ELSYS | PART OF BEMSIQ GROUP

ERS NB-IoT/LTE-M Series
Operating manual

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.

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

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:[IMEI 2]

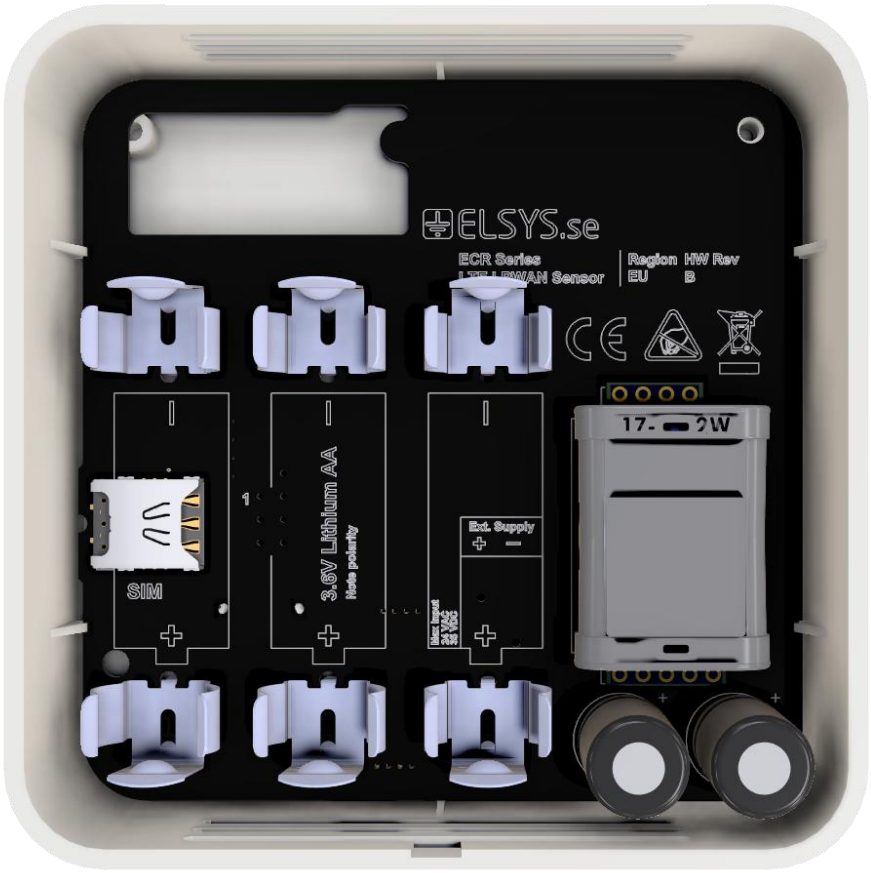
1.4 Main features

- Compatible with NB-IoT and LTE-M networks
- Compatible with nano-SIM and eSIM
- 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

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 SIM card holders, either on the top- or bottom of the PCB depending on what level of user accessibility is desired.
A SIM card is required for the sensor to boot.



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 $LiSOCl_2$ batteries (ER14505) and have slots for 3 batteries. The battery slots have reverse polarity protection.

CAUTION – Risk of explosion if the battery is replaced by an incorrect type

3. Sensor setup & configuration

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

Settings written to the sensor in an unpowered state will be stored in the sensor'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 via NFC, see application note "ERS NB-IoT/LTE-M series NFC specification".

For details on changing settings and device management via LwM2M, see application note "ERS NB-IoT/LTE-M series LwM2M specification".

All settings can be pre-programmed in production, contact the ELSYS sales team for customization options.

