



## LoRaWAN Soil pH Sensor User Manual

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Version	Description	Date
1.0	Release	2021-May-13
1.1	Fix Typo for sensor model	2021-Jul-24

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## 1. Introduction

### 1.1 What is LoRaWAN Soil pH Sensor

The Dragino LSPH01 is a **LoRaWAN Soil pH Sensor** for IoT of Agriculture. It is designed to measure the soil PH and soil temperature, so to send to the platform to analyze the soil acid or alkali level. The probe is IP68 waterproof.

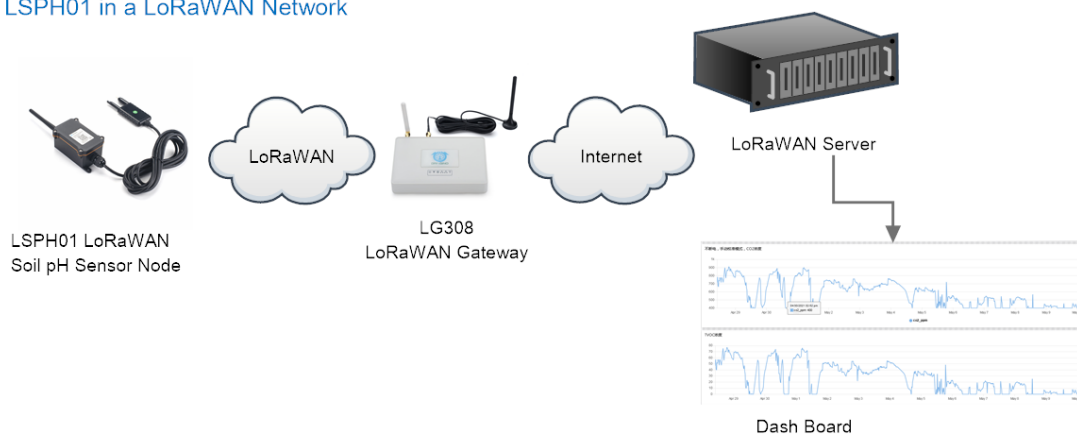
LSPH01 probe is made by Solid AgCl reference electrode and Pure metal pH sensitive electrode. It can detect soil's **pH** with high accuracy and stable value. The LSPH01 probe can be buried into soil for long time use.

The LoRa wireless technology used in LSPH01 allows device to send data and reach extremely long ranges at low data-rates. It provides ultra-long range spread spectrum communication and high interference immunity whilst minimizing current consumption.

LSPH01 is powered by **8500mAh Li-SOCI2 battery**, it is designed for long term use up to 5 years.

Each LSPH01 is pre-load with a set of unique keys for LoRaWAN registrations, register these keys to local LoRaWAN server and it will auto connect after power on.

#### LSPH01 in a LoRaWAN Network



### 1.2 Features

- ✧ LoRaWAN 1.0.3 Class A
- ✧ Ultra-low power consumption
- ✧ Monitor soil pH with temperature compensation.
- ✧ Monitor soil temperature
- ✧ Monitor Battery Level
- ✧ Support pH calibration by end user
- ✧ Bands: CN470/EU433/KR920/US915/EU868/AS923/AU915/IN865
- ✧ AT Commands to change parameters
- ✧ Uplink on periodically
- ✧ Downlink to change configure
- ✧ IP66 Waterproof Enclosure

- ✧ IP68 rate for the Sensor Probe
- ✧ 8500mAh Battery for long term use

### 1.3 Probe Specification

Soil pH:

- ✧ Range: 3 ~ 10 pH
- ✧ Resolution: 0.01 pH
- ✧ Accuracy:  $\pm 2\%$  under (0~50 °C, Accuracy will poor under 0 due to frozen)
- ✧ Temperature Compensation Range: 0 ~ 50 °C
- ✧ IP68 Protection
- ✧ Length: 3.5 meters

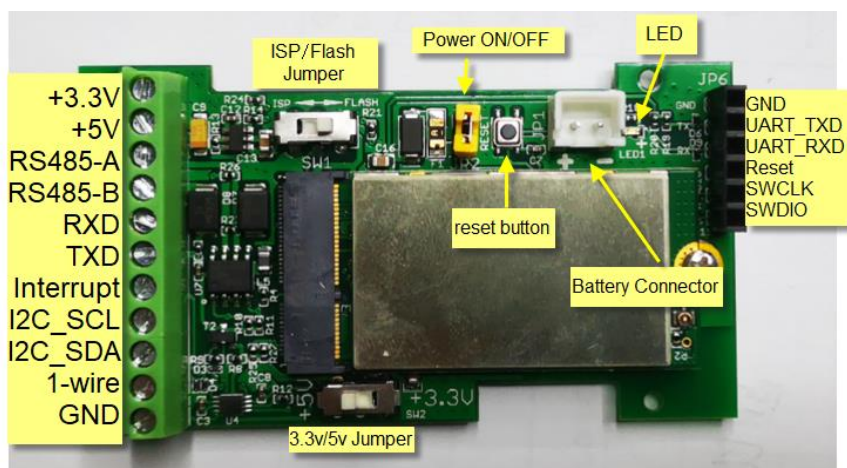
Soil Temperature:

- ✧ Range -40°C ~ 85°C
- ✧ Resolution: 0.1°C
- ✧ Accuracy:  $< \pm 0.5^\circ\text{C}$  (-10°C ~ 40°C),  $< \pm 0.8^\circ\text{C}$  (others)
- ✧ IP68 Protection
- ✧ Length: 3.5 meters

