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 IoT_Soil_Moisture_EC_Sensor_User_Manual/) ▾

SE01-NB -- NB-IoT Soil Moisture & EC Sensor User Manual

Last modified by Mengting Qiu (/xwiki/bin/view/XWiki/ting) on 2023/11/20 14:22



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1. Introduction

1.1 What is NB-IoT Soil Moisture & EC Sensor

The Dragino SE01-NB is a **NB-IoT Soil Moisture & EC Sensor** for IoT of Agriculture. It is designed to measure the **soil moisture of saline-alkali soil and loamy soil**. It has been calibrated in factory for Mineral soil type.

It detects **Soil Moisture, Soil Temperature** and **Soil Conductivity**, and uploads the value via wireless to NB-IoT IoT Server.

SE01-NB supports different uplink methods including **MQTT, MQTTs, UDP & TCP** for different application requirement, and support uplinks to various IoT Servers.

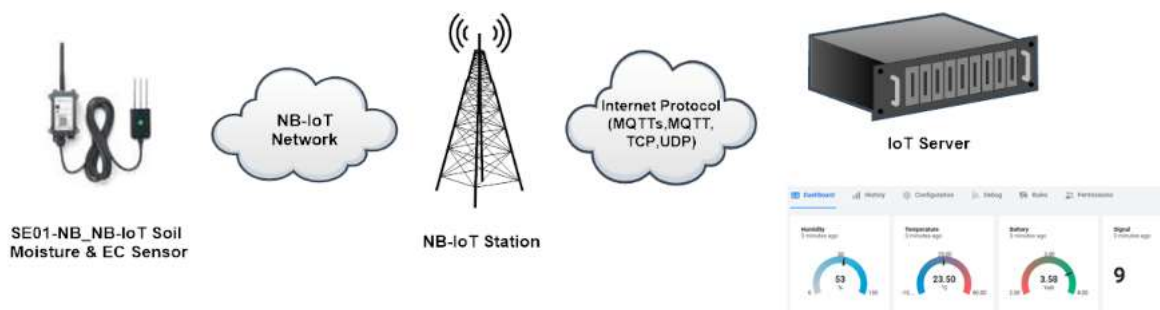
SE01-NB **supports BLE configure and OTA update** which make user easy to use.

SE01-NB is powered by **8500mAh Li-SOCI2 battery**, it is designed for long-term use up to several years.

SE01-NB has optional built-in SIM card and default IoT server connection version. Which makes it works with simple configuration.



SE01-NB in a NB-IoT Network



1.2 Features

- NB-IoT Bands: B1/B2/B3/B4/B5/B8/B12/B13/B17/B18/B19/B20/B25/B28/B66/B70/B85 @H-FDD
- Ultra-low power consumption
- Monitor Soil Moisture
- Monitor Soil Temperature
- Monitor Soil Conductivity
- Multiply Sampling and one uplink
- Support Bluetooth v5.1 remote configure and update firmware

- Uplink on periodically
- Downlink to change configure
- 8500mAh Battery for long term use
- Nano SIM card slot for NB-IoT SIM

1.3 Specification

Common DC Characteristics:

- Supply Voltage: 2.5v ~ 3.6v
- Operating Temperature: -40 ~ 85°C

Soil Moisture:

- Range: 0-100.00 V/V %
- Resolution: 0.01 V/V %
- Accuracy: $\pm 3\%$ (0-53%) V/V %, $\pm 5\%$ (>53%) V/V %
- Measure Method: FDR , with temperature & EC compensate

Soil Temperature

- Range: -40.00°C ~ 85.00°C
- Resolution: 0.01°C
- Accuracy: -10°C ~ 50°C: <0.3°C, All other: <0.6°C
- Measure Method: RTD, and calibrate

Soil Conductivity

- Range: 0-20000 uS/cm(25°C)(0-20.0EC)
- Resolution: 1 uS/cm
- Accuracy: 2%FS
- Measure Method: Conductivity, with temperature compensate

NB-IoT Spec:

NB-IoT Module: BC660K-GL

Support Bands:

- B1 @H-FDD: 2100MHz
- B2 @H-FDD: 1900MHz
- B3 @H-FDD: 1800MHz
- B4 @H-FDD: 2100MHz
- B5 @H-FDD: 860MHz
- B8 @H-FDD: 900MHz
- B12 @H-FDD: 720MHz
- B13 @H-FDD: 740MHz
- B17 @H-FDD: 730MHz
- B18 @H-FDD: 870MHz
- B19 @H-FDD: 870MHz
- B20 @H-FDD: 790MHz
- B25 @H-FDD: 1900MHz
- B28 @H-FDD: 750MHz
- B66 @H-FDD: 2000MHz
- B70 @H-FDD: 2000MHz
- B85 @H-FDD: 700MHz

Battery:

- Li/SOCI2 un-chargeable battery
- Capacity: 8500mAh
- Self Discharge: <1% / Year @ 25°C
- Max continuously current: 130mA
- Max boost current: 2A, 1 second

Power Consumption

- STOP Mode: 10uA @ 3.3v
- Max transmit power: 350mA@3.3v

1.4 Applications

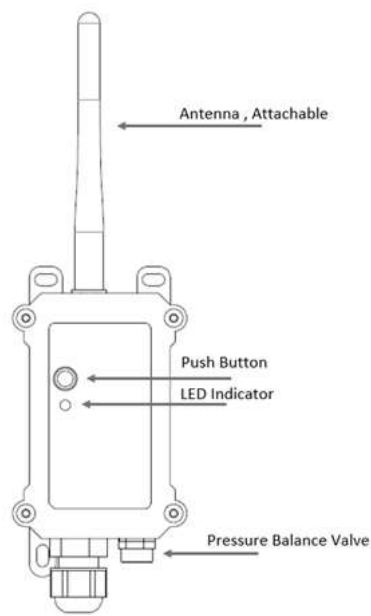
- Smart Agriculture

1.5 Sleep mode and working mode

Deep Sleep Mode: Sensor doesn't have any NB-IoT activate. This mode is used for storage and shipping to save battery life.

