WIRELESS LORAWAN® and BLUETOOTH® TEMPERATURE SENSOR USER MANUAL

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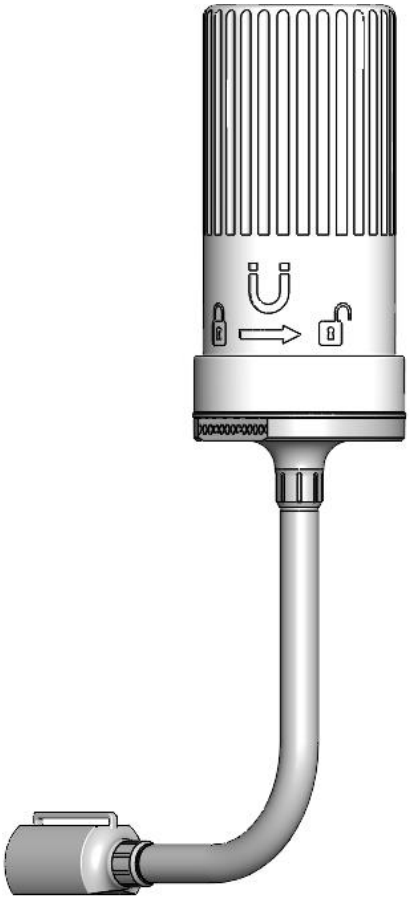
Revision 1.0



PRE RSION

REVISIONS

DATE	Revision	Change Description	Prepared by	Approver
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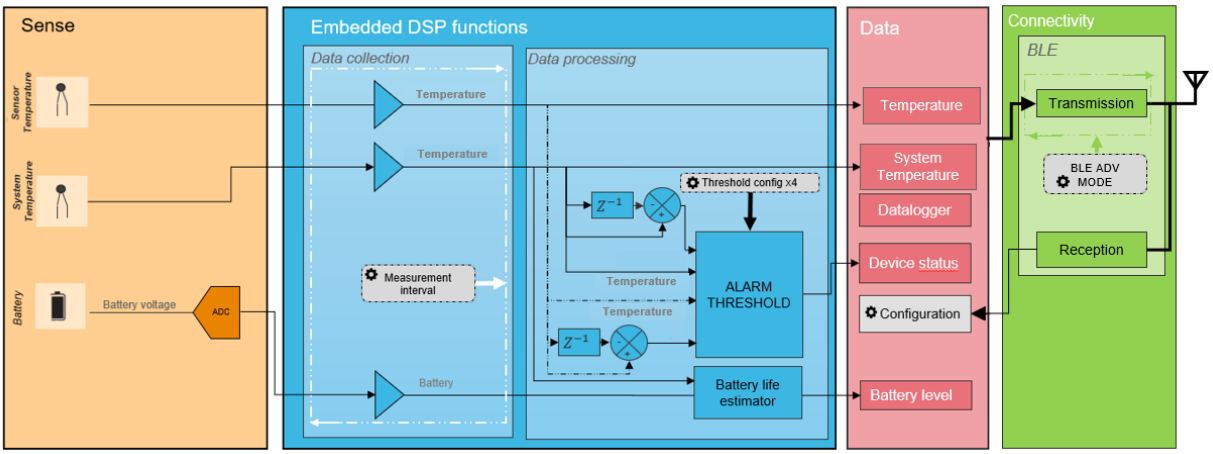
1 GLOBAL OVERVIEW

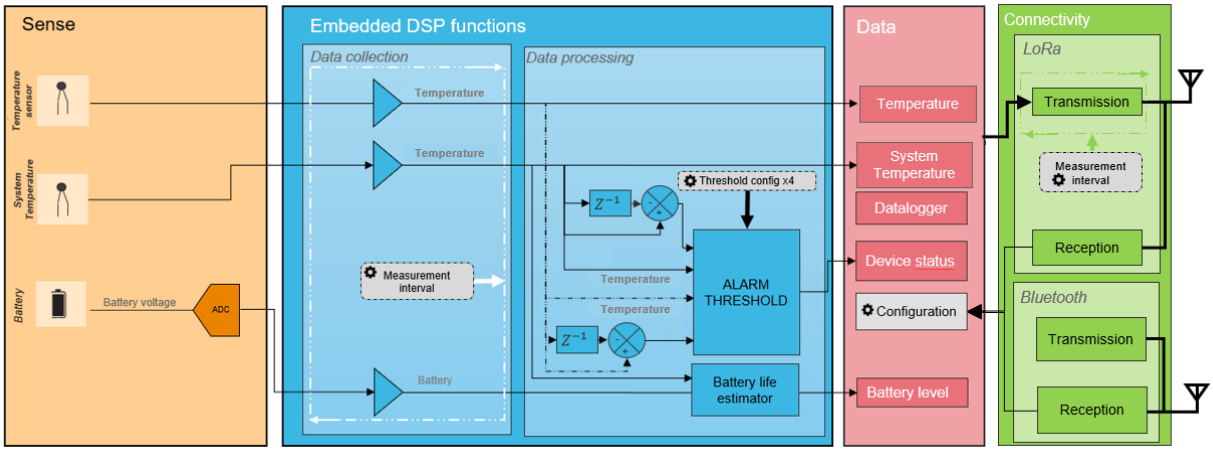
The temperature sensor operates as a smart device. It offers sensor acquisition, data processing, analysis, and wireless communication capabilities.
The sensor computes temperature data in a smart way:

- Delta detection
- raw data

The threshold can be configured. The user may choose between data options to feed threshold.



BLE can be used for local configuration for 1 hour after activation.



LoRaWAN® connectivity will be used to send sensor data periodically. Once configured and connected to a LoRaWAN® network, the downlink frame can then be used to configure the

sensor.

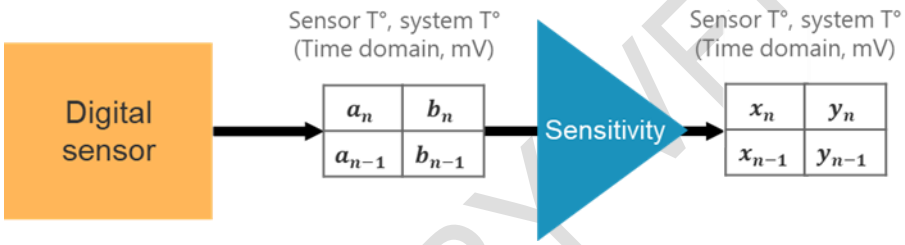
This sensor has two Bluetooth® modes:

- Advertisement Mode: provides data periodically and provides access to Connected Mode.
- Connected Mode: mode for configuration and advanced features.

2 MEASUREMENT PROCESS

The platform acquires digital data from the sensor:

- The system acquires and stores data.
- The system applies sensitivity to the raw value.



Data collection diagram

At every measurement interval, the platform powers up the sensor and requests a new acquisition, then the sensor provides Temperatures data.
Both data types are stored. When the measurement interval is changed, a new measurement is performed, and the new value is received by the system.

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3 DATA PROCESS

3.1 Data processing

Time domain data is used to calculate a variation between two data types.

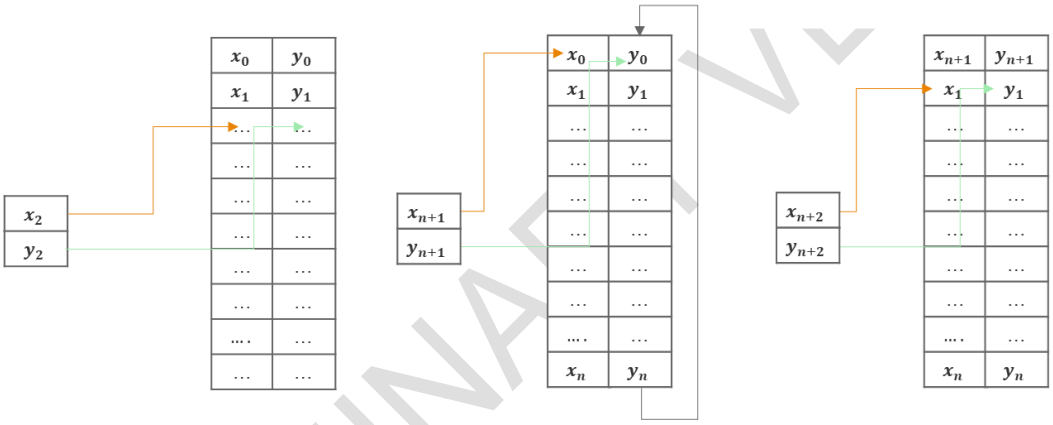
$$Delta(n) = x_n - x_{n-1}$$

3.2 Trig measurement command

When BLE connected mode is activated, the user can request a new measurement without waiting for the measurement interval. After a trigger measurement command, measurement will occur after the next interval.

3.3 Datalog data

The system stores in 4096 data points in memory. When the memory is full FIFO is used to manage data storage.



Data stored in memory is available in BLE connected mode.
The last data stored in memory will have index 0.
System can provide information about data acquired: min, max, mean, standard deviation.

3.4 Live mode

When connected mode is activated, the user can get access to live mode. It will acquire data at a new measurement interval fixed at 100ms and provide all data in “real time”.

When the user ends the BLE connection, the system returns to its current configuration and applies the defined measurement interval.

Note: If a threshold is reached during live mode the system will use the threshold measurement interval. Otherwise, it will use a standard measurement interval.

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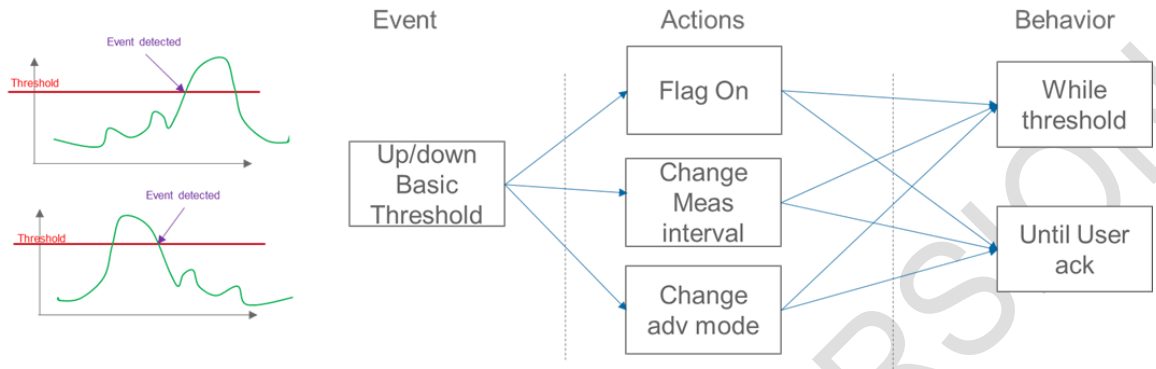
3.5 Threshold event manager

Threshold event manager allows users to have a defined configuration when a value reaches a specified level (main sensor and/or secondary sensor).



- Greater_Than/Less_Than threshold: Every new acquired value is compared to a threshold.

$$Threshold_{greater} = x_n > \text{Thr}$$

Threshold high formula

$$Threshold_{Less} = x_n < \text{Thr}$$

Threshold low formula

The user can configure 2 thresholds for the same input acquired value. If two thresholds are selected, different configurations can be set:

- Range threshold: $Thrmin < xn < Thrmax$ If a value is outside of a range defined by $Thrmin$ and $Thrmax$, the system will change its actions and behavior. The system will automatically define $Thrmin$ and $Thrmax$ upon a value defined by user.
- Successive threshold: $xn > Thr1$ & $xn > Thr2$ or $xn < Thr1$ & $xn < Thr2$. The user can have two levels of action and behavior when Thr1 and Thr2 is reached.

- Actions: When a threshold is reached, the system will set a flag. This flag is available on advertisement frame. Upon user configuration the system can change the advertisement mode and measurement interval. This configuration can be done on BLE connected mode.

- Behavior: This new configuration can last while the threshold is reached or until user clears the threshold flag. Configurations can be performed in BLE connected mode.

