Operating Manual

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ERS NB-IoT/LTE-M Series

Cellular Wireless Sensor

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Important safety information

Read this manual before attempting to install the device!

Failure to observe recommendations included in this manual may be dangerous or cause a violation of the law. The manufacturer, ElektronikSystem i Umeå AB will not be held responsible for any loss or damage resulting from not following the instructions of this operating manual.

- The device must not be dismantled or modified in any way.
- The device is only intended for indoor use. Do not expose it to moisture.

The device is not intended to be used as a reference sensor, and ElektronikSystem i Umeå AB will not be held liable for any damage which may result from inaccurate readings.

- The device must never be subjected to shocks or impacts.
- To clean the device, wipe with a soft moistened cloth. Use another soft, dry cloth to wipe dry. Do not use any detergent or alcohol to clean the device.

Disposal note in accordance with Waste from Electrical and Electronic Equipment (WEEE) Directive 2012/19/EU

The device, as well as all the individual parts, must not be disposed of with household waste or industrial waste. You are obliged to dispose of the device at the end of its service life in accordance with the requirements of Directive 2012/19/EU to protect the environment and to reduce waste through recycling. For additional information and how to carry out disposal, please contact the certified disposal service providers.

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Purpose of This Document

This operating manual provides essential information for the correct installation, configuration, and use of the ERS NB-IoT/LTE-M Series of sensors.
The purpose of this manual is to ensure that all users understand the device's capabilities, limitations, and safety requirements in order to achieve optimal performance and avoid damage or incorrect operation.

This manual is intended for:

- **Installers** responsible for physical installation and initial configuration.
- **System integrators** are responsible for connecting devices to cloud services and managing communication parameters.
- **Maintenance personnel** who perform diagnostics or firmware updates.

Disclaimer

ElektronikSystem i Umeå AB assumes no responsibility for any damage, malfunction, or data loss resulting from:

- Failure to follow the instructions in this manual.
- Unauthorized modification or repair of the device.
- Use of accessories, batteries, or SIM cards not approved by the manufacturer.
- Operation outside the specified environmental or electrical limits.

All specifications are subject to change without prior notice.
Users must ensure compliance with local regulations and safety standards before deployment.

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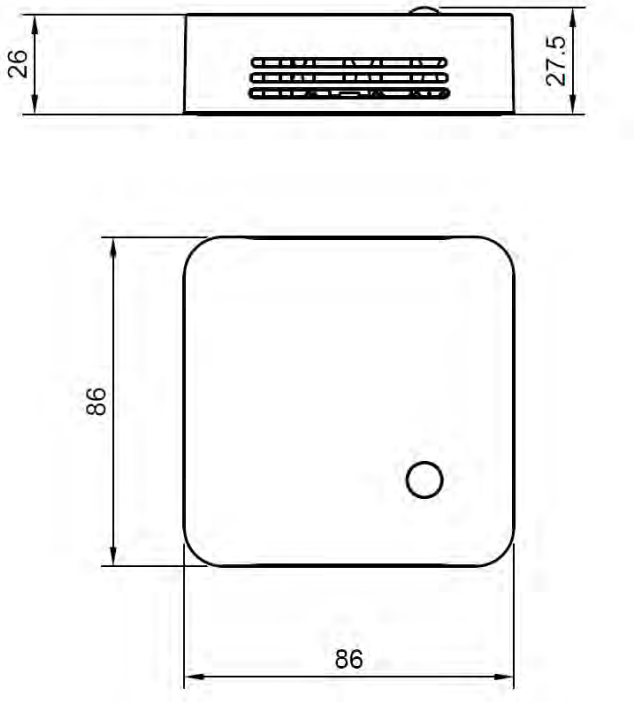
1. Description

The ERS NB-IoT/LTE-M series of sensors are universal indoor climate sensors that communicate using cellular LPWAN technology, NB-IoT and LTE-M. The sensor measures, depending on model, temperature, humidity, light intensity, CO2-level, sound-level, volatile organic compounds (VOC), occupancy and detects motion. The ERS NB-IoT/LTE-M is a battery-powered device and is designed to be wall mounted. The sensors are equipped with NFC (Near Field Communication) for easy configuration with an NFC-enabled smartphone.

1.1 Dimensions



Weight without batteries: 75-85 g depending on model

Weight with batteries: 125-135 g depending on model

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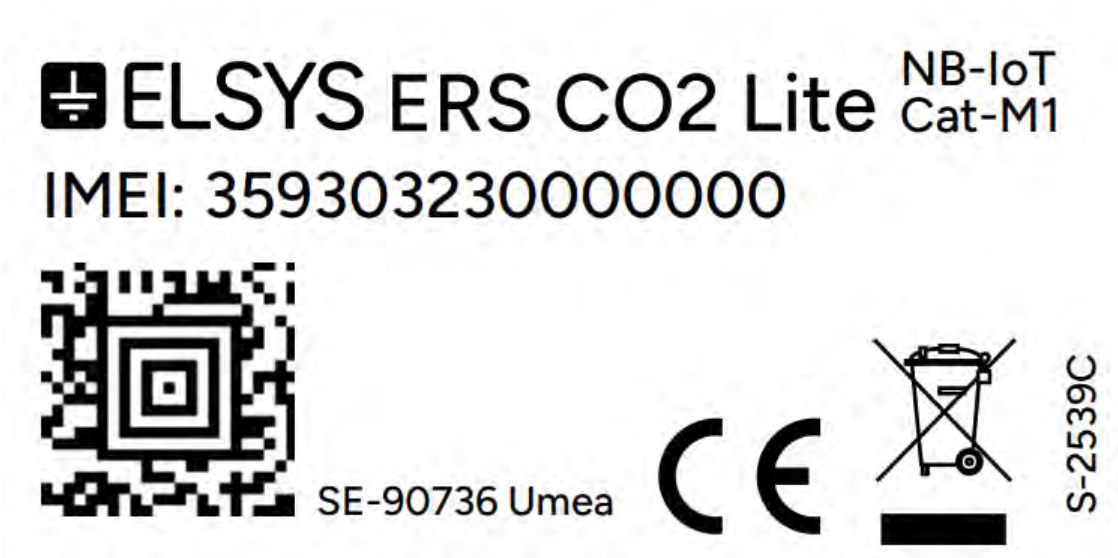
1.2 Product Labeling

The back plate of the device is labeled with the device type, the device IMEI and a barcode of Aztec type containing the device type and IMEI with the following structure: [Device type],IMEI:[IMEI number]



1.3 Box Labeling

The box is labeled with a label with device type, number of devices, firmware version, hardware revision, production year/week and a QR-code that contains device type, amount, and IMEIs of all devices with the following structure:
[Device type]-[Amount],IMEI:[IMEI 1],[IMEI 2]

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1.4 Main features

- Compatible with NB-IoT and LTE-M networks
- Compatible with nano-SIM and eSIM (eSIM optional for larger batches)
- Device management via LwM2M
- Data delivery via LwM2M and UDP
- Firmware over-the-air update (FOTA)
- Measures ambient temperature
- Measures ambient humidity
- Measures light intensity*
- Measures CO_2 level*
- Measures sound level*
- Measures VOC level*
- Detects room occupancy*
- Detects motion using a passive IR sensor*
- Indicates low, normal or high values with an LED*
- Easy installation
- Easy configuration
- May be installed on a wall or any (non-metallic) surface
- Battery powered
- Long-range communication
- Configurable over NFC
- Ten years of battery life**
- Supported LTE bands: 3, 8, 20
- CE Approved
- RoHS compliant

* Depending on model

** With data sampled and sent every 30 minutes on CEL0

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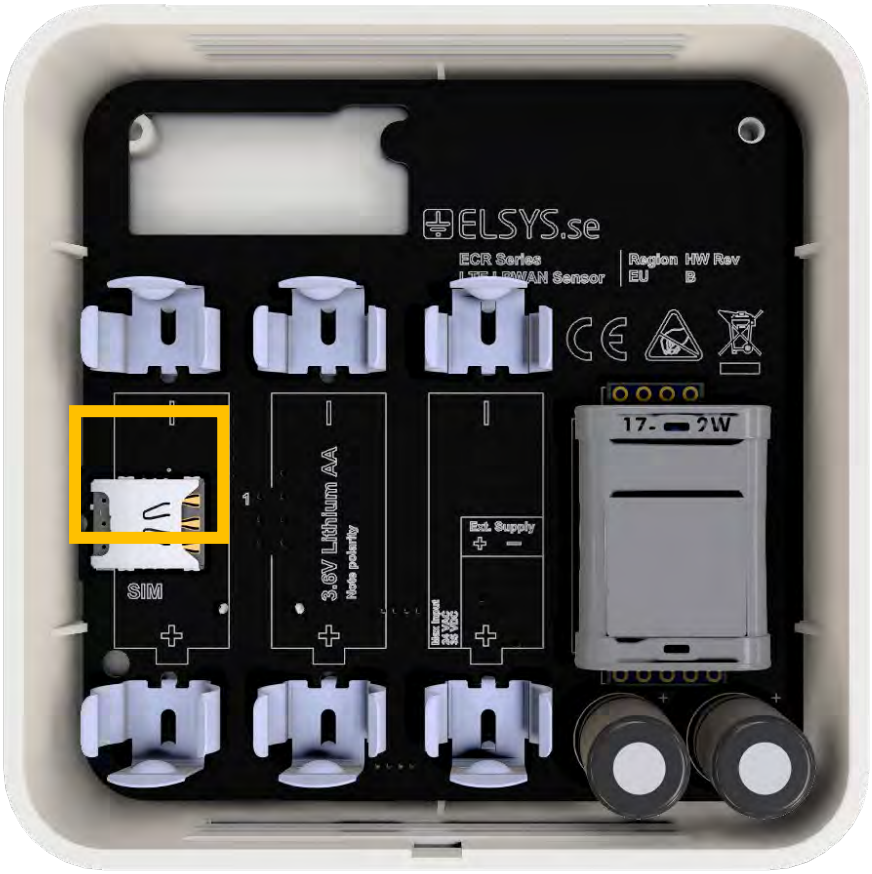
2. Installation

2.1 SIM Card

The ERS NB-IoT/LTE-M series of sensors are compatible with either Nano SIM or eSIM. There are two available positions for the nano SIM-card holders, either on the back- or front-facing side of the PCB depending on what level of user accessibility is desired. The default position is the back-facing side of the PCB, being the most user accessible option.