Working Mode: In this mode, Sensor will work as NB-IoT Sensor to Join NB-IoT network and send out sensor data to server. Between each sampling/tx/rx periodically, se

1.6 Button & LEDs



Behavior on ACT	Function	Action
Pressing ACT between 1s < time < 3s	Send an uplink	If sensor has already attached to NB-IoT network, sensor will send an uplink packet, blue led will blink once. Meanwhile, BLE module will be active and user can connect via BLE to configure device.
Pressing ACT for more than 3s	Active Device	Green led will fast blink 5 times, device will enter OTA mode for 3 seconds. And then start to attach NB-IoT network. Green led will solidly turn on for 5 seconds after joined in network. Once sensor is active, BLE module will be active and user can connect via BLE to configure device, no matter if device attach NB-IoT network or not.
Fast press ACT 5 times.	Deactivate Device	Red led will solid on for 5 seconds. Means device is in Deep Sleep Mode.

Note: When the device is executing a program, the buttons may become invalid. It is best to press the buttons after the device has completed the program execution.

1.7 BLE connection

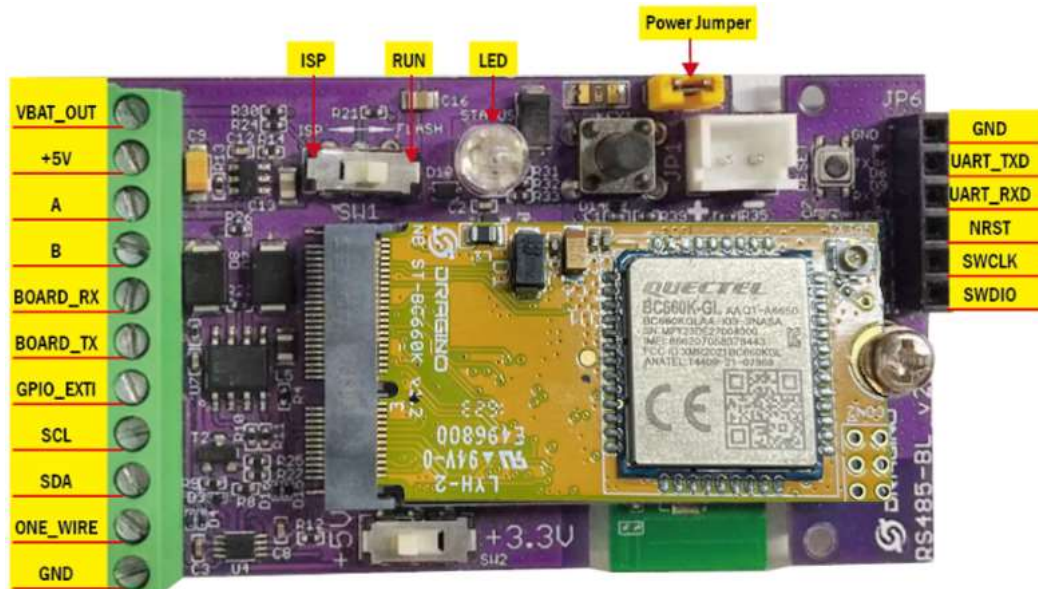
SE01-NB support BLE remote configure and firmware update.

BLE can be used to configure the parameter of sensor or see the console output from sensor. BLE will be only activate on below case:

- Press button to send an uplink
- Press button to active device.
- Device Power on or reset.

If there is no activity connection on BLE in 60 seconds, sensor will shut down BLE module to enter low power mode.

1.8 Pin Definitions & Switch



1.8.1 Jumper JP2

Power on Device when put this jumper.

1.8.2 BOOT MODE / SW1

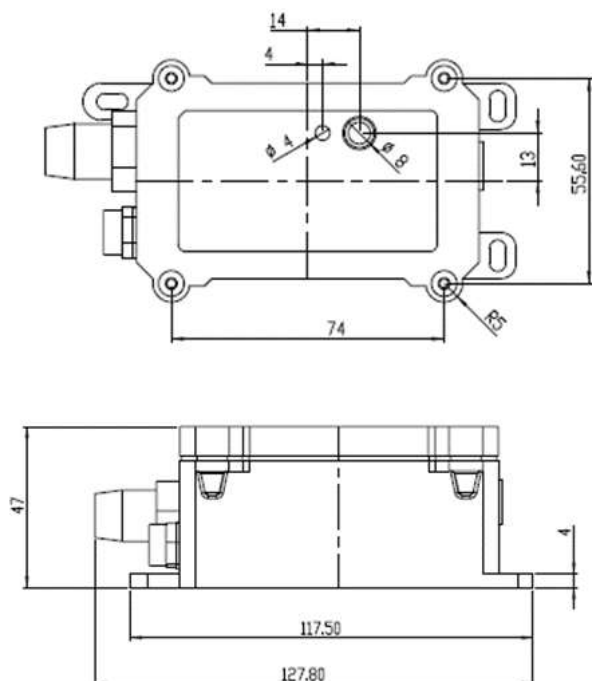
- 1) **ISP**: upgrade mode, device won't have any signal in this mode. but ready for upgrade firmware. LED won't work. Firmware won't run.
- 2) **Flash**: work mode, device starts to work and send out console output for further debug

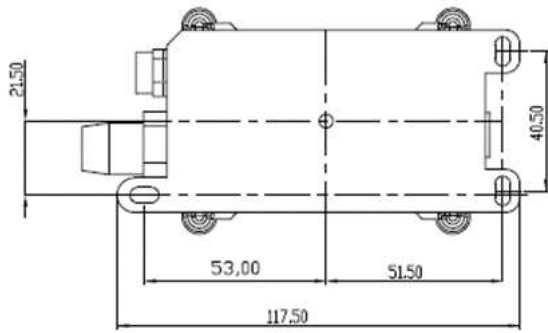
1.8.3 Reset Button

Press to reboot the device.

