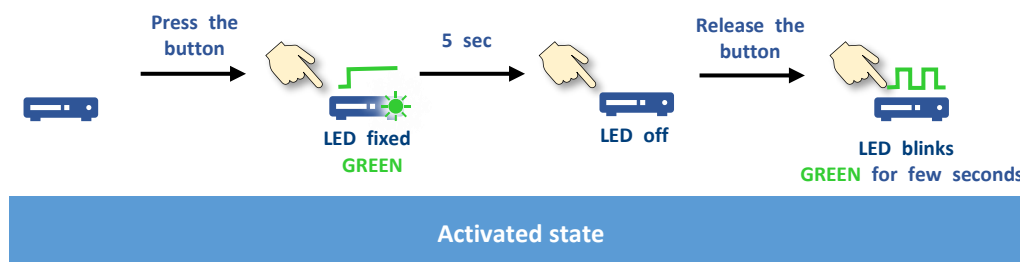
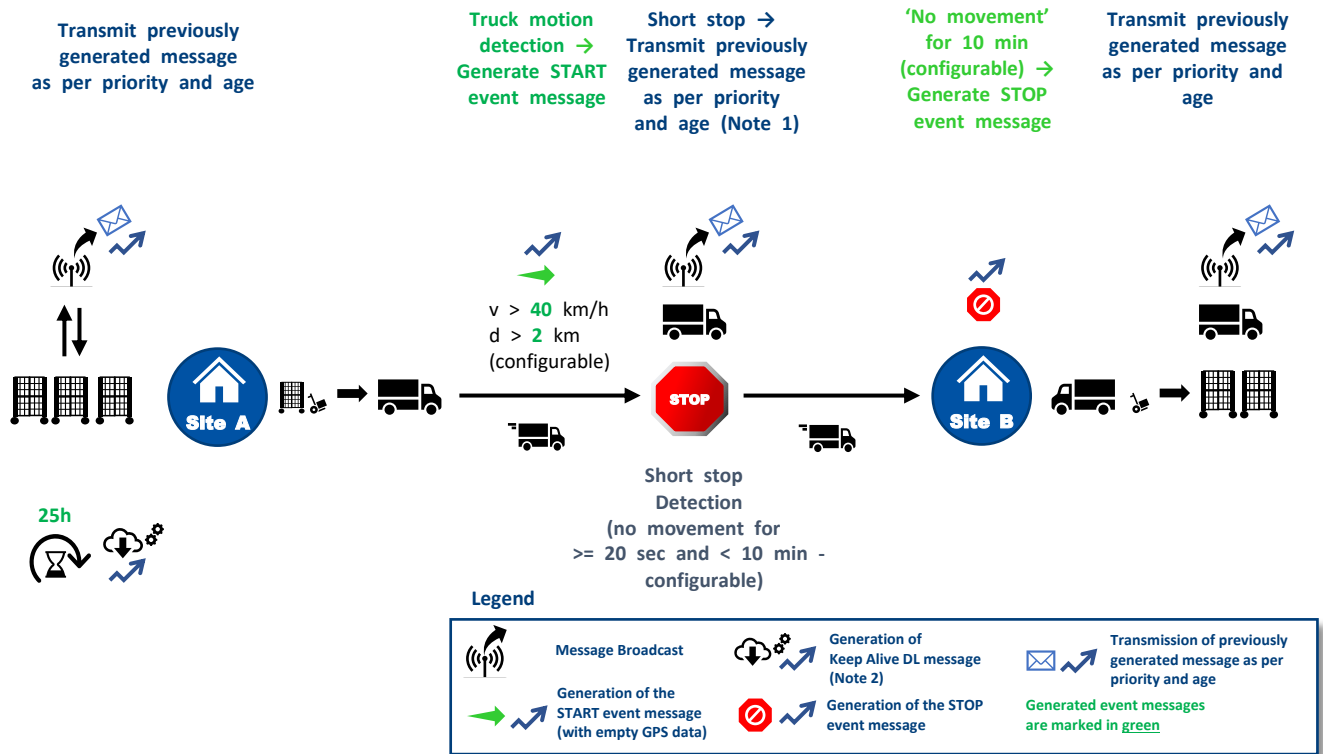


Figure 8 – Force new configuration download by Tamper Button (device already activated)

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2.4. Movement transition

2.4.1. Normal scenario



Notes.