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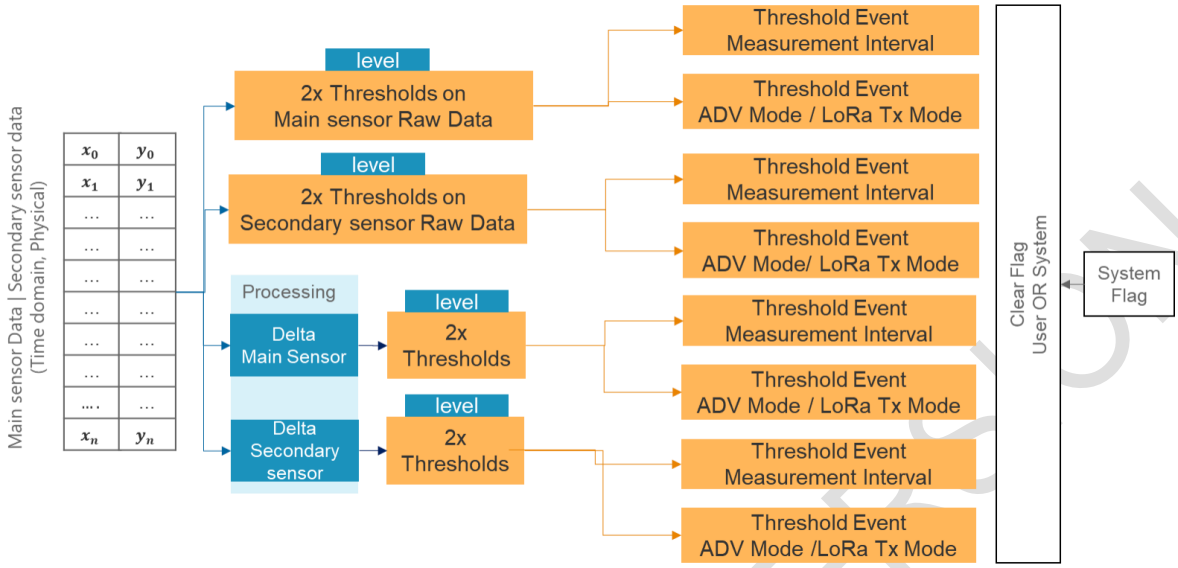

Threshold manager bloc diagram

At configuration, the user needs to define:

- Data to consider: main sensor and/or secondary sensor
- Data to use: raw data and/or Delta
- Threshold level and type: “greater than” or “less than”
- Event after threshold: flag, measurement interval, Advertisement mode

Every newly acquired value is compared to a defined threshold. The sensor will then complete a specific action and behavior that is defined by the user:

- Set up flags to inform the user that a threshold is reached
- Change BLE Advertisement mode (only on event mode activated) or change LoRaWAN® TX mode (only if LoRaWAN® connectivity is available and event mode is activated)
- Change measurement interval (only on event mode activation)

If there are conflicts when several thresholds are reached:

- System will use the lowest measurement interval and at each new threshold reached or released, a new configuration analysis will performed.
- System will give priority to: LoRaWAN® On Measurement mode

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4 COMMUNICATION

LoRaWAN® communication can:

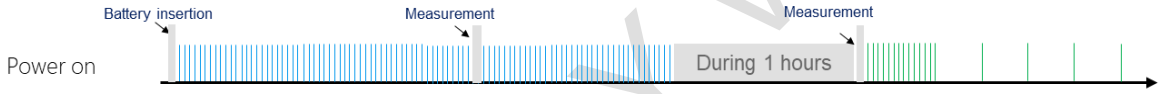
- Receive configuration for central system.
- Send requested configuration parameters.
- Send data.
- Send Keep Alive.

The device includes a LoRaWAN® MAC 1.0.3 rev A compliant interface (see LoRaWAN®1.0.3 Specification). It operates as a Class A end-device.

4.1 PRELIMINARY PHASE: for 1 hour after power on

4.1.1 Bluetooth® Behavior

When the device is powered on, a yellow LED blinks to confirm the proper battery insertion. From the sensor startup and for 1 hour, the device advertises every 1 second. This allows the user to configure the product by switching to connected mode.



ADV behavior during 1rst hour

4.1.2 LoRaWAN® & BLE Behavior

When initiating a measurement and a LoRaWAN® communication, BLE is disabled. Between BLE advertisement OFF and LoRaWAN® communication ON takes 4000ms.
The device performs an initial set of acquisitions on the factory default settings.
The Join Request process allows customer identification and connection to the LoRaWAN® network. The procedure is performed as follows:

- At startup, a request to join the LoRaWAN® network (called “Join Request”) is sent from the unit.
- If the Join Request is accepted, a connection is made, and the sensor can begin sending data via upstream links to the LoRaWAN® network.

- If the Join Request fails, the unit tries again every (see Unjoined paragraph) seconds until the request is accepted. The Join Request signal from the LoRaWAN® radio transmitter is never transmitted simultaneously with an advertising or connection signal from Bluetooth® radio transmitter.

Once LoRaWAN® communication is ended, the system will reactivate BLE. It takes 950ms between LoRaWAN® communication OFF and BLE communication ON.

During this phase the user can configure the system by using BLE connected mode.
This phase can be activated locally with magnet.

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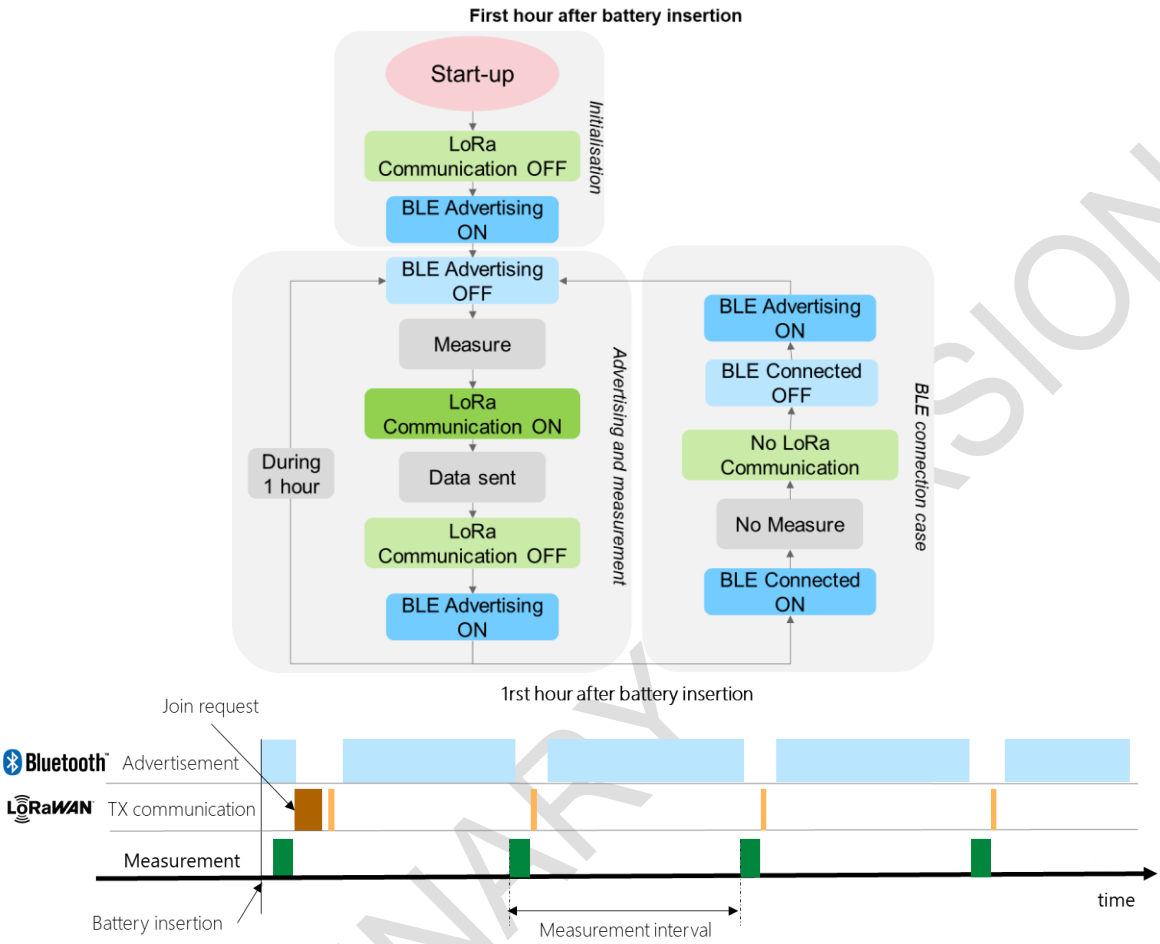

ADV & LoRaWAN® behavior during 1rst hour

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4.2 NOMINAL MODE PHASE: 1 hour after power on

4.2.1 Keep Alive

A Keep Alive is a simple message that confirms to the user that the device is operating and communicating. A Keep Alive message will be sent at least once a day. Keep Alive intervals can be changed by the user with defined values of 2 hours, 4 hours, 12 hours, and 24 hours (default value). This configuration can be made over BLE and LoRaWAN®.

The Keep Alive frame is different than the Periodic frame
(see Keep Alive paragraph).

4.2.2 Bluetooth®

- LoRaWAN® is disabled
- The device acquires data from the sensor. Then it processes the measurements depending on the default parameters.
- Data is sent over BLE depending on BLE_ ADV_MODE
- Once BLE advertisement is ended, the system enters an idle state.

There are three BLE advertising modes:

- **1) ADV Burst + Periodic mode: (Default ADV mode)**
  After each measurement, the system will send an advertisement at a 1s interval for 15 seconds. This will provide multiple chances for the gateway to connect to the device. After 15 seconds, the device will advertise at 10s intervals until the next measurement. During this phase, the connection between the system and an external device could be more difficult. Between two measurements, the data in the advertisement frames are the same. The payload is only updated after every measurement interval.

- **2) ADV On Measure Mode:**
  After each measurement, the sensor will send an advertisement at a 1s interval for 15 seconds. This will provide multiple chances for the gateway to connect to the device. After 15 seconds, the device will stop advertising.

  This ADV Mode can be selected by using BLE services **ADV_CFG** for current state and **THS_ADV_MODE** if a threshold is activated.

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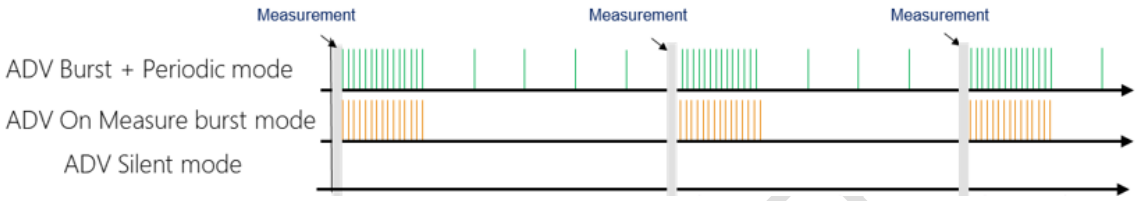
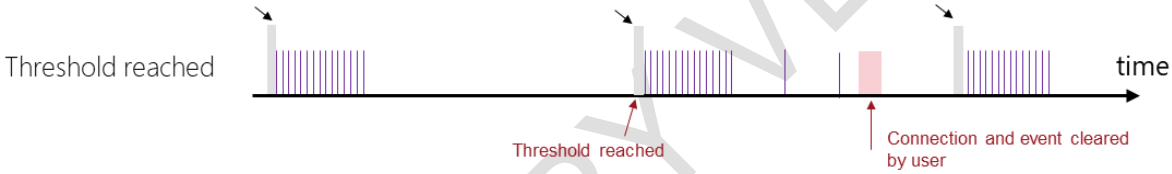
- **3) ADV Silent Mode:**
  The sensor will not send an advertisement after each measurement. This ADV Mode can be selected by using BLE services **ADV_CFG**.
  This mode is not recommended if threshold is not activated and **THS_ADV_MODE** is not configured. The only way to change configuration over BLE is to use the magnet and activate advertisement (see 4.2.4 Magnet Event).

Comparison of ADV mode



If the threshold is reached after a measurement, the system will use threshold configuration (ADV mode and measurement interval).



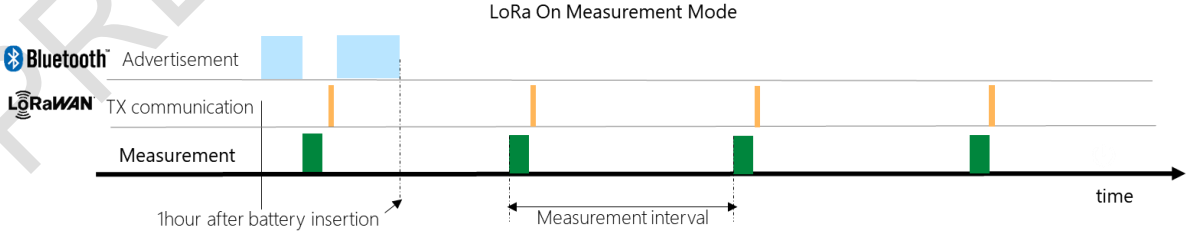
Example of ADV On Measure Mode and ADV Periodic mode after a threshold

4.2.3 LoRaWAN®

- BLE is disabled.
- The device acquires data from the sensor. Then, depending on the default parameters, it will process the measurements.
- If this LoRaWAN® join procedure is successful, the data is transmitted. This is dependent on the LoRaWAN® measurement mode.
- Once LoRaWAN® communications are ended, the system enters an idle state.

There are two LoRaWAN® communication modes:

- **1) LoRaWAN® On Measurement mode:** data is sent at every measurement interval.