1.9 Mechanical

Main Device Dimension:





Probe Dimension:



1.10 Installation in Soil

Measurement the soil surface



Choose the proper measuring position. Avoid the probe to touch rocks or hard things. Split the surface soil according to the measured deep. Keep the measured as origin:



Dig a hole with diameter > 20CM.

Horizontal insert the probe to the soil and fill the hole for long term measurement.

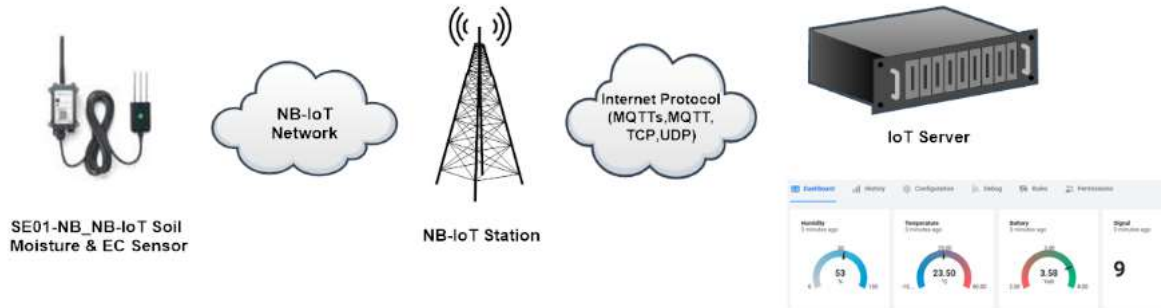
2. Use SE01-NB to communicate with IoT Server

2.1 Send data to IoT server via NB-IoT network

The SE01-NB is equipped with a NB-IoT module, the pre-loaded firmware in SE01-NB will get environment data from sensors and send the value to local NB-IoT network

Below shows the network structure:

SE01-NB in a NB-IoT Network



There are two version: **-GE** and **-1D** version of SE01-NB.

GE Version: This version doesn't include SIM card or point to any IoT server. User needs to use AT Commands to configure below two steps to set SE01-NB send data to

- Install NB-IoT SIM card and configure APN. See instruction of Attach Network (<http://wiki.dragino.com/xwiki/bin/view/Main/General%20Configure%20to%20Connect%20to%20IoT%20server%20for%20NB%20%26%20NS%20NB-IoT%20models/#H3.5A0Node-RedA028viaA0MQTT29>)
- Set up sensor to point to IoT Server. See instruction of Configure to Connect Different Servers (<http://wiki.dragino.com/xwiki/bin/view/Main/General%20Configure%20to%20Connect%20to%20IoT%20server%20for%20NB%20%26%20NS%20NB-IoT%20models/#H3.6A0ThingsBoard.CloudA028viaA0MQTT29>)

Below shows result of different server as a glance.

Servers	Dash Board	Comments
Node-Red (http://wiki.dragino.com/xwiki/bin/view/Main/General%20Configure%20to%20Connect%20to%20IoT%20server%20for%20NB%20%26%20NS%20NB-IoT%20models/#H3.5A0Node-RedA028viaA0MQTT29)		
DataCake (http://wiki.dragino.com/xwiki/bin/view/Main/General%20Configure%20to%20Connect%20to%20IoT%20server%20for%20NB%20%26%20NS%20NB-IoT%20models/#H3.4Datacake)		
Tago.IO (http://wiki.dragino.com/xwiki/bin/view/Main/General%20Configure%20to%20Connect%20to%20IoT%20server%20for%20NB%20%26%20NS%20NB-IoT%20models/#H3.7A0Tago.ioA028viaA0MQTT29)		
General UDP (http://wiki.dragino.com/xwiki/bin/view/Main/General%20Configure%20to%20Connect%20to%20IoT%20server%20for%20NB%20%26%20NS%20NB-IoT%20models/#H3.1GeneralA0UDPA0Connection)	Raw Payload. Need Developer to design Dash Board	
General MQTT (http://wiki.dragino.com/xwiki/bin/view/Main/General%20Configure%20to%20Connect%20to%20IoT%20server%20for%20NB%20%26%20NS%20NB-IoT%20models/#H3.2GeneralA0MQTTA0Connection)	Raw Payload. Need Developer to design Dash Board	
ThingSpeak (http://wiki.dragino.com/xwiki/bin/view/Main/General%20Configure%20to%20Connect%20to%20IoT%20server%20for%20NB%20%26%20NS%20NB-IoT%20models/#H3.3A0ThingSpeakA028viaA0MQTT29)		
ThingsBoard (http://wiki.dragino.com/xwiki/bin/view/Main/General%20Configure%20to%20Connect%20to%20IoT%20server%20for%20NB%20%26%20NS%20NB-IoT%20models/#H3.6A0ThingsBoard.CloudA028viaA0MQTT29)		

1D Version: This version has 1NCE SIM card pre-installed and configure to send value to DataCake. User Just need to select the sensor type in DataCake and Activate S (<http://wiki.dragino.com/xwiki/bin/view/Main/General%20Configure%20to%20Connect%20to%20IoT%20server%20for%20NB%20%26%20NS%20NB-IoT%20models/#H3.4Datacake>)

2.2 Payload Types

To meet different server requirement, SE01-NB supports different payload type.

