iNode LoRa

Energy Meter

electricity consumption meter

user manual

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1. INTRODUCTION

We would like to introduce you to the family of iNode devices operating in LoRa® technology and with the **LoRaWAN** protocol.

iNode LORA EM is a wireless monitor for electricity consumption. It is intended mainly for home automation. By analyzing daily consumption, it can help reduce energy costs by choosing a better-suited tariff and changing user habits.

Based on Wikipedia about LoRa® :

LoRa® (Long Range) uses license-free sub-gigigahertz radio frequency bands (so-called ISM band), such as 169 MHz, 433 MHz, 868 MHz (Europe) and 915 MHz (North America). The data transmission rate in the LoRa® system is between 0.3 kb / s and 37.5 kb / s. Because of the techniques used to minimize the use of energy, LoRa® is not suitable for real-time services, but only for applications in which delays can be tolerated.

The adopted network topology is the so-called star-of-stars - the central element is surrounded by intermediate elements - so-called gateways, which communicate with end devices. The higher the number of end devices in a cell, the lower the network throughput.

In the radio layer, LoRa® uses the CSS (chirp spread spectrum) modulation technique developed by Semtech , which has the ability to receive a signal below the noise level.

Pros and cons

LoRa® modulation is characterized by low energy demand of the device used for communication. This protocol adapts the transmitter power and transmission speed to the current propagation conditions (wave propagation). In practice, this means a long working time of the sensor on one battery.

LoRa® modulation has a range of up to several kilometers. In this respect, it prevails over solutions such as Bluetooth and WiFi.

The use of LoRa® technology does not involve license fees for frequencies. The technology LoRa® used unlicensed frequency band (433 MHz, 868 MHz and 915 MHz). The technology LoRa® can connect multiple devices, making this protocol suited for use as a communication solution for cities.

The downside of LoRa® modulation is the speed of data transmission. It is in the range of 0.3-37,5 kbps. It prevents devices from sending large data, but allows the sensor network to work.

Another limitation of the LoRa network is the high price of communication modules.

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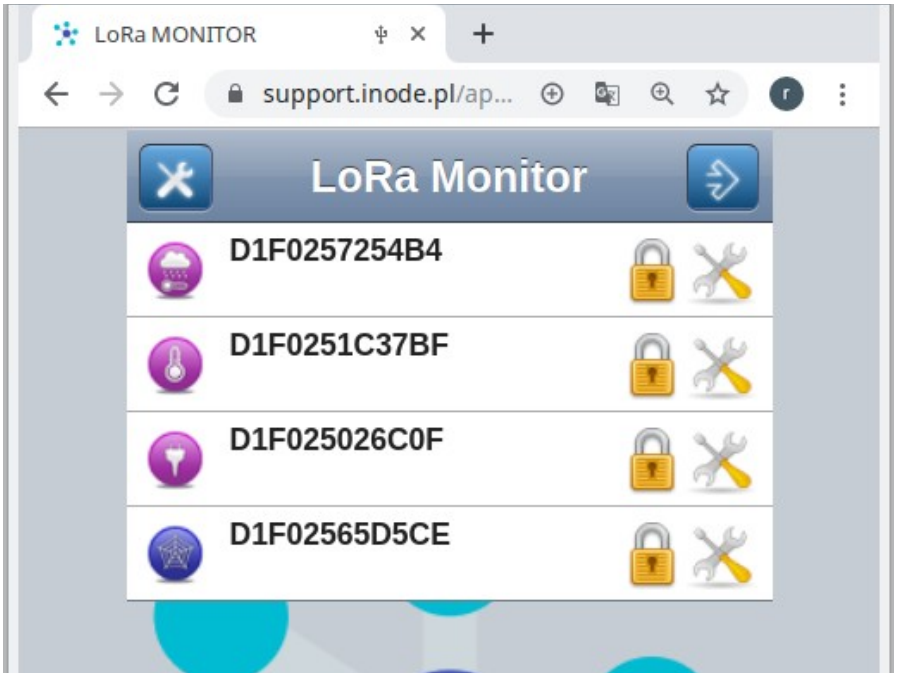
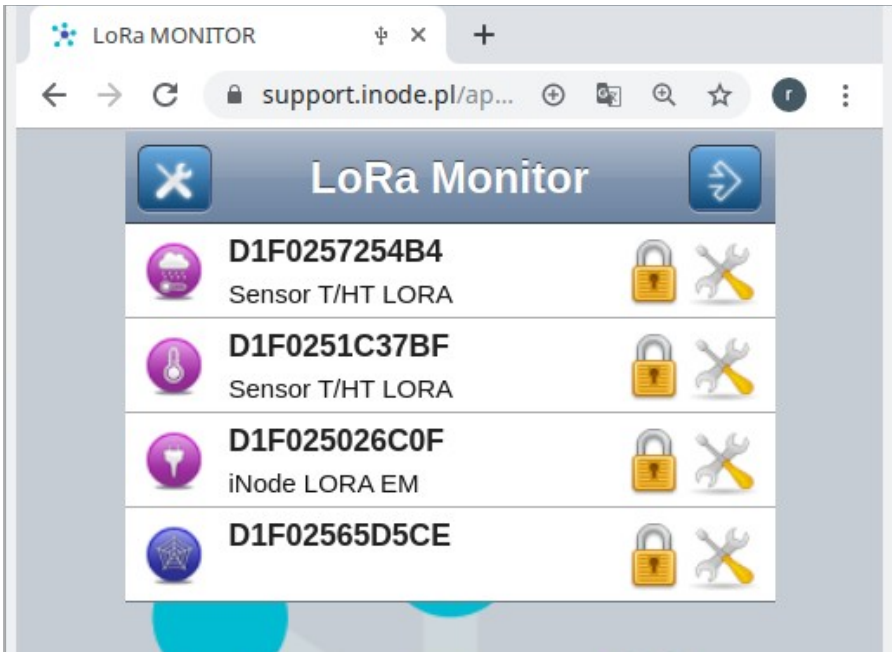
Lora®, LoraWAN®, Bluetooth ®, Windows, Android, Google, Microsoft, Chrome, Linux, Murata, Semtech, ST are used in this brochure for informational purposes only and belong to their respective owners.

2. MONITOR

In this mode, **iNode LoRa Monitor** shows from which devices **iNode LoRa** adapter receives broadcast frames. Whether this is in GFSK or in LoRa depends on the adapter configuration. Each type of **iNode LoR**a device has a different icon.



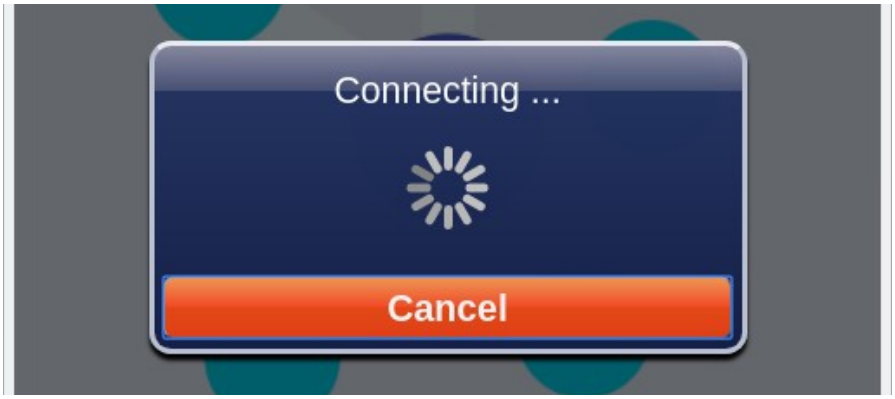
Scanning effect in LoRa.

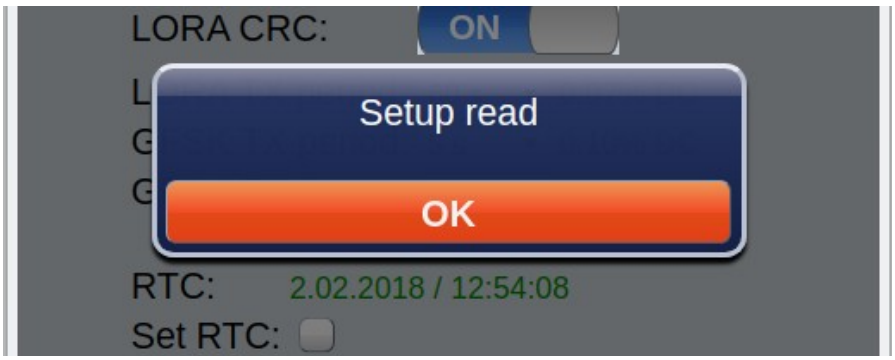


Scanning effect in GFSK.