A SIM card or eSIM is required for the sensor to boot.



Default SIM-card position

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2.2 Battery operation

The ERS NB-IoT/LTE-M series are available as battery powered devices.
Battery powered sensors are compatible with 3.6 V Li$SOCl_2$ batteries (ER14505) and have slots for 3 batteries. The battery slots have reverse polarity protection.

2.2.1 Battery storage and transport recommendations

- Only use 3.6 V Li-$SOCl_2$ (ER14505) cells from approved suppliers.
- Store batteries in a cool, dry, and well-ventilated area, ideally between +10 °C and +25 °C.
- Avoid exposing batteries to direct sunlight, open flames, or temperatures exceeding +60 °C.
- Do not store batteries inside the sensor unless mounted with a pull-tab for extended periods if the device is not used.
- During transport, batteries must be kept in their original packaging or equivalent protective containers to prevent short circuits or mechanical stress.
- Observe all relevant UN 3090/3091 transport regulations for lithium metal batteries.

2.2.2 Environmental requirements

- Do not store or operate the device in environments with high humidity or condensation risk.
- Avoid freezing conditions (< 0 °C) or heat above +50 °C, as this may degrade performance and cause leakage.
- Keep away from corrosive substances or conductive dust.

2.2.3 In case of battery leakage or swelling

- If a battery appears leaking, swollen, or discolored, do not touch it directly.
- Use protective gloves and remove the affected cell carefully.
- Clean the compartment with a dry, lint-free cloth. Do not use water or solvents.
- Dispose of damaged batteries according to local hazardous waste regulations.
- Never attempt to recharge, short-circuit, or incinerate Li-$SOCl_2$ batteries.

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2.3 Mounting Guidelines

• Place the sensor in an open space on the wall, with an installation height of 1.6 meters (does not apply to ERS Eye LoRa).
• For best RF and measurement performance, make sure you mount the sensor with the ventilation openings vertically. See installation in chapter 2.4.
• Make sure that the sensor is not placed in direct sunlight, close to heating vents, near windows, air ventilation where it may measure values that are not representative for the rest of the room.

2.3.1 Motion PIR

The PIR can self-trigger if sensors are placed too close to each other. Keep this in mind when you mount or test the sensors.

2.3.2 Room occupancy sensor

The Grid Eye sensor of the ERS Eye has an 8x8 temperature matrix with a field of view of 60° and a range of 5 meters for detecting humans. Keep this in mind when you place the sensor and make sure that you have enough sensors to cover your whole desired area. Preferably place the ERS Eye LoRa in the ceiling at between 2.2 to 5 meters height. Do not place the sensor so it faces windows or moving heat sources as this can cause a false positive reading.

2.3.3 Sound level

Think carefully about the placement of the ERS Sound LoRa. If the sensor is placed close to loud sources such as machines or ventilation, it will be reflected in the sensor readings due to sounds being louder close to the source.

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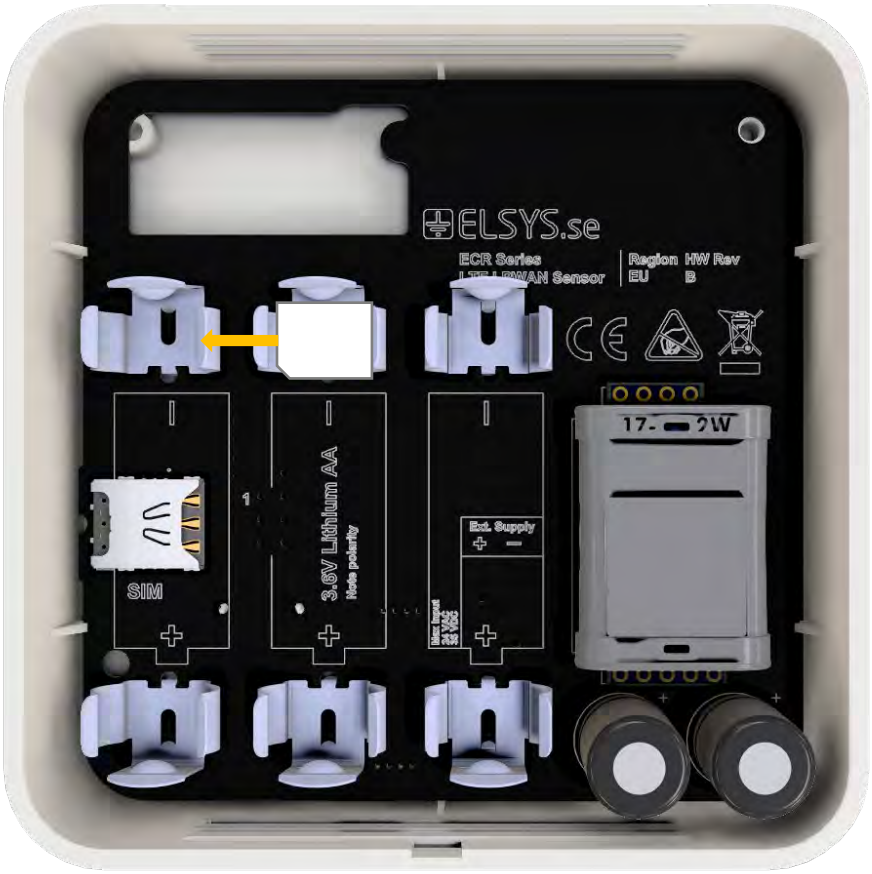
2.4 Installation

1. Remove the back panel of the sensor by gently prying the tab with a small screwdriver.

2. Insert the SIM-Card by sliding it into the SIM-card holder. If the sensor has been ordered with eSIM, skip this step.



3. Install the batteries by pressing the batteries into the battery holders, noting the polarity of the batteries.

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4. Mount the back panel securely to the wall with at least 2 appropriate screws, using some of the four mounting holes. Alternatively, attach the sensor with double sided adhesive tape.
Note: Tape and screws not included, tape sold separately

5. Attach the sensor part by hinging it on the back panel

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3. Sensor setup & configuration

The device settings are made up of “parameters”, where each parameter controls different features of the ERS NB-IoT LTE-M device.

All settings can be configured via ELSYS Sensor Settings smartphone application with near field communication (NFC) or over the air via LwM2M or ELTP.

All settings and parameters mentioned in this document are featured in the ELSYS Sensor Settings app.

Settings written to the device via NFC in an unpowered state will be stored in the device’s NFC chip and loaded into the sensor once it’s powered.

Changes in settings made via NFC will be immediately reflected in LwM2M settings objects, and vice versa.

For details on changing settings and device management via LwM2M, see Appendix A, “ERS NB-IoT/LTE-M series LwM2M specification”.

For details on changing settings via NFC, see Appendix D, “ERS NB-IoT/LTE-M Series NFC Specification”.

All available settings can be pre-programmed in production; Contact the ELSYS sales team for information on customization options at info@elsys.se

Google Play Store

Apple App Store

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4. LED behavior

All ERS NB-IoT/LTE-M series sensors are equipped with an LED in the bottom right corner of the front. On sensors with a PIR, the LED is located under the PIR lens.

The LED is used to indicate sensor status and events.
Sensors that feature a PIR also feature a traffic light setting which lets the sensor LED be configured to indicate when internal sensor values are within our outside of selectable ranges. The LED can be configured to be always off if no user indication is desired.

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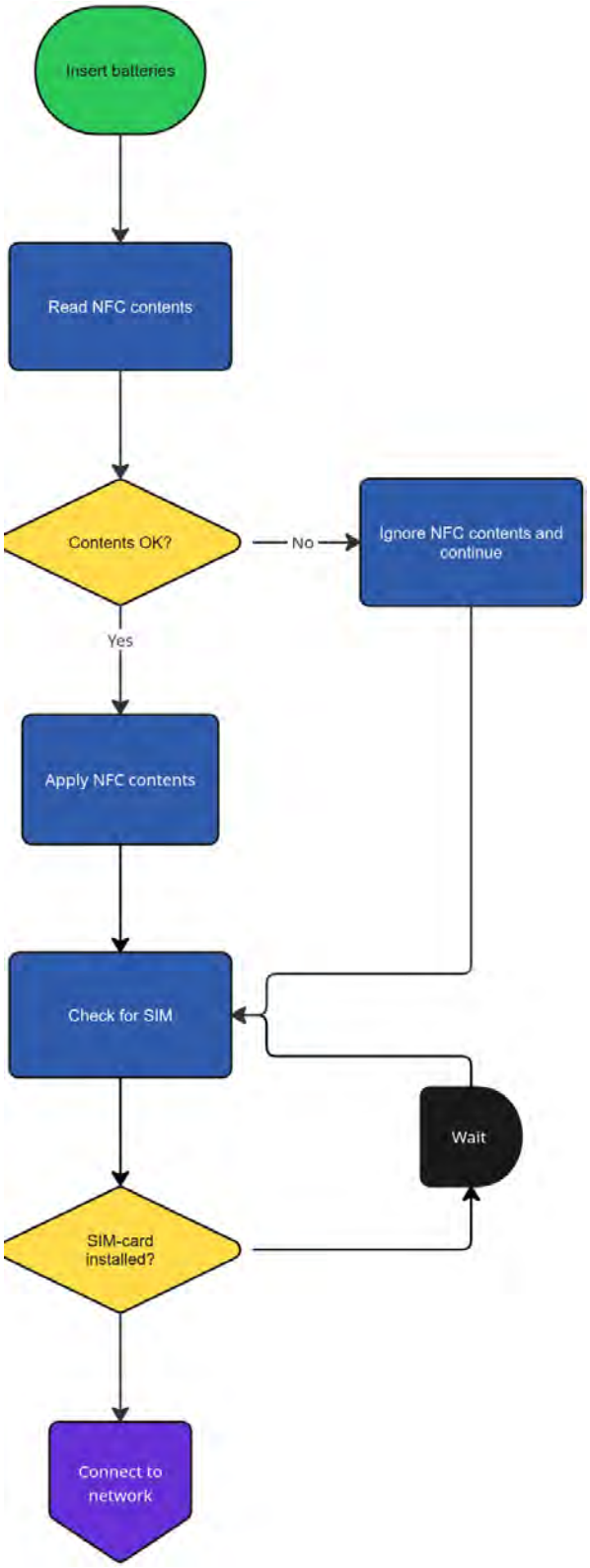
5. Sensor startup

The sensor will start as soon as batteries are inserted. At start-up it will load the current contents of the NFC chip and apply any new settings. The device ensures that a SIM-card is installed before proceeding to connect to the network.