Includes:

- General JSON format payload. (Type=5)
- HEX format Payload. (Type=0)
- ThingSpeak Format. (Type=1)
- ThingsBoard Format. (Type=3)

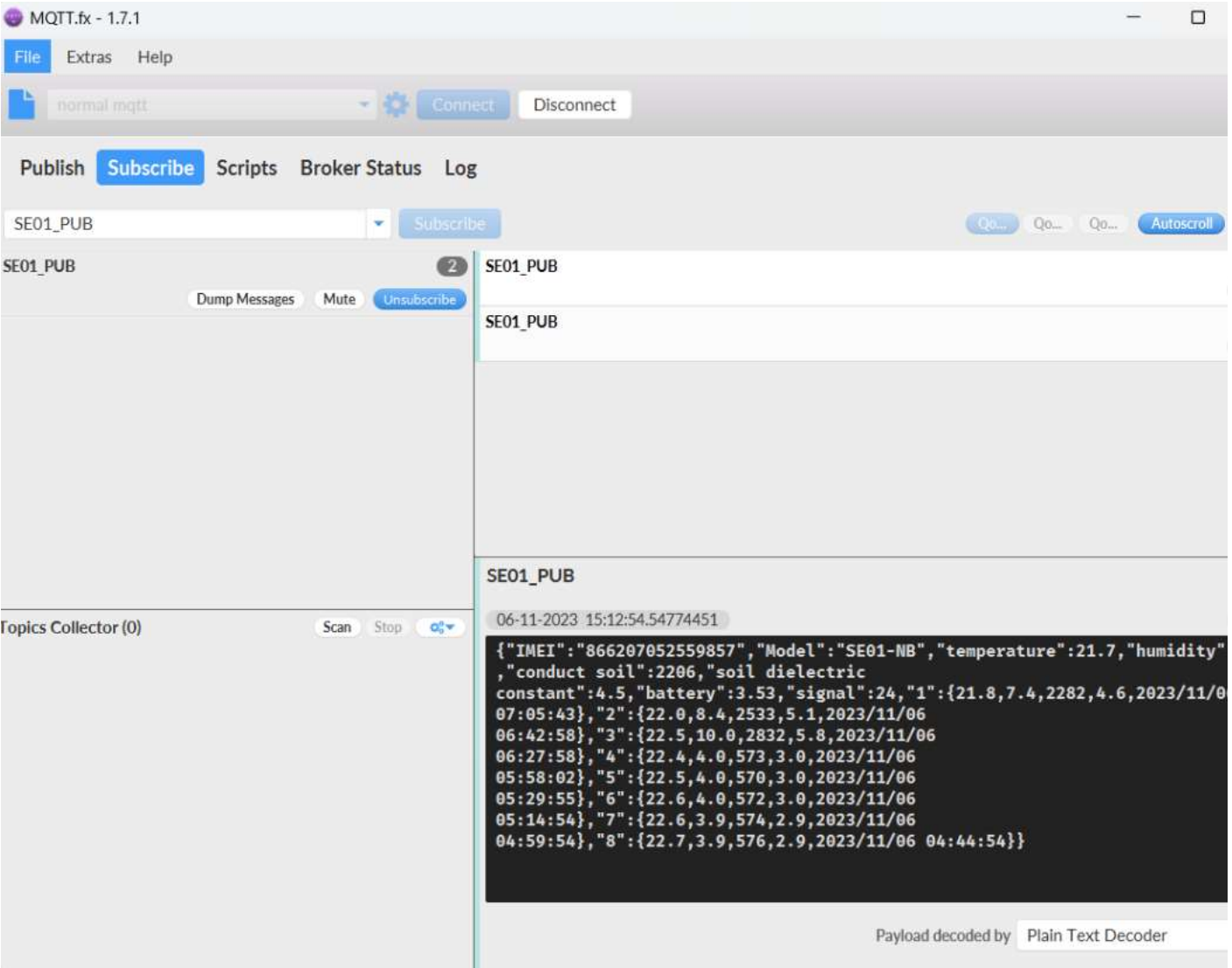
User can specify the payload type when choose the connection protocol. Example:

AT+PRO=2,0 // Use UDP Connection & hex Payload
AT+PRO=2,5 // Use UDP Connection & Json Payload
AT+PRO=3,5 // Use MQTT Connection & Json Payload

2.2.1 General Json Format(Type=5)

This is the General Json Format. As below:

`{"IMEI":"866207052559857","Model":"SE01-NB","temperature":21.7,"humidity":7.2,"conduct soil":2206,"soil dielectric constant":4.5,"battery":3.53,"signal":24 06:27:58},"4":{"22.4,4.0,573,3.0,2023/11/06 05:58:02},"5":{"22.5,4.0,570,3.0,2023/11/06 05:29:55},"6":{"22.6,4.0,572,3.0,2023/11/06 05:14:54},"7":{"22.6,3.9,574,2.9,2023/11/06 04:59:54},"8":{"22.7,3.9,576,2.9,2023/11/06 04:44:54}}}`



Notice, from above payload:

- Temperature, Humidity, Conduct soil & Soil dielectric constant, Battery & Signal the value at uplink time.
- Json entry 1 ~ 8 are the last 1 ~ 8 sampling data as specify by **AT+NOUD=8** Command. Each entry includes (from left to right): Soil Temperature, Soil Moisture, Sc