- For each Short stop event, the number of messages sent depends on the configuration and on the number of generated messages in the queue. In particular: GPS location - 1 message, WiFi location - 2 messages, If both locations are unavailable - 1 message will be sent.
- Keep alive DL message is generated regardless of whether it is in a relocation or not. It can be generated while driving and sent at the nearest stop. There is a rotation of keepalive messages each with their own data format.
- Device is never sending messages while being in movement, message is just generated and send out when device is not moving
- Whenever Skalli device is doing a WiFi scan, it always does a "full" scan. No Reduced scan. Difference of power consumption is negligible. Yet, it's configurable.
- START message will always be a Location_Update message with empty GPS data (Long 0/Lat 0). Hence, start position need to be derived from previous STOP event.

Figure 9 – Normal scenario of the movement transition

Note: Messages can be generated any time even when the asset is moving or even throttling is enabled and the threshold for the day has been reached. Generated messages will be transmitted on the next stop based on the priority/age irrespective it is a short stop or fill relocation complete stop.

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2.4.2. Long drive scenario

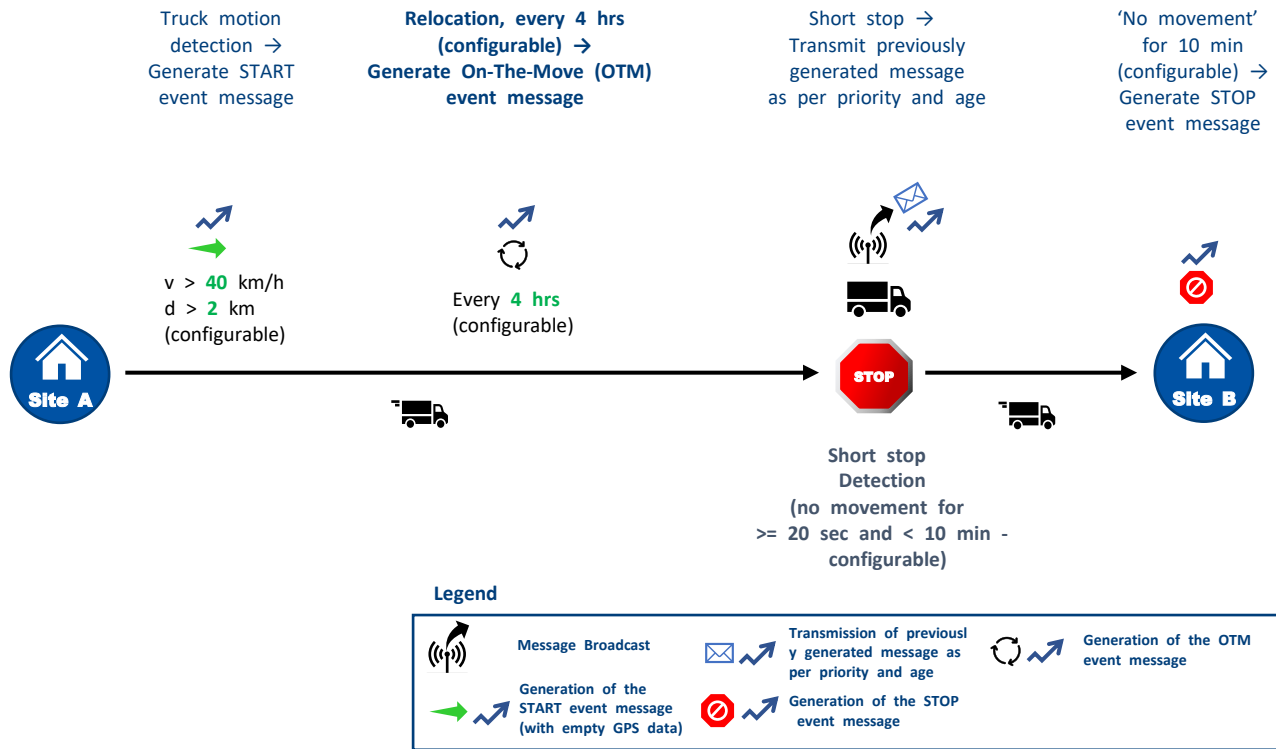


Figure 10 – Long Drive scenario of the movement transition

Note: OTM can be Enabled/Disabled through DL settings

Note: OTM interval can be configured from 30min – 17hrs

Note: Using short intervals of OTM will decrease battery lifetime.