If a SIM-card is not installed, the device will periodically check for a SIM-card, gradually increasing the time between SIM-card checks. If the device has been powered for a long time without a SIM-card inserted and a SIM-card is inserted, it's recommended to reboot the device for quicker SIM-card detection.



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Upon successfully booting, the sensor will initialize the modem, connect to the network and connect to the cloud using the current configuration before running the main process.

Network and cloud attachment status will be continuously checked during runtime, and detected detachment from the cloud or the network will result in a re-attachment procedure that gradually increases the time between attach attempts to preserve battery and prevent the network from getting overloaded. Network attach/detach is described in detail in §7 and cloud attach/detach is described in detail in §8.

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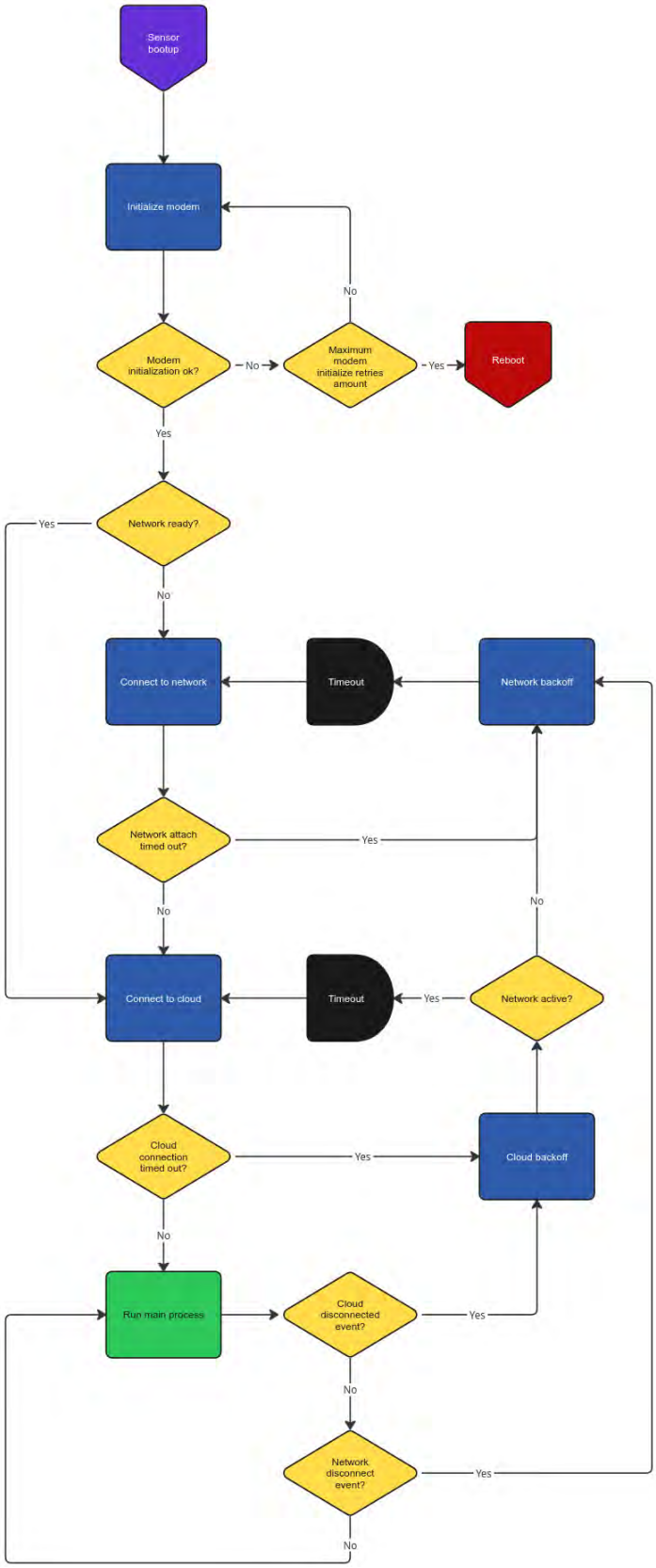

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6. Sensor power off

The ERS NB-IoT/LTE-M series contains energy storage that will be able to power the device for a long time after the batteries are removed. **To turn the sensor off, the user must manually power down the device using NFC and the Elsys Sensor Settings App**

To power the device off, remove the batteries and write the reboot command.
Writing the reboot command to the sensor when batteries are still inserted will cause the sensor to reboot. If batteries are removed without the power-off command being issued, the energy storage voltage will eventually reach the threshold for auto power off and will shut itself off.
The sensor can be turned on again by re-installing the batteries. The sensor will perform a normal bootup as described in §5.

6.1 Auto Power Off

The sensor features an automatic power-off. The sensor will automatically turn itself off when the internal energy storage reaches the shutoff voltage threshold (see §18.3 for power-off voltage threshold).

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7. Network

The ERS NB-IoT/LTE-M series features communication on cellular networks using NB-IoT and LTE CAT-M. The sensors can automatically gather the information required to connect to the network from the installed SIM card, or network connection information can be manually set. All data in the radio layer is encrypted.

7.1 Network Connection

The ERS NB-IoT/LTE-M series of devices gathers all necessary network parameters from the installed SIM-card, but some parameters are available for manually configuring the network connection to be used in specific mobile networks (see §7.2)

7.2 Manual Network Connection Configuration Parameters

7.2.1 PLMN/Operator Lock

Restrict the SIM/eUICC to register **only** on a specified Public Land Mobile Network (PLMN). This is useful when a fixed home operator is required, and roaming must be prevented. When set, the device will attempt to register only on the specified PLMN. If that network is unavailable, the device will remain unregistered.
When left blank, roaming is allowed according to the SIM/eUICC profile and subscription.

Parameter	Value
PLMN Lock	MCC-MNC

7.2.2 APN Lock

The APN (Access Point Name) determines how the device attaches to the LTE-M / NB-IoT data network. Enter the APN exactly as provided by your mobile operator. This APN will only be used if the the SIM/eUICC profile is missing a default APN. After changing the APN, you must reboot the modem for the new setting to take effect.

Parameter	Value
APN Lock	APN

7.3 Connection mode

The sensor can communicate using a preferred standard or a specific standard only. When set to preferred, the sensor is able to switch depending on availability and quality of the technologies in the network.

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Parameter	Value	Band
Connection mode	0	NB-IoT Preferred
	1	Cat-M1 Preferred
	2	NB-IoT Only
	3	Cat-M1 Only

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7.5 Network attachment

Network attach is the process where the device tries to register with the cellular network and acquire an IP connection.

When attaching to the LTE network, the sensor will gradually increase the wait time if the network attach attempt is unsuccessful to preserve battery life and prevent overloading the network.

Two user-parameters dictate the network attachment process:

Parameter	Unit	Default value
Network attach timeout	Seconds	630
Network attach retry delay	Seconds	60

7.6 Coverage Enhancement Level Dependent Transmission Interval

The ERS NB-IoT/LTE-M series offers coverage enhancement level (CEL) dependent maximum transmission intervals for CEL1 and CEL2. Enabling CEL dependent transmission interval limits how often the device will report data, overriding the current send configuration. Setting the CEL dependent transmission intervals to 0 turns the feature off.

Parameter	Unit	Default Value
CEL1 Transmission Interval	Seconds	3600
CEL2 Transmission Interval	Seconds	43200

Caution: Changing this can increase power consumption and data usage. Not recommended to modify. Recommended minimum: 3600 seconds (1 hour)

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The network attach timeout is the allowed time frame from the device requesting an IP-address from the network to an IP-address being granted by the MNO. If an IP-address is not obtained within the network attach timeout, the device will wait for an amount of time decided by how many attempts have been previously made, and the network attach retry delay parameter.

Network attach attempt	Wait time multiple (fixed)
1	1
2	2
3	5
4	60
5	240
6	480
7…14	720
15	N/A (system reboot)

Once the sensor has reached its seventh network attach attempt it will try another seven attempts at the highest wait time multiple (720) before rebooting and ultimately restarting the network attach procedure from the beginning.
To preserve battery life, the sensor will attempt to keep its network context as long as possible.

If the sensor fails to connect to the cloud after seven attempts, it will revert back to the network attach sequence. The subsequent cloud connection attempts will then be at the highest wait time multiple (240).