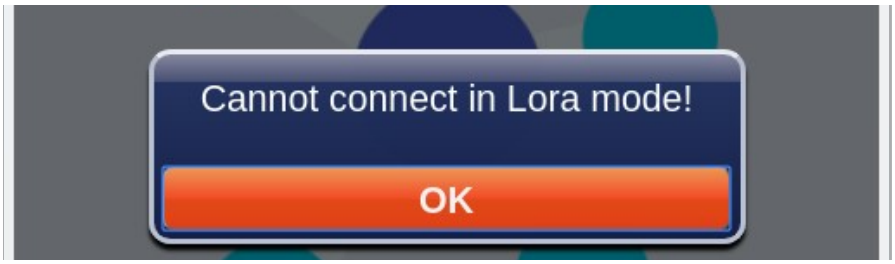
Depending on whether the scan is in GFSK or LoRa, there may be other devices in the list.

The icon  allows establishing connection with the **iNode LoRa** device. This is only possible if the adapter is in GFSK mode and the device you want to connect to also works in this mode. Due to the fact that GFSK modulation enables faster data transmission than LoRa modulation, it was used in **iNode LoRa** sensors to configure and replace firmware.





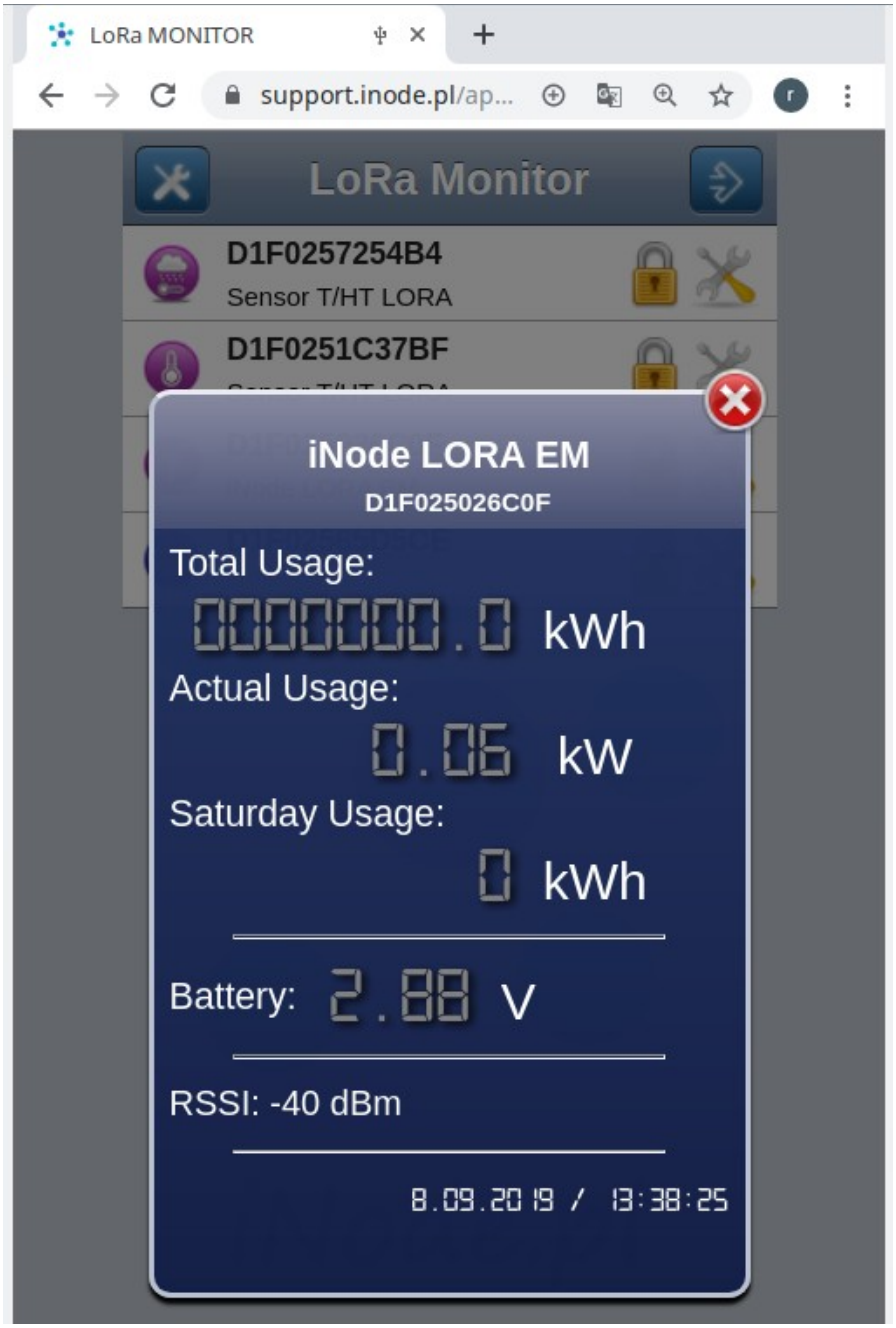
Otherwise, the message *Cannot connect in Lora mode!* will appear.



Based on Wikipedia about GFSK:

GFSK (Gaussian FSK) - a variation of FSK modulation, used for wireless communication within DECT systems, Bluetooth and Z-Wave devices, in which electromagnetic waves in the shape of a Gaussian curve are used. Logical "1" is represented by a positive carrier frequency deviation, and "0" as a negative deviation. In the Bluetooth system, the minimum frequency deviation is 115 kHz. Smoothing of the edges of the impulses is carried out using a Gaussian filter, the effect of which is to reduce the width of the signal spectrum; the next stage is FSK modulation.

iNode LoRa Monitor shows a unique device address on the list of scanned devices. After selecting particular device, a window appears showing the data sent in the broadcast frame received from it.