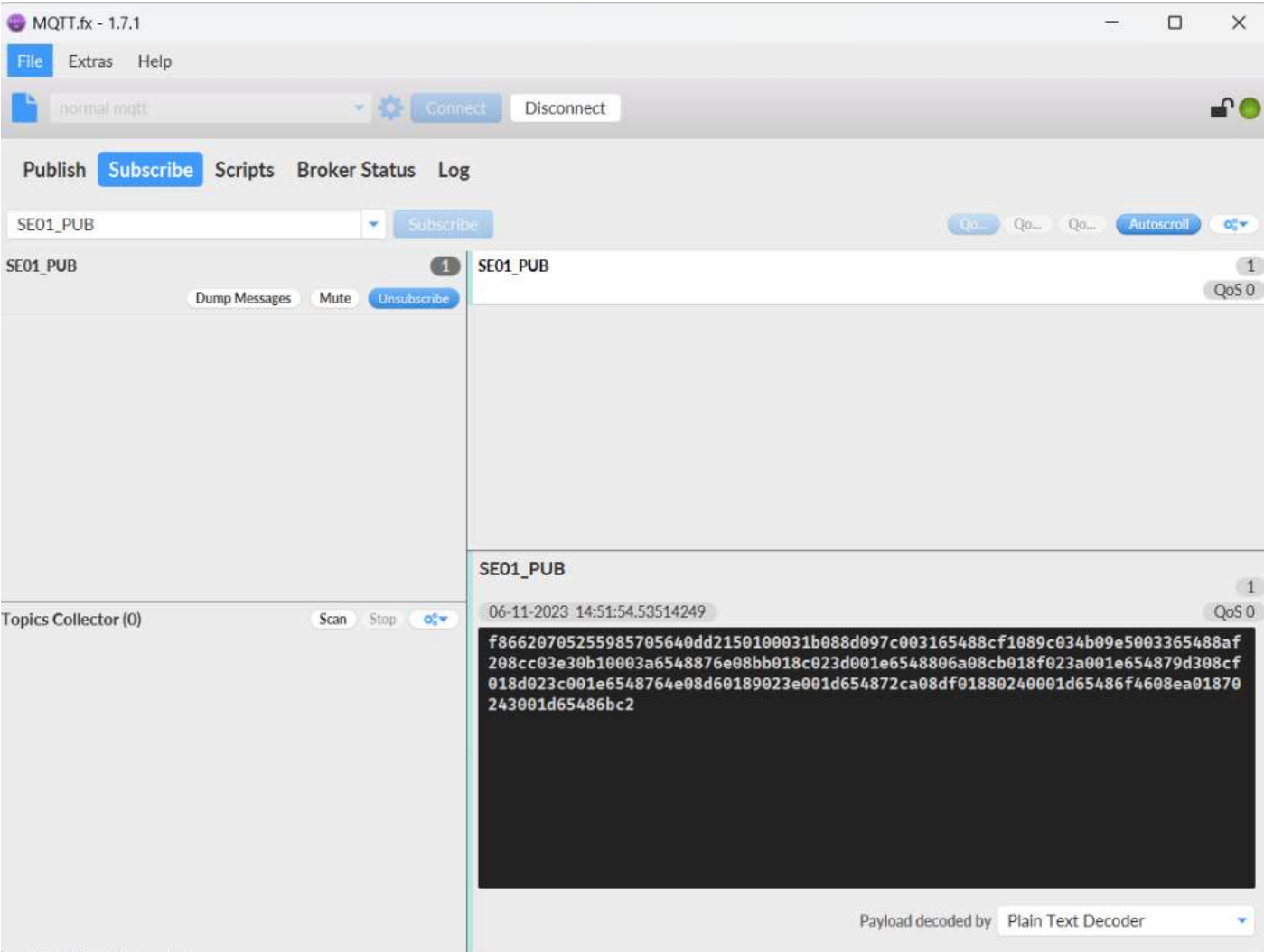
2.2.2 HEX format Payload(Type=0)

This is the HEX Format. As below:

f86620705255985705640dd2150100031b088d097c003165488cf1089c034b09e5003365488af208cc03e30b10003a6548876e08bb018c023d001e6548806a08cb018f0:

HEX Format for SE01-NB (AT+NOUD=8)											
f866207058386669 IMEI 8 Bytes				0564 Version	0d8f BAT	17 Signal	01 Mod	00 Interrupt	0000 Soil Moisture	09e5 Soil Temperature	0000 Soil EC 15 Bytes
09e0 Soil Temperature	0000 Soil Moisture	0000 Soil Conductivity(EC)	0000 Soil dielectric constant	64e6ffa2 Time stamp				00fd02670000000064e6fd22 last 2nd data 12 Bytes			
010702660000000064e6fb06 last 5th data 12 Bytes				00fe02640000000064e6fa52 last 6th data 12 Bytes				00fd02730000000064e6f99e last 7th data 12 Bytes			
								00fe02630000000064e6fc6e last 3rd data 12 Bytes			
								00fe02600000000064e6fb8a last 8th data 12 Bytes			

If we use the MQTT client to subscribe to this MQTT topic, we can see the following information when the NB sensor uplink data.



Version:

These bytes include the hardware and software version.

Higher byte: Specify Sensor Model: 0x05 for SE01-NB

Lower byte: Specify the software version: 0x64=100, means firmware version 100

BAT (Battery Info):

Ex1: 0x0CC6 = 3270mV

Signal Strength:

NB-IoT Network signal Strength.

Ex1: 0x18 = 24

- 0-113dBm or less
- 1-111dBm
- 2...30-109dBm...-53dBm
- 31-51dBm or greater
- 99Not known or not detectable

Soil Moisture

Get the moisture content of the soil. The value range of the register is 0-10000(Decimal), divide this value by 100 to get the percentage of moisture in the soil.

For example, if the data you get from the register is **0x05 0xDC**, the moisture content in the soil is **05DC(H) = 1500(D) / 100 = 15%**.

Soil Temperature

Get the temperature in the soil. The value range of the register is -4000 - +800(Decimal), divide this value by 100 to get the temperature in the soil. For example, if the dat

Example:

If payload is 0105H: ((0x0105 & 0x8000)>>15 === 0),temp = 0105(H)/100 = 2.61 °C

If payload is FF7EH: ((FF7E & 0x8000)>>15 ===1),temp = (FF7E(H)-FFFF(H))/100 = -1.29 °C

Soil Conductivity (EC)

Obtain **soluble salt concentration** in soil or **soluble ion concentration in liquid fertilizer** or **planting medium**. The value range of the register is 0 - 20000(Decimal)(C

For example, if the data you get from the register is 0x00 0xC8, the soil conductivity is 00C8(H) = 200(D) = 200 uS/cm.

Generally, the EC value of irrigation water is less than 800uS / cm.