Example On Measure LoRaWAN® Mode

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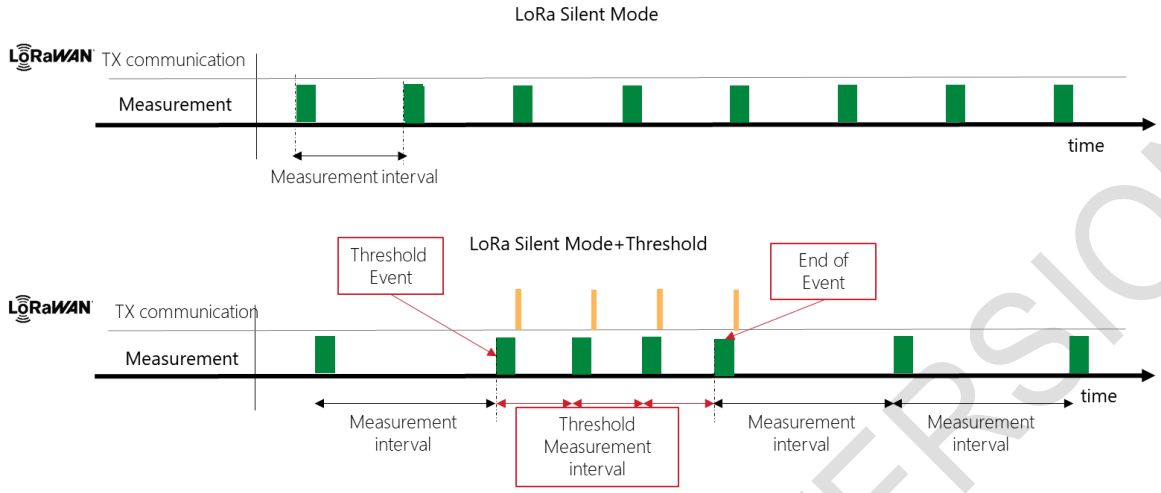
- **2) LoRaWAN® Silent mode:** The system doesn't t send data periodically. It measures and stores the data. It will send data only if a threshold is reached.

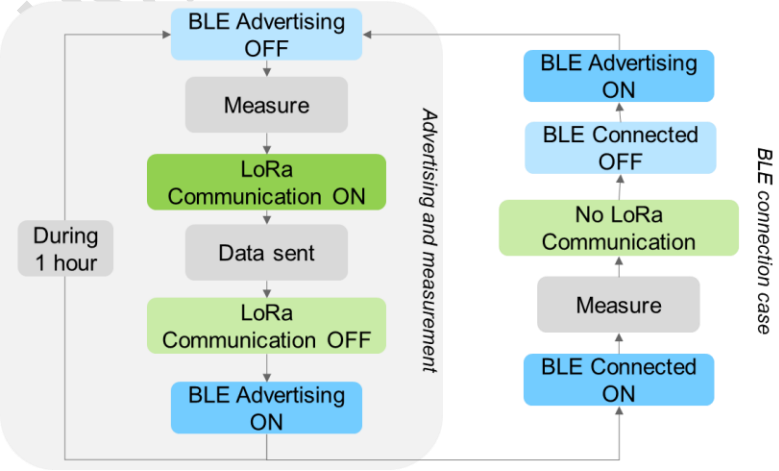


Example On Event LoRaWAN® Mode

Note: If silent mode is selected and no event is detected, configuration over LoRaWAN® can be done only when a Keep Alive message is sent. TE IoT platform is a LoRaWAN® Class A and will listen only when it sends uplink data to the gateway.

4.2.4 Bluetooth® Connected mode

If the sensor is advertising, the user can initiate a connection and the sensor will switch into BLE Connected mode. While a communication is established between the sensor and the master, measurements and LoRaWAN® transmissions are frozen.
This mode is used to configure the device parameters.



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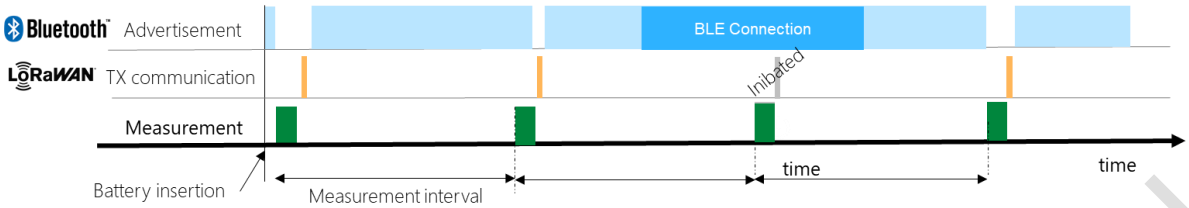
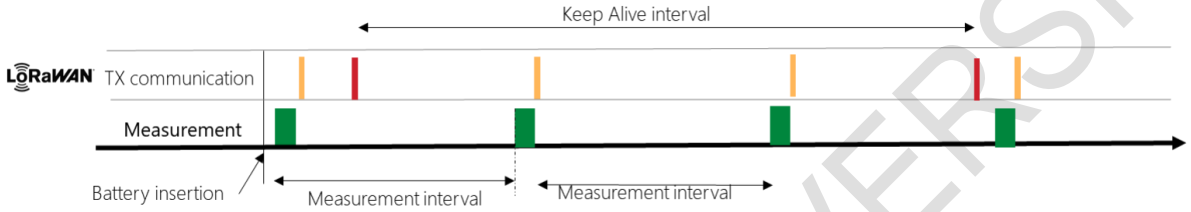


4.2.5 LoRaWAN® Keep Alive

There are 2 different modes for LoRa Keep Alive:

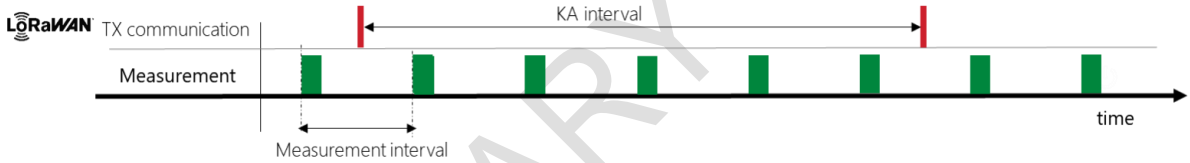
-1) Always Keep Alive

Keep Alive is always sent, even if the sensor sent data during Keep Alive interval.

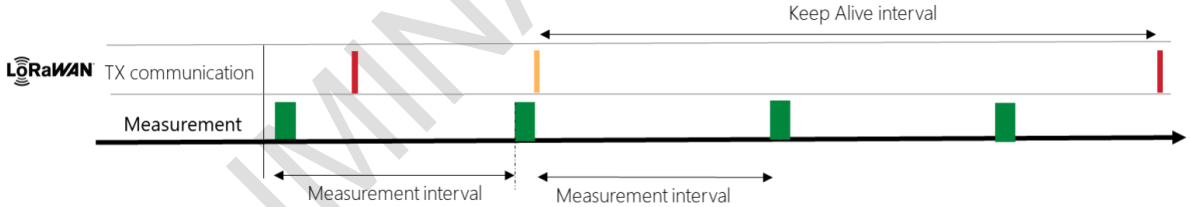


- 2) Power efficiency Keep Alive:

If a LoRaWAN® frame is sent, Keep Alive interval is reset.



Example Power efficiency Keep Alive with no communication



Example Power efficiency Keep Alive with a communication

4.2.6 Special event: Magnet

If the user wants to make an asynchronous data acquisition, or access BLE connected mode, a magnet can be used. The magnet event will trigger a measurement to enter the preliminary phase.

If the system is in connected mode, a magnet event will stop connected mode and set the sensor back to the nominal phase.

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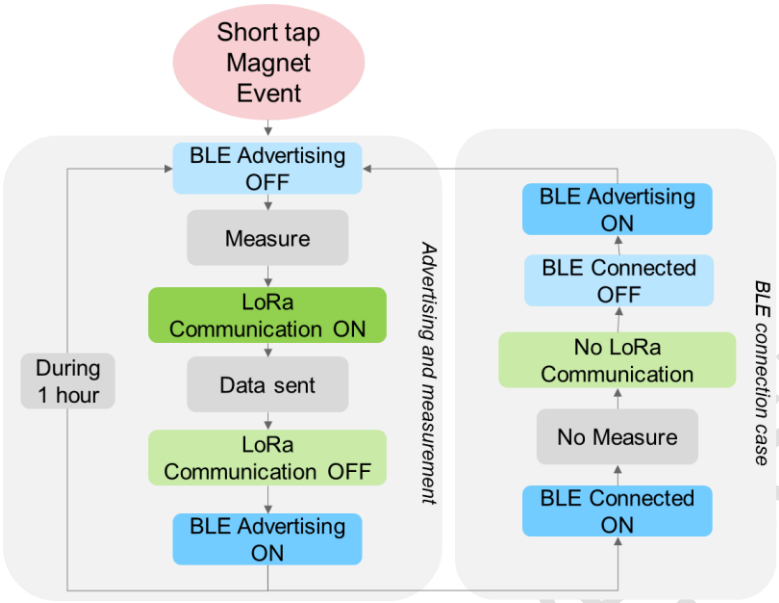

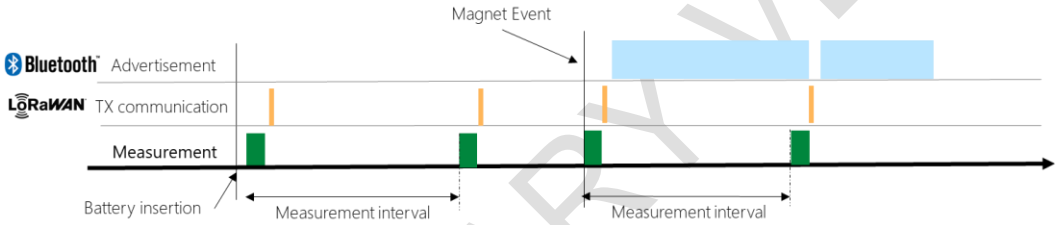

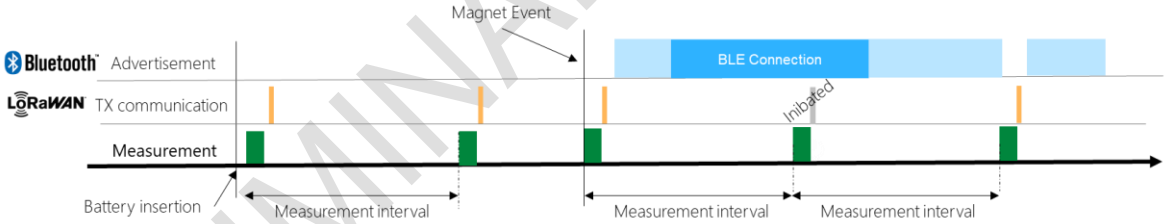

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4.3 Bluetooth® Communication

4.3.1 Bluetooth® Connected Mode

Users can connect to the system with a Bluetooth® device such as a computer, smartphone, or tablet. BLE connected mode enables configuration, access to special functions and firmware updates.
The product is embedded with 2 different BLE connected modes, which are listed below:

Operating mode	Description	Condition
Standard	User mode to configure the sensor and activate some specific functions only available when connected	None
DFU	Mode used during firmware updates.	OTA update

Note: If the device is in BLE connected mode and a power off (remove the battery) occurs without being disconnected from the central device, configuration will be lost.

4.3.2 Access to Connected mode

To access connected mode, the user should use a BLE enabled device. When an advertisement is sent by the system, the BLE device will be able to make the connection.

4.3.3 Exiting from Connected mode

When in connected mode, there are two ways to disconnect:

- Use the disconnect software function on the BLE central device
- Use the magnet to disconnect

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4.3.4 Device Firmware Update (DFU Mode):

DFU mode should be used to upgrade the sensor firmware. It is accessible from the standard operating mode.

Firmware updates will be assigned by TE Connectivity.

The DFU works with a single bank only. This means that if the firmware update is interrupted (power cut off or BLE disconnection), the application firmware will be corrupted, and the sensor will stay in DFU mode. The user will have to retry the upgrading process. Note that the DFU MAC address is the sensor MAC address +1.

4.3.5 List of services available

Users on the BLE connected mode can access a list of services. Each service includes characteristics which allow the user to configure the sensor.
Every service and characteristic share a common UUID. Only bytes #3 and #4 (XXXX) differ from the identifier.

BLE UUID	B614XXXX-B14A-40A6-B63F-0166F7868E13
UUID Service key	XXXX

4.4 LORAWAN® COMMUNICATION

4.4.1 Frequency plans

The LoRaWAN® communication protocol operates in an unlicensed radio spectrum. The part number must be selected to match with the of operation and be in line with local regulations.

Region	Frequency	Channel Plan	Common name
Europe (EU)	868 MHz	EU862-870	EU868
United State (US)	915 MHz	US902-928	US915

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4.4.2 Data rates

Following the LoRaWAN® specification, each data rate is a combination of one spreading factor and one bandwidth.

4.4.2.1 EU868

For European regions, the product supports data rates from 0 up to 7 in both uplink and downlink directions.