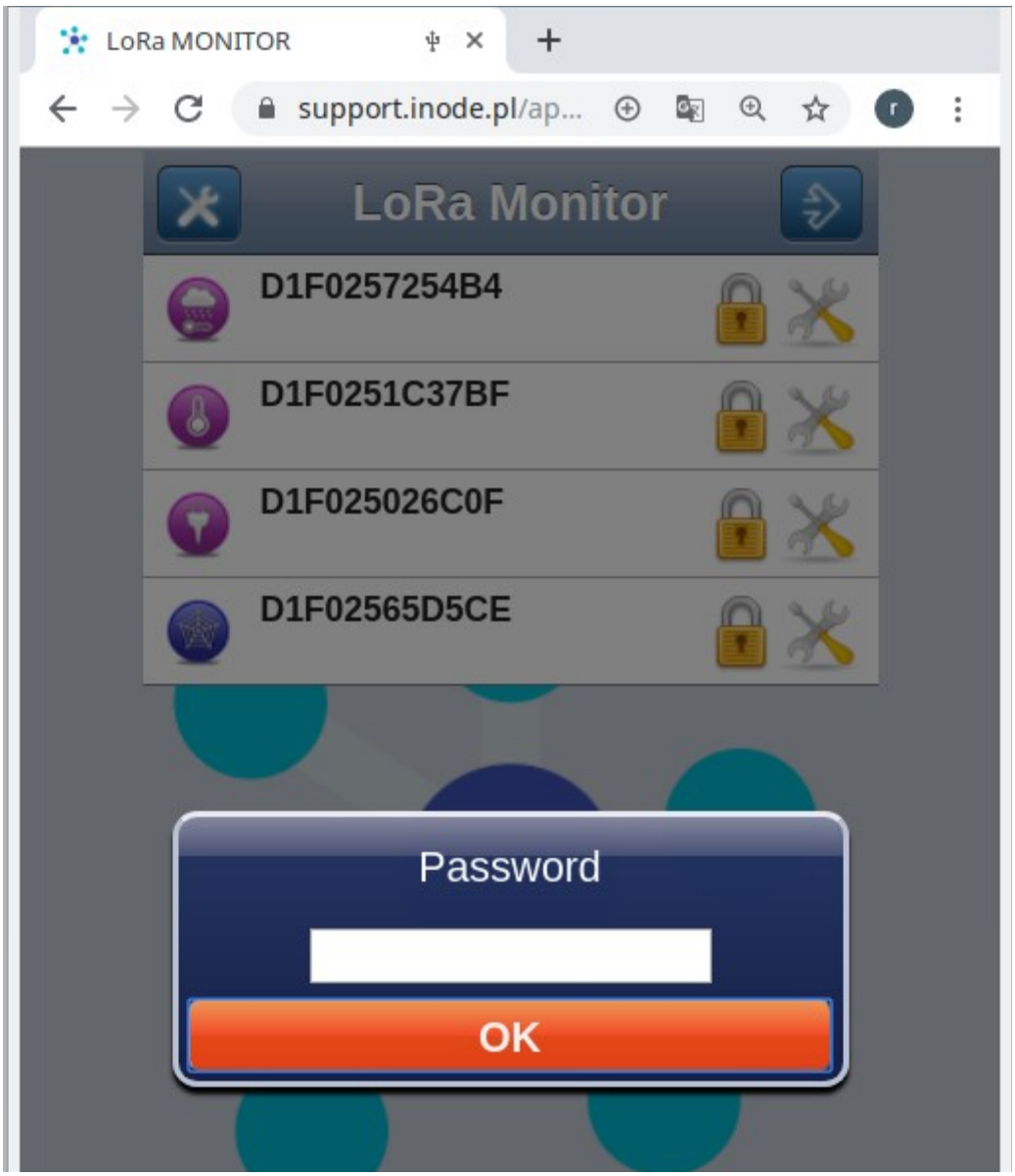


If the **iNode LoRa** device is battery powered, you can see information about the battery voltage. This voltage is measured during transmitting a broadcast frame with LoRa modulation. In idle mode and GFSK one it is higher. The minimum voltage at which **iNode LoRa** devices can work is 1.8V.

In addition, information about the level of the received signal is provided - RSSI and the signal-to-noise ratio - SNR (only in LoRa).

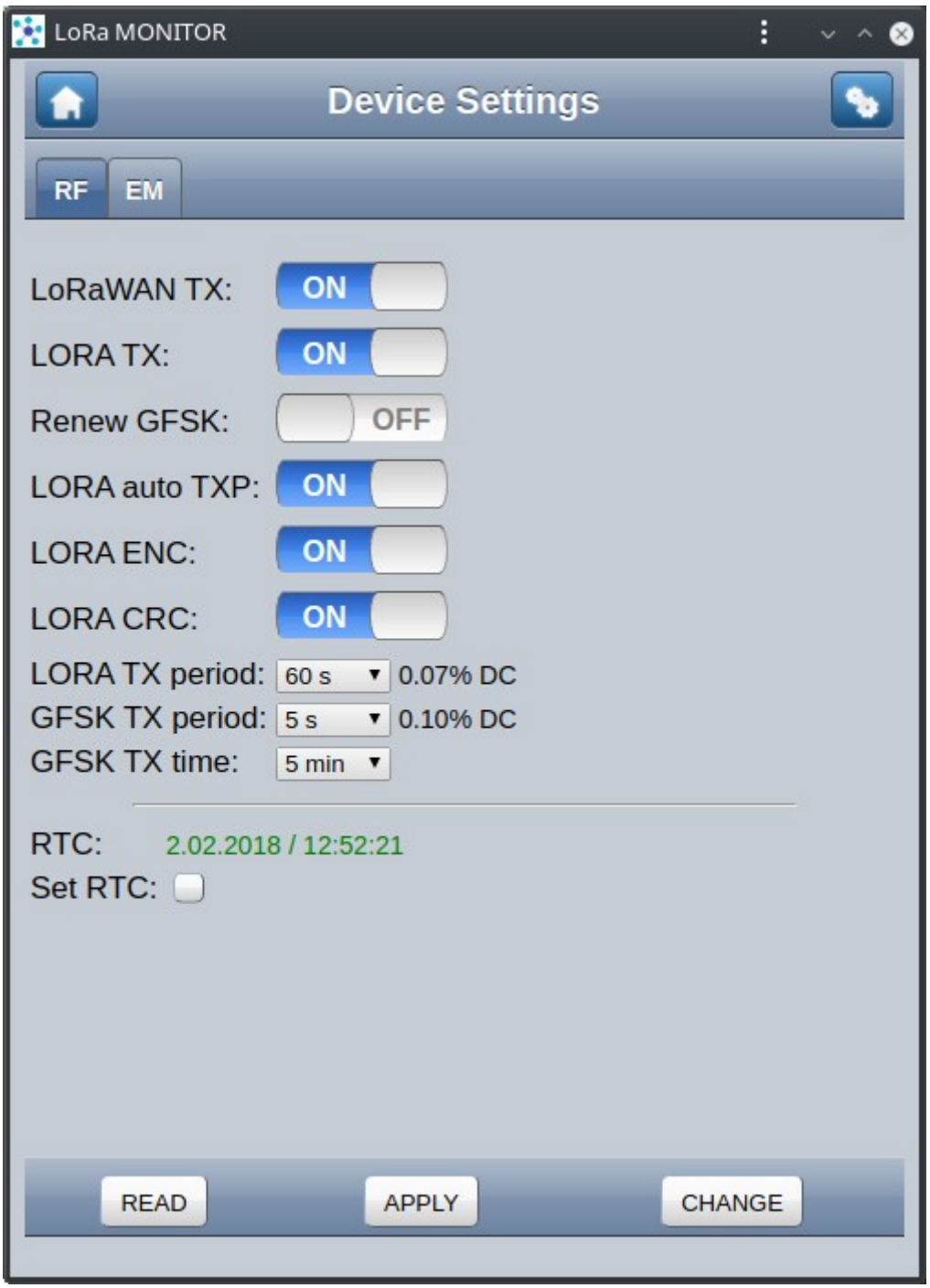
At the very bottom on the right is the date and time of receipt of the last broadcast frame.

The icon  allows you to enter the password necessary to establish a GFSK connection. By default, after the first scan of a device with a given address, it is an empty string. The application remembers entered passwords in the browser database.



3. iNode LoRa device configuration

After selecting the icon  in the list with scanned devices, the **iNode LoRa Monitor** application will try to connect to the given device. When it succeeds, a screen similar to the one below will appear (this one is for **iNode LORA EM**). The ***READ*** button reads data from the device. The ***APPLY*** button changes settings only until the power is turned off or the device is reset. The ***CHANGE*** button changes them permanently and saves them in non-volatile memory. Return to ***MONITOR*** mode is possible after selecting the icon 



3.1 RF

3.1.1 LoRaWAN TX

This switch enables and disables transmission with **LoRa** modulation and with **LoRaWAN** protocol. The device will start working in this mode 5 minutes after turning on the power.

3.1.2 LORA TX

This switch enables and disables transmission with LoRa modulation. If the coverage in GFSK is sufficient for operation, broadcasting in LoRa can be turned off to save battery. The **iNode LoRa Monitor** application will prevent simultaneous disabling of GFSK and LoRa broadcasting. The device must always broadcast to be able to connect to it.

3.1.3 Renew GFSK

This switch allows, if the device only transmits in LoRa, to activate transmission in GFSK for the time specified in ***GFSK TX***. The receiving device (adapter) must then have ***Active Scan*** mode on.

3.1.4 LORA auto TXP

This switch enables the automatic selection of the transmit power level. The receiving device (adapter) must then be in ***Auto TXP*** mode.

3.1.5 LORA ENC

This switch allows the encrypting transmitted data frames. The receiving device (adapter) must then have the password to decryption them entered in the ***PASSWORD*** field.

3.1.6 LORA CRC

This switch allows inclusion of the addition of the checksum to the transmitted data frames. The data frame is longer and it also transmits longer.

3.1.7 LORA TX period

The period of sending broadcast frames by LoRa. On the right, the DC factor is given for the given LoRa TX modulation parameters. It should be remembered that **iNode LoRa** devices are radio and the user must ensure that their operating parameters are compatible with the permissible for a given frequency band. A given device may not transmit too often, because it will prevent transmission to another, especially if its range is large, and so it is when it transmits with high power. Transmission power should also not be greater than allowed by law. The maximum output power allowed in Europe by ETSI is +14 dBm, except for the G3 band, where it can be up to +27 dBm.