Cloud connection attempt	Wait time multiple (fixed)
1	1
2	1
3	1
4	2
5	5
6	60
7 and up	240

7.7 Roaming

The ERS NB-IoT/LTE-M supports roaming with handover when connected to a Cat-M1 network, but the roaming capabilities are decided by the combination of the SIM and the specific network operator (MNO). The sensor will gather network data during operation

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and build an internal list of allowed networks (PLMNs) as well as forbidden networks (FPLMNs) depending on the MNO.

7.8 Network status

The network status can be read via NFC to get direct feedback on the connection status during the installation process.

Network status and active parameters can be read via LwM2M or the MNO platform if supported.

7.9 Network Power Saving Features

ERS NB-IoT/LTE-M devices support eDRX and PSM and will use them depending on the availability in the network to improve battery life.
If the network does not support PSM the ERS NB-IoT/LTE-M series features a “force PSM” mode that can be used to achieve close to PSM performance. The feature is experimental and is not guaranteed to work.

PSM Force	False = off (default)

Note: PSM and eDRX availability depends on your network operator and location, consult your network operator on PSM support.

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8. Provisioning

ERS NB-IoT/LTE-M has the option to be provisioned using a custom provisioning server with Elsys Provisioning Protocol (ELPP) and/or LwM2M bootstrapping as provisioning methods. Provisioning is not mandatory.

The devices will first use the ELPP URL if one is provided, and secondly the LwM2M bootstrap URL if one is provided.

8.1 Custom Provisioning

On first network attach, if a provisioning URL is set, the device posts a compact JSON with identity and current settings to that endpoint. The server may reply with a new NFC configuration (see Appendix) and/or a firmware update URL.

The new configuration is applied immediately and persisted; a firmware URL triggers an over-the-air update and reboot on completion. If provisioning fails or returns nothing, the device continues using its existing cloud configuration for this session. Provisioning runs once per attach. The user can respond with a new configuration without a provisioning URL to disable further provisioning requests.

See the ELPP document for format/specifics.

8.2 LwM2M Bootstrapping

See §9.3 for details.

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9. Device management

The ERS NB-IoT/LTE-M series of sensors are compatible with device management (DM) using LwM2M. The sensor can be configured to connect directly to the DM or to be enrolled to the DM server using bootstrapping.

For information on device management and supported objects using LwM2M, refer to application note "ERS NB-IoT/LTE-M Series LwM2M guide".

9.1 Device management server attach procedure

Two user-parameters dictate the LwM2M attachment process:

Parameter	Unit	Default Value
Cloud attach timeout	Seconds	630
Cloud attach retry delay	Seconds	60

The cloud attach timeout is the allowed time frame from the device requesting to connect to the specified device management server to the connection request being accepted by the device management server. If the connection request isn't answered by the server within the cloud attach timeout, the device will wait for an amount of time decided by a multiplier that corresponds with how many attempts have been previously made, and the cloud attach retry delay parameter.

Cloud attach attempt	Wait time multiple (fixed)
1	1
2	1
3	1
4	2
5	5
6	60
7…14	240
15	N/A (network backoff)

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Once the sensor has reached its seventh network attach attempt it will try another seven attempts at the highest wait time multiple (720) before falling back to network backoff procedure to refresh the LTE context to prevent errors that need a new network attach to be resolved.

9.2 LwM2M Settings

LwM2M can be set to device management only, device management and data, or completely off.
The extent of the LwM2M usage is dictated by the LwM2MData-parameter.
To turn LwM2M completely off and operate without device management, leave the LwM2M Endpoint blank (consult Appendix A for details).

Parameter	Value
LwM2M Data	0=LwM2M data off (Device management only) 1=LwM2M on

Warning: When LwM2M is completely turned off, the only way to change the device settings is via NFC.

9.3 LwM2M Management server parameters

The devices can be configured to communicate directly with the LwM2M server, or to be bootstrapped to the LwM2M server via a provisioning server. This is dictated by the LwM2MBoot parameter.

Parameter	Value	Bootstrapping
LwM2M Bootstrap	0	Off
	1	On

Table n – LwM2MBoot parameter description

When bootstrapping is turned on, the provisioning server address and PSK parameter will be used as bootstrap server credentials.

Parameter	Description
LwM2M Endpoint	LwM2M/Bootstrap server URL
LwM2M PSK	LwM2M/Bootstrap server PSK (16 bytes)

Table n – Available LwM2M-server parameters

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10. Firmware over-the-air update (FOTA)

Both application firmware and modem firmware can be updated over-the-air using either ELPP or LwM2M. To initiate FOTA update, a URL pointing to a compressed (.zip) file containing either the modem firmware or the application firmware or both.

The procedure for FOTA update is the same for ELPP and LwM2M with the key difference being that with LwM2M the FOTA update URL must be provided by the LwM2M server as an IPSO-object.

The firmware must be signed with a secret key provided by ELSYS for the firmware to be applied.

Both the device and LwM2M includes data integrity protection to keep the modem and application processors to write faulty data.

Note: FOTA update operations are energy intensive and consume a high amount of battery power. To avoid unnecessary operations, a check is made that the version to be updated is in fact different than what is already installed on the sensor. Both upgrades as well as downgrades are supported. A binary file officially signed by ELSYS must be used for the update to work.

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11. Data delivery

The interval of sampling and sending data is dictated by the sample and send parameters. All samples are timestamped with RTC time, which is synchronized with the network.
A circular buffer is implemented and is used if data transmissions are unsuccessful. The buffer is also available if sampling between transmissions is desired. The sensor will try to empty the whole buffer with each transmission. If the buffer is filled because of multiple subsequently failed transmissions, the oldest data in the buffer will be replaced with new data as it is sampled.

The ERS NB-IoT/LTE-M series has selectable application layer protocols and data can be delivered via either LwM2M using IPSO-objects, or via UDP using selectable payload encoding with SenML CBOR and ELTP (ELSYS Lightweight Transport Protocol) as options.

Data is delivered to the server using a single URL.

11.1 Data Consumption

The data consumption will be dependent on what application layer protocol is used, the amount of payload data that is to be sent (dependent on sensor type), and what sample interval is set. To achieve the lowest possible data consumption, using UDP as data delivery protocol is recommended.

11.2 Sensor Sampling

Sampling of the internal sensors of the devices are made periodically on the basis of a main “tick” set in seconds, that’s configurable using the Timebase parameter.

Parameter	Unit
Timebase	Seconds

Sensor sampling is configured as a multiple of the Timebase, and each sensor type has its own parameter.

Parameter	Unit
Temperature period	Multiple of Timebase
Humidity period	Multiple of Timebase
Light period	Multiple of Timebase
PIR period	Multiple of Timebase
CO2 period	Multiple of Timebase

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VOC period	Multiple of Timebase
Sound period	Multiple of Timebase
Battery period	Multiple of Timebase

Data is sent to the selected destination as decided by the send period parameter which is a multiple of the Timebase.

Parameter	Unit
Send Period	Multiple of Timebase

11.2 Adaptive Send Rate

The ERS-NB-IoT/LTE-M series features adaptive send rate (ASR), which changes the way sampling and sending data works.
When ASR is enabled, the period parameter functions changes to threshold multiples, the internal sensors are sampled on every "tick" of the Timebase, and data is reported if the [threshold * multiple] are exceeded.

Parameter	Hysteresis threshold base value
Temperature period (Threshold multiple)	0.1 °C
Humidity period (Threshold multiple)	2 % RH
Light period (Threshold multiple)	50 Lux
PIR period	Not affected by ASR
CO2 period (Threshold multiple)	40 ppm
VOC period (Threshold multiple)	TBD
Sound period (Threshold multiple)	TBD
Battery period (Threshold multiple)	25 mV

The send period parameter function also changes when ASR is activated and functions as a threshold for how many "ticks" can pass without any sensor threshold being exceeded before the sensor will send data.

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11.3 Sample and Send Setup Examples

Setup for single sample send every 30 minutes, ASR off

Parameter	Value
Timebase (seconds)	1800
Sensor(s) period (multiple)	1
Send period (multiple)	1

Setup for sample every 10 minutes and sending data every hour, ASR off

Parameter	Value
Timebase (seconds)	600
Sensor(s) period (multiple)	1
Send period (multiple)	6

Setup for sample every 15 minutes with ASR, temp hysteresis **0.5 °C, humidity hysteresis 6% RH** and maximum time of 1 hour between sending data.

Parameter	Value
Timebase (seconds)	900
Temperature period (Threshold multiple)	5
Humidity period (Threshold multiple)	3
Send period (multiple)	4

11.4 Historical Sensor Data

Historical data is supported using both the LwM2M IPSO-objects and UDP application protocol formats. Up to 50 samples can be stored before transmitting and emptying the sample buffer.

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12. Data logging

The ERS NB-IoT/LTE-M series supports data logging to a server that isn't used for device management or data delivery.
Log data is sent using UDP and a proprietary format, Elsys Debug Logging Protocol (ELDLP).

Warning: Activating data logging significantly increases data- and battery consumption.

13. Debugging

The ERS NB-IoT/LTE-M series features debugging via NFC for checking device status and troubleshooting in the field. Available debug information is specified in Appendix E.

Follow these steps to acquire the debug information from the device.

1. Write an acquire debug action command to the device using NFC
2. Wait for 5 seconds for the device to write the debug information to the NFC
3. Read the debug information using NFC

14. Battery life optimization

The ERS NB-IoT/LTE-M series are designed to work autonomously for 10 years with sampling every 30 minutes and data reporting every hour using LwM2M on a PSM supported network with good signal quality.

To achieve the calculated battery life there are a few things to consider:

The most power consuming operations that the sensor performs are all network related.

Power use is significantly increased on higher enhancement levels, make sure the sensor is placed in a location with good network coverage. A quick and simple way to get a general idea of the network coverage is to use a smartphone app able to display LTE signal quality parameters.