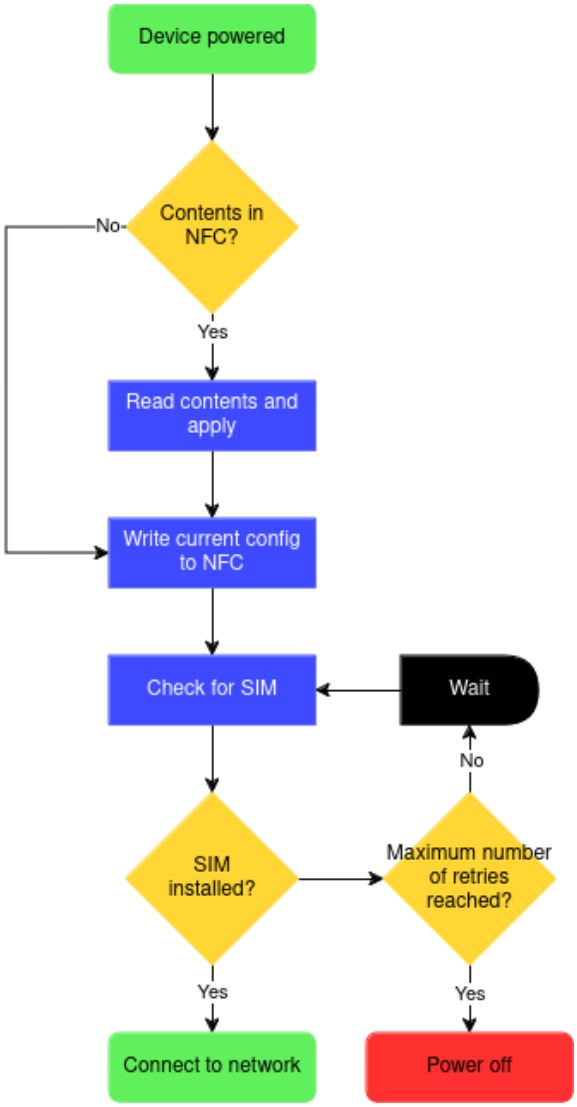
4. LED behavior

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.

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. A check is then made to ensure that there is a SIM card installed.

After booting and doing an initial check of the internal systems, the sensor will try to attach to the network using the set network configuration.
If the sensor fails to attach, it will wait for (time) and try again until successful.



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 therefore requires the user to write a power-off command via NFC to the sensor *after* the batteries have been removed.
Writing the power-off 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 §14.3 for power-off voltage threshold).

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 Settings

7.1.1 Network Connection

Auto	Manual

Table n – Network connection parameter

7.1.1.2 Manual Network Connection Configuration Parameter

APN
Operator

Table n – Manual network configuration parameter

7.1.2 Band lock

The sensor may be set to only communicate using a specific frequency band if needed. When the band lock is activated, the sensor will only communicate using the band selected by the active band lock parameter.

Off	3	8	20

Table n – Band lock parameter

7.1.3 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.

NB-IoT Preferred
Cat-M1 Preferred
NB-IoT Only
Cat-M1 Only

Table n – Connection mode parameter

7.2 Network behavior

When attaching to the 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. The wait time is selectable by the user, and the wait time is multiplied by a predefined, non-changeable factor with each unsuccessful attempt.

Network attach attempt	Wait time multiple (fixed)
1	1
2	2
3	5
4	60
5	240
6	480
7 and up	720

Table n – Network attach backoff multipliers

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

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

Table n – Cloud connection backoff multipliers

7.3 Roaming

The ERS NB-IoT/LTE-M supports roaming, 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 and build an internal list of allowed networks (PLMNs) as well as forbidden networks (FPLMNs) depending on the MNO.

7.4 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.

8. 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”.

8.1 Device management settings

Device management can be turned off, set to communicate directly with the DM server or to use a bootstrap server.

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

Off	LwM2M	LwM2M Bootstrapped

Table n – Available device management settings

8.1.1 LwM2M Management server parameters

DM URL
DM PSK

Table n – Available direct to DM-server parameters

8.1.2 LwM2M Bootstrap server parameters

When set to bootstrapping, the bootstrap server address will only be used for the first successful connection attempt.

Bootstrap URL
Bootstrap PSK

Table n – Available LwM2M Bootstrap server parameters

8.2 Firmware over-the-air update (FOTA)

Both application firmware and modem firmware can be updated over-the-air using LwM2M. Note: FOTA 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.

9. 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.

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.

Data is delivered to the server using a single URL.

9.1 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.

9.1 Sample and send setup examples

Setup for single sample send every 30 minutes

Parameter	Value
Sample period (seconds)	1800
Send period (multiple)	1

Setup for sample every 10 minutes and sending data every hour

Parameter	Value
Sample period (seconds)	600
Send period (multiple)	6

10. Battery life optimization

The ERS NB-IoT/LTE-M series of sensors are designed to work autonomously for 10 years with sampling every 10 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.

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.

10.1 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.

Each measurement type has a selectable threshold that, when exceeded, will trigger the sensor to send the data.

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

11. Security

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

Firmware updates over-the-air requires signing by the manufacturer.