2.4.3. Keep-Alive

Keep alive message contains most of the diagnostics information (Temp, Uptime, Battery status, etc). It rotates the sent information.

Keep Alive is usually send every 25hrs. This interval is configurable (30min – 17 hrs)

2.4.4. Startup behaviour on Boot event (i.e. BLE Reset)

On Startup, the device will send a Boot message, followed by a Keep_Alive message, including DL request

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2.4.5. In-Flight Detection

Device is supporting In-Flight Detection. Take-Off event and Landing event will be detected by using pressure sensor.

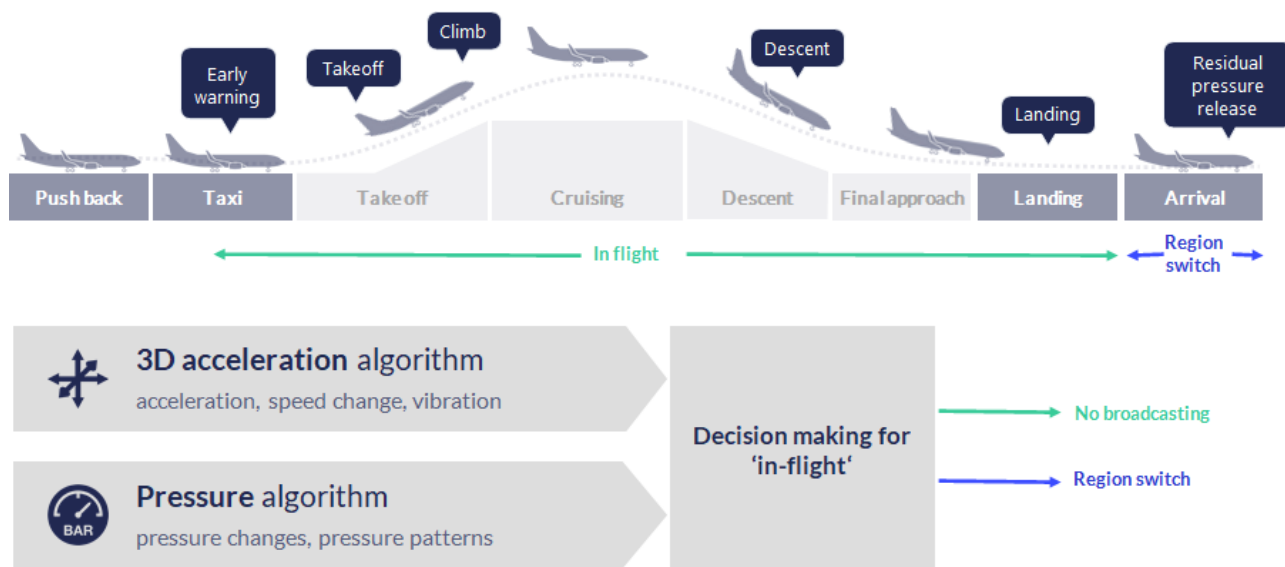


Figure 11 – In-Flight Detection

2.4.6. Overseas Transport / Container Boat

There is no special mode for Overseas transport. In default configuration, the device will update its location based on the OTM interval set by DL config. Note that there is usually no Sigfox Coverage on the sea. Yet, that's acceptable as the ship keeps moving and all messages will only be send out once the ship has stopped (i.e. at harbour).

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2.5. Message queue

It is important to understand that Skalli has a prioritized message queue handling. Each message, that shall be send out, is added to general message queue as a first step. When message was successfully sent out, it is automatically moved to DI queue (if DI feature is enabled). If DI functionality is not enabled, message will be deleted from 1st queue, after sending.

Each message has a pre-defined priority (Urgent/High/Normal/Low) [even Boot messages]. Ref. to fig. 10. Based on the priorities, the messages within the queue are handled. Of course, urgent messages have highest Priority.