3.1.8 GFSK TX period

The period of sending broadcast frames by GFSK . On the right, the DC factor is given for the given GFSK TX modulation parameters. It should be remembered that **iNode LoRa** devices are radio and the user must ensure that their operating parameters are compatible with the permissible for a given frequency band. A given device may not transmit too often, because it will prevent transmission to another, especially if its range is large, and so it is when it transmits with high power. Transmission power should also not be greater than allowed by law. The maximum output power allowed in Europe by ETSI is +14 dBm, except for the G3 band, where it can be up to +27 dBm.

3.1.9 GFSK TX time

Here you can set how long the device will transmit via GFSK after power up or reset. The **iNode LoRa Monitor** application will prevent simultaneous disabling of GFSK and LoRa broadcasting. The device must always broadcast to be able to connect to it.

3.1.10 RTC

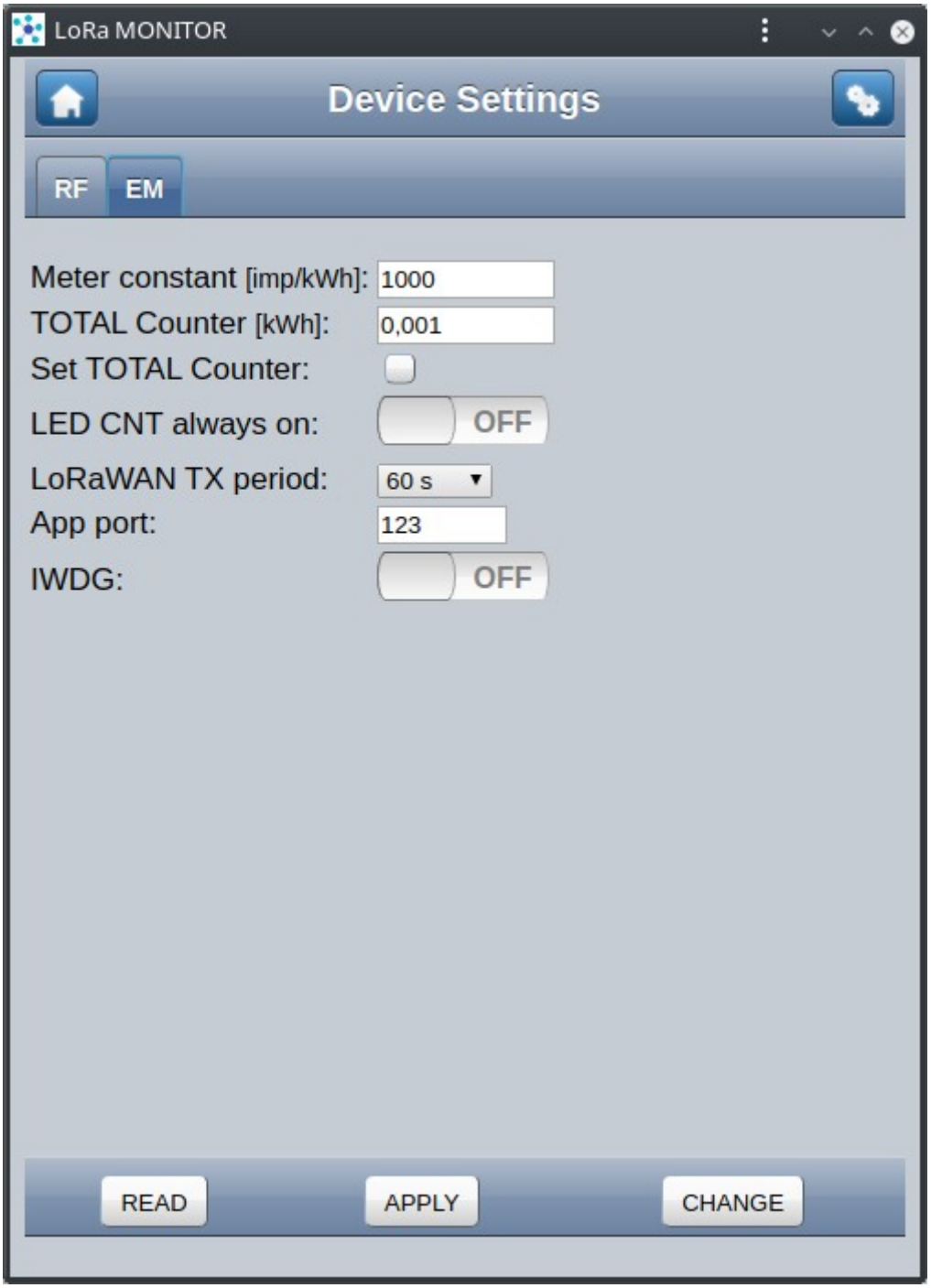
Shows the date and time read from the device.

3.1.11 Set RTC

After selecting and selecting the ***APPLY*** or ***CHANGE*** button, the date and time on the device will be set.

3.2 EM

This tab allows you to modify the operating parameters of **iNode LORA EM**.



3.2.1 Meter constant

Here we can provide a constant of electric meter with which **iNode LORA EM** works. It must be expressed in impulses / kWh and must not be greater than 16383.

3.2.2 TOTAL Counter

The pulse counter value read from **iNode LORA EM** is displayed here . User can now enter new value. However, it will be saved into the device only when ***Set TOTAL Counter*** is selected.

3.2.3 Set TOTAL Counter

Selecting this option and selecting the ***APPLY*** or ***CHANGE*** button will save the value from the ***TOTAL Counter*** to ***iNode LORA EM***.

3.2.4 LED CNT always on

After selecting this option, the LED repeating the LED indicator on the meter will be lit all the time. Otherwise it is always off.

3.2.5 LoRaWAN TX period

Here we can choose how often data from the device will be sent in **LoRaWAN** mode.

3.2.6 App port

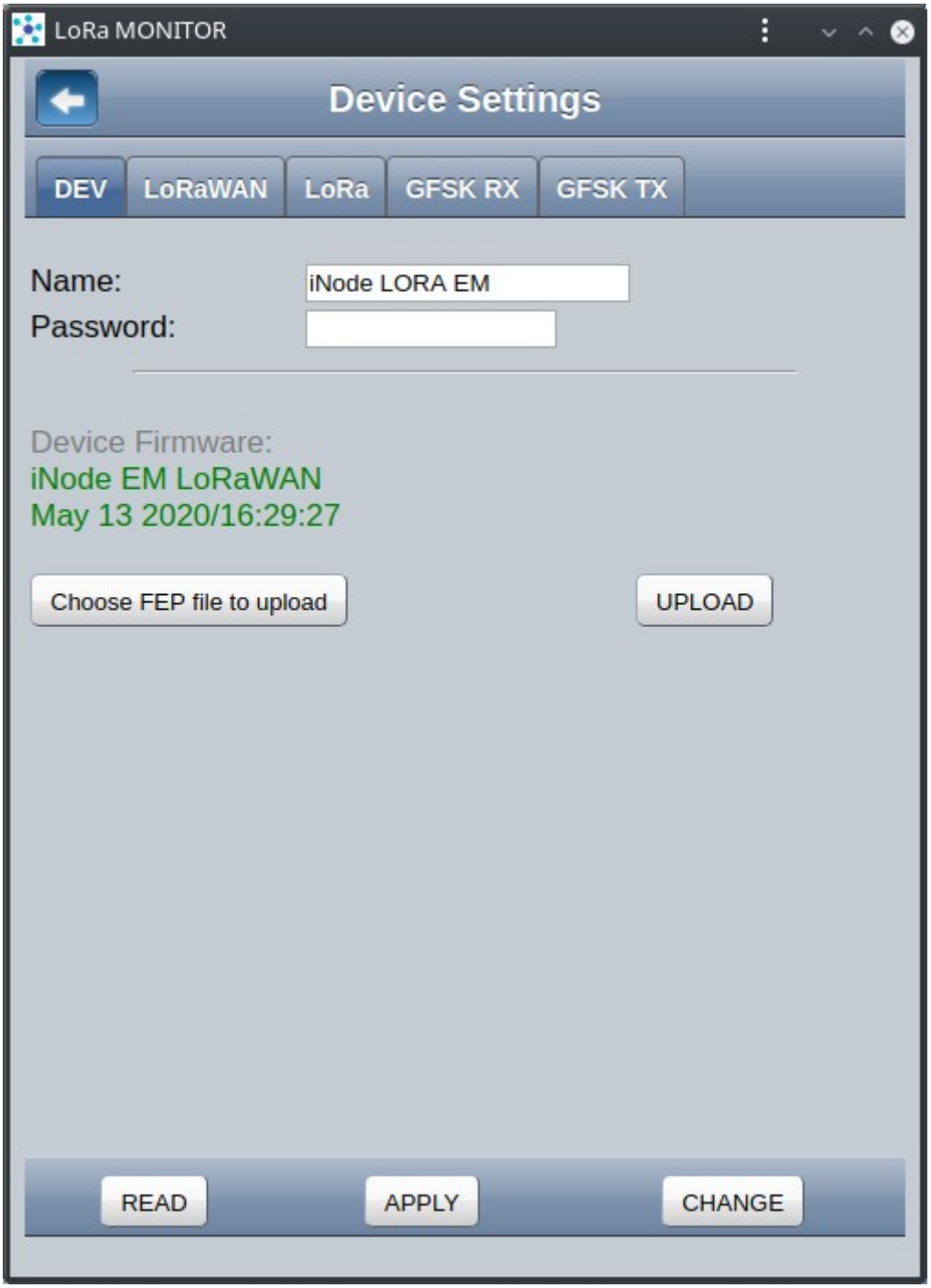
The port number to which data is sent in **LoRaWAN** mode.