### 1.4 Applications

- ✧ Smart Agriculture

### 1.5 Pin mapping and power on



## 2. Configure LSPH01 to connect to LoRaWAN network

### 2.1 How it works

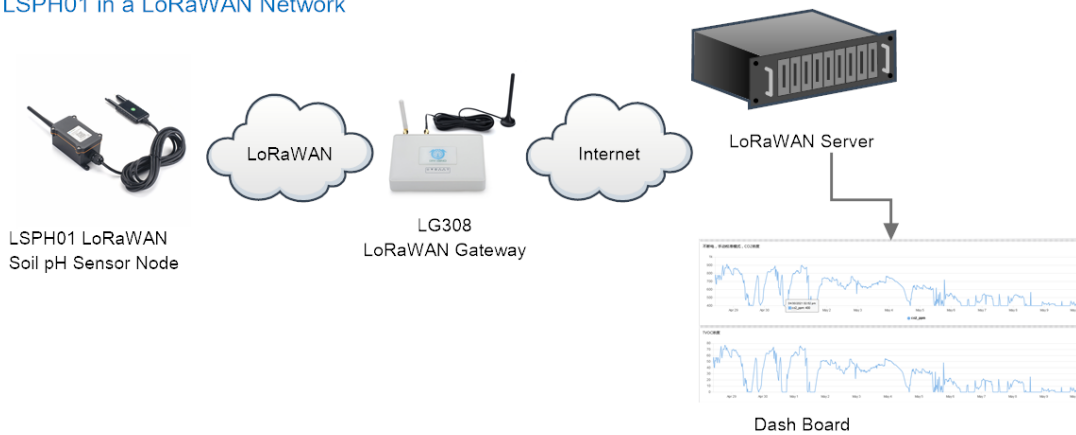
The LSPH01 is configured as LoRaWAN OTAA Class A mode by default. It has OTAA keys to join LoRaWAN network. To connect a local LoRaWAN network, you need to input the OTAA keys in the LoRaWAN IoT server and power on the LSPH01. It will automatically join the network via OTAA and start to send the sensor value. The default uplink interval is 20 minutes.

In case you can't set the OTAA keys in the LoRaWAN OTAA server, and you have to use the keys from the server, you can [use AT Commands](#) to set the keys in the LSPH01.

### 2.2 Quick guide to connect to LoRaWAN server (OTAA)

Following is an example for how to join the [TTN v3 LoRaWAN Network](#). Below is the network structure; we use the [LG308](#) as a LoRaWAN gateway in this example.

LSPH01 in a LoRaWAN Network



The LG308 is already set to connected to [TTN network](#), so what we need to now is configure the TTN server.

**Step 1:** Create a device in TTN with the OTAA keys from LSPH01.

Each LSPH01 is shipped with a sticker with the default device EUI as below:



You can enter this key in the LoRaWAN Server portal. Below is TTN screen shot:

### Register the device

#### Register end device

From The LoRaWAN Device Repository [Manually](#)

##### Preparation

###### Activation mode\*

- Over the air activation (OTAA)
- Activation by personalization (ABP)
- Multicast
- Do not configure activation

###### LoRaWAN version ⓘ\*


###### Network Server address

###### Application Server address

###### External Join Server ⓘ

 Enabled

###### Join Server address



### Add APP EUI and DEV EUI

#### Register end device

From The LoRaWAN Device Repository [Manually](#)

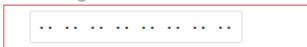
- 1 Basic settings  
End device ID's, Name and Description
- 2 Network layer settings  
Frequency plan, regional parameters, end device class and session keys.
- 3 Join settings  
Root keys, NetID and kek labels.

###### End device ID ⓘ\*

###### AppEUI ⓘ\*

###### DevEUI ⓘ\*

###### End device name

###### End device description

Optional end device description; can also be used to save notes about the end device

## Add APP EUI in the application

### Register end device

From The LoRaWAN Device Repository Manually

- 1 Basic settings  
End device ID's, Name and Description
- 2 Network layer settings  
Frequency plan, regional parameters, end device class and session keys.
- 3 Join settings  
Root keys, NetID and kek labels.

Frequency plan <sup>?</sup> \*

Europe 863-870 MHz (SF12 for RX2) | v

LoRaWAN version <sup>?</sup> \*

MAC V1.0.3 | v

Regional Parameters version <sup>?</sup> \*

PHY V1.0.3 REV A | v

LoRaWAN class capabilities <sup>?</sup>

Supports class B

Supports class C

Advanced settings v

< Basic settings Join settings >

## Add APP KEY

### Register end device

From The LoRaWAN Device Repository Manually

- 1 Basic settings  
End device ID's, Name and Description
- 2 Network layer settings  
Frequency plan, regional parameters, end device class and session keys.
- 3 Join settings  
Root keys, NetID and kek labels.

#### Root keys

AppKey <sup>?</sup> \*

BD 72 1D AC F3 CC AB 67 72 8D 7A F5 4D DF 30 8B | ↻

Advanced settings v

< Network layer settings Add end device



## Step 2: Power on LSPH01

Put a Jumper on JP2 to power on the device. ( The Switch must be in FLASH position).



**Step 3:** The LSPH01 will auto join to the TTN network. After join success, it will start to upload messages to TTN and you can see the messages in the panel.

↔ 16:08:36	Link ADR request enqueued	DevAddr: 26 08 2E E4
↓ 16:08:36	Successfully scheduled data downlink	DevAddr: 26 08 2E E4
↓ 16:08:36	Schedule data downlink for transmissi...	DevAddr: 26 08 2E E4 Rxl Delay: 5
● 16:08:35	Store upstream data message	DevAddr: 26 08 2E E4
↑ 16:08:35	Forward data message to Application S...	DevAddr: 26 08 2E E4 MAC payload: 66 18 21 93 7E 92 08 94 0F A6 DC FPort: 2 SNR: 6.5 RSSI: -89 Bandwidth: 125000
↑ 16:08:35	Forward uplink data message	DevAddr: 26 08 2E E4 Payload: [ Bat: "3.365 V", Interrupt_flag: 0, Message_type: 1, PH1_SOIL: "0.62", TEMP_SOIL: "25.68", Temp_C0518828: "0.08 °C" ] 00 25 00 00 00 3E 01 00 00 00
↑ 16:08:35	Receive uplink data message	DevAddr: 26 08 2E E4
↑ 16:08:35	Successfully processed data message	DevAddr: 26 08 2E E4 FPort: 2 MAC payload: 66 18 21 93 7E 92 08 94 0F A6 DC Bandwidth: 125000 SNR: 6.5 RSSI: -89 Raw payload: 40 E4 2E 08 26 00 00 00 02 66 18 21 93 7E 92 08 94 0F A
↑ 16:08:35	Receive data message	DevAddr: 26 08 2E E4 FPort: 2 MAC payload: 66 18 21 93 7E 92 08 94 0F A6 DC Bandwidth: 125000 SNR: 6.5 RSSI: -89 Raw payload: 40 E4 2E 08 26 00 00 00 02 66 18 21 93 7E 92 08 94 0F A

## 2.3 Uplink Payload

LSPH01 will uplink payload via LoRaWAN with below payload format:

Uplink payload includes in total 11 bytes.