Size of both queues (general & DI) is 64 messages, each. Once it is full, the handling is first in, first out.

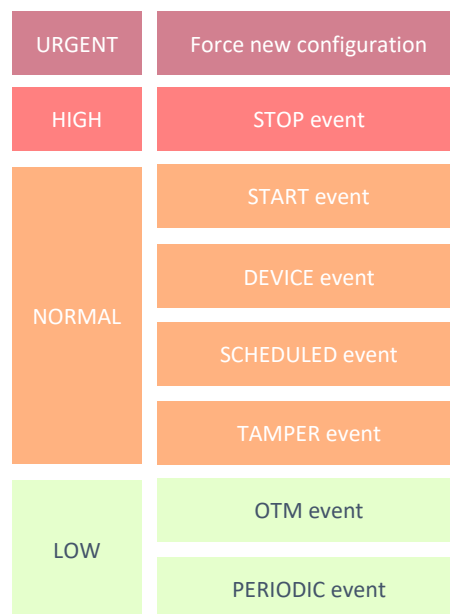


Figure 12 – Determining the priority of messages

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2.6. Procedure for selecting geolocation data

Since the device's position can be determined by several location technologies (GPS, WiFi, Sigfox Network), a procedure is defined when and in which order a localization technology is used and which data will be sent through Sigfox network.

1. If the device is can make a GPS fix, then a message with GPS data is generated.
2. If no GPS fix could be made, the device scans for Wi-Fi access points.
3. If Wi-Fi access points are not found (for example, outside the city), then a SigFox message is sent, which will be received by the base stations and the approximate position of the device will be calculated using the measured RSSI level.



Figure 13 – The procedure for selecting geolocation data for cases of unavailability of certain data

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2.7. Brown-Out Detection & Safe-Mode Handler

Brown-Out detection (Detection of undervoltage) is implemented on MCU. Device will make reboot, when detected and go into low-energy mode.

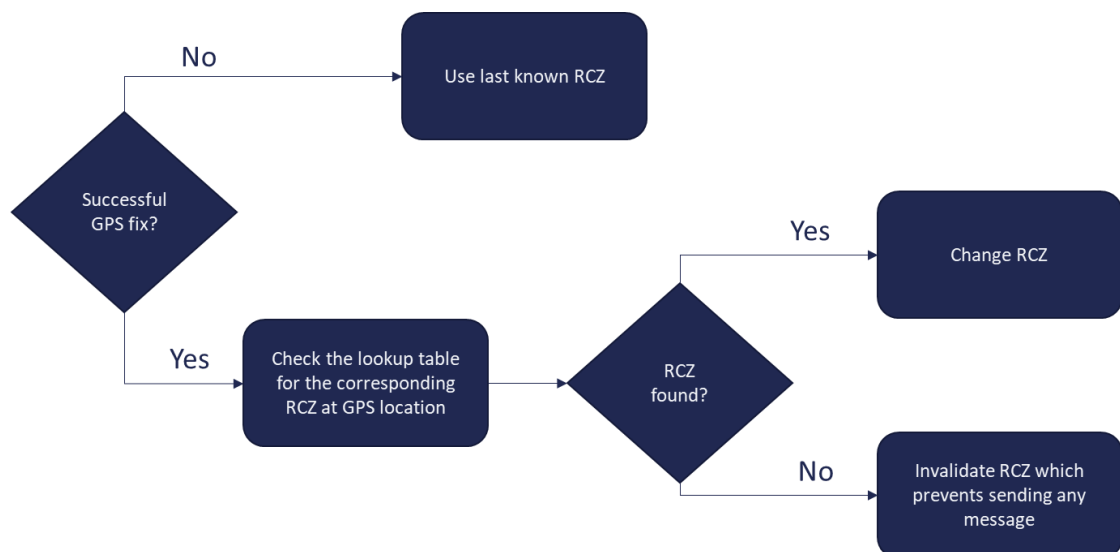
Safemode handler will be enabled after three reboots, without any successful outgoing Sigfox message. Device will stay in safemode for 10min, and then reboot again. While being in safemode, only CPU is powered.

Purpose: Avoid too many Sigfox messages when restarting.