The network should support PSM and eDRX, check with your MNO if your local cellular network supports these features.

If PSM isn't supported, the sensor features the function "Force PSM" which may improve performance on non-PSM supported networks.

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Warning: If PSM is not supported in the network, a much higher power consumption is to be expected.

UDP is an option for data delivery which is lighter weight than LwM2M. Using UDP for data delivery reduces power consumption and enables longer battery life or shorter transmission intervals.

14.1 Adaptive Send Rate (ASR)

Adaptive Send Rate can be used to limit the amount of data that the sensor sends by holding off on sending data if the sensor data has not changed enough from previous transmissions.

Using ASR will lead to enhanced battery life and reduced data consumption while ensuring that important data is sent.

15. Security

All traffic is encrypted in the radio layer by the modem.
Additional encryption in the application layer is added, with DTLS-PSK encryption of LwM2M data and AES-128-GCM encryption of UDP data.

FOTA requires the binaries to be signed by the manufacturer.

The device NFC can be locked by writing a special lock command along with the desired lock code. When the device is locked, only the IMEI will be featured in the NFC content, and the device will block all content written to the device while the device is in a locked state. Locking the device also blocks action commands like calibration-, debugging- and current sensor data acquisition commands.

The device can be unlocked by writing the lock command and the code that locks it (see Appendix C for details).

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16. Internal sensors

The populated internal sensors in the ERS NB-IoT/LTE-M series differ between models according to the table below.

	ERS	ERS Lite	ERS CO2	ERS CO2 Lite	ERS Sound	ERS VOC	ERS Eye
Temperature	x	x	x	x	x	x	x
Humidity	x	x	x	x	x	x	x
Light	x		x		x	x	x
Motion	x		x		x	x	x
CO2			x	x			
Room Occupancy							x
Sound level					x		
VOC						x	
NFC	x	x	x	x	x	x	x

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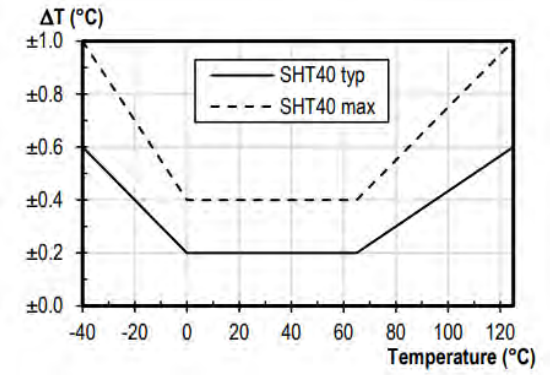
16.1 Temperature

Resolution: 0.1 °C

Accuracy: 0.2 °C typical, see figure



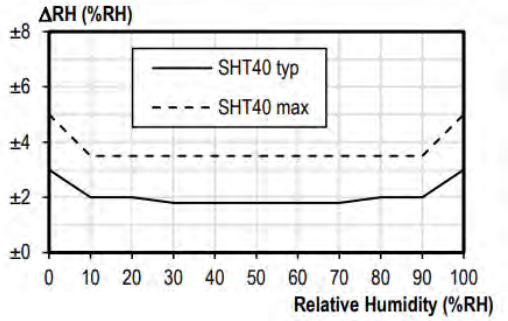
Temperature Sensor Parameters

Parameter	Description
Temperature Period	Temperature sensor sampling period

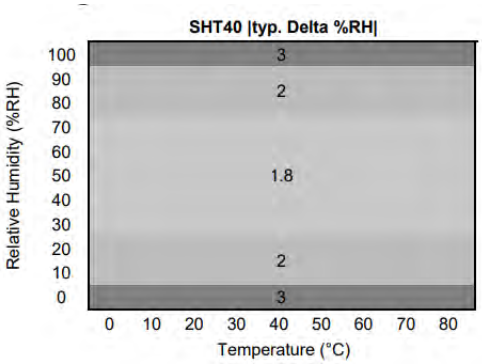
16.2 Humidity

Resolution: 1 % RH

Accuracy at 25 °C: ±2 % RH, see figure



Accuracy of RH over temperature: See figure



16.2.1 Humidity sensor parameters

Parameter	Description
Humidity Period	Light sensor sampling period

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16.3 Light

The light sensor sits behind the PIR lens. For correct reading, make sure it isn't obstructed. Accuracy can depend on the angle of the light source.

Range: 0-65535 lux

Accuracy: ±10% or ±10 lux, whichever is greater.

16.3.1 Light Sensor Parameters

Parameter	Description
Light Period	Light sensor sampling period

16.4 CO2

The CO2 sensor normally runs an automatic baseline correction algorithm (ABC), with a period of 8 days. For a fully corrected measurement, the ABC needs 3 consecutive 8-day periods where the sensor sees fresh air (400 ppm) sometime during each ABC period. It can also be calibrated manually, and the ABC can be turned off. In this case it is recommended to do manual calibration in fresh air once/year.

Range: 400-10000 ppm

Accuracy: 400-5000 ppm: ±30 ppm, ±3 % of reading (15-35 °C, 0-80 % RH)

5001-10000 ppm: ±10 % of reading (15-35 °C, 0-80 % RH)

16.4.1 CO2 Sensor Parameters

Parameter	Description
CO2 Period	CO2 sensor sampling period
CO2 Reference Value	CO2 fresh air reference value (offset)
CO2 ABC Period	CO2 Automatic baseline calibration interval (default 180 hours).
CO2 Calibration	Forced CO2 sensor calibration action Fresh air Forced ABC calibration Factory reset

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16.5 Motion PIR

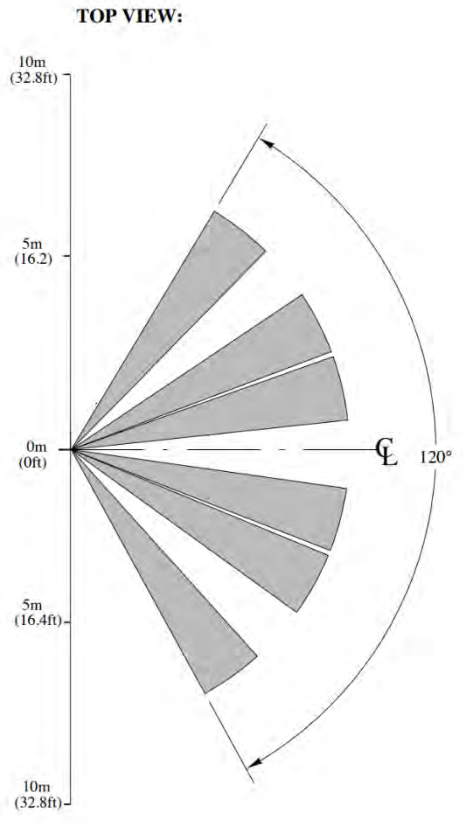
The PIR is able to detect human motion when the temperature difference increases or decreases between the fields created by the PIR lens.

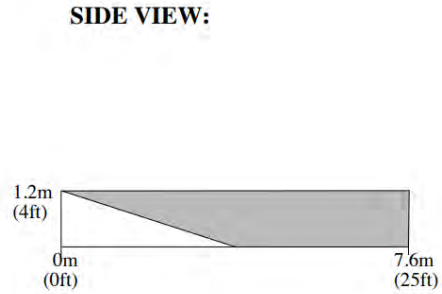
The PIR is sampling continuously, and the number of times the PIR has been triggered is reported according to the PIR period parameter.

In addition to counting, a trigger mode is available (PIR Trigger Once) which lets the sensor send an immediate (triggered) message the first time the PIR is triggered each sample period. When set to trigger mode, the device reports the count in addition to the triggered message.

Note: The PIR has a blanking time of 8 seconds right after motion event and transmission. Any movements during this time will be ignored.

16.5.1 PIR Lens Detection Pattern





16.5.2 PIR Parameters

Parameter	Description
PIR Period	PIR reporting period

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PIR Sensitivity	PIR motion detection sensitivity
Motion Configuration	PIR Mode. Available modes: PIR off PIR Count PIR Trigger Once

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16.6 Eye

The room occupancy algorithm uses both the PIR sensor and an 8x8 pixel heat map sensor. If the PIR triggers, occupancy is detected. If the PIR doesn't trigger, the heat map is enabled, and its pattern is compared to a filtered mean value of the room. If there is a big enough difference between the two, occupancy is detected. Please allow for up to 24 hours for the algorithm to stabilize after installation. The time between the PIR being triggered and the device heatmap being enabled is decided by the Eye Timeout parameter.

16.6.1 Detailed description

When the PIR is triggered, room occupancy is set to 1. If no other motion is detected within 5 minutes, the sensor captures a heat map image. Room occupancy is set to 2 if heat signatures are detected, otherwise, room occupancy is set to 0 and a new background image is calibrated. Whenever the occupancy value is changed, the ERS Eye will trigger a transmission. No triggered transmission will be done as long as the occupancy value remains unchanged. Periodic transmissions will send all values, including occupancy.

Examples of occupancy values:

- Occupancy 0: Unoccupied.
- Occupancy 1: Occupied. Occupancy detected by motion.
- Occupancy 2: Occupied. Occupancy detected by heat signatures.

Heat map viewing angle: 60°x60° Heat map accuracy (typical): ± 2.5°C 7.6.2 Special functions for ERS Eye Hot spot: Reports highest temperature pixel. Raw data: Reports all 8x8 pixel temperature data.

16.6.2 Special functions for ERS Eye

Hot spot: Reports highest temperature pixel.
Raw data: Reports all 8x8 pixel temperature data.

16.6.3 Eye Parameters

Parameter	Description
Eye Timeout	PIR trigger to heatmap enabled time (in milliseconds)
Motion Configuration	Eye Mode. Available modes: Default occupancy mode Eye Hotspot

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	Eye Raw Data

Hot spot: Reports highest temperature pixel.