TimeStamp:

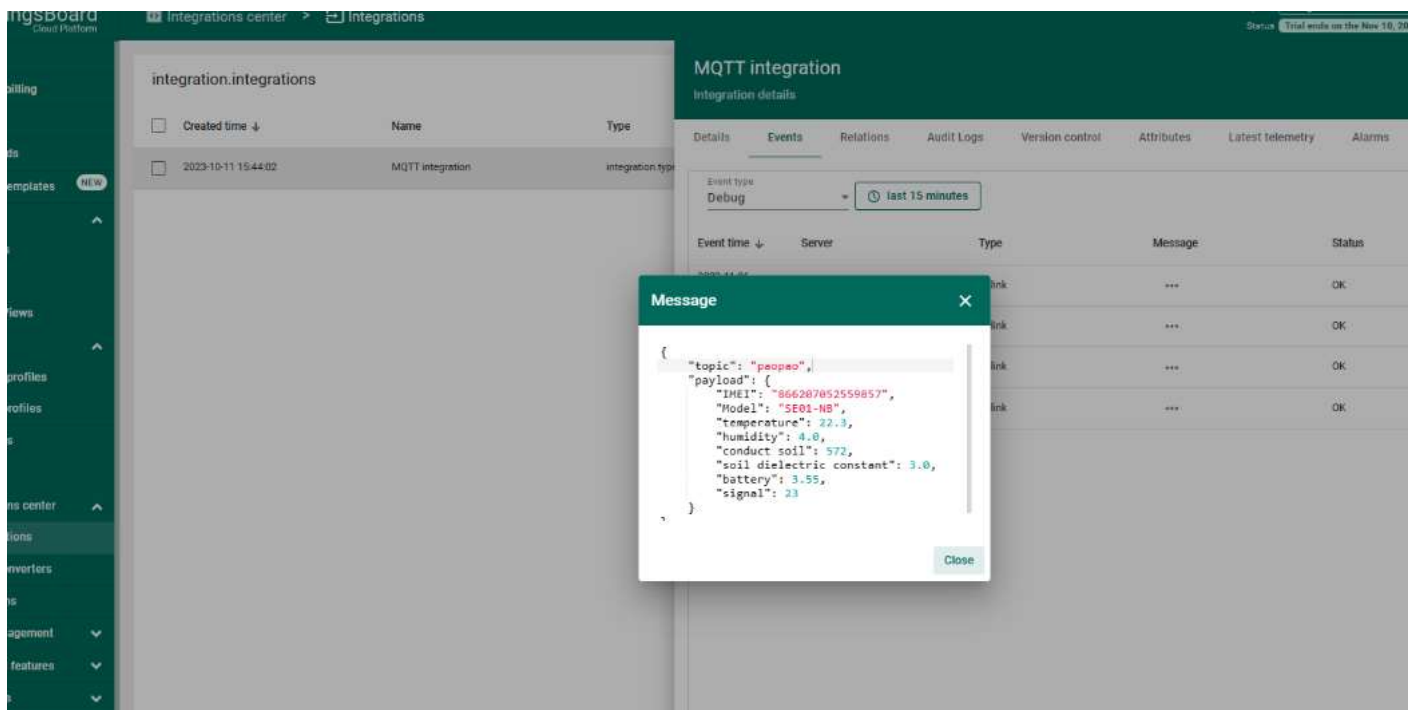
Unit TimeStamp Example: 64d49439(H) = 1691653177(D)

Put the decimal value into this link(<https://www.epochconverter.com>) (<https://www.epochconverter.com>)) to get the time.

2.2.3 ThingsBoard Payload(Type=3)

Type3 payload special design for ThingsBoard, it will also configure other default server to ThingsBoard.

```
{
  "IMEI": "866207052559857",
  "Model": "SE01-NB",
  "temperature": 22.3,
  "humidity": 4.0,
  "conduct soil": 572,
  "soil dielectric constant": 3.0,
  "battery": 3.55,
  "signal": 23
}
```