Data Rate (DR)	Spreading Factor (SF)	Bandwidth (BW)	Bitrate (bit/s)
0	SF12	125 kHz	250
1	SF11	125 kHz	440
2	SF10	125 kHz	980
3	SF9	125 kHz	1,760
4	SF8	125 kHz	3,125
5	SF7	125 kHz	5,470
6	SF7	250 kHz	11,000

4.4.2.2 US915

For the US915, the data rates supported by the product are:

Direction	Data Rate (DR)	Spreading Factor (SF)	Bandwidth (BW)	Bitrate (bit/s)
Uplink	0	10	125	980
	1	9	125	1,760
	2	8	125	3,125
	3	7	125	5,470
	4	8	500	12,500
Downlink	8	12	500	980
	9	11	500	1,760
	10	10	500	3,900
	11	9	500	7,000
	12	8	500	12,500
	13	7	500	21,900

4.4.3 TX power

RF transmitting systems must adhere to certain rules set by the regulatory bodies such as FCC (*Federal Communications Commission*) or ETSI (The European Telecommunications Standards Institute). Radio devices must not exceed certain ERP or EIRP values set by these regulatory bodies.
Depending on the regional parameters, the product supports the following power:

4.4.3.1 EU868

TX Power	Power (dBm)	Power (mW)
0-1	+14 dBm	25
2	+12 dBm	16
3	+10 dBm	10
4	+8 dBm	6.3
5	+6 dBm	4
6	+4 dBm	2.5
7	+2 dBm	1.6

4.4.3.2 US915

TX Power	Power (dBm)	Power (mW)
0-8	+14 dBm	25
9	+12 dBm	16
10	+10 dBm	10

4.4.4 Time on air limitation

4.4.4.1 Duty cycle (EU868 only)

The European Telecommunications Standards Institute (ETSI) sets the maximum duty cycle for the EU868 at 1%, which is the maximum amount of time a device may spend communicating. This means that in 24h a device should not transmit more than 864 seconds.

Example: <u>On measurement mode</u>
The table below shows the effect of the data rate on the maximum number of uplink message which could be transmitted in a day. Assuming the payload size of the uplink message to be 11 bytes, it gives the following results:

Duty cycle limitation effect (EU868)							
DR	0	1	2	3	4	5	6
Number max of uplink per day	582	1165	2330	4662	8396	15265	30530
Minimum uplink interval	2min30	1min15	37s*	19s*	11s*	6s*	3s*

***Minimum configurable uplink interval is 1 min.**

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4.4.4.2 Dwell time (US913 only)

There are no duty cycle limitations under Federal Communications Commission (FCC), but the device must respect a certain limit of transmission duration. This parameter is called “dwell time” and should not exceed 400ms per channel. Dwell time is the amount of time needed for a transmission.
This parameter is always respected by the product due to its compressed payload.
Note that in case of *FOptsLen*>3, the payload may be fragmented for DR0.

4.4.5 Modes of operation

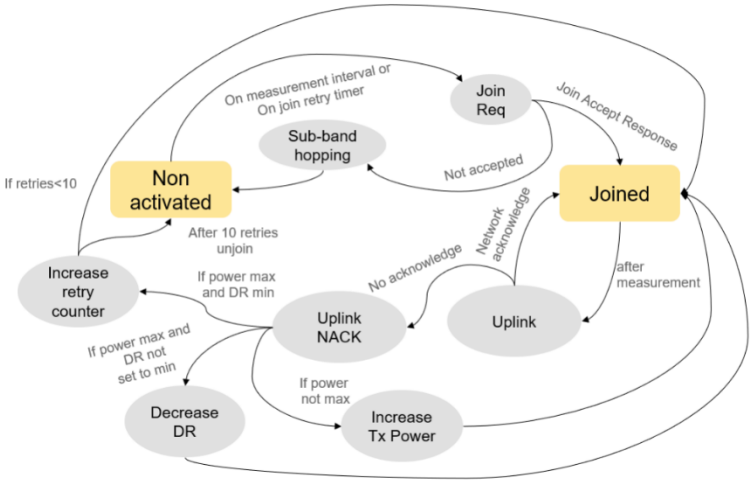
Enrollment

To be recognized by the LoRaWAN® server, the product must be enrolled on the final application server.
Use the LoRaWAN® keys provided by TE Connectivity with the device.

Dev EUI	64-bit unique identifier of the end-device. Pre-provisioned by TE
App EUI	64-bit extended unique identifier. Provided by TE
App KEY	128-bit Pre-provisioned by TE Connectivity

Join and activation

After power on, the sensor performs a self-diagnostic then it initiates a join-request to the



LoRaWAN®™ network using Over-The-Air-Activation (OTAA).

PRELIMINARY VERSION

4.4.5.1 Join accept

In case of a sufficient LoRaWAN® coverage, and if the device was already enrolled in the server database, the network server responds to the join-request with a join-accept message.

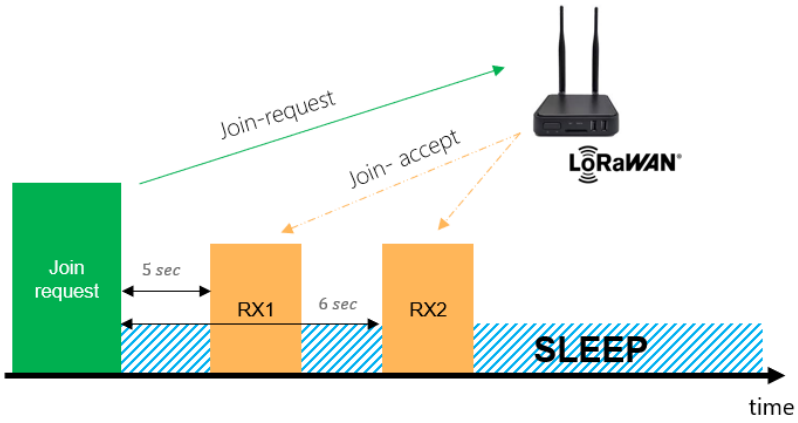


Figure 1:join accept

The possible reception windows delays are:

Window	Parameters	Delay
RX1	JOIN_ACCEPT_DELAY1	5s
RX2	JOIN_ACCEPT_DELAY2	6s

During that operation, the end-device shares the sessions keys with the server.

PRELIMINARY VERSION

4.4.5.2 Unjoined

If the LoRaWAN® gateway is out of the product range, or if the end-device is not enrolled on the network, the product will not receive any join accept response and will be in an unjoined state.
In that state, system tries to rejoin the network every 10 seconds and increases the join timer in case of failure by 20%, up to 30 minutes maximum.
However, the rejoin timer may conflict with the measurement interval. If the rejoin happens at the same time as a measurement, the measurement will synchronize with rejoin.

The value of the retry timer can be found below:

Try index	Calculation	Next retry in second
1	N/A	8
2	8*1.25	10
3	10*1.25	12.5
4	12.5*1.25	15.625
N	(N-1)*1.25	Limit to 30min

Note that for EU868 regions, the join-request may be sent only every 8 hours due to duty-cycle restriction.

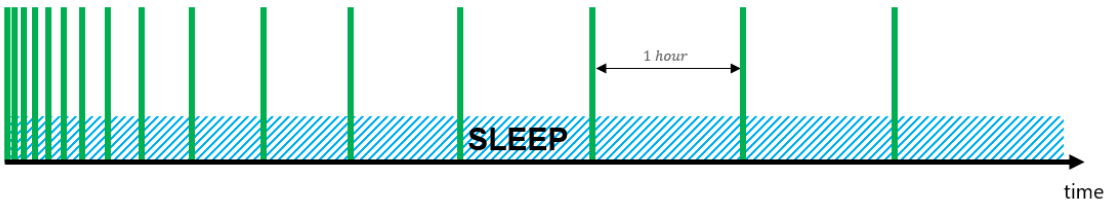


Figure 2: Rejoin procedure in case of failure

Normal mode

Once the product has joined the LoRaWAN® network, it operates in normal mode.

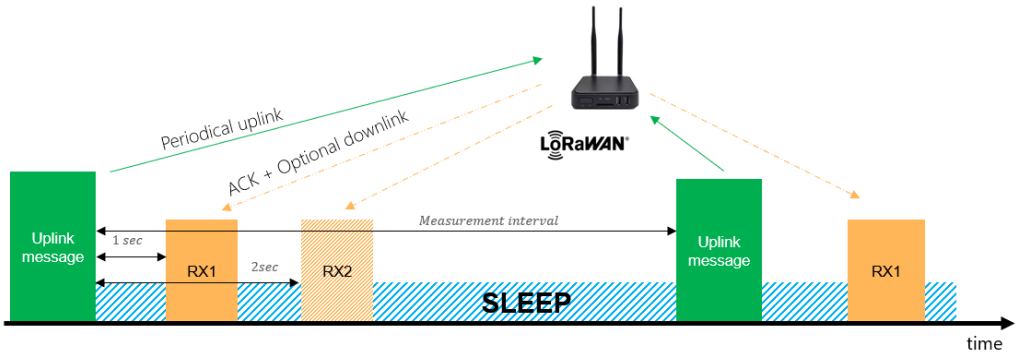


Figure 3 Normal mode of operation

Uplink message

Every measurement determined by the measurement interval or new threshold event will trigger an uplink message.
If the server does not send back the LoRaWAN® ACK flag, the product implements an error counter. After 10 consecutive fails, it will try to rejoin the network.

To ensure that the sensor is still alive a Keep Alive frame is sent. The interval between the Keep Alive frame can be changed by the user. This frame is a dedicated frame.

4.4.5.3 Downlink message

Following each uplink transmission, the end-device (LoRaWAN® Class A) opens one or two receive windows for potential downlink messages. If no packet is destined for the product in RX1, the device opens the second receive window (RX2).
The possible reception windows delays are:

Window	Parameters	Delay
RX1	RECEIVE_DELAY1	1s
RX2	RECEIVE_DELAY2	2s

If the sensor is configured with LoRaWAN® Event Mode, the system will receive a configuration only when Keep Alive is sent.
This frame is a dedicated frame.
Keep alive interval can be configured by the user.

4.4.5.4 Message Priority

The system cannot perform a measurement phase and communication phase at the same time. The communication phase can be nominal uplink, keep alive or downlink.
In case of downlink response or a Keep Alive not sent due to duty cycle, the frame will be postponed by 2 minutes and 30 seconds upon priority.
For system stability system set priority upon phase:

Priority 1: Downlink
While downlinks are received or communication is on LoRaWAN® RX with no downlink, no measurements and communication (nominal uplink and Keep Alive) are performed.
After each downlink response, if no other downlink is received downlink phase is ended.
Measurement, nominal uplink and keep alive will be restarted at same interval as before.

PRELIMINARY VERSION

Priority 2: Measurement and nominal uplink
If a downlink phase is not in progress, the system measures and sends an uplink. When a Keep Alive should occur in a timeslot of 30s before a measurement, the measurement will be performed. Keep Alive is not performed and never sent.

Priority 3: Keep Alive: If no measurement is scheduled and the system isn't in a downlink phase, system will send a Keep Alive signal.

4.4.6 Specific Led Behavior for LoRaWAN®

LoRaWAN® Specific Led Behavior

Category	Mode	Description	Pattern
Operation	LoRaWAN® join request	Join request message	3 very fast blinks
	Uplink	Sending uplink message	Very fast blink
Status	Success	Operation successful	Very fast blink
	Fail	Operation failed	1 second long on

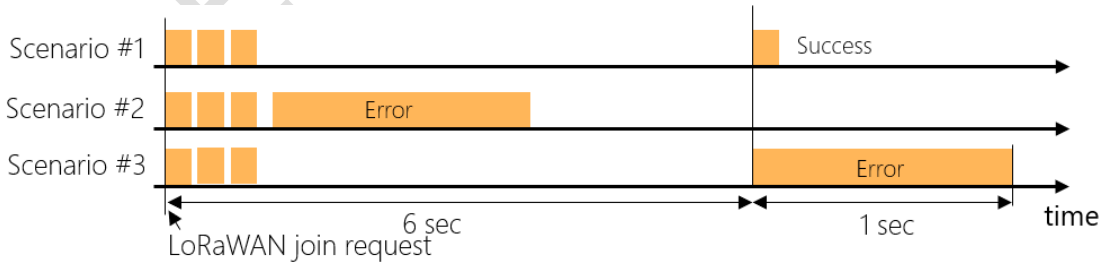
LoRaWAN® join request example

A normal join request gives 3 shorts blinks (few milliseconds on), a 6 second delay, then another short blink. In case of an error, the LED is turned on for about 1 second.

Scenario #1: A LoRaWAN® join request is shown with 3 short blinks (few milliseconds on) and about a 6 seconds later, another short blink (join accept from the gateway).

Scenario #2: For EU-868 region, if an error pattern (1 second on) is shown just after the 3 blinks, it means the device hasn't sent the message due to duty cycle restrictions.

Scenario #3: In case of no response from the gateway, and after about 6 seconds after the 3 short blinks, the LED is turned on for about 1 second.



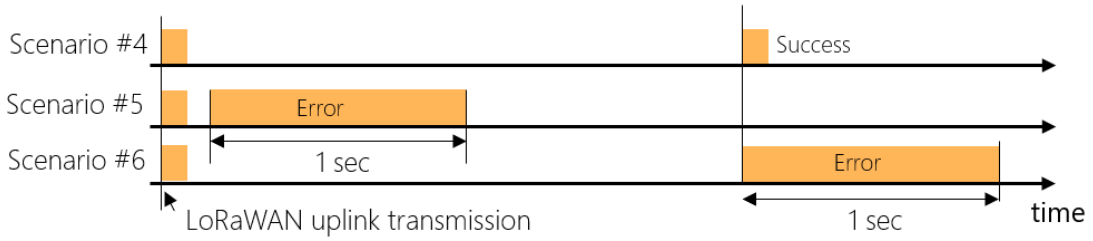
PRELIMINARY VERSION

4.4.7 LoRaWAN® uplink transmission example

Scenario #4: A normal uplink transmission gives 1 short blink (few milliseconds on) and few seconds later, another short blink (ACK from the gateway).