3.2.7 IWDG

We can enable and disable the hardware watchdog. In **LoRaWAN** mode it is always turned off to save energy.

3.3 RF Settings

After selecting the button  the **iNode LoRa Monitor** application will allow you to configure the RF (radio) parameters of the device. They are similar to those for the **iNode LoRa** adapter.



3.3.1 DEV

3.3.1.1 Name

Here you can change the device name sent by GFSK in the frame with the answer to the active query.

3.3.1.2 Password

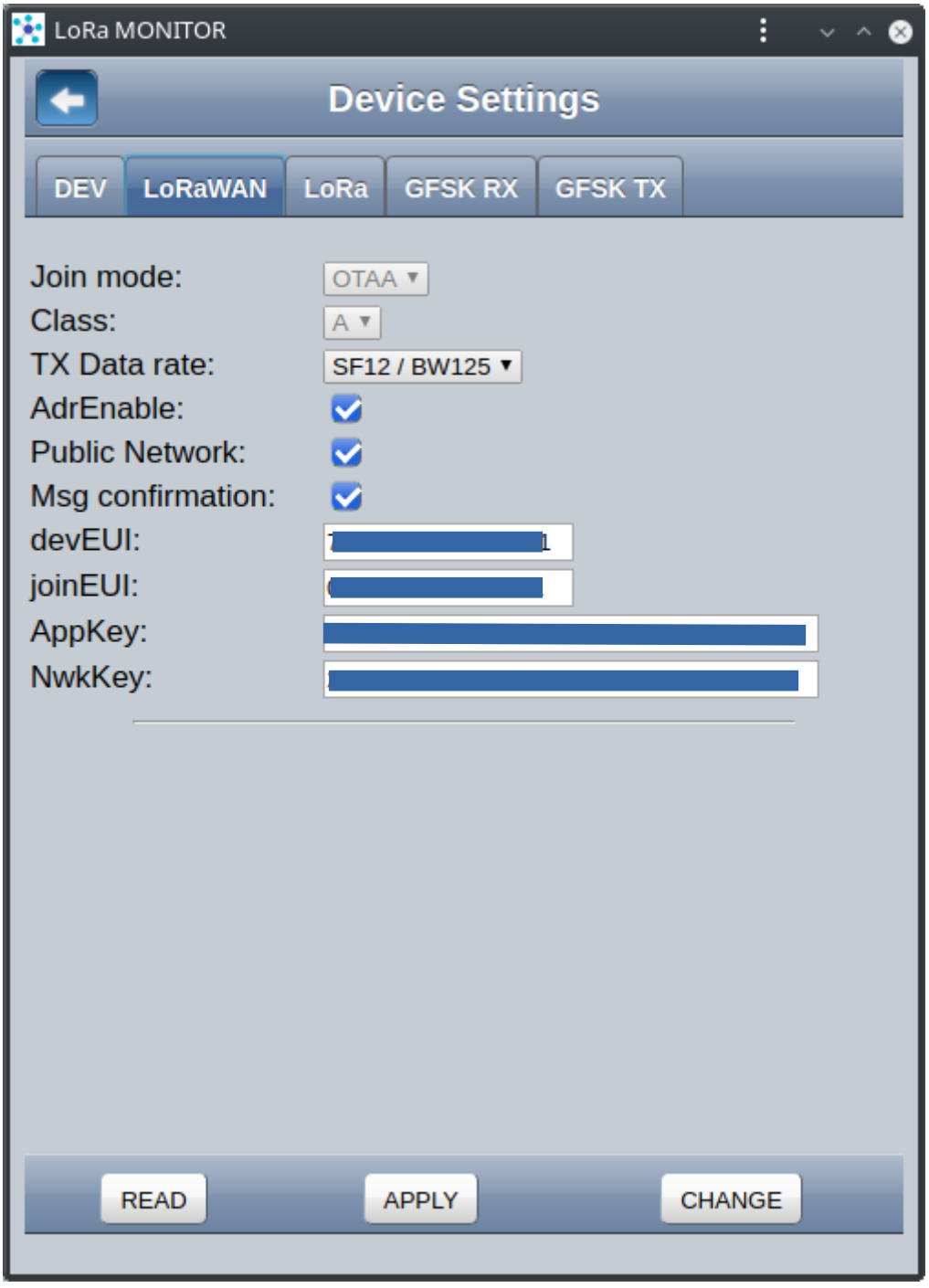
Here you can enter the password for access to the device via GFSK. The default is an empty string.

3.3.1.3 Device Firmware

This part of the tab displays information about the firmware in the device. After pressing the ***Choose FEP file to upload*** button, the system browser window will appear for choosing a firmware file. Files with firmware for ***iNode LoRa*** devices have the extension *.fep* and contain information for which device they are intended. Therefore, it is not possible to upload to the device firmware intended for another.