Raw data: Reports all 8x8 pixel temperature data.
Note: The heat map will also detect other warm objects (e.g., laptops). Warm objects that stay in the same place will eventually be calculated into the background image

16.7 Sound Level

The sound level sensor continuously measures the average and peak sound pressure levels with no missing events. The analog part is always on, with a peak-hold circuit for peak level, and a mean-value filtering for average value. The digital part wakes and samples both signals every 10 s and does the final calculation before sending the data at the desired send interval.

Frequency range: 100 Hz – 15 kHz

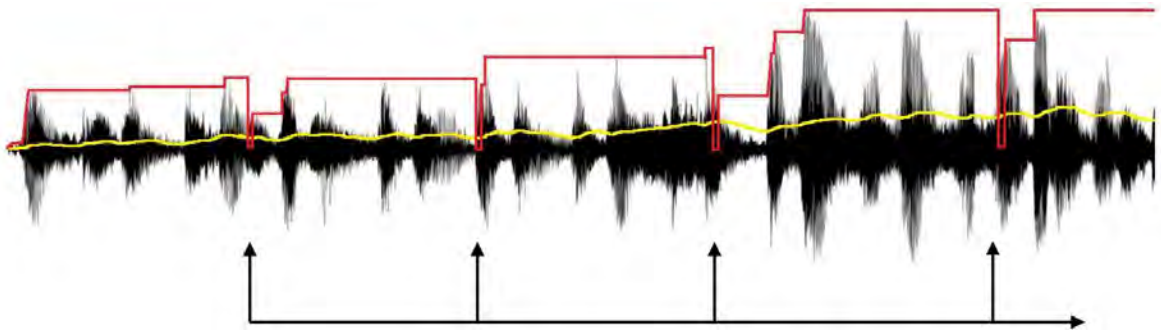
Average value range: 31 – 75 dB SPL

Peak value range: 59 – 100 dB SPL

Filtering: dBA

Sound resolution: 1 dB

Sound accuracy: ±5 dB



10s sample and peak reset. For every send interval, the ERS Sound calculates total peak and average for all samples. Red = peak, yellow = average.

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16.7 Sound Sensor Parameters

16.8 VOC

Resolution:

TBD

Accuracy: TBD

Measurement range: TBD

16.8 VOC Sensor Parameters

Parameter	Description
TBD	TBD

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17. Service and maintenance

No serviceable parts inside. If service is needed other than battery or SIM replacement, please contact your distributor.

17.1 Sensor calibration

Internal sensors are factory calibrated. No end-user access or manual trim is provided.

17.1.1 CO2 sensor

Automatic Baseline Correction (ABC) runs periodically and requires exposure to fresh air (≈400 ppm) to converge. ABC period: **8 days** (default). Recommended practice: ensure the device experiences fresh-air conditions during normal operation. If ABC is disabled, perform a manual fresh-air calibration at least annually via the Elsys Sensor Settings app or configuration payload.

17.1.2 Temperature / Humidity

Factory calibrated; no field calibration supported.

17.1.3 PIR

Factory calibrated; no field calibration supported.

17.1.4 Occupancy (ERS Eye)

Self-calibrating background model. Allow up to 24 h after installation or relocation for the occupancy algorithm to stabilize before evaluating performance.

17.1.5 Sound level.

Factory calibrated; no user calibration supported.

17.1.6 VOC

TBD

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18. Device specifications

18.1 Mechanical

Dimensions	86 x 86 x 26 mm
Weight	125-135 grams depending on model (including batteries)
Enclosure	PC/ABS plastic
IP rating	IP30
Mounting	Screws / adhesive tape
Recommended installation height	1.6 m (wall)

18.2 Operating conditions

Usage environment	Indoor
Temperature	0 – 50 °C
Humidity	0 – 80 % (non-condensing)

18.3 Power supply

Power supply type	Battery
Operating voltage	3.2 - 3.6 VDC
Battery voltage	3.6 VDC
Battery type	3 x AA 14505 (Li-SOCl2)
Battery life	Up to 10 years (Depending on settings and environmental factors)

18.4 Radio/wireless

Wireless technology	LTE-Cat M1 NB-IoT NB1, NB-IoT NB2
Wireless security	AES-128-GCM
Supported LTE bands	3, 8, 20
Bandwidth	1.4 MHz (LTE-M) 200 kHz (NB-IoT)
RF transmit power	23 dBm maximum
Compliance	LTE 3GPP (rel. 14) GCF Power class 3 (23 dBm) GCF Power class 5 (20 dBm)

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	RED 2014/53/EU, RoHS 2011/65/EU WEEE 2012/19/EU

18.5 Device management

LwM2M version	1.1

18.6 Device communication

Supported transport layer protocols	UDP, CoAP
Supported application layer protocols	LwM2M, UDP
Supported device management protocols	LwM2M

18.7 Security

Transport layer	DTLS-PSK
Application layer	AES-128 encryption

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19. Regulations

19.1 Legal notices

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19.2 Declaration of Conformity

Hereby, ElektronikSystem i Umeå AB declares that the radio equipment type Radio communication devices for low-speed data R&TTE Class 1 is in compliance with Directive 2014/53/EU, Directive 2011/65/EU and Directive 2012/19/EU.

The full text of the EU declaration of conformity is available at:
https://www.elsys.se/link/eu-doc

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21. Revision history

Version	Date	Comment
1.0	2025-10-09	First release

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Glossary of Abbreviations

CBOR – Consise Binary Object Representation
CEL – Coverage Enhancement Level
CoAP – Constrained Application Protocol
DTLS – Datagram Transport Layer Security
eDRX – Extended Discontinuous Reception
ELDLP – ELSYS Debug Logging Protocol
ELPP – ELSYS Provisioning Protocol
ELTP – ELSYS Transport Layer Protocol
IMEI – International Mobile Equipment Identity
JSON – JavaScript Object Notation
LPWA – Low Power Wide Area (network)
LwM2M – Lightweight machine to machine
MNO – Mobile Network Operator
PSK – Pre-shared key
PSM – Power Save Mode
PSU – Power suppl
RSRP – Reference Signal Received Power
SenML – Sensor Measurement list
UDP – User datagram protocol
URL – Uniform Resource Allocator

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Appendix A – ERS NB-IoT LTE-M Series LwM2M Specification

Standard IPSO objects are used for measurement data such as temperature, humidity etc. See separate document for available LwM2M objects.

Custom configuration IPSO Object

Implements a custom IPSO object (ID: 31501) for device-specific settings, enabling configuration via LwM2M.

Resource ID	Resource Name	Operations	Type	Units	Range	Mandatory	Description
0	Serial	R	String			Mandatory	Serial number of device.
100	Connection Mode	RW	Integer		0:3	Optional	Connection mode 0 = NB preferred 1 = Cat-M1 preferred 2 = NB only, 3 = Cat-M1 only.
101	Band Lock	RW	Integer		0,3,8,20	Optional	Band lock setting.
102	Network Attach Timeout	RW	Integer	s		Mandatory	Timeout for network attach in seconds.
103	Initial Network Attach Retry Delay	RW	Integer	s		Mandatory	Timeout for retrying network attach in seconds.
104	Cloud Connection Timeout	RW	Integer	s		Mandatory	Timeout for cloud connection in seconds.
105	Initial Cloud Connection Retry Delay	RW	Integer	s		Mandatory	Timeout for retrying cloud connection in seconds.
106	PSM Force Enable	RW	Boolean			Optional	Force enable power saving mode (PSM).
107	PLMN Lock	RW	Integer			Optional	Lock the device to a specific PLMN (network provider)
108	Minimum Transmission Interval (CE Level 1)	RW	Integer	s		Optional	Minimum transmission interval for CE level 1 (moderate signal quality) in seconds.
109	Minimum Transmission Interval (CE Level 2)	RW	Integer	s		Optional	Minimum transmission interval for CE level 2 (very poor signal quality) in seconds.
110	APN Override	RW	String			Optional	Override the default Access Point Name (APN) for network connection. Empty = AUTO

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Resource ID	Resource Name	Operations	Type	Units	Range	Mandatory	Description
200	Sensor Sample Interval	RW	Integer	s	60:	Mandatory	Interval for sensor sampling in seconds.
201	Sensor Send Period	RW	Integer		1:255	Mandatory	Period for sending sensor data time = sample interval * period
202	CO2 Reference Value	RW	Integer	ppm		Optional	Reference value for CO2 sensor calibration.
203	CO2 ABC Interval	RW	Integer	hours		Optional	ABC (Automatic Baseline Correction) interval in hours.
204	Temperature Period / Threshold Multiplier	RW	Integer		1:255	Optional	Period for temperature measurements / threshold multiplier when ASR is enabled.
205	Humidity Period / Threshold Multiplier	RW	Integer		1:255	Optional	Period for humidity measurements / threshold multiplier when ASR is enabled.
206	Light Period / Threshold Multiplier	RW	Integer		1:255	Optional	Period for light measurements / threshold multiplier when ASR is enabled.
207	Motion Period / Threshold Multiplier	RW	Integer		1:255	Optional	Period for motion (PIR) measurements / threshold multiplier when ASR is enabled.
208	CO2 Period / Threshold Multiplier	RW	Integer		1:255	Optional	Period for CO2 measurements / threshold multiplier when ASR is enabled.
209	VDD Period / Threshold Multiplier	RW	Integer		1:255	Optional	Period for VDD measurements / threshold multiplier when ASR is enabled.