Normal uplink payload:

Size (bytes)	2	2	2	2	1	1	1
Value	<a href="#">BAT</a>	<a href="#">Temperature (Optional)</a>	<a href="#">Soil pH</a>	<a href="#">Soil Temperature</a>	<a href="#">Digital Interrupt (Optional)</a>	Reserve	<a href="#">Message Type</a>

↔ 16:08:36 Link ADR request enqueued	DevAddr: 26 08 2E E4	
↓ 16:08:36 Successfully scheduled data downlink ...	DevAddr: 26 08 2E E4	
↓ 16:08:36 Schedule data downlink for transmissi...	DevAddr: 26 08 2E E4	Rx1 Delay: 6
● 16:08:36 Store upstream data message	DevAddr: 26 08 2E E4	
↑ 16:08:36 Forward data message to Application S...	DevAddr: 26 08 2E E4	MAC payload: 66 18 21 93 7E 92 08 94 0F A6 DC   FPort: 2 SNR: 6.5 RSSI: -99 Bandwidth: 125000
↑ 16:08:36 Forward uplink data message	DevAddr: 26 08 2E E4	Payload: [ Bat: "3.366 V", Interrupt_flag: 0, Message_type: 1, PMS_SOIL: "0.62", TEMP_SOIL: "26.68", Temp_DS18B20: "0.00 °C" ]   00 26 08 00 00 3E 01 00 00 00
↑ 16:08:36 Receive uplink data message	DevAddr: 26 08 2E E4	
↑ 16:08:36 Successfully processed data message	DevAddr: 26 08 2E E4	FPort: 2 MAC payload: 66 18 21 93 7E 92 08 94 0F A6 DC   Bandwidth: 125000 SNR: 6.5 RSSI: -99 Raw payload: 40 E4 2E 08 26 00 00 02 66 18 21 93 7E 92 08 94 0F A
↑ 16:08:36 Receive data message	DevAddr: 26 08 2E E4	FPort: 2 MAC payload: 66 18 21 93 7E 92 08 94 0F A6 DC   Bandwidth: 125000 SNR: 6.5 RSSI: -99 Raw payload: 40 E4 2E 08 26 00 00 02 66 18 21 93 7E 92 08 94 0F A

### 2.3.1 Battery Info

Check the battery voltage for LSPH01.

Ex1: 0x0B45 = 2885mV

Ex2: 0x0B49 = 2889mV

### 2.3.2 DS18B20 Temperature sensor

This is optional, user can connect external DS18B20 sensor to the [+3.3v, 1-wire and GND pin](#) . and this field will report temperature.

**Example:**

If payload is: 0105H: (0105 & FC00 == 0), temp = 0105H /10 = 26.1 degree

If payload is: FF3FH : (FF3F & FC00 == 1) , temp = (FF3FH - 65536)/10 = -19.3 degrees.

### 2.3.3 Soil pH

Range: 0 ~ 14 pH

Example:

**0x02B7(H) = 695(D) = 6.95pH**

### 2.3.4 Soil Temperature

Get Soil Temperature

**Example:**

If payload is: 0105H: (0105 & FC00 == 0), temp = 0105H /10 = 26.1 degree

If payload is: FF3FH : (FF3F & FC00 == 1) , temp = (FF3FH - 65536)/10 = -19.3 degrees.

### 2.3.5 Interrupt Pin

This data field shows if this packet is generated by interrupt or not. [Click here](#) for the hardware and software set up.

Example:

- 0x00: Normal uplink packet.
- 0x01: Interrupt Uplink Packet.

### 2.3.6 Message Type

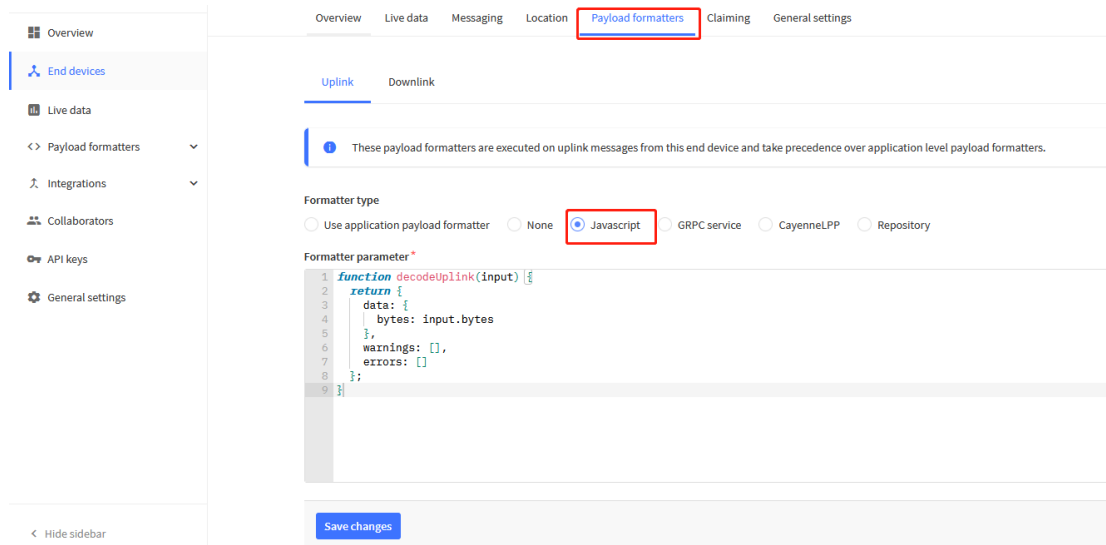
For a normal uplink payload, the message type is always 0x01.