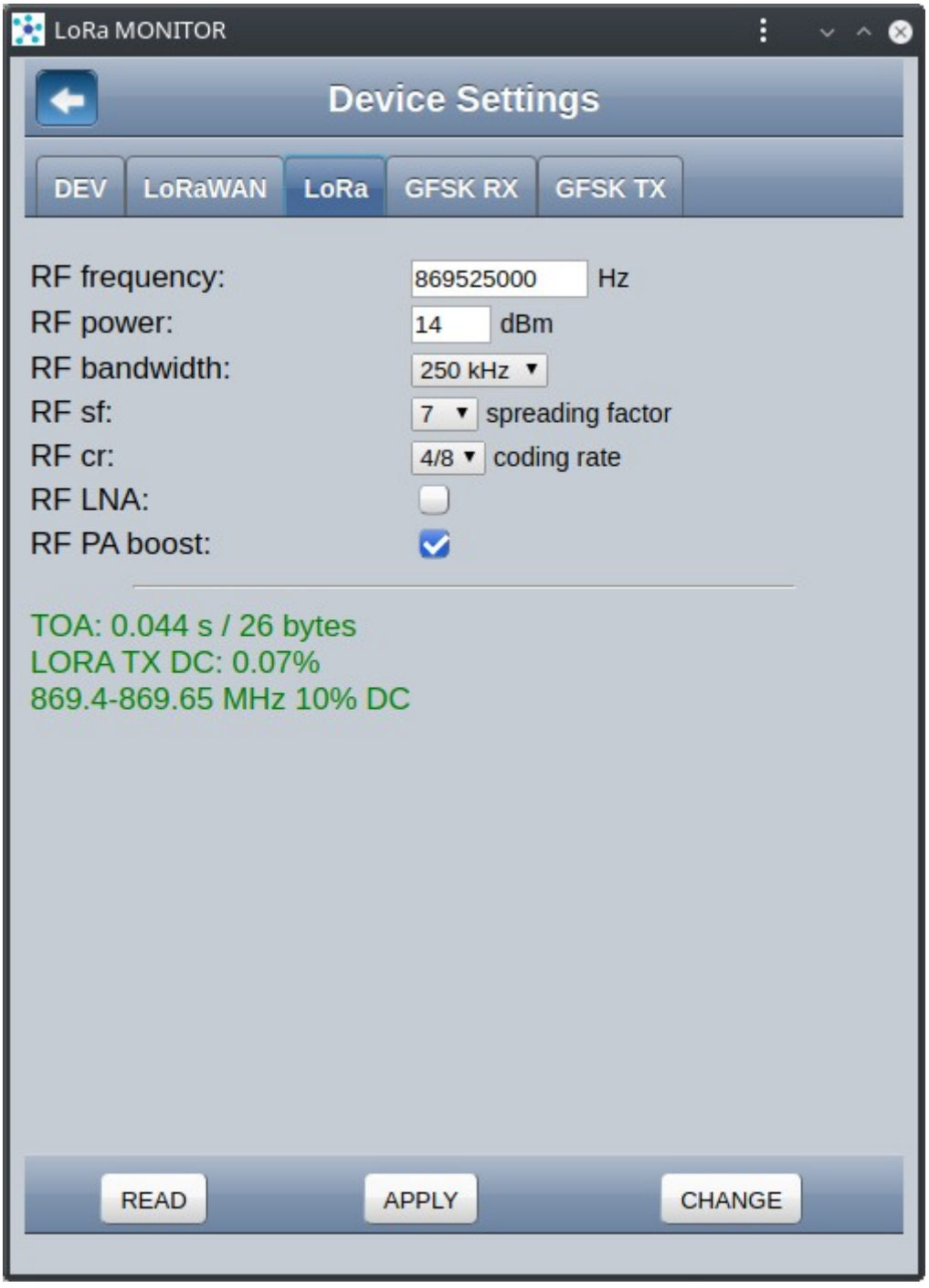
3.3.2 LoRaWAN

This tab allows you to change the **LoRaWAN** operating parameters. It may only be available if the device's firmware enables operation in this mode.



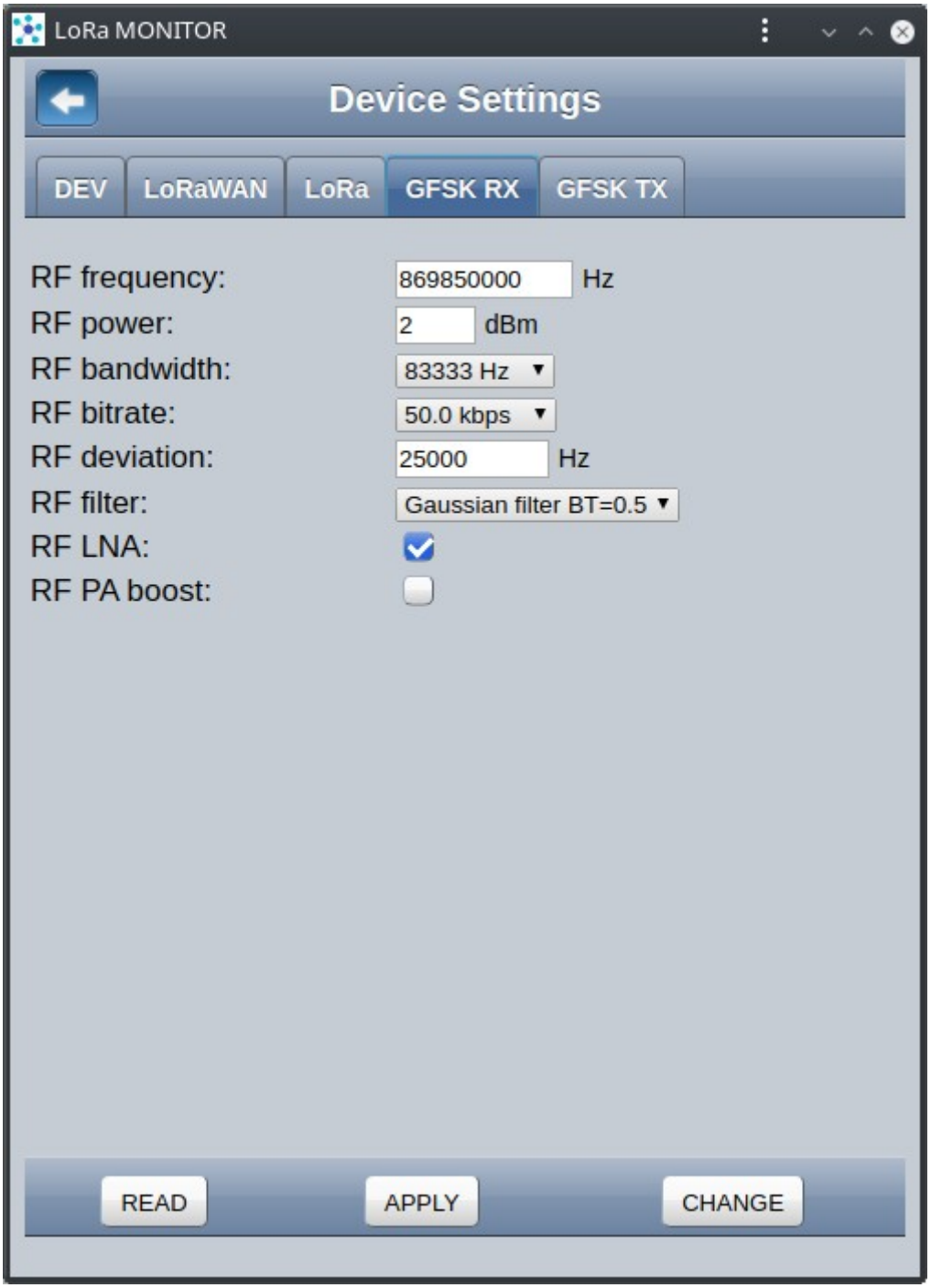
3.3.3 LoRa

This tab allows you to change LoRa modulation parameters of the device. Please note that these parameters must be the same in the **iNode LoRa** adapter, otherwise it will not receive any data from device. Below all parameters information is displayed, what is the maximum allowable value of DC coefficient in a given frequency band, and what is obtained by the device - LORA TX DC. This information is only helpful and the user should confirm it with the regulator. The maximum output power allowed in Europe by ETSI is +14 dBm.