2.8. Region Code Switching

(1) GPS based

Whenever a GPS localization is done, it always checks for proper regioncode zone (RCZ) and changes to different region-settings in case it's necessary. Note that if you can't determine the region (i.e China), the device stops sending anything.



(2) Monarch based

Skalli includes Monarch Scan capability.

Monarch scan can be triggered by following events:

- On detection of a landing event
- No known region can be determined for >7d
 - GPS location without known region (i.e. on the sea or in border cases)
 - And no successful DL

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3. CUSTOMER FRONT-END “SENSOLUS PLATFORM” (OPTIONAL)

Sensolus is offering a Front-End / Webinterface called Sensolus Platform.

<https://stickntrack.sensolus.com/>

This Front-End offers multiple functionality.

- Localisation info
- Statistics
- Device History data
- Details of received messages
- Geo-Zones
- Alarms

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4. FIRMWARE UPDATE (OPTIONAL)

It is possible to perform FW update, manually.

You need special App, which is available through Apple App Store® and Google Play Store®.



App "Sensolus"

A separate manual, for FW update is available in Confluence DB.

Note: Using the app requires access data to Sensolus platform.

Note: A FW update must be queued, by operator, to have related button available, within App.

Note: You need proper role within Sensolus Platform. (i.e. "User_Editor"). "User_Viewer" does NOT include FW upgrade functionality

Important: After FW update, the device might remain in pre-activated state, including factory settings. Hence, you need to activate it again, unless device is mounted to an asset – in that case the device will automatically re-activate. Additionally, configuration is set back to standard settings. So, you'll have to re-configure it.

Related decision criteria:

- if the FW key (Git-SHA) is different from before, the device will erase its internal profile and start from the default one. In this case, it means, it will wait for activation and config is set back to standard config.
- if the Git-SHA is the same as the previous image, the device will boot, keeping all of its profile setting. So if it was activated before, it will continue like a normal reboot. (Since the activation state is stored in the profile, internally)

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5. CONNECTION TO EXTERNAL SENSORS (OPTIONAL)

! This feature is NOT enabled for AlpsAlpine's *Sigfox Ready* version.

BT Devices/Sensors can be linked, through the Sensolus platform. Note that there is a list of supported devices. Means, when there is additional sensor that should be supported, a FW change might be required. Tracker acts as a gateway. Note that 1 tracker can handle up to 2 BT sensors.

Following sensors can be used (Example)

- Temp. Sensor
- Humidity Sensor
- Pressure Sensor
- Radar Sensor (i.e. distance detection)
- etc.

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6. DOWNLINK SETTINGS

(OPTIONAL) Downlink settings can be applied through Sensolus Platform. There is a GUI available.

AlpsAlpine is offering a stand-alone DL configurator. It will create related payload that can be sent to Skalli device, through Sigfox backend.

Following Table is an overview of customer relevant settings available within Skalli device:

Parameter	Description	Min	Max	Default
GPS_ENABLED	Enables/disables the GPS feature; Any GPS action will be skipped if disabled	0 (disabled)	1 (enabled)	1
MESSAGE_KEEPALIVE_ENABLE	Send "keepalive" messages or not	0 (disabled)	1 (enabled)	1
MESSAGE_KEEPALIVE_PERIOD_H	Interval for keepalive message (in hours)	1	64	24
TRIGGER_MOTION_ENABLED	Generate start/stop/otm trigger events, when enabled	0 (disabled)	1 (enabled)	1
TRIGGER_MOTION_JOURNEY_STOP_TIMEOUT_S	Required time (sec) "not moving" before a journey is stopped.	5	5120	300
TRIGGER_MOTION_OTM_PERIOD_M	On-the-move period for journeys, while moving (in minutes)	1	1024	40
TRIGGER_PERIODIC_ENABLE	Periodic trigger enable/disable	0 (disabled)	1 (enabled)	0
TRIGGER_PERIODIC_PERIOD_M	Period of the trigger in minutes	1	8192	360
TRIGGER_SCHEDULED_AMOUNT_N	How many triggers are in the schedule	1	6	6
TRIGGER_SCHEDULED_ENABLE	Scheduled trigger enable/disable	0 (disabled)	1 (enabled)	0
TRIGGER_SCHEDULED_TIME_1	Time of day that trigger 1 expires. In minutes from 00:00	0	2550	0
TRIGGER_SCHEDULED_TIME_2	Time of day that trigger 2 expires. In minutes from 00:00	0	2550	240
TRIGGER_SCHEDULED_TIME_3	Time of day that trigger 3 expires. In minutes from 00:00	0	2550	480
TRIGGER_SCHEDULED_TIME_4	Time of day that trigger 4 expires. In minutes from 00:00	0	2550	720
TRIGGER_SCHEDULED_TIME_5	Time of day that trigger 5 expires. In minutes from 00:00	0	2550	960
TRIGGER_SCHEDULED_TIME_6	Time of day that trigger 6 expires. In minutes from 00:00	0	2550	1200
FLIGHT_DETECTION_ENABLE	Enable flight detection algorithm	0 (disabled)	1 (enabled)	0
TRUMI_SPEED_THRESHOLD_KMH	Minimum speed which must be exceeded once to allow a change from motion detection to relocation. Value is given in km/h	0	75	40
TRUMI_DISTANCE_THRESHOLD_M	Limit for traveled distance since start, exceeding this limit causes a change from motion detection to relocation. Value is given in meter	0	7875	2000
TAMPER_UNMOUNTING_TIME_THRESHOLD_S	Tamper detection threshold for detecting unmounted state. Value in seconds. Value '0' disables the unmounted state entirely (Tracker is always considered "mounted")	0	70	10
TAMPER_ACTION_PERIOD_H	Tamper detection action period in hours	0	255	12
WIFI_ENABLED	Enable WiFi functionality	0 (disabled)	1 (enabled)	1

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7. READ MESSAGES / PARSER

AlpsAlpine is offering a separate Parser (Python based) to identify all messages sent by the Skalli device.

8. DEBUGGING

There is two possibilities of Debugging

- Via BT connection (BLE), it is possible to retrieve detailed debugging information. (Only for DEV purpose). Related App “Sensolus” need to be used. Within the App, you can find “BT Console” button. Note: You need proper access rights. This possibility give more detailed information about the device – and is a live debugging interface.
- Simple Debug Sigfox message (enabled by default and can be disabled by changing the profile) can be generated on error condition and will be added to the queue with LOW priority.

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9. TECHNICAL SPECIFICATION

Dimension [mm] (L x W x H)	175 x 55 x 29 mm
Weight:	180g
Housing Material	PBTGF30
Operating Temperature [°C]	-20 till +60
Connectivity Sigfox, RC1:	Class 0
Localization technology (accuracy)	GPS 5-10m Wifi 25-100 m
Sigfox network-triangulation	up to 5 km
Battery Lifetime	Up to 8 years (at 2 messages per day)
Certification	Sigfox Ready, Sigfox Verified Class 0, CE, FCC, GITEKI, ANATEL, NOM, DO-160, etc.
Protection Class	IP69
Maximum relative humidity:	95 %
Battery	Not replaceable 5600 mAh, 3.6V, nominal 25°C (Li-SoCl ₂ , 2xER17505M parallel connected cells)
Mounting Method	Rivets, Screws, Zip-ties, Double side adhesive



Figure 14 –Dimensions

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10. MOUNTING POSITION

In order to mount the Skalli to the asset, 2 rivets or screws have to be insert through the two holes of the device on the sides. There are arrows on the device label to indicate the best mounting orientation. It is advised to place the Skalli on the top part of the asset, in order to avoid any hits/impacts from a forklift or any other type of vehicles. Additionally, make sure Skalli is not covered/surrounded by metal as this might cause bad reception of build-in antennas.

The ideal positions for mounting the Skalli on the asset is illustrated below.