Valid Message Type:

Message Type Code	Description	Payload
0x01	Normal Uplink	<a href="#">Normal Uplink Payload</a>
0x02	Reply configures info	<a href="#">Configure Info Payload</a>
0x03	Reply Calibration Info	<a href="#">Calibration Payload</a>

### 2.3.7 Decode payload in The Things Network

While using TTN network, you can add the payload format to decode the payload.



The screenshot shows the 'Payload formatters' configuration page in The Things Network. The 'Formatter type' is set to 'Javascript'. The 'Formatter parameter' field contains the following JavaScript code:

```

1 function decodeUplink(input) {
2   return {
3     data: {
4       bytes: input.bytes
5     },
6     warnings: [],
7     errors: []
8   };
9 }

```

The payload decoder function for TTN is here:

LSPH01 TTN Payload Decoder:

[https://www.dragino.com/downloads/index.php?dir=LoRa\\_End\\_Node/LSPH01/Decoder/](https://www.dragino.com/downloads/index.php?dir=LoRa_End_Node/LSPH01/Decoder/)

## 2.4 Uplink Interval

The LSPH01 by default uplink the sensor data every 20 minutes. User can change this interval by AT Command or LoRaWAN Downlink Command. See this link:

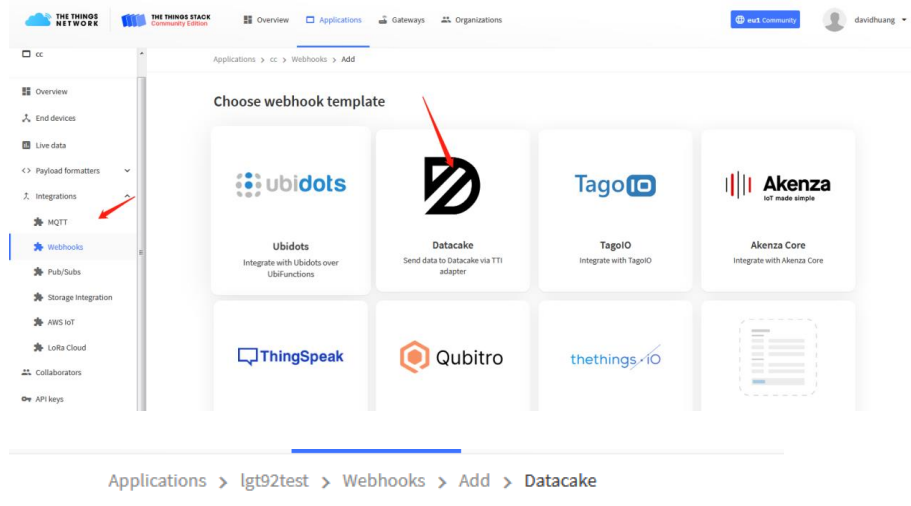
[http://wiki.dragino.com/index.php?title=End\\_Device\\_AT\\_Commands\\_and\\_Downlink\\_Commands#Change\\_Uplink\\_Interval](http://wiki.dragino.com/index.php?title=End_Device_AT_Commands_and_Downlink_Commands#Change_Uplink_Interval)

## 2.5 Show Data in DataCake IoT Server

[DATAKAKE](#) provides a human friendly interface to show the sensor data, once we have data in TTN, we can use [DATAKAKE](#) to connect to TTN and see the data in DATAKAKE. Below are the steps:

**Step 1:** Be sure that your device is programmed and properly connected to the network at this time.

**Step 2:** To configure the Application to forward data to DATAKAKE you will need to add integration. To add the DATAKAKE integration, perform the following steps:



### Add custom webhook

#### Template information



#### Datacake

Send data to Datacake via TTI adapter

[About Datacake](#) | [Documentation](#)

#### Template settings

Webhook ID \*

Token \*

Datacake API Token

Step 3: Create an account or log in Datacake.

Step 4: Create LSPH01 product.

## Add Device



LoRaWAN



PARTICLE



API



D Zero



D Zero LTE



PINCODE

**STEP 1**  
Product

**STEP 2**  
Network Server

**STEP 3**  
Devices

**STEP 4**  
Plan

## Datacake Product

You can add devices to an existing product on Datacake, create a new empty product or start with one of the templates. Products allow you to share the same configuration (fields, dashboard and more) between devices.

### New Product from template

Create new product from a template

### Existing Product

Add devices to an existing product

### New Product

Create new empty product

## New Product

If your device is not available as a template, you can start with an empty device. You will have to create the device definition (fields, dashboard) and provide the payload decoder in the device's configuration.

Product Name

Next

## Add Device



LoRaWAN



PARTICLE



API



D Zero



D Zero LTE



PINCODE

STEP 1  
Product

STEP 2  
Network Server

STEP 3  
Devices

STEP 4  
Plan

## Network Server

Please choose the LoRaWAN Network Server that your devices are connected to.

<input checked="" type="radio"/>		The Things Stack V3 TTN V3 / Things Industries	<input type="button" value="Uplinks"/>	<input type="button" value="Downlinks"/>
<input type="radio"/>		The Things Network V2 The old Things Network	<input type="button" value="Uplinks"/>	<input type="button" value="Downlinks"/>
<input type="radio"/>		Helium	<input type="button" value="Uplinks"/>	<input type="button" value="Downlinks"/>
<input type="radio"/>		LORIoT	<input type="button" value="Uplinks"/>	<input type="button" value="Downlinks"/>
<input type="radio"/>		Kerlink Wanesy	<input type="button" value="Uplinks"/>	
Showing 1 to 5 of 8 results			<input type="button" value="Previous"/>	<input type="button" value="Next"/>

### Add Device



LoRaWAN



PARTICLE



API



D Zero



D Zero LTE



PINCODE

STEP 1  
Product

STEP 2  
Network Server

STEP 3  
Devices

STEP 4  
Plan

### Add Devices

Enter one or more LoRaWAN Device EUIs and the names they will have on Datacake.