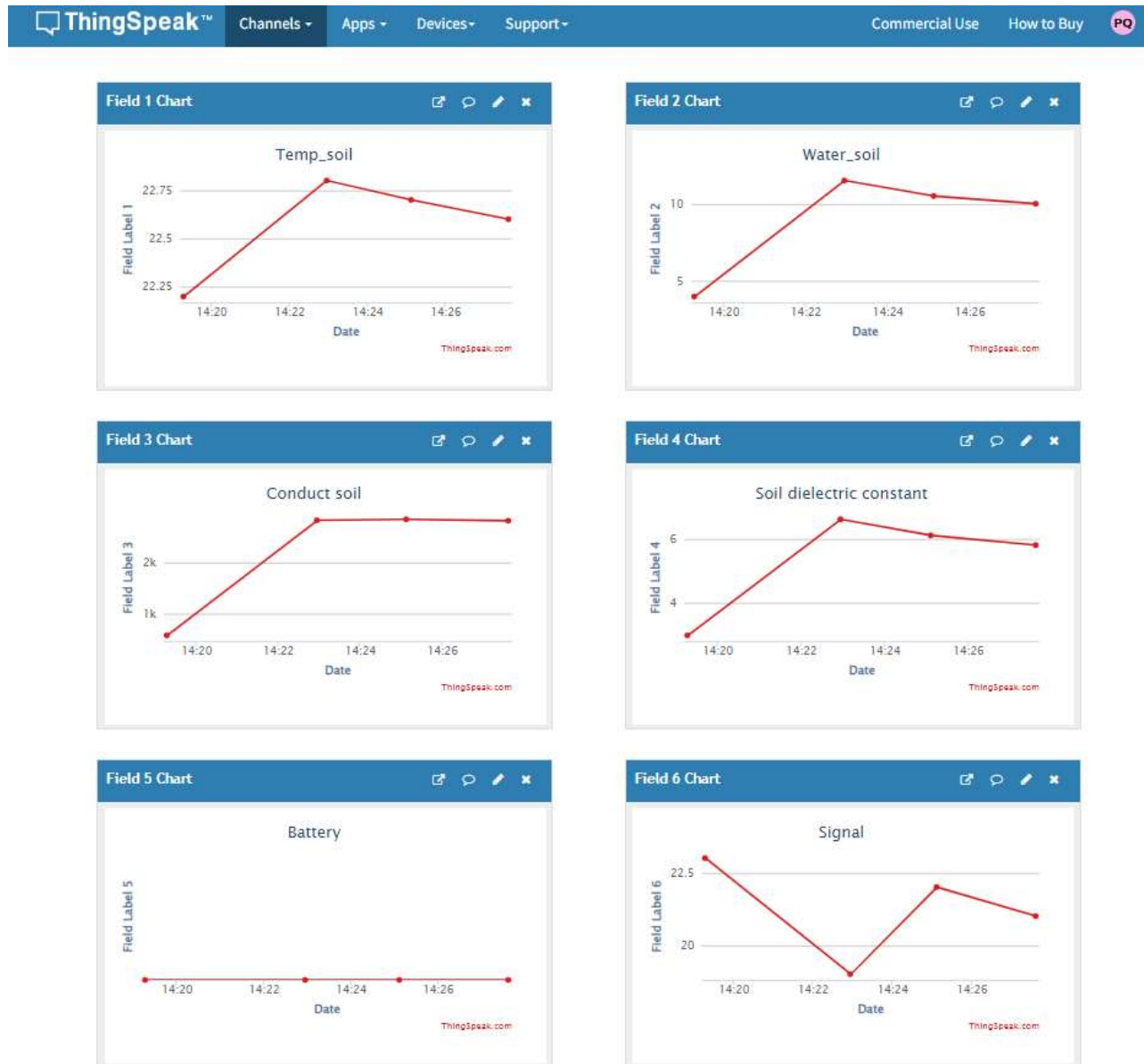
2.2.4 ThingSpeak Payload(Type=1)

This payload meets ThingSpeak platform requirement. It includes six fields. Form 1~6 are:

Temperature, Humidity, Conduct soil , Soil dielectric constant, Battery & Signal. This payload type only valid for ThingsSpeak Platform

As below:

field1=Temperature value&field2=Humidity value&field3=Conduct soil value&field4=Soil dielectric constant value&field5=Battery value&field6=Signal value



2.3 Test Uplink and Change Update Interval

By default, Sensor will send uplinks **every 2 hours** & AT+NOUD=8

User can use below commands to change the **uplink interval**.

AT+TDC=600 // Set Update Interval to 600s

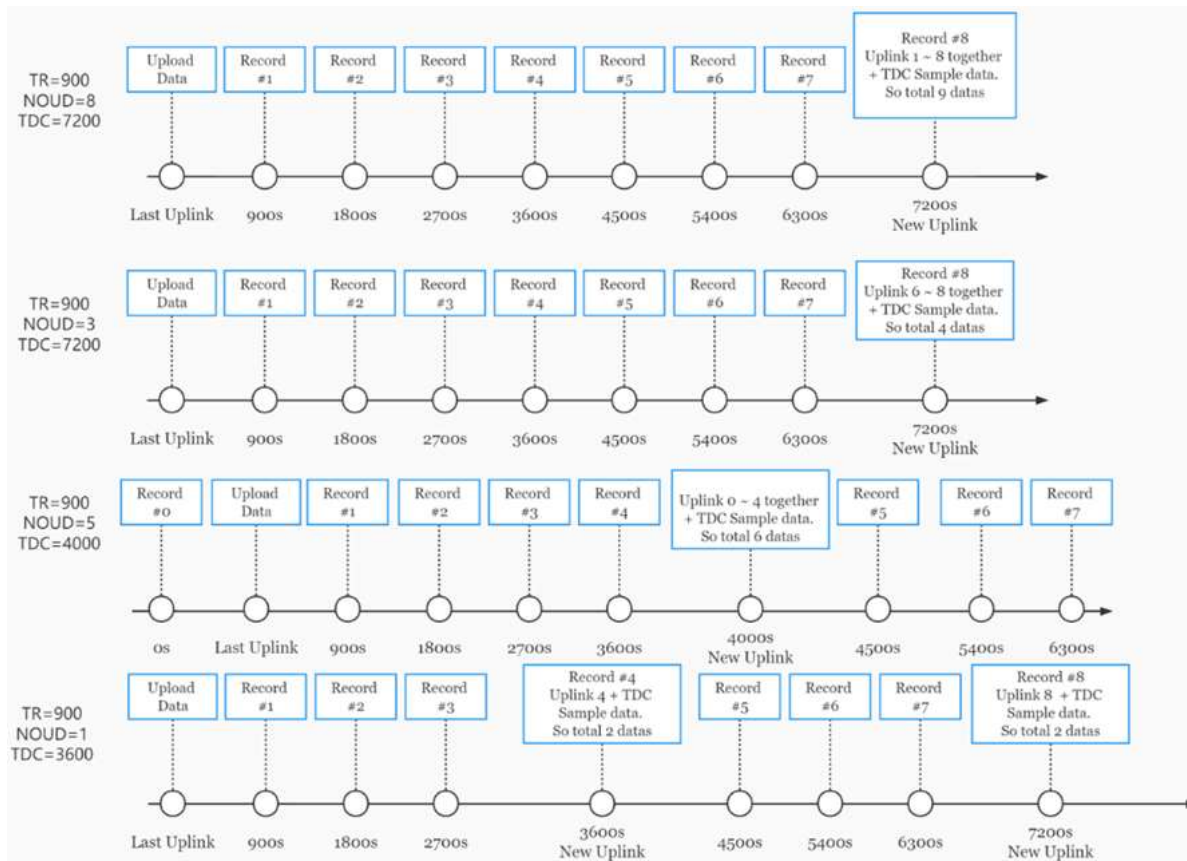
User can also push the button for more than 1 seconds to activate an uplink.