Scenario #5: For EU-868 region, if an error pattern (1 second on) is shown just after a short blink, it means the device hasn't sent the message due to duty cycle restrictions.

Scenario #6: In case of no response from the gateway (the confirmed message needs a downlink with an acknowledge), delay is about 8 seconds after the short blink, the LED is turned on for about 1 second (NACK).



4.5 PAYLOAD description

4.5.1 Keep Alive

ADVERTISEMENT GENERIC											
byte	0	1	2	3	4	5	6	7	8	9	10
field	CI		DEVTYPE		CUSTOM ADVERTISING DATA				CNT		DEV STAT

- CI: Company identifier, 0xDE08
- DEVTYPE: Information about the product
- CUSTOM ADV DATA: 4-byte array
- CNT: measurement counter
- DEVSTAT: System global status
- BATT: Battery level

PRELIMINARY VERSION

4.5.2 BLE Generic Advertising message format

Advertising is sent during phase 1.

ADVERTISEMENT GENERIC																		
byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
field	CI		DEVTYPE		CUSTOM ADVERTISING DATA				CNT		DEV STAT	BATT	TEMP		SENSOR32			

- CI: Company identifier, 0x08DE
- DEVTYPE: Information about the product
- CUSTOM ADV DATA: 4-byte array
- CNT: measurement counter
- DEVSTAT: System global status
- BATT: Battery level
- TEMP: Secondary data from sensor 2-Byte.
- SENSOR32: Main data from the sensor 4-Byte
  SENSOR32 data type is defined by DEVTYPE output field.

4.5.3 Uplink message (Platform -> Gateway)

4.5.3.1 Keep Alive

LoRaWAN® Keep Alive (fport30 + confirmed flag)						
byte	0	1	2	3	4	5
field	DEVTYPE		CNT		DEV STAT	BATT

- DEVTYPE: Information about the product
- CNT: measurement counter
- DEVSTAT: System global status
- BATT: Battery level

PRELIMINARY VERSION

4.5.3.2 Nominal Data uplink

The uplink “sensor data” message follows the standard format.

LoRaWAN® Nominal Uplink format (fport:10 + confirmed flag depending on % of acknowledge)												
byte	0	1	2	3	4	5	6	7	8	9	10	11
field	DEVTYPE		CNT		DEV STAT	BATT	TEMP16		SENSOR32			

- DEVTYPE: Information about the product
- CNT: measurement counter
- DEVSTAT: System global status
- BATT: Battery level
- TEMP: Secondary data from sensor 2-Byte.
- SENSOR32: Main data from the sensor 4-Byte (sensor temperature)
  SENSOR32 data type is defined by DEVTYPE output field.

4.5.3.3 Uplink Information Response frame

LoRaWAN® Information Response Uplink format (fport:20)												
byte	0	1	2	3	…							n
field	OPERATION RESPONSE	UUID		PAYLOAD								

- RESPONSE: Context about response from the system.

Note: (*Only for software version 3.3.X and above*) After a Read (0x00) or Write+Read(0x02) request, the sensor automatically sends a Response (fPort 20) as soon as possible (directly in US915 or when the Duty Cycle limitation elapses in EU868).

Also, the sensor sends a response (fPort 20) if an error is detected when a Write (0x01) is performed. This should not impact the periodic uplink messages.

OPERATION RESPONSE								
byte	0							
bit	7	6	5	4	3	2	1	0
field	UUID_UNK	OPERATION_ERR	READ_ONLY	NET_ERR	PERIOD_SKIP		OPERATION	

PRELIMINARY VERSION

- UUID_UNK: set if characteristic does not exist
- OPERATION_ERR: set if invalid payload or configuration
- READ_ONLY: set if not able to write because the field is read only
- NET_ERR: set if partial response sent (check DR vs payload max)
- PERIOD_SKIP: If there is a conflict with the periodic message, the system informs the network that it is giving priority to the operation frame. The measurement is stored but not sent.
- OPERATION

Read/Write	Value
Read	0
Write + Read of last data written Note: Read the value from the register even if the write fails.	2

- UUID: Service ID to identify the service answer.
  Note1: UUID for LoRaWAN® operation requests and responses are UUID characteristics.
- PAYLOAD: Information from the service

4.5.3.4 Downlink message (Gateway -> Platform)

The downlink frame formats are defined as below.

Information and configuration request downlink

LoRaWAN® Write or Write/Read Request Downlink format (fport:20)												
byte	0	1	2	3	…							n
field	OPERATION REQUEST	UUID		PAYLOAD								

Frame format for Write or Write/Read request

LoRaWAN® Read Request Downlink format (fport:20)			
byte	0	1	2
field	OPERATION REQUEST	UUID	

Frame format for write request

- OPERATION REQUEST: Define if the user wants to read, write, or write with system acknowledgement of the data

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OPERATION REQUEST								
byte	0							
bit	7	6	5	4	3	2	1	0
field					FRAGMENTED DATA		OPERATION	

OPERATION	Value	Comment
Read	0	Read a configuration/data over LoRaWAN® *Note: Read function is not available for threshold and datalog. To read threshold or datalog the user should use the Write/Read operation frame with threshold or the datalog read function*.
Write	1	Write a configuration/data over LoRaWAN®. *Note1: If the configuration is Read Only, the system will send back an operation error* *Note2: The read function is not available for threshold and datalog. To read threshold or datalog the user should use the Write/Read operation frame with threshold or the datalog read function*.
Write + Read of last data written	2	Write configuration/data over LoRaWAN® and then the system will read and send the value stored into configuration. *Note1: If a write error occurs value read will be the same as before.*

- **UUID**: Service ID to identify the service answer.
  Note1: UUID for LoRaWAN® operation request and response are UUID characteristic.
- **PAYLOAD**: Information from the service. Payload is empty if a read request is asked.

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4.5.4 Global overview of payload available depending on communication

Function	Service Address	Information	Characteristic Address UUID to use for LoRaWAN® communication	Payload size (Bytes)	BLE	LoRaWAN®
Generic access	1800	Device Name	2A00	25	Connected: R	/
		Appearance	2A01	2	Connected: R	/
		Peripheral Preferred Connection Parameters	2A04	8	Connected: R	/
		Central Address Resolution	2AA6	1	Connected: R	/
Generic Attribute	1801	Service Change	2A05	0	Connected: R	/
Device information	180A	Model Number	2A24	6	Connected: R	Operation Msg: R
		Serial Number	2A25	13	Connected: R	Operation Msg: R
		Firmware revision	2A26	23	Connected: R	Operation Msg: R
		Hardware revision	2A27	7	Connected: R	Operation Msg: R
		Manufacturer	2A29	9	Connected: R	Operation Msg: R
Device	FC00	Device status	FC01	1	Connected: R/N Advertising: R	Periodic Uplink Keep Alive Msg
Battery	180F	Battery level	2A19	1	Connected: R/W Advertising: R	Periodic Uplink Keep Alive Msg Operation Msg: R/W/W+R
Bluetooth®	CD00	Customer Specific Data	CD01	4	Connected: R/W Advertising: R	/
		BLE Adv Mode Configuration	CD02	1	Connected: R/W	Operation Msg: R/W/W+R
		Change Device Name	CD03	25	Connected: R/W ScanResp: R	/
Environmental sensing	181A	Internal platform temperature	2A6E	2	Connected: R/N	Operation Msg: R

PRE

Function	Service Address	Information	Characteristic Address UUID to use for LoRaWAN® communication	Payload size (Bytes)	BLE	LoRaWAN®
Keep Alive	CE00	Keep Alive configuration	CE01	1	Connected: R/W	Operation Msg: R/W/W+R
Data collection	B300	Measurement Counter	B301	2	Connected: R/W/N Advertising: R	Periodic Uplink Keep Alive Msg Operation Msg: R
		Measurement interval	B302	3	Connected: R/W	Operation Msg: R/W/W+R
		Trig measurement	B303	1	Connected: W	Operation Msg: W/W+R
Last data from sensor	DA00	Last data acquired	DA01	6	Connected: R/N Advertising: R	Periodic Uplink Operation Msg: R
Live Mode	B400	Live Measurement interval	B401	1	Connected: R	/
		Live mode configuration	B402	1	Connected: R/W	/
Threshold	B200	Threshold	B201	5	Connected: R/W/N	Operation Msg: W/W+R
Datalog Raw value	DB00	Datalog data	DB01	/	Connected: R/W/N	Operation Msg: W/W+R
LoRaWAN®	F800	LoRaWAN® Mode Configuration	F810	1	Connected: R/W	Operation Msg: R/W/W+R
		DevEUI	F801	8	Connected: R	Operation Msg: R
		AppEUI	F802	8	Connected: R	Operation Msg: R
		Region	F803	1	Connected: R	Operation Msg: R
		NetID	F804	4	Connected: R	Operation Msg: R
		Status (Reserved)	F805		Connected: R	Operation Msg: R
		Percentage of confirmed uplink	F806	1	Connected: R/W	Operation Msg: R/W/W+R
DFU	FE59	OTA process	-	/		
Engineering	DD00	Reserved	DD01	/	Connected: R/W	/

Note1: Two BLE generic services are embedded into the sensor:

- GENERIC ATTRIBUTE
- GENERIC ACCESS

These are mandatory for BLE use.

Note2: UUID for LoRaWAN® operation request and response are UUID characteristics.

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Note3: All bytes in a frame are coded in BigEndian when used with a TE custom service
All bytes in a frame are coded in LittleEndian when linked with BLE standard
When specific code is implemented, a note is added into description.

Note4: All array of byte is coded in BigEndian

Note5: Serial Number is the BLE MAC Address

Note6: When a byte is composed of bit fields, unused bits must remain set to “0”.
Setting an empty or unused bit might create unexpected behavior of the sensor when writing into a bit field register.

4.5.5 Device status

DEVICE STATUS								
byte	0							
bit	7	6	5	4	3	2	1	0
field	SENSOR_ Error	CONFIG_ Error	COM_ Error	CONDITION	SYSTEM PHASE			Battery_ Error

- **SENSOR_Error:** Sensor error (more details on sensor diagnosis)
- **CFG_Error:** Configuration Error (Reserved for future use)
- **COM_Error:** Communication error
  (more details on communication diagnosis)
- **CONDITION:** Threshold related
- **SYSTEM PHASE**:

System Phase	Value
Preliminary (LoRaWAN® and BLE (ex:1rst hours))	1
Nominal (LoRaWAN® or BLE only MODE)	0

- **BATT_Error:** Battery error (more details on Battery diagnosis)

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4.5.6 Device Type

DEVTYPE: Information about the product

DT VALUE																
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	SW Platform				Sensor				Wireless				Output Type SENSOR32			
	0	Error			0	Error			0	Error			0	Error		
	1	Platform_21			1	Vibration			1	BLE			1	Float		
					2	Temperature			2	BLE / LoRaWAN®			2	Integer		
					3	Pressure										
					4	Humidity										

Example for a Temperature BLE only product the DT value will be:

DT Value	Description
0x1211	Temperature Generic BLE with a float data type

4.5.7 Diagnosis

4.5.7.1 Sensor diagnosis

Sensor diagnosis								
bit	7	6	5	4	3	2	1	0
field	TEMP16_OoR_ ERR	TEMP16_CRC_ ERR	TEMP16_CAL_ ERR	TEMP16_CIR_ ERR	SENSOR32_OoR _ERR	SENSOR32_CRC _ERR	SENSOR32_CAL _ERR	SENSOR32_CIR_ ERR

- **TEMP16_OoR:** Secondary sensor data out of range.
  Sensor temperature -40°C +125°C *(sensor operation T° range -30°C to +60°C)*
- **TEMP16_CRC_ERR**: Secondary sensor data read error (CRC error)
- **TEMP16_CAL_ERR**: Secondary sensor calibration error (not possible to read from

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EEPROM or not calibrated in ROM)

- **TEMP16_CIR_ERR**: Secondary sensor circuitry error (no answer from sensor). It concerns the acquisition of the sensor and the sensor calibration reading.
- **SENSOR32_OoR**: Main sensor data out of range or unreliable.
  Embedded into Register address (0x40)
- **SENSOR32_CRC_ERR**: Main sensor data read error (CRC data error)
- **SENSOR32_CAL_ERR**: Main sensor calibration error
  (not possible to read from EEPROM or not calibrated in ROM)
- **SENSOR32_CIR_ERR**: Main sensor circuitry error
  (No answer from sensor)

4.5.7.2 Communication diagnosis

COMMUNICATION Diagnosis								
bit	7	6	5	4	3	2	1	0
field						LORA_REGIONAL_RESTRICTION	LORA_POWER_ERROR	LORA_NETWORK_JOIN_ERROR

- **LoRa_Network_Join_Error:**

State	Value
System connected to network	0
System has not joined a LoRaWAN® network	1

- **LoRa_Power_Error:**

State	Value
No power issues	0
Power issue occurs	1

- **LoRa_Regional_Restriction:**

State	Value
No restriction	0
LoRaWAN® communication is restricted by region policy (Duty cycle)	1

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4.5.7.3 Battery diagnosis

Sensor diagnosis								
bit	7	6	5	4	3	2	1	0
field						BATTERY_ WARNING	BATTERY_ LOW	BATTERY_ CHANGE

BATTERY_Warning:
Voltage drop occurs during Measurement, Communication, or Sleep mode:

- Measurement continues (in case of voltage drop during measure data into frame is replace by NaN or 7FFFFFFF).
- Communication continues

State	Value
No battery warning	0
Battery warning occurs	1

BATTERY_Low: Battery capacity is below 15%
User should plan a battery change:

- Measurement continues
- Communication continues

State	Value
No battery issues	0
Battery low	1

BATTERY_Change: Several voltage issues occur during sleep or communication.
User should change the battery:

- Measurement is stopped
- Communication is only Keep Alive

State	Value
No battery change requested	0
Battery change requested	1

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4.5.8 Battery

BATTERY								
bit	7	6	5	4	3	2	1	0
field	BATTERY8							

BATTERY8: percentage of remaining battery. Writing 0xFF in this register will reset the battery algorithm to 100%.
Other values written here will be ignored.