DEVEUI	NAME
<input type="text" value="00 00 00 00 00 00 00 66 8 bytes"/>	<input type="text" value="LSPH01"/>

[+ Add another device](#)

**Consistent with DEUI on TTN**

[Back](#) [Next](#)

Step 5: add payload decode

Download Datacake decoder from:

[https://www.dragino.com/downloads/index.php?dir=LoRa\\_End\\_Node/LSPH01/Decoder/](https://www.dragino.com/downloads/index.php?dir=LoRa_End_Node/LSPH01/Decoder/)

### LSPH01

Location	Serial Number 0000000000000066	Last update	Product Slug lsph01
----------	-----------------------------------	-------------	------------------------

Dashboard History Downlinks **Configuration** Debug Rules Permissions

#### General Configuration

**Name**

**Location**

**Tags**  
You can use tags to organize your devices and create filters on the dashboard

### Payload Decoder

Product-wide setting

When your devices sends data, the payload will be passed to the payload decoder, alongside the event's name. The payload decoder then transforms it to measurements.

```

3 // (array) of bytes to an object or fields.
4 var value=(bytes[0]<<8 | bytes[1]) & 0x3FFF;
5 var bat=value/1000;//Battery,units:v
6
7 value=bytes[2]<<8 | bytes[3];
8 if(bytes[2] & 0x80)
9 {value |= 0xFFFF0000;}
10 var temp_0518020=(value/10).toFixed(2);//0518020,temperature
11
12 value=bytes[4]<<8 | bytes[5];
13 var ph=(value/100).toFixed(2);
14
15 value=bytes[6]<<8 | bytes[7];
16 var temp0;
17 if((value & 0x8000)>>15 === 0)
18 | temp=(value/10).toFixed(2);//temp_SOIL,temperature
19 else if((value & 0x8000)>>15 === 1)
20 | temp=(value-0xFFFF)/10).toFixed(2);
21
22 var i_flag = bytes[8];
23 var mes_type = bytes[10];
24 return [
25 | {
26 |   field: "BAT",
27 |   value: batV
28 | },
29 | {
30 |   field: "PH",
31 |   value: ph
32 | },
33 | {
34 |   field: "TEMP",
35 |   value: temp
36 | }
37 ];
38 ]

```

Port
Try Decoder

Name	Identifier	Type	Current Value
BAT	BAT	Float	0
PH	PH	Float	0
temp	TEMP	Float	0

After added, the sensor data arrive TTN, it will also arrive and show in Mydevices.

## LSPH01

Location: -    Serial Number: 0000000000000066    Last update: Tue May 18 2021 16:40:14 GMT+0800    Product Slug: Lsph01

Dashboard   History   Downlinks   Configuration   Debug   Rules   Permissions

**BAT**  
a few seconds ago

**TEMP**  
a few seconds ago

**PH**  
a few seconds ago



## 2.6 Installation and Maintain

### 2.6.1 Before measurement

If the LSPH01 has more than 7 days not use or just clean the pH probe. User should put the probe inside pure water for more than 24 hours for activation. If no put in water, user need to put inside soil for more than 24 hours to ensure the measurement accuracy.

### 2.6.2 Measurement

#### Measurement the soil surface



Choose the proper measuring position. Split the surface soil according to the measured deep.

Put pure water, or rainwater to make the soil of measurement point to moist mud. Remove rocks or hard things.

Slowly insert the probe to the measure point. Don't use large force which will break the probe. Make sure not shake when inserting.

Put soil over the probe after insert. And start to measure.

#### Measurement inside soil

Dig a hole with diameter > 20CM.

Insert the probe inside, method like measure the surface.

### 2.6.3 Maintain Probe

1. pH probe electrode is fragile and no strong. User must avoid strong force or hitting it.
2. After long time use (3~ 6 months). The probe electrode needs to be clean; user can use high grade sandpaper to polish it or put in 5% hydrochloric acid for several minutes. After the metal probe looks like new, user can use pure water to wash it.
3. Probe reference electrode is also no strong, need to avoid strong force or hitting.
4. User should keep reference electrode wet while not use.
5. Avoid the probes to touch oily matter. Which will cause issue in accuracy.
6. The probe is IP68 can be put in water.

## 2.7 Calibration

User can do calibration for the probe. It is limited to use below pH buffer solution to calibrate: 4.00, 6.86, 9.18. When calibration, user need to clean the electrode and put the probe in the pH buffer solution to wait the value stable ( a new clean electrode might need max 24 hours to be stable).

After stable, user can use below command to calibrate.

pH buffer solution	AT Command to calibrate	Downlink Command	Read Cal Value
4.00	AT+PHCAL=4	0x13 04 Reply with Calibrate payload	AT+PHCAL=? Example 41,61,91
6.86	AT+PHCAL=6	0x13 06 Reply with Calibrate payload	AT+PHCAL=?
9.18	AT+PHCAL=9	0x13 09 Reply with Calibrate payload	AT+PHCAL=?
Factory Default	AT+PHCAL=15	0x13 15 Reply with Calibrate payload	AT+PHCAL=? Example 151

### Calibration Payload

Size (bytes)	1	1	1	7	1
<b>Value</b>	PH4 Calibrate value	PH6.86 Calibrate value	PH9.18 Calibrate value	Reserve	<a href="#">Message Type</a> Always 0x03

User can also send 0x14 downlink command to poll the current calibration payload.

Downlink Control Type	FPort	Type Code	Downlink payload size(bytes)
Get Calibration Version Info	Any	14	2

- Reply to the confirmation package: 14 01
- Reply to non-confirmed packet: 14 00

## 2.8 Frequency Plans

The LSPH01 uses OTAA mode and below frequency plans by default. If user want to use it with different frequency plan, please refer the AT command sets.

### 2.8.1 EU863-870 (EU868)

Uplink:

868.1 - SF7BW125 to SF12BW125  
868.3 - SF7BW125 to SF12BW125 and SF7BW250  
868.5 - SF7BW125 to SF12BW125  
867.1 - SF7BW125 to SF12BW125  
867.3 - SF7BW125 to SF12BW125  
867.5 - SF7BW125 to SF12BW125  
867.7 - SF7BW125 to SF12BW125  
867.9 - SF7BW125 to SF12BW125  
868.8 - FSK

Downlink:

Uplink channels 1-9 (RX1)  
869.525 - SF9BW125 (RX2 downlink only)

### 2.8.2 US902-928(US915)

Used in USA, Canada and South America. Frequency band as per definition in LoRaWAN 1.0.3 Regional document.

