LHT65N/S LoRaWAN Temperature & Humidity Sensor Manual

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on 2025/04/24 09:39

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1. Introduction

1.1 What is LHT65N/S LoRaWAN Temperature & Humidity Sensor

The Dragino **LHT65N/S Temperature & Humidity sensor** is a Long Range LoRaWAN Sensor. It includes a **built-in Temperature & Humidity sensor** and has an external sensor connector to connect to an external **Temperature Sensor.**

The LHT65N/S allows users to send data and reach extremely long ranges. It provides ultra-long range spread spectrum communication and high interference immunity whilst minimizing current consumption. It targets professional wireless sensor network applications such as irrigation systems, smart metering, smart cities, building automation, and so on.

LHT65N/S has a **built-in 2400mAh non-chargeable battery** which can be used for up to 10 years*.

LHT65N/S is full compatible with LoRaWAN v1.0.3 Class A protocol, it can work with a standard LoRaWAN gateway.

LHT65N/S supports **Datalog Feature**. It will record the data when there is no network coverage and users can retrieve the sensor value later to ensure no miss for every sensor reading.

*The actual battery life depends on how often to send data, please see the battery analyzer chapter.

1.2 Features

- LoRaWAN v1.0.3 Class A protocol
- Frequency Bands: CN470/EU433/KR920/US915/EU868/AS923/AU915
- AT Commands to change parameters
- Remote configure parameters via LoRaWAN Downlink
- Firmware upgradeable via program port
- Built-in 2400mAh battery for up to 10 years of use.
- Built-in Temperature & Humidity sensor
- Optional External Sensors
- Tri-color LED to indicate working status
- Datalog feature (Max 3328 records)

1.3 Specification

Built-in Temperature Sensor:

- Resolution: 0.01 °C
- Accuracy Tolerance : Typ ±0.3 °C
- Long Term Drift: < 0.02 °C/yr
- Operating Range: -40 ~ 85 °C

Built-in Humidity Sensor:

- Resolution: 0.04 %RH
- Accuracy Tolerance : Typ ±3 %RH
- Long Term Drift: < 0.25 RH/yr
- Operating Range: 0 ~ 96 %RH

External Temperature Sensor:

- Resolution: 0.0625 °C
- ±0.5°C accuracy from -10°C to +85°C
- ±2°C accuracy from -55°C to +125°C
- Operating Range: -55 °C ~ 125 °C

1.4 Model Difference

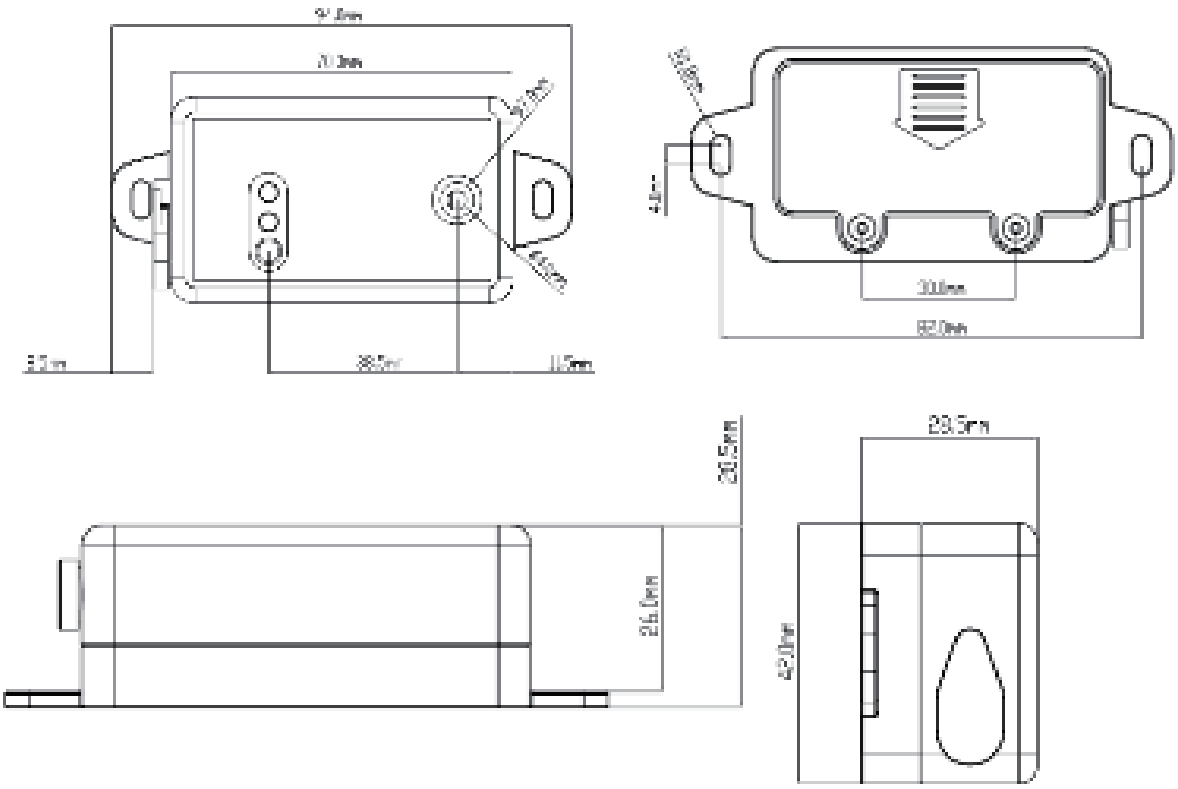
The LHT65N and LHT65S share identical core functionalities. Their differences lie in the **antenna design** and **enclosure dimensions**.