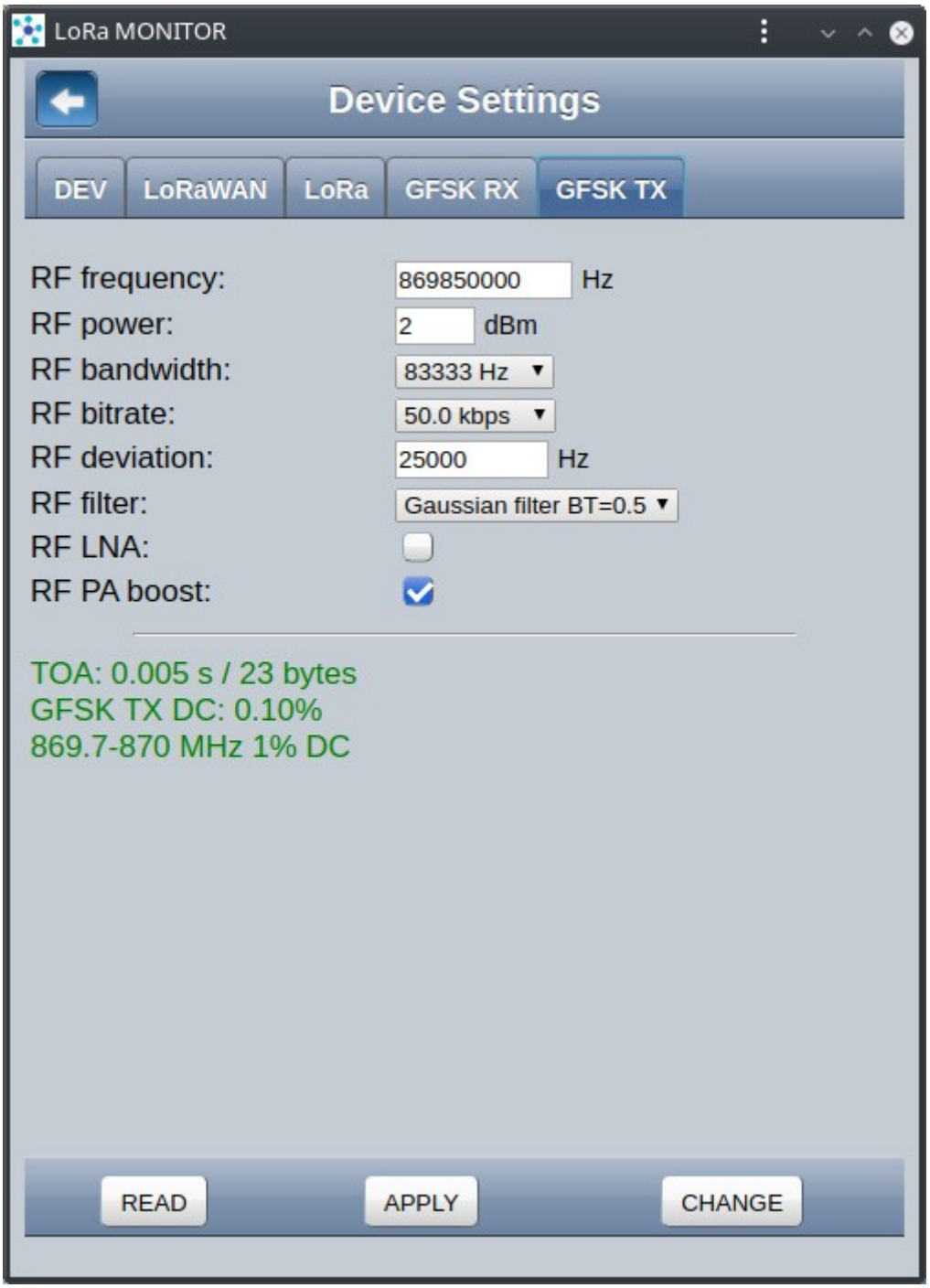
3.3.4 GFSK RX

This tab allows you to change the GFSK modulation parameters of the device in RX mode, i.e. receiving data. Please note that these parameters must be the same (GFSK TX) in the adapter, otherwise it will not send any data to the device. Devices **iNode Lora** have a so-called emergency mode, which is activated for 5 minutes after the power is turned on. They transmit over GFSK for 5 minutes with the parameters as in the window below.



3.3.5 GFSK TX

This tab allows you to change the GFSK modulation parameters of the device in TX mode, i.e. sending data. Please note that these parameters must be the same (GFSK RX) in the **iNode LoRa** adapter, otherwise it will not receive any data from the device. Below all parameters information is displayed, what is the maximum permissible value of DC coefficient in a given frequency band, and what is obtained by the device - GFSK TX DC. This information is only helpful and the user should confirm it with the regulator. The maximum output power allowed in Europe by ETSI is +14 dBm.



4. Data frame in GFSK or LoRa mode

The LoRa USB adapter in GFSK or LoRa scan mode sends following HCI frames:

043E1E0201007F28214525F0D1120EFF9082140042000100E803E0ED10020A02F0

043E1B0201047F28214525F0D10F0E09694E6F6465204C4F524120454DF3

The first one contains data from the broadcasting frame and the second one from the answer to the active query.

4.1 HCI frame with scan results (GFSK and LoRa)

043E1E0201007F28214525F0D1120EFF9082140042000100E803E0ED10020A02F0

043E1E

- **04** → HCI packet indicator: 0x04 EVENT
- **3E** → event_code = 0x3E → LE EVENTS
- **1E** → HCI parameter total length → 0x1E = 30

0201007F28214525F0D112

- **02** → Subevent_Code = 0x02 → LE Advertising Report event
- **01** → Num_Reports = 0x01 → number of responses in event (always 1)
- **00** → Event_Type[i] = 0x00 → connectable uni-directed advertising (ADV_IND)
- **7F** → SNR; in GFSK mode not available (value 127)
- **28214525F0D1** → Address[i] = D1F025452128 (Public Device Address) - MAC address of device
- **12** → Length_Data[i] = 0x12 = 18 (length of the Data[i] field)

0EFF9082140042000100E803E0ED10

- **0E** → 0x0E → Length = 14
- **FF** → EIR Data Type = 0xFF - «Manufacturer Specific Data» tag
- **9082** → 0x8290 **iNode LoRa EM** identifier; bit 2=1 → range 3.3V – 3.69V; bit 2=0 → range 1.8V – 3.3V;
- **1400** → 0x0014 – value counted in a minute; average power consumed in a given minute is (0x0014/0x03E8)*60=(20/1000)*60=1.2 kW
- **42000100** → 0x00010042 total number of pulses counted; amount of kWh = 0x00010042/0x03E8=65.602 kWh
- **E803** → 0x03E8 = 1000 pulses/kWh (the meter constant is youngest 14 bits of this value); the oldest 2 bits carry information about the selected counting unit: 0-[kWh], 1-[m³], 2 lub 3 - pulses;
- **E0** → 0xE0 – the four oldest bits value of 0xE is the battery voltage coded: 0xE=14 -> Vbat=(14-2)*10=120% - I.e. 3.24V; we convert the percentage into voltage according to the formula: (((Vbat*1.2V)/100)+1.8V) – range 1.8V – 3.3V;

(((Vbat*0.3V)/100)+3.3V) – range 3.3V – 3.69V;

ED10 → 0x10ED - the 4 oldest bits are the coded day of the week (0-Sunday, 1-Monday, .., 7-Saturday) for which the value counted in the last 24 hours is sent in the units set in the device; in this case, the day of the week is 1 -> Monday, and the value of energy consumed is 0x00ED = 237 kWh;

020A02

02 → 0x02 → Length = 2

0A → EIR Data Type = 0x0a → «Tx Power Level» tag

02 → 0x02 = 2dBm

F3 → RSSI[i] = 0xF3 → RSSI = -13dBm (signed integer); Range: -127 < N < +20dBm; 127 RSSI is not available

4.2 HCI frame with active query response (GFSK)

043E1B0201047F28214525F0D10F0E09694E6F6465204C4F524120454DF3

043E1B

04 → HCI packet indicator: 0x04 EVENT

3E → event_code = 0x3e → LE EVENTS

1B → HCI parameter total length → 0x1B = 27

0201047F28214525F0D112

02 → Subevent_Code = 0x02 → LE Advertising Report event

01 → Num_Reports = 0x01 → number of responses in event (always 1)

04 → Event_Type[i] = 0x00 → connectable uni-directed advertising (ADV_IND)

7F → SNR; in GFSK mode not available (value 127)

28214525F0D1 → Address[i] = D1F025452128 (Public Device Address) - MAC address of the device

0F → Length_Data[i] = 0x0F = 15 (length of the Data[i] field)

0E09694E6F6465204C4F524120454D

0E → 0x0E → Length = 14

09 → EIR Data Type = 0x09 - «Complete Local Name» tag

694E6F6465204C4F524120454D → iNode LORA EM

F3 → RSSI[i] = 0xF3 → RSSI = -13dBm (signed integer); Range: -127 < N < +20dBm; 127 RSSI is not available

5. Payload LoRaWAN

In **LoRaWAN** mode the following data is transmitted:

7D8DFFB0000014005201010 0E80310EDDE0B

7D → 0x7D → RegPaConfig; MaxPower=7 Pmax=10.8+0.6*7=15 [dBm]; OutputPower=0x0d=13; Pout=Pmax-(15-OutputPower)=15-(15-13)=15-2=13 [dBm]

8D → 0x8D → RSSI = -115 [dBm]; only if the messages are sent with confirmation;

FF → 0xFF → SNR = -1 [dBm]; only if the messages are sent with confirmation;

B00000 → 0x0000B0 → counter of sent messages = 0x0000B0

1400 → 0x0014 - value counted in a minute; average power consumed in a given minute is (0x0014/0x03E8)*60=(20/1000)*60=1.2 kW

52010100 → 0x00010152 total number of counted pulses; amount of kWh = 0x00010152 / 0x03E8 = 65, 874 kWh

E803 → 0x03E8 = 1000 pulses/kWh (the meter constant is the youngest 14 bits of this value); the oldest 2 bits carry information about the selected counting unit: 0- [kWh], 1- [m³], 2 or 3 - pulses;

ED10 → 0x10ED - the 4 oldest bits are the coded day of the week (0- Sunday, 1-Monday, .., 7-Saturday) for which the value counted in the last 24 hours is sent in the units set in the device; in this case, the day of the week is 1 -> Monday, and the value of energy consumed is 0x00ED = 237 kWh;

DE0B → 0x0BDE; supply voltage in mV =3038 [mV]

6. INSTALLATION OF THE DEVICE AT THE METER

There are two LEDs on one side of the device. One of them (LED1 - white) shows that the device is active - a short flash (only if IWDG is on) or transmits - a flash lasting as long as RF transmission. In **LoRaWAN** mode this LED flashes twice if confirmation from the **LoRaWAN** gateway has been received. Otherwise it's off.