To make sure the end node supports all sub band by default. In the OTAA Join process, the end node will use frequency 1 from sub-band1, then frequency 1 from sub-band2, then frequency 1 from sub-band3, etc to process the OTAA join.

After Join success, the end node will switch to the correct sub band by:

- Check what sub-band the LoRaWAN server ask from the OTAA Join Accept message and switch to that sub-band
- Use the Join successful sub-band if the server doesn't include sub-band info in the OTAA Join Accept message ( TTN v2 doesn't include)

### 2.8.3 CN470-510 (CN470)

Used in China, Default use CHE=1

Uplink:

486.3 - SF7BW125 to SF12BW125  
486.5 - SF7BW125 to SF12BW125  
486.7 - SF7BW125 to SF12BW125  
486.9 - SF7BW125 to SF12BW125  
487.1 - SF7BW125 to SF12BW125  
487.3 - SF7BW125 to SF12BW125  
487.5 - SF7BW125 to SF12BW125  
487.7 - SF7BW125 to SF12BW125

Downlink:

506.7 - SF7BW125 to SF12BW125  
506.9 - SF7BW125 to SF12BW125  
507.1 - SF7BW125 to SF12BW125  
507.3 - SF7BW125 to SF12BW125

507.5 - SF7BW125 to SF12BW125  
507.7 - SF7BW125 to SF12BW125  
507.9 - SF7BW125 to SF12BW125  
508.1 - SF7BW125 to SF12BW125  
505.3 - SF12BW125 (RX2 downlink only)

#### 2.8.4 AU915-928(AU915)

Frequency band as per definition in LoRaWAN 1.0.3 Regional document.

To make sure the end node supports all sub band by default. In the OTAA Join process, the end node will use frequency 1 from sub-band1, then frequency 1 from sub-band2, then frequency 1 from sub-band3, etc to process the OTAA join.

After Join success, the end node will switch to the correct sub band by:

- Check what sub-band the LoRaWAN server ask from the OTAA Join Accept message and switch to that sub-band
- Use the Join successful sub-band if the server doesn't include sub-band info in the OTAA Join Accept message ( TTN v2 doesn't include)

#### 2.8.5 AS920-923 & AS923-925 (AS923)

**Default Uplink channel:**

923.2 - SF7BW125 to SF10BW125  
923.4 - SF7BW125 to SF10BW125

**Additional Uplink Channel:**

(OTAA mode, channel added by JoinAccept message)

**AS920~AS923 for Japan, Malaysia, Singapore:**

922.2 - SF7BW125 to SF10BW125  
922.4 - SF7BW125 to SF10BW125  
922.6 - SF7BW125 to SF10BW125  
922.8 - SF7BW125 to SF10BW125  
923.0 - SF7BW125 to SF10BW125  
922.0 - SF7BW125 to SF10BW125

**AS923 ~ AS925 for Brunei, Cambodia, Hong Kong, Indonesia, Laos, Taiwan, Thailand, Vietnam:**

923.6 - SF7BW125 to SF10BW125  
923.8 - SF7BW125 to SF10BW125  
924.0 - SF7BW125 to SF10BW125  
924.2 - SF7BW125 to SF10BW125  
924.4 - SF7BW125 to SF10BW125  
924.6 - SF7BW125 to SF10BW125

**Downlink:**

Uplink channels 1-8 (RX1)  
923.2 - SF10BW125 (RX2)

#### 2.8.6 KR920-923 (KR920)

Default channel:

922.1 - SF7BW125 to SF12BW125  
922.3 - SF7BW125 to SF12BW125  
922.5 - SF7BW125 to SF12BW125

Uplink: (OTAA mode, channel added by JoinAccept message)

922.1 - SF7BW125 to SF12BW125  
922.3 - SF7BW125 to SF12BW125  
922.5 - SF7BW125 to SF12BW125  
922.7 - SF7BW125 to SF12BW125  
922.9 - SF7BW125 to SF12BW125  
923.1 - SF7BW125 to SF12BW125  
923.3 - SF7BW125 to SF12BW125

Downlink:

Uplink channels 1-7 (RX1)

921.9 - SF12BW125 (RX2 downlink only; SF12BW125 might be changed to SF9BW125)

### 2.8.7 IN865-867 (IN865)

Uplink:

865.0625 - SF7BW125 to SF12BW125  
865.4025 - SF7BW125 to SF12BW125  
865.9850 - SF7BW125 to SF12BW125

Downlink:

Uplink channels 1-3 (RX1)

866.550 - SF10BW125 (RX2)

## 2.9 LED Indicator

The LSPH01 has an internal LED which is to show the status of different state.

- The sensor is detected when the device is turned on, and it will flash 4 times quickly when it is detected.
- Blink once when device transmit a packet.

## 2.10 Firmware Change Log

**Firmware download link:**

[http://www.dragino.com/downloads/index.php?dir=LoRa\\_End\\_Node/LSPH01/Firmware/](http://www.dragino.com/downloads/index.php?dir=LoRa_End_Node/LSPH01/Firmware/)

**Firmware Upgrade Method:**

[http://wiki.dragino.com/index.php?title=Firmware\\_Upgrade\\_Instruction\\_for\\_STM32\\_base\\_products#Introduction](http://wiki.dragino.com/index.php?title=Firmware_Upgrade_Instruction_for_STM32_base_products#Introduction)

### 3. Configure LSPH01 via AT Command or LoRaWAN Downlink

Use can configure LSPH01 via AT Command or LoRaWAN Downlink.

- AT Command Connection: See [FAQ](#).
- LoRaWAN Downlink instruction for different platforms:  
[http://wiki.dragino.com/index.php?title=Main\\_Page#Use\\_Note\\_for\\_Server](http://wiki.dragino.com/index.php?title=Main_Page#Use_Note_for_Server)

There are two kinds of commands to configure LSPH01, they are:

- **General Commands.**

These commands are to configure:

- ✓ General system settings like: uplink interval.
- ✓ LoRaWAN protocol & radio related command.

They are same for all Dragino Device which support DLWS-005 LoRaWAN Stack. These commands can be found on the wiki:

[http://wiki.dragino.com/index.php?title=End\\_Device\\_Downlink\\_Command](http://wiki.dragino.com/index.php?title=End_Device_Downlink_Command)

- **Commands special design for LSPH01**

These commands only valid for LSPH01, as below:

#### 3.1 Set Transmit Interval Time

Feature: Change LoRaWAN End Node Transmit Interval.