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Resource ID	Resource Name	Operations	Type	Units	Range	Mandatory	Description
300	Adaptive Sampling	RW	Boolean			Optional	Enable or disable adaptive sampling.
301	PIR Configuration	RW	Integer		0,2,5	Optional	PIR configuration: 0 = off 2 = count mode 5 = trigger once mode.
302	PIR Sensitivity	RW	Integer		0:2	Optional	PIR sensitivity level.
303	LED configuration	RW	Integer		0:1	Optional	LED mode
304	Disable NFC	RW	Boolean			Optional	Disable NFC interface access
305	Light Compensation Factor	RW	Integer		0:10000	Optional	Light compensation factor for light sensor. 1000 = 1.0

Resource ID	Resource Name	Operations	Type	Units	Range	Mandatory	Description
400	LwM2M Sensor Data	RW	Boolean			Mandatory	Enable or disable LwM2M sensor data reporting.
401	LwM2M URL	RW	String			Mandatory	URL for LwM2M server.
402	LwM2M Bootstrap	RW	Boolean			Mandatory	Enable or disable LwM2M bootstrap.
403	LwM2M PSK	W	String			Mandatory	Pre-shared key for LwM2M server.

Resource ID	Resource Name	Operations	Type	Units	Range	Mandatory	Description
500	CoAP URL	RW	String			Optional	URL for CoAP server.
501	CoAP PSK	W	String			Optional	Pre-shared key for CoAP server.

Resource ID	Resource Name	Operations	Type	Units	Range	Mandatory	Description
600	Provisioning URL	RW	String			Optional	URL for provisioning server.

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Appendix B – Elsys Lightweight Transport Protocol (ELTP) Specification

Appendix B – Elsys Lightweight Transport Protocol (ELTP) Specification

(scope: payload types, sensor entry schema, encryption, on-wire framing, UDP downlink behavior)

Payload types

- **0x01 – JSON** (UTF-8 text)
- **0x02 – CBOR** (RFC 8949 binary)

Both carry a list of sensor entries gathered from the device.

Sensor entry schema

Sensor types and their CBOR value/JSON string equivalents:

Type	CBOR type code	JSON `"t"`
Temperature	0	"temp"
Humidity	1	"hum"
CO2	2	"co2"
Light	3	"light"
PIR	4	"pir"
Battery voltage	5	"vdd"

Fields per entry:

- **type** (code above)
- **value** (floating-point measurement)
- **timestamp** (device timestamp; width depends on format)

JSON payload (type = 0x01)

- Container: JSON array `[ . . . ]`
- Element: object with three fields

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Key	Value
"t"	string ("temp"|"hum"|"co2"|"light"|"pir"|"vdd"|"unknown")
"v"	number (measurement value)
"ts"	unsigned integer (timestamp UNIX epoch)

Example

```
[
  {"t":"temp","v":22.15,"ts":1727356800001},
  {"t":"co2","v":812.0,"ts":1727356805234},
  {"t":"vdd","v":3.72,"ts":1727356810456}
]
```

Behavior: entries are packed until the buffer is nearly full; the array is always properly closed.

CBOR payload (type = 0x02)

- Container: CBOR array
- Element: 3-item array `[type_code, value, timestamp]`

• `type_code` = unsigned integer (0..5)

• `value` = **float16**

• `timestamp` = **uint32** (lower 32 bits), UNIX timestamp

Diagnostic example

```
[
  [0, 22.125, 1727356800],
  [2, 812.0,  1727356810],
  [5, 3.72,   1727356820]
]
```


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Encryption (uplink and downlink)

- **Cipher:** AES-128-GCM (authenticated encryption)
- **Key:** 16 bytes (provisioned)
- **IV/Nonce:** 12 bytes (unique per packet)
- **Additional Authenticated Data (AAD):** 8-byte DeviceID (authenticated, not encrypted)
- **Authentication tag:** 16 bytes (appended after ciphertext)

Properties: confidentiality for inner header + payload; integrity/authenticity for ciphertext and AAD.

Framing (on-wire)

Outer packet (one UDP datagram)

Field	Size (bytes)	Description
DeviceID	8	Stable device identifier (also used as GCM AAD)
IV	12	AES-GCM nonce
Ciphertext	variable	Encrypted inner header + payload
AuthTag	16	AES-GCM authentication tag

Ciphertext contents (plaintext layout before encryption)

Byte(s)	Field	Size	Endianness	Description
0	Flags	1		—
1–2	Seq	2	Big-endian	Monotonic packet sequence (wraps at 65535)
3	PayloadType	1	—	`0x01 = JSON`, `0x02 = CBOR`
4..N	Payload	N-4	—	JSON (UTF-8) or CBOR bytes

Flags

Bits	Value	Used by	Effect
7–6	Protocol version (2-bit value)	Device & Server	Selects ELTP version encoded in this byte.
5–2	Reserved	—	Must be 0 when sent; ignore when received.
1	Downlink extend requested	Server → Device	Device opens an additional 5-second receive window (up to 3 total).

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0	Acknowledgement requested	Device & Server	Device sends an uplink ACK (empty payload) unless the app generates a response. Device requests ACK from server.

UDP downlink behavior (device)

- The device opens **receive windows**; each window waits up to **5000 ms** for a UDP downlink datagram from the server.
- Maximum number of consecutive windows per cycle: **3**. Extra windows are opened only if the server requests extension via a downlink flag.
- On packet reception:
  - Authenticate/decrypt with AES-GCM (using the shared key, the received IV, and DeviceID as AAD).
  - Parse **Flags|Version**, **Seq**, **PayloadType**, and **Payload**.
  - Deliver payload to the application if present.
- **Acknowledgement/response:**

  If the downlink requests an ACK **or** the application returns a response, the device sends an **uplink reply** to the sender's IP/port:

  • **Empty ACK:** same framing, zero-length payload.

  • **Application response:** same framing, payload type = request's type, payload = app data.

The device increments the sequence number for the reply.

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Appendix C – Elsys Lightweight Debug Logging Protocol (ELDLP) Specification

ELDLP is a format used by the ERS NB-IoT/LTE-M series of devices that can be used to obtain errors and warnings. **Do not enable it unless instructed by ELSYS support, as it will increase data and power consumption significantly.**

Description of packet format:

Transport: UDP datagrams (no encryption/compression, best-effort delivery).

Datagram layout:

Header	Payload
12 bytes, device IMEI + log index	0 to 1024 bytes

Header consists of device IMEI (8 bytes) with a 4-byte log index for reconstructing the log output.
Treat the payload as a byte stream of logging output, lines may span packet boundaries.

Example server handling (minimal):

1. Listen on the configured UDP port.
2. Parse first 12 bytes as header (device_id[8], log_index BE).
3. Remaining bytes are log text to store/process.
4. Use (device_id, log_index) to order packets and detect gaps/duplicates.

Operational notes:
• UDP provides no ordering or guaranteed delivery.
• Maximum payload per packet is 1024.

Object	ID	Resources available (name and RID)
Ambient Light Sensor	3301	Application Type (5750) Sensor Units (5701) Sensor Value (5700) Min Measured (5601) Max Measured (5602)

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		Timestamp (5518)
Presence Sensor	3302	Digital Input Counter (5501) Timestamp (5518)
Temperature Sensor	3303	Sensor Units (5701) Sensor Value (5700) Min Measured (5601) Max Measured (5602) Min Range (5603) Max Range (5604) Timestamp (5518)
Humidity Sensor	3304	Sensor Units (5701) Sensor Value (5700) Min Measured (5601) Max Measured (5602) Min Range (5603) Max Range (5604) Timestamp (5518)
CO_2 Concentration Sensor	3325	Application Type (5750) Sensor Units (5701) Sensor Value (5700) Min Measured (5601) Max Measured (5602) Min Range (5603) Max Range (5604) Timestamp (5518)

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Appendix D – ELSYS Lightweight Provisioning Protocol (ELPP) Specifications

1. Overview

ELPP is a simple IoT provisioning protocol that uses HTTPS for secure communication. Devices send current configuration, identification, and connection debug data to a server. The server responds with updated

configuration and firmware updates if available.

2. Endpoint Specification

- URL Path: /req
- Method: POST
- Query Parameter: IMEI

3. JSON Definition

3.1 Request Body

Key	Type	Description
Current Config	String	Local/NFC-read configuration data.
imei	String	Redundant identifier for validation
fw	String	Application firmware version
hw	String	Device hardware version
Connection status	Object	Debug parameters (see table below)

Key	Type	Description
imei	String	Modem/device IMEI
sim	Integer	SIM slot or SIM index
iccid	String	SIM card identifier
imsi	String	Subscriber identity
mfw	String	Modem firmware version
cloud	Integer	Cloud connection state
reg	Integer	Network registration status
mev	Integer	Last modem event code
curb	Integer	Current active band

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supb	String	Supported bands
area	String	Area network code
oper	String	Current operator
cell	String	Cell identifier in hex
uemode	Integer	UE mode
ltemode	Integer	LTE-M support
nbmode	Integer	NB-IoT support
ts	String	Date/Time from network
apn	String	Access Point Name
rsrp	Integer	Signal Strength in dBm
Ip	String	IP address

3.2 Response Body

Parameter	Type	String
new_config	String or null	New configuration if available
fota_url	String or null	Firmware update URL if available

4. JSON Examples

4.1 Request example

```
1 {
2 " current_config ": " NFC contents " ,
3 " imei ": "123456789012345" ,
4 " fw ": "0.0.1" ,
5 " hw ": " bergom - lite " ,
6 " connection_status ": {
7 " imei ": "123456789012345" ,
8 " sim ": 1 ,
9 " iccid ": "8991101201234567890" ,
10 " imsi ": "234510123456789" ,
11 " mfw ": "1.0.0" ,
12 " cloud ": 3 ,
13 " reg ": 1 ,
14 " mev ": 2 ,
15 " curb ": 20 ,
16 " supb ": "1 ,2 ,3" ,
```