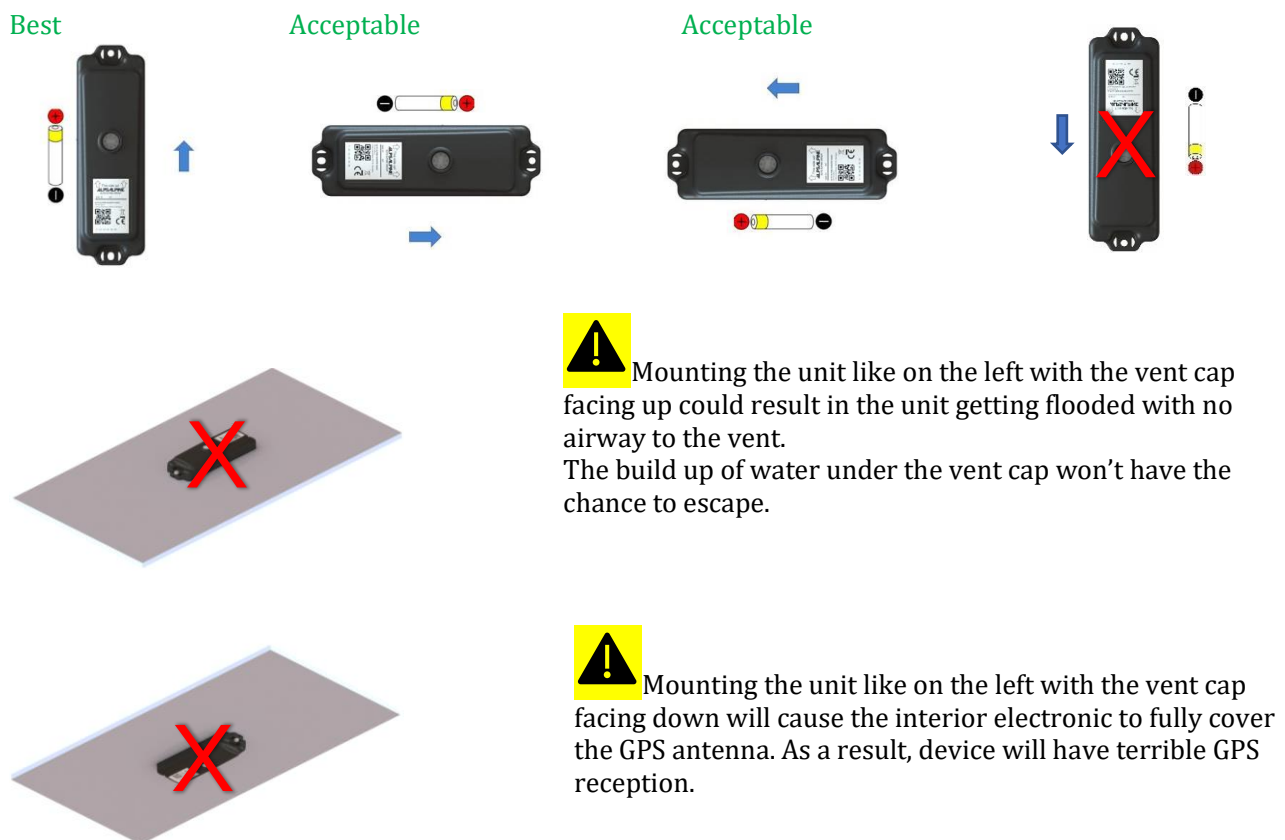


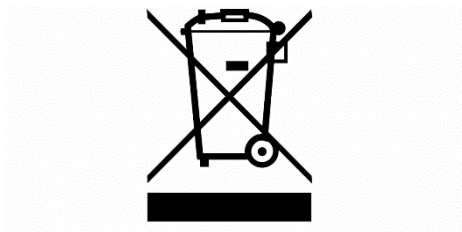
Figure 15 –Mounting Positions

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11. PACKAGING / SHIPPING INFORMATION

- Standard box has 70 units
- Box size [cm] (L x W x H): 39,5 x 30 x 24
- Total Weight: 8,80 Kg

12. DISPOSAL



Make sure you apply to the rules of disposal, existing within your country.

GER: Skalli device is registered at EAR (Elektro-Altgeräte Register) and has an WEEE number (Waste of Electrical and Electronic Equipment).

13. DISCLAIMER

We make every effort to ensure that the information and technical details in this handbook are accurate and complete. Nevertheless, this document is not a contractual agreement and cannot be used as a reference for any warranty claims. The reception of Sigfox messages is highly dependent on Sigfox coverage and many other environmental factors, therefore ALPS ALPINE is not liable to any monetary impacts due to lost messages.

Due to IP69 certification, warranty is lost if the device is opened.