##### AT Command: AT+TDC

Command Example	Function	Response
AT+TDC=?	Show current transmit Interval	30000 OK the interval is 30000ms = 30s
AT+TDC=60000	Set Transmit Interval	OK Set transmit interval to 60000ms = 60 seconds

##### Downlink Command: 0x01

Format: Command Code (0x01) followed by 3 bytes time value.

If the downlink payload=0100003C, it means set the END Node's Transmit Interval to 0x00003C=60(S), while type code is 01.

- Example 1: Downlink Payload: 0100001E // Set Transmit Interval (TDC) = 30 seconds
- Example 2: Downlink Payload: 0100003C // Set Transmit Interval (TDC) = 60 seconds

### 3.2 Set Interrupt Mode

Feature, Set Interrupt mode for GPIO\_EXIT.

#### AT Command: AT+INTMOD

Command Example	Function	Response
AT+INTMOD=?	Show current interrupt mode	0 OK the mode is 0 = No interruption
AT+INTMOD=2	Set Transmit Interval 0- (Disable Interrupt), 1- (Trigger by rising and falling edge), 2- (Trigger by falling edge) 3- (Trigger by rising edge)	OK

#### Downlink Command: 0x06

Format: Command Code (0x06) followed by 3 bytes.

This means that the interrupt mode of the end node is set to 0x000003=3 (rising edge trigger), and the type code is 06.

- Example 1: Downlink Payload: 06000000 // Turn off interrupt mode
- Example 2: Downlink Payload: 06000003 // Set the interrupt mode to rising edge trigger

### 3.3 Calibrate Sensor

Detail See [Calibration Guide](#) for the user of 0x13 and 0x14 downlink commands

### 3.4 Get Firmware Version Info

Feature: use downlink to get firmware version.

#### Downlink Command: 0x26

Downlink Control Type	FPort	Type Code	Downlink payload size(bytes)
Get Firmware Version Info	Any	26	2

- Reply to the confirmation package: 26 01
- Reply to non-confirmed packet: 26 00

Device will send an uplink after got this downlink command. With below payload:

Configures info payload:

Size (bytes)	1	1	1	1	1	5	1
Value	Software Type	Frequency Band	Sub-band	Firmware Version	Sensor Type	Reserve	<a href="#">Message Type</a> Always 0x02

**Software Type:** Always 0x03 for LSPH01

**Frequency Band:**

- \*0x01: EU868
- \*0x02: US915
- \*0x03: IN865
- \*0x04: AU915
- \*0x05: KZ865
- \*0x06: RU864
- \*0x07: AS923
- \*0x08: AS923-1
- \*0x09: AS923-2
- \*0xa0: AS923-3

**Sub-Band:** value 0x00 ~ 0x08

**Firmware Version:** 0x0100, Means: v1.0.0 version

**Sensor Type:**

- 0x01: LSE01
- 0x02: LDDS75
- 0x03: LDDS20
- 0x04: LLMS01
- 0x05: LSPH01
- 0x06: LSNPK01
- 0x07: LDDS12



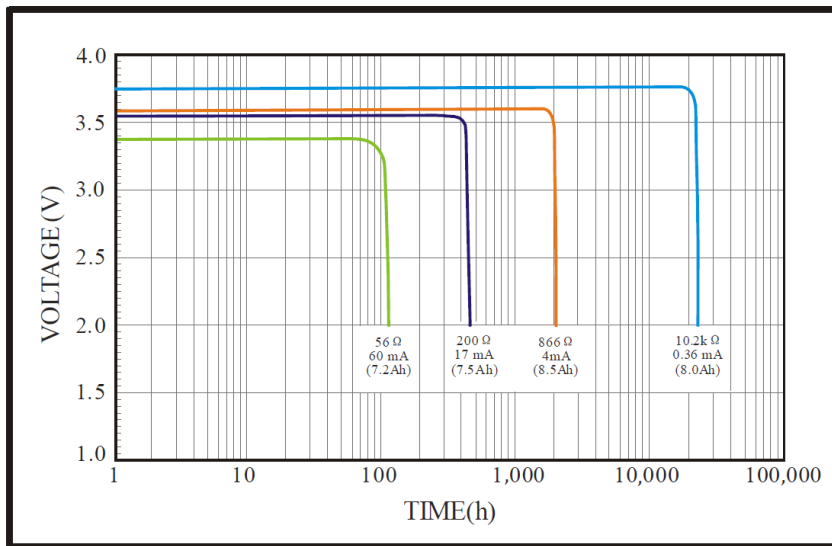
## 4. Battery & How to replace

### 4.1 Battery Type

LSPH01 is equipped with a [8500mAh ER26500 Li-SOCI2 battery](#). The battery is un-rechargeable battery with low discharge rate targeting for 8~10 years use. This type of battery is commonly used in IoT target for long-term running, such as water meter.

The discharge curve is not linear so can't simply use percentage to show the battery level. Below is the battery performance.

#### 1. Typical discharge profile at +20°C (Typical value)



Minimum Working Voltage for the LSPH01:  
LSPH01: 2.45v ~ 3.6v

### 4.2 Replace Battery

Any battery with range 2.45 ~ 3.6v can be a replacement. We recommend to use Li-SOCI2 Battery. And make sure the positive and negative pins match.

### 4.3 Power Consumption Analyze

Dragino Battery powered product are all runs in Low Power mode. We have an update battery calculator which base on the measurement of the real device. User can use this calculator to check the battery life and calculate the battery life if want to use different transmit interval.