4.5.9 Bluetooth®

4.5.9.1 Customer specific data

CAD			
3	2	1	0
CAD			

- **CAD**: Custom Advertisement Data: 4Bytes

4.5.9.2 BLE Adv Mode Configuration

ADV_CFG								
bit	7	6	5	4	3	2	1	0
field	ADV_MUTE						ADV_MODE	

ADV_MUTE: when the external device is connected, the system stops advertising until the next event or measurement if this flag is set. Flag is reset on next event.

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ADV_MODE:

Mode	Value	Description
ADV Burst + Periodic Mode	0	Advertisement 15 times every second after measurement then every 10 seconds
ADV On Measure Burst Mode	1	Advertisement 15 times every second only after a measurement.
ADV Silent Mode	2	No advertisement included even after measurement.
ADV Periodic Mode	3	Advertise periodically

4.5.9.3 Advertisement interval for ADV Periodic Mode

Note: On LoRaWAN® devices this service will be hidden during BLE discovery mode.
Interval between two advertisements **when ADV Periodic mode is selected.**

ADV_Interval								
bit	7	6	5	4	3	2	1	0
field						ADV_INTERVAL_PERIODIC_ONLY *ADV periodic mode only*		

ADV_INTERVAL_PERIODIC_ONLY: (ADV periodic mode only)

Value	Description
0	Advertisement every 500ms
1	Advertisement every 1s.
2	Advertisement every 1,5s.
3	Advertisement every 2s.
4	Advertisement every 3s.
5	Advertisement every 4s.
6	Advertisement every 5s.
7	Advertisement every 10s.

Note1: Default value is 10s. Minimum value is 500ms.
Note2: This value can be only use for ADV Periodic.

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4.5.9.4 Change Device Name

Change device name characteristic allows customer to change device name.

Device Name							
24	-	5	4	3	2	1	0
DEVICE NAME							

- **DEVICE NAME**: Device name when BLE scan: 25 Bytes

Note1: Only ASCII characters are permitted.
Note2: Any (0x00) \0 is recognized as an end of string.
Note3: Value returned is a string (without \0 at the end)

4.5.10 Internal platform temperature

INTERNAL_TEMPERATURE16																
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
field	INTERNAL_TEMPERATURE16															

INTERNAL_TEMPERATURE16 (signed): Internal temperature of the platform

$$TEMP_{\circ C} = INTERNAL_TEMPERATURE16 * 0.01$$

4.5.11 Keep Alive

Configure Keep Alive over LoRaWAN®.

Keep Alive Configuration								
bit	7	6	5	4	3	2	1	0
field				Keep_Alive_Mode		Keep_Alive Interval		

Keep Alive Interval

State	Value
Keep Alive every 24h	0
Keep Alive every 12h	1
Keep Alive every 8h	2
Keep Alive every 4h	3
Keep Alive every 2h	4

Note: Default value is 24 hours.

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Keep_Alive_Mode:

State	Value
Keep Alive Active and send every time	0
Keep Alive Active and not emitted if a data is sent between two Keep Alive. Keep Alive interval is reset when a frame is sent	1
Keep Alive Disabled	2

Note: Default value is 0.

4.5.12 Data Collection

4.5.12.1 Measurement Counter

MEASUREMENT COUNTER (R/W)																
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
field	CNT16															

- **CNT16**: Number of measurements done. When it reaches 0XFFFF it will reset to 0x0000. Writing 0x0000 will reset the counter to 0x0000. Other values won't affect current counter.

4.5.12.2 Measurement interval

Interval between two measurements.

MEAS_INTERVAL			
Byte	0	1	2
field	HOUR8	MINUTE8	SECOND8

- **HOUR8**: Number of hours [0-255]
- **MINUTE8**: Number of minutes [0-255]
- **SECOND8**: Number of seconds [0-255]
- MEAS_INTERVAL = "HOUR8" & "MINUTE8" & "SECOND8"

Note1: Default value is 10min. Minimum value is 1second. Value 0x000 (0h0min0s) is not considered.

Note2: It is possible to write the value only in minutes (e.g:120min).
The system will automatically transform values into standard time representation (e.g:120min = 2hours).

Note3: When a measurement interval is modified by the user, the next new measurement will be completed after the new measurement interval the system won't wait until the end of the current measurement interval.

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Note4: Maximum value is HOUR8: 0xFF MINUTE8: 0x3B SECOND8: 0x3B. (255h 59min 59s) If a written value exceeds this value, it won't be considered.

4.5.12.3 Trigger Measurement

When using a TRIG, the system will send the data first over BLE and then LoRaWAN®

TRIG MODE								
bit	7	6	5	4	3	2	1	0
field	DISCON							TRIG

TRIG: trigger a new measurement flow (read raw values, temperature, battery and process the data)

Trig	Value
Disabled	0
Request a new measurement	1

DISCON: force BLE disconnection before measurement trigger.

Trig	Value
Disabled	0
BLE connected mode disconnection	1

Note: Only 0x81 and 0x01 are allowed.

4.5.12.4 Last data from sensor

Last data acquired from the sensor:

Last data						
Byte	0	1	2	3	4	5
field	TEMP16		SENSOR32			

TEMP16: Temperature of the sensor

Sensor Type	TEMP16	Format/Unit
Temperature	IOT platform T°	Big Endian Signed 16bit 1LSB = 0.01°C

PRELIMINARY VERSION

SENSOR32 (signed): Data from the sensor

Sensor Type	SENSOR32	Format/Unit
Temperature	T°C	Big Endian Float 32bit 1LSB=0.01°C

4.5.13 Live mode

4.5.13.1 Measurement interval

This mode is only available over BLE connection.

LIVE_MODE_MEAS_INTERVAL								
bit	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
field	LIVE_MODE_MEAS_INTERVAL8							

MEAS_LIVE_INTERVAL8: Read Only value in milliseconds.

4.5.13.2 Live mode configuration

LIVE_MODE_CFG								
bit	7	6	5	4	3	2	1	0
field								ENABLE

ENABLE: enable or disable Live mode.

Enable	Value
Disabled	0
Enabled	1

NOTE: Two ways are available to stop “Live mode”:

- BLE disconnection from the central device or with the magnet
- Send Live Mode disable to LIVE_MODE_CFG

4.5.14 Threshold

To request threshold parameters, use the following frame:

Request Threshold information		
byte	0	1
field	ID DATA	PARAM SEL

The sensor will respond with the following frame:

PRELIMINARY VERSION

Answer after a Read requestion						
byte	0	1	2	3	4	5
field	ID DATA	PARAM SEL	DATA32			

To write threshold parameters:

Write Threshold Configuration						
byte	0	1	2	3	4	5
field	ID DATA	PARAM SEL	DATA32			

ID_DATA: defines the source for threshold value

Source		Value
Main sensor raw data threshold 1	*Temperature sensor (T°C)*	0x0
Main sensor Delta threshold 1		0x1
Secondary sensor raw data threshold 1	*IOT platform temperature (T°C)*	0x2
Secondary Sensor Delta Threshold 1		0x3
Main sensor raw data threshold 2	*Temperature sensor (T°C)*	0x4
Main Sensor Delta threshold 2		0x5
Secondary sensor Raw data threshold 2	*IOT platform temperature (T°C)*	0x6
Secondary sensor Delta threshold 2		0x7
Error	ID_DATA not defined or threshold configuration error	0xF

PARAM SEL: Select parameters to be changed (more details below)

Value	
THS_CONFIG	0x0
THS_LEVEL	0x1
MEAS_INTERVAL	0x2
Communication_MODE	0x3

- **PARAM SEL**=0x0 (Threshold configuration)

This command can be used with multiple parameters.

PRELIMINARY VERSION

Data32 format:

THS_CONFIG																																
Byte	3								2								1								0							
bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
field	EVT_FLAG	THRESHOLD	CONDITION	AUTO_CLR	ACTION: MEAS	ACTION: ADV MODE	ACTION: COMM MODE LoRa																									

EVT_FLAG: Forcing this bit to 0 clears the event flag until the next trigger.

State	Value
No event detected	0
Threshold event detected	1

THRESHOLD ENABLE

State	Value
Deactivated	0
Threshold activated	1

CONDITION: Define the threshold condition

Condition	Value
Data32 < Threshold Level	0
Data32 > Threshold Level	1

AUTO_CLR: Auto clear once event condition

State	Value
Keep flag even if the threshold is ended	0
Auto clear Flag after threshold end	1

ACTION: MEAS_INTERVAL: Change Measurement Interval after the threshold level reached

State	Value
Disabled	0
Change measurement interval after threshold	1

PRELIMINARY VERSION

ACTION: ADV MODE BLE: Change Advertisement mode after the threshold level reached

State	Value
Disable	0
Change ADV Mode BLE after threshold	1

ACTION: COMM MODE LoRaWAN®: Change LoRaWAN® Communication mode after the threshold level reached

State	Value
Disable	0
Change LoRaWAN® communication mode after threshold	1

PARAM SEL=0x1 Data32 format: Threshold level

THS_LEVEL				
Byte	3	2	1	0
field	INT32 / FLOAT32			
	N/A		INT16	

Same data format as SENSOR32 /TEMP16
Default value: 0x0

PARAM SEL=0x2 Data32 format: Measurement interval after a threshold reached

MEAS_INTERVAL				
Byte	3	2	1	0
field	HOUR8	MINUTE8	SECONDE8	0 (Not Use)

Note1: Default value is 1min. Minimum value is 1s.
Note2: Value 0x000 (0h0min0s) is not consider.
Note3: Maximum value is HOUR8: 0xFF MINUTE8: 0x3B SECOND8: 0x3B.
(255h 59min 59s) If a written value exceeds this value, it will not be considered.
PARAM SEL=0x3 Data32 format: Communication mode after a threshold reached.

THS_COMM_MODE																																
Byte	3								2								1								0							
bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0

PRELIMINARY VERSION

field							BLE_ADV_MODE							LoRaWAN® COMM MODE																	

BLE_ADV_MODE:

Mode	Value	Description
Periodic mode	0	Advertisement 15 times after measurement then every 10 seconds
On Measure mode	1	Advertisement only after a measurement (15 consecutive ADV)
ADV Silent mode	2	No advertisement included even after measurement
Periodic mode	3	Periodic advertisement

LoRaWAN®_COMM_MODE:

Mode	Value	Description
LoRaWAN® On Measurement Mode	0	Send a frame every measurement

4.5.15 Datalog

4.5.15.1 Datalog array access request

ARRAY ACCESS REQUEST				
byte	0	1	2	3
field	TYPE8	INDEX16		LENGTH8

- **TYPE8**: Data (0 = TEMPERATURE16, 1 = SENSOR32, 2 = TEMPERATURE16 + SENSOR32).
- **INDEX16**: start index from 0 up to 4095 for raw data (MSB first)
  0=latest data acquired, 4095= oldest data acquired

PRELIMINARY VERSION

- **LENGTH8**: number of values to be read. Admissible range depends on TYPE8:
  - 1-120 for TYPE8=TEMPERATURE16
  - 1-60 for TYPE8=SENSOR32
  - 1-40 for TYPE8= TEMPERATURE16 + SENSOR32

If the required length is larger than network capabilities, the frame will be filled with the maximum possible data. No data will be truncated.
Over LoRaWAN®, if the network does not allow the sensor to provide the amount of data, a Network_Error flag will be set in the Operation Response field.

4.5.15.2 Datalog array access response with notification

ARRAY ACCESS RESPONSE									
byte	0	1	2	3			-	m-1	m
field	TYPE8	INDEX16		LENGTH8	VALUE_0			VALUE_n	

- **TYPE8**: Data (0 = TEMPERATURE16, 1 = SENSOR32, 2 = TEMP16 + SENSOR32).
- **INDEX16**: start index of the value
- **LENGTH8**: number of values sent
- **VALUE_n**: SENSOR32 or TEMP16 or SENSOR32 + TEMP16. For TEMP16 the 1st Byte is a 0 value

Note: In case of error, ARRAY ACCESS RESPONSE will be 0xFFFFFFFF.