The second LED (LED2 - green) indicates the counted pulses. It glows normally darker than LED1 to save battery. Its operation can be checked, for example, with an infrared remote control from the TV.

On the opposite side of the device from the LED2 diode there is a photo-transistor lens . In order for **iNode LORA EM** to count error-free flashes of the LED diode in the electricity meter, the photo-transistor must be directed directly at it , and **iNode LORA EM** should be placed as close to the meter as possible. However, please remember that the hole for the LED in the meter coincides with the field of view of the photo-transistor. If these conditions are met and **iNode LORA EM** will work properly even placed on the plexiglas plate protecting the meter in power connector at home. Strong external lighting may disturb the operation of the device.

When mounting, make sure that the antenna area is not near metal surfaces that could disturb the operation of the device.

***iNode LORA EM** – view after removing the cover*

7. BATTERY CHANGE

Battery CR 2 power **iNode LORA EM** should act to 6 months. In fact, the speed of its consumption depends on many factors, e.g. operating mode, temperature, data period , set transmission power level, etc. The battery voltage as a function of time (energy consumed from it) is practically flat for a long time. Only at the end of the battery voltage begins to decrease rapidly, and its internal resistance increases, which leads to rapid wear.

To replace the battery:

1. Open the housing:

   The **iNode LORA EM** housing can be opened without using tools. Inside is a printed circuit board, most of which is occupied by a metal battery holder.

2. Slide the old battery out of the holder.

3. Insert a new battery:

   When the old battery is not completely used up, wait a few dozen seconds before inserting a new battery so that the device can properly restart. The battery should be inserted between the contact springs so that the side marked with "+" is in contact with the flat spring. If the operation was carried out correctly, the white LED should start flashing.

4. Close the housing.

8. TECHNICAL SPECIFICATIONS

GFSK/LoRa radio parameters:

- RX/TX:
  - ISM: 868 MHz;
- output power (minimum / maximum):
  - ISM: 2dBm / 20dBm;
- modulation:
  - GFSK;
  - LoRa - CSS (chirp spread spectrum) modulation;
- internal antenna:
  - 868 and 915MHz dual (wide-band) ISM band SMD chip antenna;
  - frequency: 858 - 928 MHz;
  - average gain: -2,5dBi;

GFSK/LoRa:

- configurable from PC:
  - GFSK modulation: frequency, power, bandwidth, bit rate, deviation;
  - LoRa modulation: frequency, power, bandwidth, sf, cr;
  - TX power in range from +2dBm to +20dBm;
  - GFSK broadcasting period;
  - LoRa or LoRaWAN broadcasting period;
  - LoRaWAN operating parameters;
  - device name;
  - energy meter constant;
  - user password;

Power supply:

- 3V – CR2 battery;

Housing:

- plastic;
- dimensions: 52mm x 32 mm x 19 mm (LxWxH);

Others:

- remote firmware update and configuration via GFSK;
- two LEDs;
- operating temperature: from -30 to 65°C;
- humidity: 35-90% RHG;
- weight (without battery / with battery): 13 g / 23 g ;

Lightning sensor (photo-transistor):

- viewing angle: ±12 °;
- spectral range: 620 nm – 960 nm;
- operating frequency: max. 50Hz;

Equipment:

- CR2 battery;

Software:

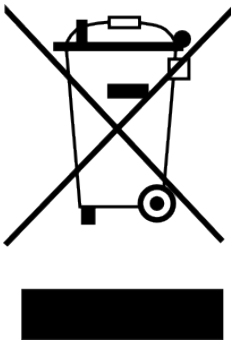
- Google CHROME: Android OS, Linux, Windows 10;

Chipset:

- STM32L082;
- SX1276;

The manufacturer reserves the right to change device and software parameters as well as introduce other construction solutions.

9. CORRECT PRODUCT REMOVAL (WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT)



The packaging materials are 100% suitable for use as a secondary raw material. The packaging should be disposed of in accordance with local regulations. Keep packaging materials out of the reach of children as they pose a source of danger. The marking on the product or in related texts indicates that the product should not be disposed of with other household waste after it has expired. To avoid harmful effects on the environment and human health due to uncontrolled waste disposal, please separate the product from other types of waste and recycle responsibly to promote the reuse of material resources as a permanent practice.

Correct disposal of the device:

- Pursuant to the WEEE Directive 2012/19 / EU, the symbol of the crossed wheeled waste container means all electrical and electronic devices subject to selective collection.
- After the end of its useful life, this product must not be disposed of as normal household waste, but should be sent to a collection point for the recycling of electrical and electronic equipment. This is indicated by the symbol of the crossed-out wheeled waste container, placed on the product or in the operating instructions or packaging.
- The materials used in the device are reusable according to their designation. Thanks to the reuse, use of materials or other forms of use of used devices, you make a significant contribution to the protection of our natural environment.
- For information on the appropriate disposal point for used electrical and electronic equipment, please contact your local municipality administration or the device seller.
- Used, fully discharged batteries and accumulators must be disposed of in specially marked containers, taken to special waste collection points or sellers of electrical equipment.
- Users in companies should contact their supplier and check the terms of the purchase contract. The product should not be disposed of with other household waste.

Numer Deklaracji 1/02/2018 Data wystawienia Deklaracji 01.02.2018 r.
Number of declaration of Conformity *Date of issue of declaration*

DEKLARACJA ZGODNOŚCI UE RED

UE RED DECLARATION OF CONFORMITY

Producent / *Manufacturer*:

ELSAT s.c.

(nazwa producenta / producer's name)

ul.Warszawska 32E/1, 05-500 Piaseczno k/Warszawy

(adres producenta / producent's address)

niniejszym deklaruje, że następujący wyrób:
declare, under our responsibility, that the electrical product:

iNode LoRa EM **0x8203 CR2**

(nazwa wyrobu / product's name) *(model / model)*

spełnia wymagania następujących norm zharmonizowanych:
to which this declaration relates is in conformity with the following harmonized norm:

Short Range Devices (SRD) operating in the frequency range 25 MHz to 1 000 MHz**:**

ETSI EN 300 220-1 V 3.1.1:2017-02
ETSI EN 300 220-2 V 3.1.1:2017-02

Radio Spectrum ISM (Article 3.2 of the RED directive)**:**

ETSI EN 300 328 V2.1.1:2016-11

EMC (Article 3.1.b of the RED directive):

ETSI EN 301 489-1 V2.1.1:2016-11
ETSI EN 301 489-3 V2.1.1:2016-11
ETSI EN 301 489-17 V3.1.1:2016-11

Safety (Article 3.1.a of the RED directive):

PN-EN 62368-1:2015-03

Health (Article 3.1.a of the RED directive):

PN-EN 62311:2008

RoHs:

PN-EN IEC 63000:2019-01

jest zgodny z postanowieniami następujących dyrektyw Unii Europejskiej:
is compatible with the following European Union directives:

Dyrektywa RED 2014/53/UE
Dyrektywa EMC 2014/30/UE
Dyrektywa LVD 2014/35/UE
Dyrektywa RoHS 2011/65/UE

Procedura oceny zgodności: wewnętrzna kontrola produkcji zgodnie z załącznikiem II RED
Acceptance procedure: internal production control in accordance with Annex II of the RED Directive

01.02.2018 r. Robert Kujda
Piaseczno k/Warszawy

(data i miejscowość / date and place) Współwłaściciel

(podpis i stanowisko / signature and function)

RoHS 2 2011/65/EU