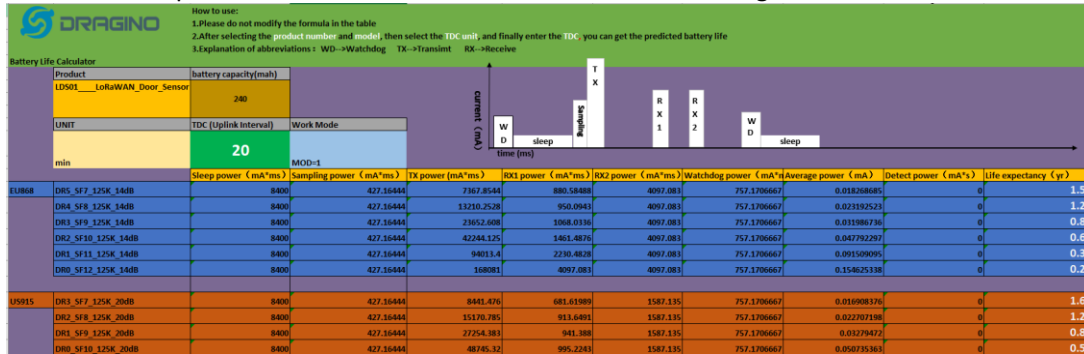
Instruction to use as below:

Step 1: Downlink the up-to-date DRAGINO\_Battery\_Life\_Prediction\_Table.xlsx from:  
[https://www.dragino.com/downloads/index.php?dir=LoRa\\_End\\_Node/Battery\\_Analyze/](https://www.dragino.com/downloads/index.php?dir=LoRa_End_Node/Battery_Analyze/)

Step 2: Open it and choose  
➤ Product Model

- Uplink Interval
- Working Mode

And the Life expectation in difference case will be shown on the right.



The battery related documents as below:

- [Battery Dimension](#),
- [Lithium-Thionyl Chloride Battery datasheet](#)
- [Lithium-ion Battery-Capacitor datasheet](#), [Tech Spec](#)



### 4.3.1 Battery Note

The Li-SiCO battery is designed for small current / long period application. It is not good to use a high current, short period transmit method. The recommended minimum period for use of this battery is 5 minutes. If you use a shorter period time to transmit LoRa, then the battery life may be decreased.

### 4.3.2 Replace the battery

You can change the battery in the LSPH01. The type of battery is not limited as long as the output is between 3v to 3.6v. On the main board, there is a diode (D1) between the battery and the main circuit. If you need to use a battery with less than 3.3v, please remove the D1 and shortcut the two pads of it so there won't be voltage drop between battery and main board.

The default battery pack of LSPH01 includes a ER26500 plus super capacitor. If user can't find this pack locally, they can find ER26500 or equivalence, which will also work in most case. The SPC can enlarge the battery life for high frequency use (update period below 5 minutes)

## 5. Use AT Command

### 5.1 Access AT Commands

LSPH01 supports AT Command set in the stock firmware. You can use a USB to TTL adapter to connect to LSPH01 for using AT command, as below.



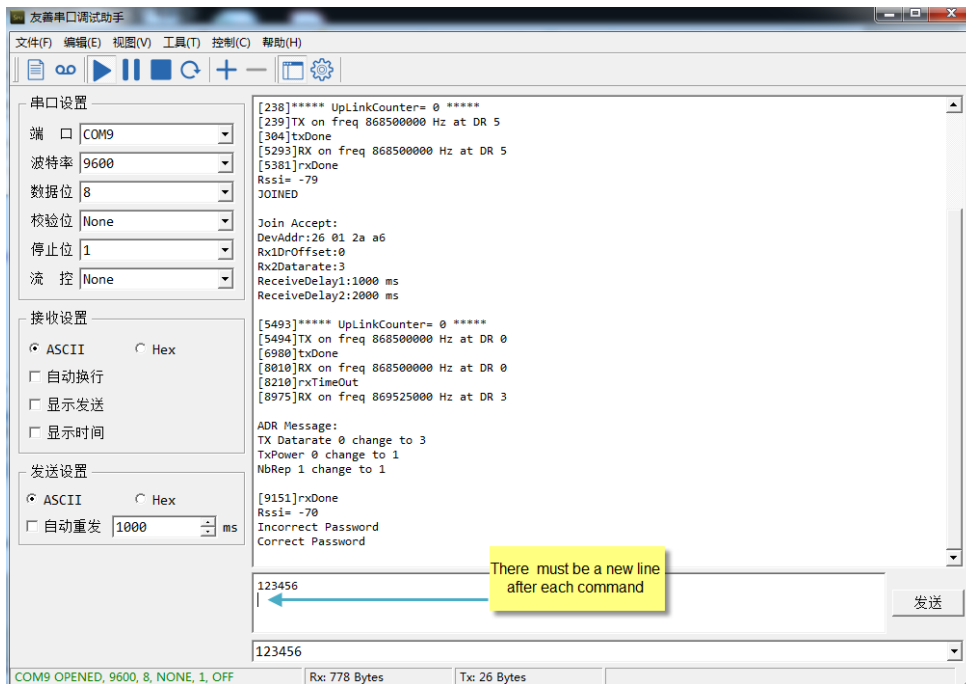
Connection:

USB TTL GND <----> GND

USB TTL TXD <----> UART\_RXD

USB TTL RXD <----> UART\_TXD

In the PC, you need to set the serial baud rate to **9600** to access the serial console for LSPH01. LSPH01 will output system info once power on as below:



Valid AT Command please check [Configure Device](#).

## 6. FAQ

### 6.1 How to change the LoRa Frequency Bands/Region

You can follow the instructions for [how to upgrade image](#).

When downloading the images, choose the required image file for download.

## 7. Trouble Shooting

### 7.1 AT Commands input doesn't work

In the case if user can see the console output but can't type input to the device. Please check if you already include the **ENTER** while sending out the command. Some serial tool doesn't send **ENTER** while press the send key, user need to add ENTER in their string.

## 8. Order Info

Part Number: **LSPH01-XX**

**XX**: The default frequency band

- **AS923**: LoRaWAN AS923 band
- **AU915**: LoRaWAN AU915 band
- **EU433**: LoRaWAN EU433 band
- **EU868**: LoRaWAN EU868 band
- **KR920**: LoRaWAN KR920 band
- **US915**: LoRaWAN US915 band
- **IN865**: LoRaWAN IN865 band
- **CN470**: LoRaWAN CN470 band

## 9. Packing Info

### Package Includes:

- LSPH01 LoRaWAN Soil Ph Sensor x 1

### Dimension and weight:

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

## 10. 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 answered as soon as possible in the before-mentioned schedule.
- 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

[support@dragino.com](mailto:support@dragino.com)