2.4 Multi-Samplings and One uplink

To save battery life, SE01-NB will sample temperature & humidity data every 15 minutes and send one uplink every 2 hours. So each uplink it will include 8 stored data +

- **AT+TR=900** // The unit is seconds, and the default is to record data once every 900 seconds (15 minutes, the minimum can be set to 180 seconds)
- **AT+NOUD=8** // The device uploads 8 sets of recorded data by default. Up to 32 sets of record data can be uploaded.

The diagram below explains the relationship between TR, NOUD, and TDC more clearly:



2.5 Triggier an uplink by external interrupt

SE01-NB has an external trigger interrupt function. Users can use the PB15 pin to trigger the upload of data packets.

AT command:

- **AT+INTMOD** // Set the trigger interrupt mode
- **AT+INTMOD=0** // Disable Interrupt
- **AT+INTMOD=1** // Trigger by rising and falling edge
- **AT+INTMOD=2** // Trigger by falling edge
- **AT+INTMOD=3** // Trigger by rising edge

3. Configure SE01-NB

3.1 Configure Methods

SE01-NB supports below configure method:

- AT Command via Bluetooth Connection (**Recommended**): BLE Configure Instruction (<http://wiki.dragino.com/xwiki/bin/view/Main/BLE%20Bluetooth%20Remote%20Control>)
- AT Command via UART Connection : See UART Connection (<http://wiki.dragino.com/xwiki/bin/view/Main/UART%20Access%20for%20LoRa%20ST%20v4%20bas>)

3.2 AT Commands Set

AT+<CMD>? : Help on <CMD>

AT+<CMD> : Run <CMD>

AT+<CMD>=<value> : Set the value

AT+<CMD>=? : Get the value

General Commands

AT : Attention

AT? : Short Help

ATZ : MCU Reset

AT+TDC : Application Data Transmission Interval

AT+CFG : Print all configurations

AT+CFGMOD : Working mode selection

AT+DEUI : Get or set the Device ID

AT+INTMOD : Set the trigger interrupt mode

AT+5VT : Set extend the time of 5V power

AT+PRO : Choose agreement

AT+RXDL : Extend the sending and receiving time

AT+DNSCFG : Get or Set DNS Server

AT+GETSENSORVALUE : Returns the current sensor measurement

AT+NOUD : Get or Set the number of data to be uploaded

AT+CDP : Read or Clear cached data

AT+SHTEMP: Get or Set alarm of temp

AT+SHHUM: Get or Set alarm of moisture

AT+SERVADDR : Server Address

UDP Management

AT+CFM : Upload confirmation mode (only valid for UDP)

MQTT Management

AT+CLIENT : Get or Set MQTT client

AT+UNAME : Get or Set MQTT Username

AT+PWD : Get or Set MQTT password

AT+PUBTOPIC : Get or Set MQTT publish topic

AT+SUBTOPIC : Get or Set MQTT subscription topic

Information

AT+FDR : Factory Data Reset

AT+PASSWORD : Serial Access Password

AT+LDATA : Get the last upload data

AT+CDP : Read or Clear cached data

4. Battery & Power Consumption

SE01-NB use ER26500 + SPC1520 battery pack. See below link for detail information about the battery info and how to replace.

Battery Info & Power Consumption Analyze (<http://wiki.dragino.com/xwiki/bin/view/Main/How%20to%20calculate%20the%20battery%20life%20of%20Dragino%20sens>)

5. Firmware update

User can change device firmware to::

- Update with new features.
- Fix bugs.

Firmware and changelog can be downloaded from : **Firmware download link** (https://www.dropbox.com/sh/6i8xatl2xk65d0i/AACgGFUvzzQGaiXL_T12tk70a?dl=0)

Methods to Update Firmware:

- (Recommended way) OTA firmware update via BLE: **Instruction** (http://wiki.dragino.com/xwiki/bin/view/Main/BLE_Firmware_Update_NB_Sensors_BC660K-GL/)
- Update through UART TTL interface : **Instruction** (<http://8.211.40.43/xwiki/bin/view/Main/Firmware%20Upgrade%20Instruction%20for%20STM32%20base%20board>)

6. FAQ

6.1 How can I access t BC660K-GL AT Commands?

User can access to BC660K-GL directly and send AT Commands.

See BC660K-GL AT Command set (<https://www.dropbox.com/sh/5f6ssda5fum8rvs/AABT68l8ZzWOvZ5eg2qwOoFda?dl=0>)

6.2 Can I calibrate SE01-NB to different soil types?

SE01-NB is calibrated for saline-alkali soil and loamy soil. If users want to use it for other soil, they can calibrate the value in the IoT platform base on the value measured (https://www.dragino.com/downloads/downloads/LoRa_End_Node/LSE01/Calibrate_to_other_Soil_20230522.pdf) .

7. Order Info

Part Number: **SE01-NB-XX**

XX:

- **GE:** General version (Exclude SIM card)
- **1D:** with 1NCE* 10 years 500MB SIM card and Pre-configure to DataCake server

1NCE SIM Card NB-IoT network coverage: Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Finland, Germany, Great Britain, Greece, Hungary, Ireland, It
Virgin Islands

8. Packing Info

Package Includes:

- SE01-NB NB-IoT Soil Moisture & EC Sensor x 1
- External antenna x 1

Dimension and weight:

- Device Size: cm
- Device Weight: g
- Package Size / pcs : cm
- Weight / pcs : g

9. Support

- Support is provided Monday to Friday, from 09:00 to 18:00 GMT+8. Due to different timezones we cannot offer live support. However, your questions will be answer
- Provide as much information as possible regarding your enquiry (product models, accurately describe your problem and steps to replicate it etc) and send a mail to



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