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```
17 " area ": "0001" ,
18 " oper ": " Telia " ,
19 " cell ": " ab12cd34 " ,
20 " uemode ": 0 ,
21 " ltemode ": 1 ,
22 " nbmode ": 1 ,
23 " ts ": "2025 -02 -24 T12 :34:56 Z " ,
24 " apn ": " iot . example . com " ,
25 " rsrp ": -95 ,
26 " ip ": "10.0.0.1"
27 }
28 }
```

4.2 Response Example

```
1 {
2 " new_config ": " SplPer :600\ nLwM2MUrl : coaps :// test . world .io :5694\ n " ,
3 " fota_url ": " https :// super . fota . server . se / fota_package . zip "
4 }
```


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Appendix E – ERS NB-IoT LTE-M Series NFC Specification

The NFC format is used to configure the devices both via NFC and as part of the ELPP protocol.

Format

The ERS NB-IoT Series NFC configuration uses a type/value format.

[Key]:[Value]

Multiple parameters can be changed at once by separating each key/value pair with a new-line character (\n).

All settings changes should be written to the device as NFC type text record.

Parameter Table

Parameter	Key	Description	Type	Unit	Default
Sample Period	SplPer	Main time-base for the sensor	Int	Seconds	1800
Send Period	SendPer	Send period multiplier.	Int	Multiple of SplPer	1
Adaptive Sample Rate	ASR	Adaptive Send Rate.	Int	Bool	0
Temperature period	TempPer	Sample multiplier for temperature.	Int	Multiple of SplPer	1
Humidity period	RhPer	Sample multiplier for humidity.	Int	Multiple of SplPer	1
Light period	LightPer	Sample multiplier for the light sensor.	Int	Multiple of SplPer	1
PIR period	PirPer	Sample multiplier for PIR (motion count).	Int	Multiple of SplPer	1
CO2 period	CO2Per	Sample multiplier for CO_2.	Int	Multiple of SplPer	1
Battery period	VddPer	Sample multiplier for battery voltage (VDD).	Int	Multiple of SplPer	1
Connection mode	ConnMode	Connection to be used	Int	Int (Connection mode)	0
PLMN lock	PLMNLock	Locks SIM to specific Public Land Mobile Network (PLMN = MCC+MNC). Example: 24001 locks to Telia Sweden.	Dec	PLMN	0

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APN	APN	APN used for cloud connection. Is usually stored in the SIM card but can be overwritten with this parameter.	Str	N/A	“auto”
Cloud attach timeout	CloudRetry	Shortest allowed interval for cloud connection retries	int	Second	60
Cloud attach retry delay	CloudTimeout	Maximum time to wait for a cloud connection to succeed.	Int	Seconds	600
Network attach timeout	NwkRetry	Shortest allowed interval for network attach retries	Int	Seconds	60
Network attach retry delay	NwkTimeout	Maximum time, to wait for a network attach to succeed.	Int	Seconds	630
CEL1 Transmission Interval	NwkCEL1	Minimum allowed transmission period when device is at Coverage Enhancement Level 1 (reduced signal quality).	Int	Seconds	3600
CEL2 Transmission Interval	NwkCEL2	Minimum allowed transmission period when device is at Coverage Enhancement Level 2 (very poor signal quality).	Int	Seconds	43200
PSM Force	PSMForce	Device will try to force PSM (Power Save Mode) in networks that don't have native PSM support. false = off; true = on.	Bool	N/A	0
CO2 Reference	CO2Ref	Reference value for CO_2 sensor, in ppm.	Int	CO2 ppm	400
CO2 ABC	CO2ABC	Period time for CO_2 ABC (Automated Baseline Correction).	Int	Hours	180
CO2 Calibration	CO2Cal	CO_2 calibration type (numeric selection stored in config).	Int	CO2 Calibration Action	N/A
LED Configuration	LedCfg	LED on/off etc	Int	LED Configuration	0
PIR Configuration	PirCfg	Mode for PIR (motion count). 0: Off (also turns off power to the PIR); 2: Motion count; 5: Trigger once.	Int	PIR Configuration	2
PIR Sensitivity	PirSens	PIR sensitivity setting.	Int	PIR Sensitivity	0
LwM2M Data	LwM2MData	Use LwM2M for data transmission. False = off, true = on	Bool	N/A	false
LwM2M URL	LwM2MUrl	URL of LwM2M server. Example: `coaps://lwm2m.your-server.com:5684`.	String	URL	empty
LwM2M Bootstrap	LwM2MBoot	Use bootstrap server for commissioning.	String	URL	empty
LwM2M PSK	LwM2MPsk	Security key for LwM2M.	Hex		0
ELTP URL	ELTPUrl	URL of ELTP server. ELTP = ELSYS Lightweight Transfer Protocol. URL must begin with udp://	String	URL	empty
ELTP Key	ELTPKey	Security key for ELTP.	Hex		0
ELTP ID	ELTPID	ELTP Device-ID.	Hex		Device IMEI with a 0 appended

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ELTP Ack	ELTPAck	Enable/disable ELTP acknowledgements. False = off, true = on	Bool	N/A	false
ELTP Format	ELTPFormat	ELTP format selection (numeric). 0 = JSON, 1 = SenML/CBOR	Int	ELTP Format	0
ELDLP URL	ELDLPUrl	ELDLP server URL (ELSYS Debug Logging Protocol endpoint).	String	URL	empty
Provisioning URL	ProvUrl	Provisioning server URL.	String	URL	empty
Key protection	KeyProt	Key protection enabled (prevents sending keys such as PSKs when set).	Bool	N/A	false

Actions

Action	**Key**	**Description**	**Type**	
Reboot Action	Reboot	Request device reboot via NFC. Parsed `true` triggers scheduled reboot.	Bool	Write-only
Debug Action	Debug	Enable NFC/connection debug mode, current connection debug will be written to NFC for 60 seconds.	Bool	Write-only

Read only contents

Action	**Handle**	**Description**
Locked status	Locked	NFC output locked flag (only visible when the device is locked).
Firmware version	FW	Firmware version string
Sensor	Sensor	Device variant string

Parameter Details

Connection Mode

Integer Value	Connection Mode
0	NB-IoT Preferred
1	LTE-M Preferred
2	NB-IoT Only
3	LTE-M Only

CO2 Calibration Action

Integer Value	Calibration Type
0	Fresh air
1	Forced ABC Calibration
2	Factory Reset

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LED Configuration

Integer Value	LED mode
0	Normal
1	Always off

PIR Configuration

Integer Value	PIR mode
0	Off
1	Count
2	Trigger once

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Appendix F – ERS NB-IoT LTE-M Series NFC Debug Information

Available debug information

Key	Description	Example / Notes
IMEI	Device IMEI (15 digits).	IMEI:359353123456789
ICCID	SIM card ICCID.	ICCID:8945042118021623456
IMSI	SIM subscriber IMSI.	IMSI:240011234567890
MFW	Modem firmware version string.	MFW:mfw_nrf91x1_2.5.0
Cloud	Current cloud state (numeric).	See below.
MEv	Last modem event (numeric).	See below.
Reg	LTE registration status (from +CEREG?).	Reg:1 — -1 on read error.
SupAcT	Supported access tech modes.	SupAcT:1,1 — lte_mode,nbiot_mode (1=enabled, 0=disabled).
DNS	DNS server IPv4 list or -1 if unavailable.	DNS:8.8.8.8,1.1.1.1 or DNS:-1
CurAcT	Current access technology (+CEREG AcT).	CurAcT:7 — 7=LTE-M, 9=NB-IoT (per modem docs).
CurB	Current LTE band.	CurB:20
SupB	Supported bands bitmask/descriptor.	
Area	Tracking area code (TAC).	Area:02AF (hex, length 4).
Oper	Current operator name (PLMN).	Oper:Telia SE
Cell	Cell ID (hex).	Cell:0001ABCD (up to 8 hex chars).
TS	Network date/time (ISO-like).	TS:2025-03-12T10:25:31
APN	Active APN string.	APN:iot.telia.se
RSRP	RSRP index (convert with RSRP_IDX_TO_DBM).	RSRP:35
IP	IPv4 address or 0 if not connected.	IP:10.160.23.45 or IP:0

State mappings

Cloud

Value	Name	Description
0	INITIALIZING	App starting, modem setup.
1	ATTACH_NETWORK	Start attach sequence.
2	WAITING_FOR_NETWORK	Waiting for IP/DNS readiness.
3	PROVISIONING	Calling provisioning endpoint (if configured).
4	CONNECTING_TO_CLOUD	Establishing cloud session (e.g., LwM2M).
5	CONNECTED	Connected/operational.
6	NETWORK_BACKOFF	Backoff after network attach failure/timeouts.
7	CLOUD_BACKOFF	Backoff after cloud failures/timeouts.

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MEv

Value	Name	Description
0	LIGHT_SEARCH_DONE	Light search performed; no selectable network found yet; modem will continue deeper searches.
1	SEARCH_DONE	Network search performed; either a selectable network found or all freqs scanned and modem enters limited service and will retry.
2	RESET_LOOP	Modem detected reset loop; network attach attempts restricted for ~30 minutes.
3	BATTERY_LOW	Battery voltage low; modem deactivated.
4	OVERHEATED	Device overheated; modem deactivated.
5	NO_IMEI	Modem has no IMEI.
6	CE_LEVEL_0	Coverage enhancement (RACH) level 0.
7	CE_LEVEL_1	Coverage enhancement (RACH) level 1.
8	CE_LEVEL_2	Coverage enhancement (RACH) level 2.
9	CE_LEVEL_3	Coverage enhancement (RACH) level 3.

AcT (Access Technology) values (CurAcT)

Value	Technology
7	LTE-M (Cat-M1)
9	NB-IoT
-1	Unknown / read error

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