12. Internal sensors

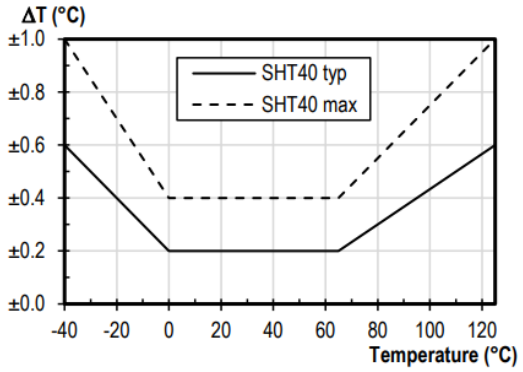
The populated internal sensors in the ERS NB-IoT/LTE-M series differ between models according to the table below.

	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

12.1 Temperature

Resolution: 0.1 °C

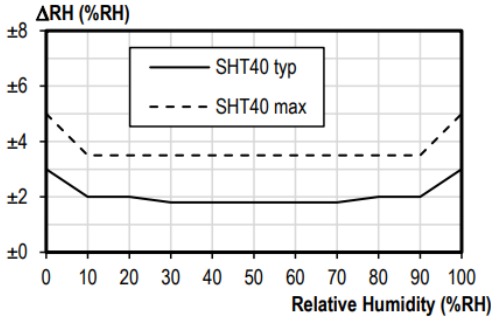
Accuracy: 0.2 °C typical, see figure



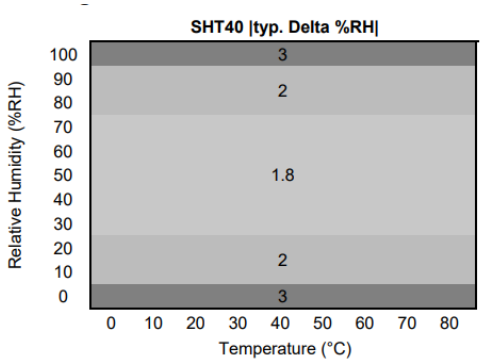
12.2 Humidity

Resolution: 1 % RH

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



Accuracy of RH over temperature: See figure



12.3 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.

12.4 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 a 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)

12.5 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.

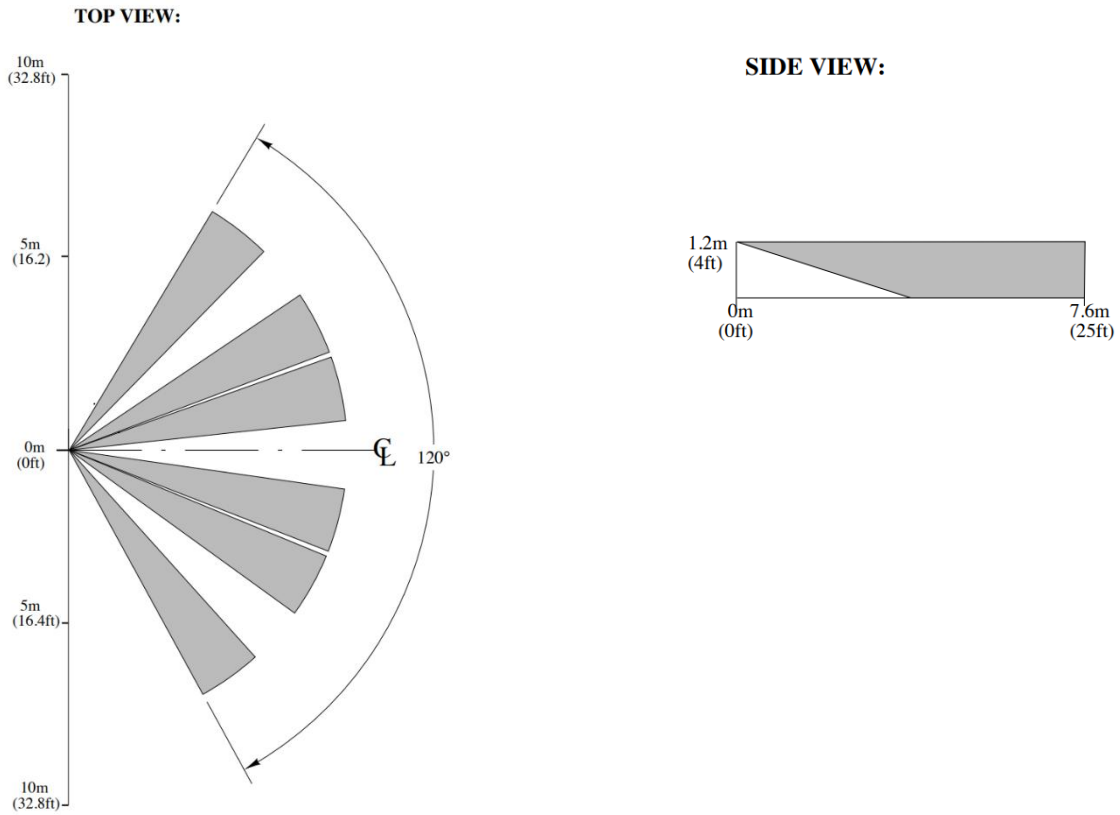
There are two options for motion detection, Count and Trigger Once.