4.5.15.3 Datalog analysis request

DATALOG STATISTIC REQUEST			
byte	0	1	2
field	TYPE8	LENGTH16	

- **TYPE8**: Value = 2
  Analysis of TEMPERATURE16 and SENSOR32
  Data format depends on sensor type. Please refer to DEVTYPE.
- **LENGTH16**: number of values to be analyzed.
  If the length required exceeds the amount of data currently stored, system will use only available data.
  The first data to be use will be last acquired data.

PRELIMINARY VERSION

4.5.15.4 Datalog statistics response with notification

DATALOG STATISTIC RESPONSE															
byte	0	1	2	3	4	5	6	7	8	9	10	11-14	15-18	19-22	23-26
field	TYPE 8	SIZE16		MEAN_T		MIN_T		MAX_T		STD_T		MEAN_S	MIN_S	MAX_S	STD_S

- **TYPE8**: Value= 2 (TEMPERATURE16 + SENSOR32).
- **SIZE16**: nb value used for computation
- **MEAN_T** Mean value of batch data analyzed for temperature
- **MIN_T** Minimum value of batch data analyzed for temperature
- **MAX_T** Maximum value of batch data analyzed for temperature
- **STD_T** Standard deviation value of batch data analyzed for temperature
- **MEAN_S** Mean value of batch data analyzed for temperature
- **MIN_S** Min value of batch data analyzed for temperature
- **MAX_S** Max value of batch data analyzed for temperature
- **STD_S** Standard deviation value of batch data analyzed for temperature

Note: In case of error, ARRAY ACCESS RESPONSE will be 0xFFFFFF.
Note: Format depends on data type. Please refer to DEVTYPE.

4.5.16 LoRaWAN® Platform

4.5.17.1 LoRaWAN® Mode configuration

LoRaWAN® TX Mode Config								
bit	7	6	5	4	3	2	1	0
field							LORAWAN®_COMM_MODE	

LoRaWAN® Communication Mode:

Mode	Value	Description
Measurement Mode	0 (Default)	LoRaWAN® Communication at every measurement
Silent Mode	1	No LoRaWAN® communication at each measurement

PRELIMINARY VERSION

4.5.17.2 DevEUI

This number is the 64-bit Device Extended Unique Identifier of the sensor. It is generated by TE and is derived from the TE Organizationally Unique Identifier (OUI) assigned by the IEEE Registration Authority.

4.5.17.3 AppEUI

This number is the 64-bit application Extended Unique Identifier of the sensor.

4.5.17.4 NET ID

Contains the operator network identifier coded on the 4-byte value (LSB first). The list of all possible operator is listed below.
NetID and DevAddr Prefix Assignments | The Things Network
For example, 0x00000013 identifies “The Things Network”.

4.5.17.5 Region

LoRaWAN® configured region for either US or EU.

4.5.17.6 Status Reserved

4.5.17.7 LoRaWAN® percentage of confirmed uplink messages

It is possible to reduce the number of acknowledgements between the LoRaWAN® gateway and the device.

LORA_ACK_PER								
byte	0							
bit	7	6	5	4	3	2	1	0
field	PERCENTAGE = 100							

PERCENTAGE: Percentage of LoRaWAN® uplink confirmed messages. From 0% up to 100%. Default is 100%.

Note: Value 0% should not be used
Note1: LoRaWAN® percentage of confirmed uplink is only applied on Nominal(Keep Alive frame is confirmed) data uplink.

PRELIMINARY VERSION

5 BATTERY

5.1 Saft LS17330

The system should be exclusively powered with an LS17330 battery.

Parameters	Typical value
Manufacturer	SAFT
Reference	LS 17330
Technology	Primary lithium-thionyl chloride (Li-SOCl2)
Nominal voltage	3.6 V
Capacity at 20°C	2100 mA
Operating temperature range	- 60°C /+ 85°C

5.2 Battery life

Depending on customer settings the battery life could extend to 10 years (dependent on measurement interval and RF communication).
The number of measurements per day will affect the battery life. More measurements will reduce the battery life.

Temperature and battery depletion can have an effect on the behavior of the system. When the temperature is higher than +60°C or lower than -30'C the electrical current availability may be reduced. A related voltage drop can affect system stability.

We have implemented some firmware mechanisms to detect this critical voltage drop. Dedicated mechanisms are implemented into:

- Sleep phase
- Measurement phase
- Communication phase

Mechanisms are based on:

- Integrated MCU voltage monitoring (POFWARN= Power Failure Warning). It will trigger a flag when voltage drops below a defined level.
- MCU internal temperature monitoring (Environmental Sensing Service)

PRELIMINARY VERSION

Sleep phase: POFWARN is set at 2.8V.
During sleep phase, if the system had several voltages drops detected (11 consecutive times) and the temperature is between [-30°C +60°C], this means that the battery may have an issue. If this issue happens several times (11 consecutive times), the system sets a battery change flag.
If the temperature is below -30°C and higher than +60°C and voltage drops are detected (10 consecutive times), the system sets a battery warning flag and will wait to be in nominal range [-30°C +60°C] to define if a battery change should be declared.

Measurement phase: POFWARN is set at 2.8V
During a measurement process POFWARN is activated to define if measurements acquired by the system are reliable.

If a voltage drop is detected during measurement, a specific measurement health process is activated to define if voltage drop happens at each measurement. If yes, the measurement value is set to 0x7FFFFFFF/NaN/7FFF. Sensor_Error, TEMP16_OOR_ERR, SENSOR32_OOR_ERR and Battery_Warning is set to 1.

Communication phase: POFWARN is set at 2.0V
Communication phase has a memory effect about voltage drop. If a POFWARN happens it will be sent on next communication. Note if a POFWARN happens, communication frame can be sent properly.
If POFWARN happens during communication, to prevent wrong payload the system will send only Keep Alive frame with warning.
Com_Error, Com_Diag_LoRa power Error and Battery_Warning is set to 1.
If system remains in this communication phase for 10 consecutive intervals, BATTERY_Diag Change will be set to 1.

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6.2 BATTERY REPLACEMENT

The 69XXN's battery must be replaced if depleted.

- Remove the plastic cover following the opening directions
- Use the orange ribbon to pull out the battery
- Put the orange ribbon back to the cavity before installing the new battery.
  Note: the battery MUST be replaced by the same battery reference, SAFT LS17330.
- Put the spacer on the negative terminal and install the battery positive upward
- Pull the spacer out and then install the plastic cover and tighten it following the locking direction. Refer to the Installation Manual or the Quick Start Guide for details of battery installation and replacement.

N.B.: Only replace the battery in non-hazardous areas.

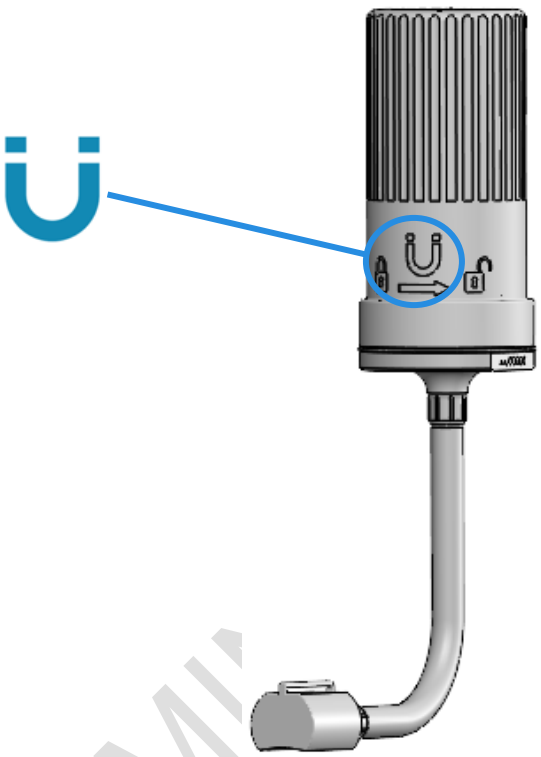
Once the battery installation is complete, the battery life meter in the firmware must be reset to a "full" battery status.

!This action is mandatory otherwise battery level will stay at 0%!

PRELIMINARY VERSION

6 MAGNETIC SWITCH

To make an asynchronous data acquisition, or access BLE connected mode, use a magnet. The magnet event will trigger a measurement, then the sensor will be in Preliminary Phase.
The magnetic switch location is indicated by the magnet drawing on the plastic cover.



The magnet must be of sufficient strength and proximity to create a magnetic field of 25 mT at the switch location.

Two different functions are available depending on the user action:

Function	User action	LED
Activates BLE for another one hour Trigs a new measurement and a LoRaWAN®™ transmission (uplink if joined, else join request Disconnect from BLE connected mode	Short tap	One fast blink. If user holds the magnet close to the switch for a longer duration, the LED will blink faster. Remove the magnet to only initiate a transmission, or else a sensor reset will be initiated
System Restart	Hold the magnet for 10 seconds.	Wait for at least 10 seconds, to see the very fast blink. Release the magnet once a very long orange led appears

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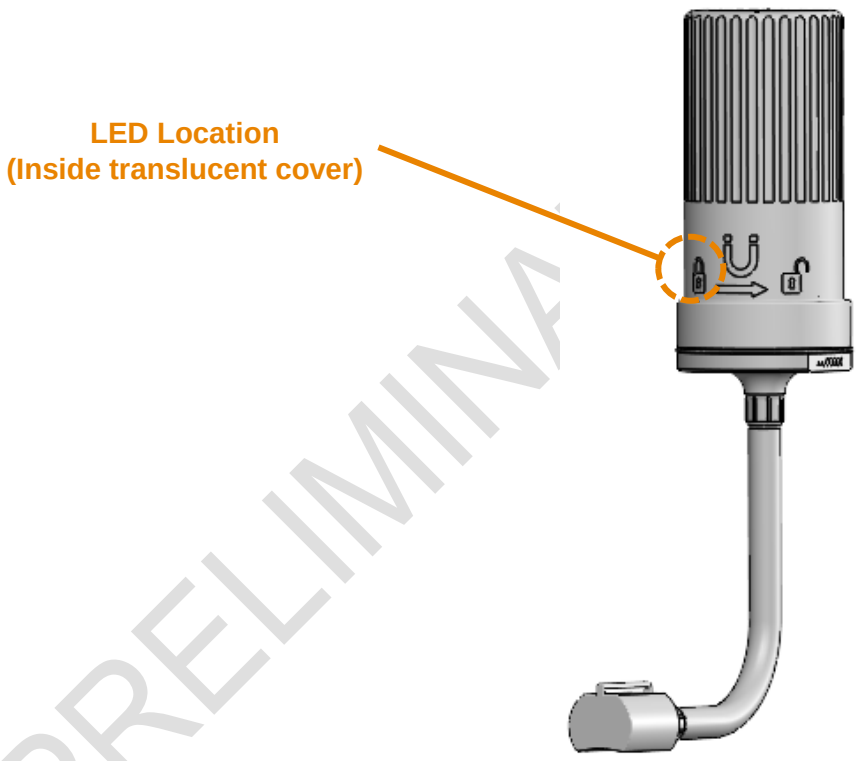
7 LED

A yellow LED is used to indicate user some specific event:

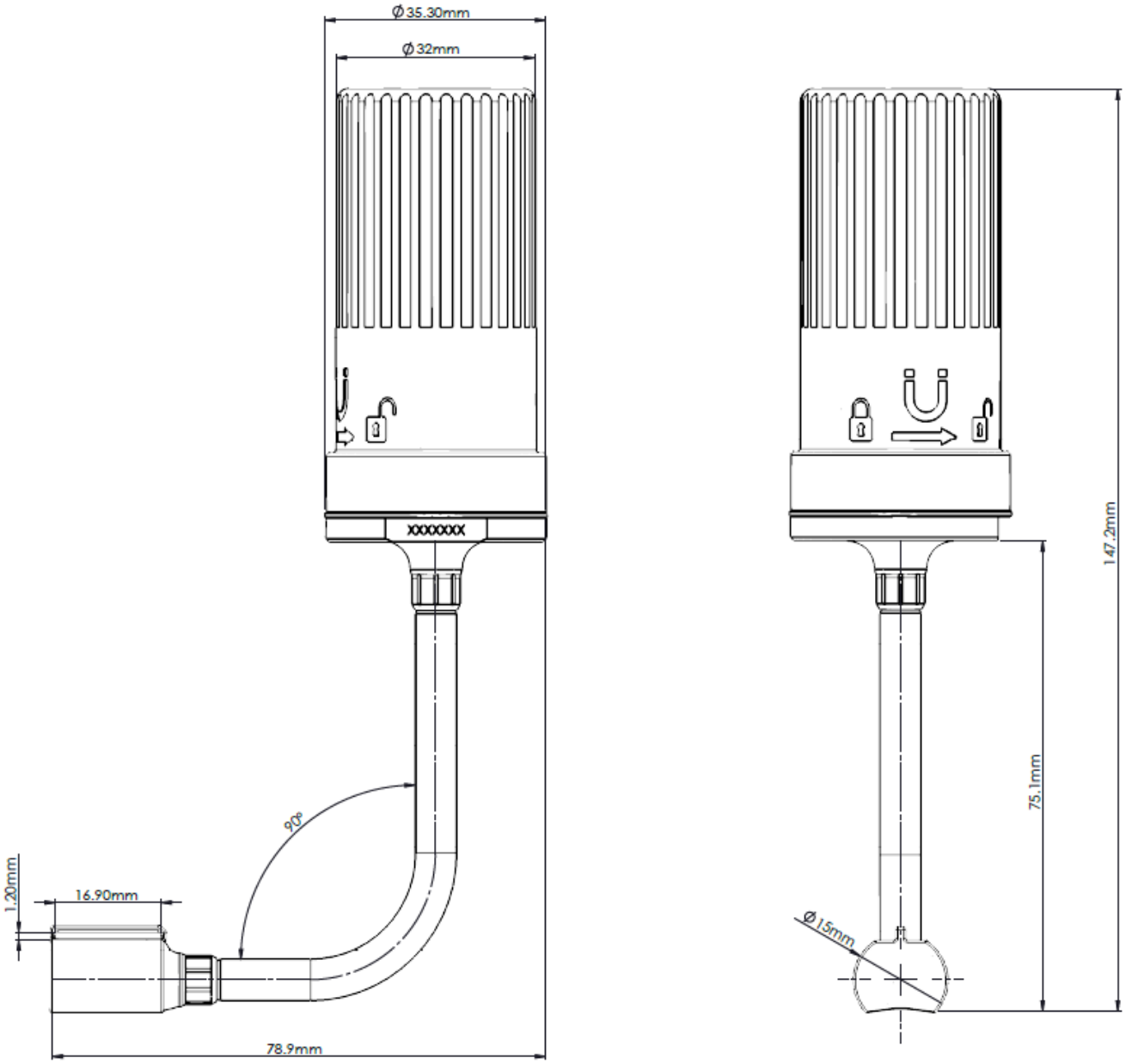
		LED Behavior
Battery insertion		ON for 2s
Magnet event		ON for 200ms
Maintaining Magnet	<3s	Slow blinking
	[3s-10s]	Fast blinking
	>10s	OFF -> reboot



PRELIMINARY VERSION

8 DIMENSIONS

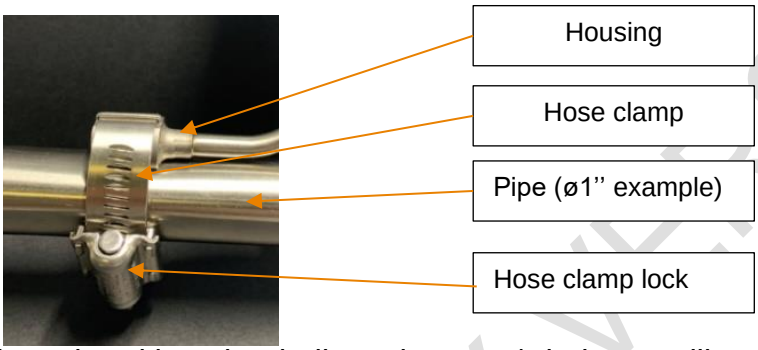
Dimensions units: Millimeter



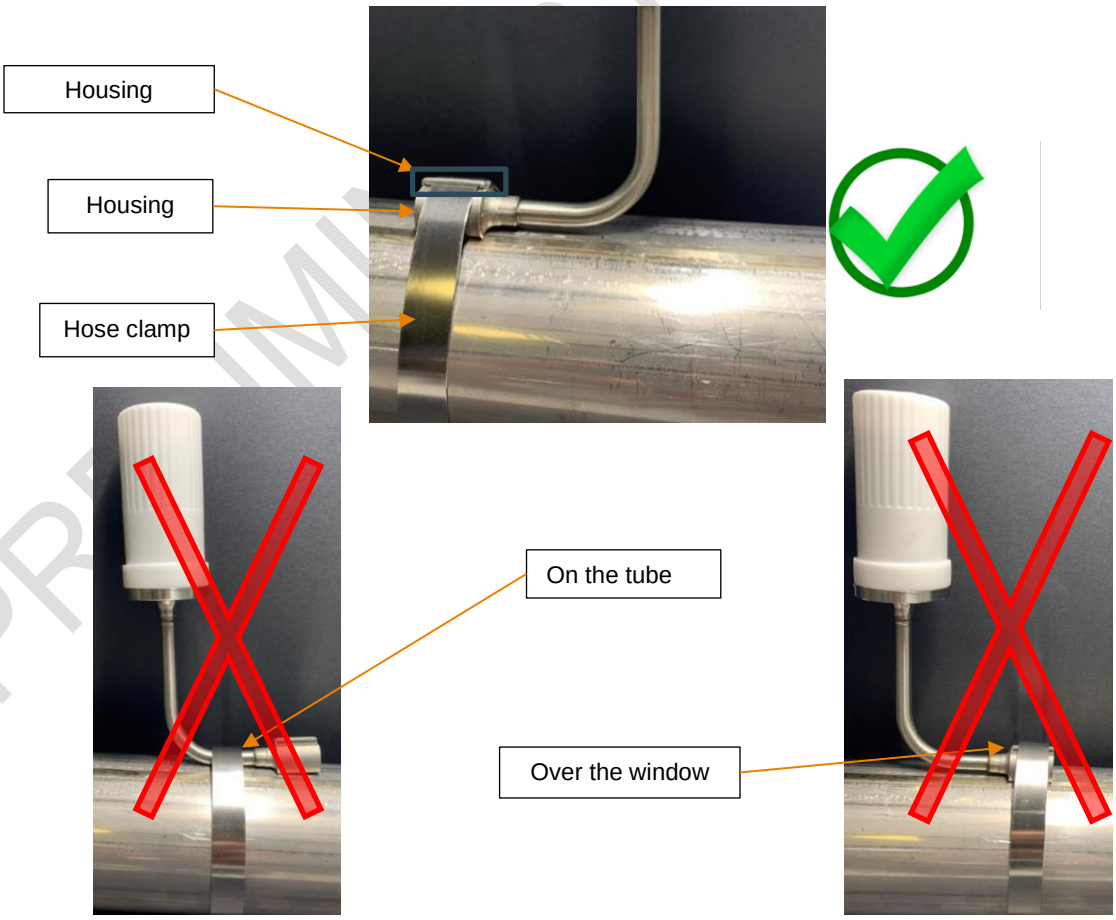
9 MOUNTING CONSIDERATIONS

The temperature sensor should be installed in a clean and compatible pipe diameter from 1” (25.4mm) to 4” (101.6mm).
Connection to the pipe is recommended by usage of a universal stainless steel hose clamp (not part of delivery):

- Type: American hose clamp
- Band width: 12.7mm (15.8mm max)
- Band thickness: 0.6mm (0.8mm max)



Insert the hose clamp band into the dedicated groove/window, as illustrated bellow. Only one hose clamp to be used per sensor.



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WARNING – The hose clamp lock shall be placed out of the housing area, in preference located on the pipe surface and not between the housing and the pipe (air area).
WARNING – Tighten the hose clamp according to its notice or datasheet and apply the recommended torque defined by original manufacturer, by using calibrated torque wrench or torque screwdriver.
WARNING – To reduce the risk of burns or frost bite, wear protective personal equipment when installing or removing from high or below-freezing temperature process or environments.

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10 ENVIRONMENTAL INFORMATION FOR ORDINARY LOCATIONS

This device complies with ordinary location standards as follows:

- Indoor or outdoor
- Wet environment
- Degree of pollution: 4
- Altitude during operation: up to 5000m

11 CERTIFICATIONS & COMPLIANCES

This sensor is certified for Intrinsic Safety when model code “EX” is selected during the ordering process. Please see ordering information in section 13 for details:
Intrinsic Safety approval is as follows:
IS Class I, Div1, Groups A, B, C, and D;
Class I Zone 0, AEx ia IIC T4 Ga;
Ex ia IIC T4 Ga;
Ex II 1 G Ex ia IIC T4 Ga

12 REGLUATORY STATEMENTS

FCC and IC

This Radio Equipment is Certified for FCC (US) and ISED (Canada).

This equipment does not support simultaneous transmissions.

Changes or modifications not expressly approved or authorized by TE Connectivity for compliance could void the user's authority to operate the equipment.

FCC Warning:

THIS DEVICE COMPLIES WITH PART 15 OF THE FCC RULES.OPERATION IS SUBJECT TO THE FOLLOWING TWO CONDITIONS: (1) THIS DEVICE MAY NOT CAUSE HARMFUL INTERFERENCE, AND (2) THIS DEVICE MUST ACCEPT ANY INTERFERENCE RECEIVED, INCLUDING INTERFERENCE THAT MAY CAUSE UNDESIRED OPERATION.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If

PRELIMINARY VERSION

this equipment does not cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to correct the interference by one or more of the following measures:

▪ Re-orient or relocate the receiving antenna

▪ Increase the separation between the equipment and the receiver▪ Connect the equipment to an outlet on a circuit that is different from that to which the receiver is connected.

▪ Consult the dealer or an experienced radio/TV technician for help.

Industry Canada (IC) Warning:

This device complies with ISED Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'ISED Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

IMPORTANT NOTE:
Radiation Exposure Statement: This equipment complies with IC radiation exposure limits set forth for an uncontrolled environment. End users must follow the specific operating instructions for satisfying RF exposure compliance.
To maintain compliance with IC RF exposure compliance requirement, please follow operation instruction as documented in this manual.

Déclaration d'exposition aux radiations
Cet équipement est conforme Canada limites d'exposition aux radiations dans un environnement non contrôlé. Cet équipement doit être installé et utilisé à distance minimum de 20cm entre le radiateur et votre corps.
A distance of 20cm shall be maintained between the antenna and users, and the transmitter may not be co-located with any other transmitter or antenna.

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13 EU CONFORMITY

The products below were tested by approved agencies and found compliant with EU regulatory standards.

Model Families: 79XXN

Product Description: Wireless Temperature sensor

Manufacture/Brand: TE Connectivity Ltd

Manufacturer:

Measurement Specialties (China) LTD

No 26 LangShan Road

518057 Shenzhen-Nanshan District, China

European Contact:

TE Connectivity Sensors France

4 Rue Gaye Marie

31027 Toulouse – France

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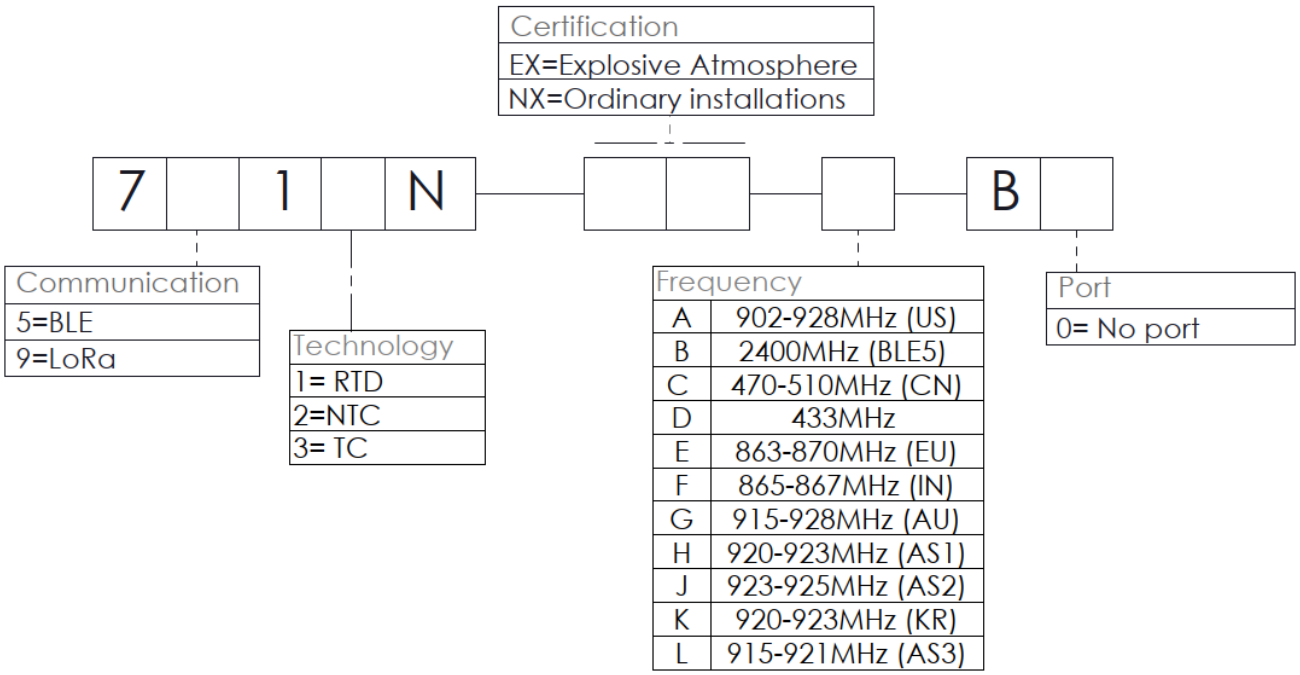
14 ORDERING INFORMATION

LoRa + BLE Sensor Model Number



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