In count mode, the sensor will report the number of times the PIR has been triggered from the last report.

In trigger once mode, the sensor will send one triggered uplink each report period, as well as the total number of triggers for the elapsed period.

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

12.5.1 PIR Lens Detection Pattern



12.6 Special functions for ERS Eye

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

12.7 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

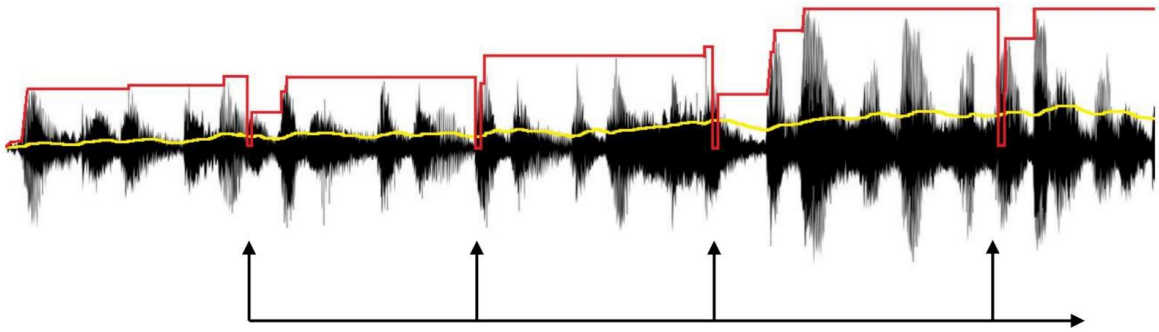
Average value range: 31 – 75 dB SPL

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.

12.8 VOC

Resolution:

0 ppb – 2008 ppb: 1 ppb

2008 ppb – 11110 ppb: 6 ppb

11110 ppb – 60000 ppb: 32 ppb

Accuracy: 15 % of measured value (typical), 40% (max)

Measurement range: 0 – 60000 ppb TVOC

13. Service and maintenance

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

14. Device specifications

14.1 Mechanical

Dimensions	85.5 x 85.5 x 26 mm
Weight	130-140 grams depending on model (including batteries)
Enclosure	PC/ABS plastic
IP rating	IP30
Mounting	Screws / adhesive tape
Recommended installation height	1.6 m (wall)

14.2 Operating conditions

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

14.3 Power supply

Power supply type	Battery or external PSU
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)
External PSU AC voltage	5 – 24 VAC
External PSU DC voltage	6 – 35 VDC
External PSU Current (min)	500 mA

14.4 Radio/wireless

Wireless technology	LTE-Cat M1 NB-IoT NB1, NB-IoT NB2
Wireless security	AES-128
Supported 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) PTCRB Power class 3 (23 dBm) PTCRB Power class 5 (20 dBm) RED 2014/53/EU, RoHS 2011/65/EU WEEE 2012/19/EU

14.5 Device management

LwM2M version	1.1

14.6 Device communication

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

14.7 Security

Transport layer	DTLS-PSK
Application layer	AES-128 encryption

15. Regulations

15.1 Legal notices

All information, including, but not limited to, information regarding the features, functionality, and/or other product specification, are subject to change without notice. ELSYS reserves all rights to revise or update its products, software, or documentation without any obligation to notify any individual or entity. ELSYS and the ELSYS logo are trademarks of ElektronikSystem i Umeå AB. All other brands and product names referred to herein are trademarks of their respective holders.

15.2 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

16. Revision history

Version	Date	Comment
0.1	27-Nov-2024	First draft
0.2	26-Mar-2025	Minor changes
0.3	27-Apr-2025	

Glossary of Abbreviations

CBOR – Consise Binary Object Representation
DTLS – Datagram Transport Layer Security
IMEI – International Mobile Equipment Idendity
LPWA – Low Power Wide Area (network)
LwM2M – Light weight machine to machine
MNO – Mobile Network Operator
PSK – Pre-shared key
PSU – Power supply
SenML – Sensor Measurement list
UDP – User datagram protocol