For antenna design:

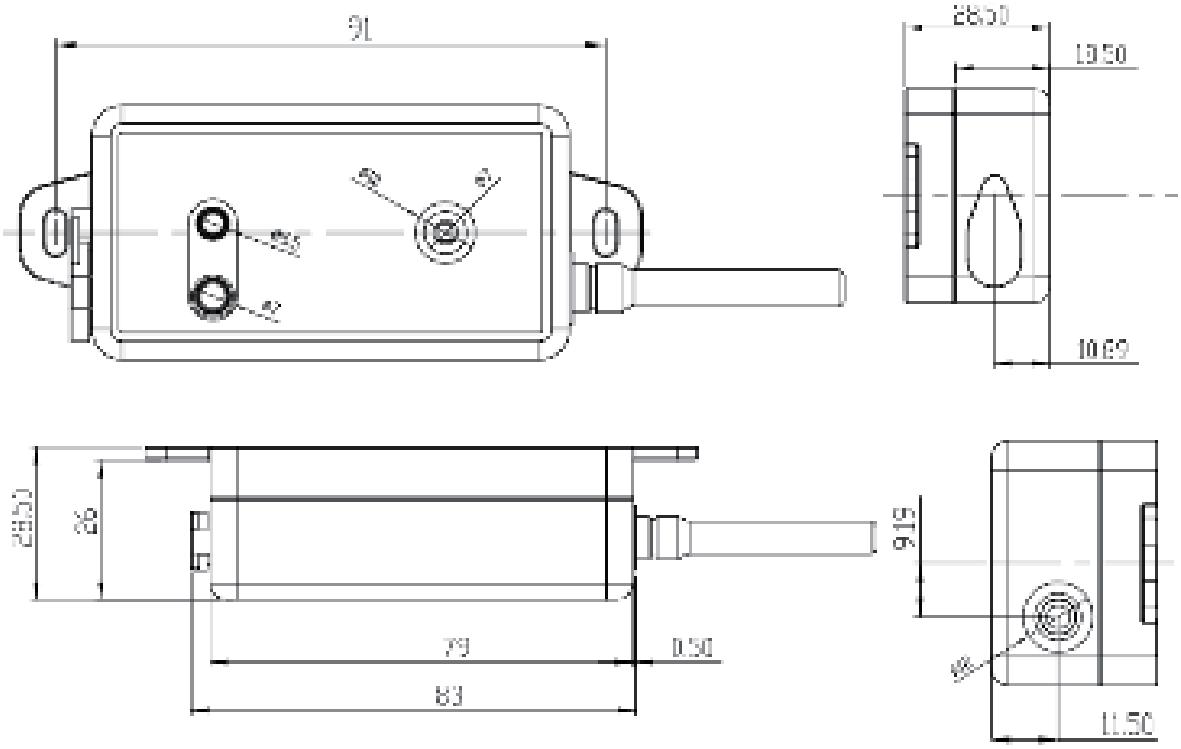
- LHT65N: Built-in spring antenna, suitable for indoor environments with stable signals.
- LHT65S: External SMA antenna, suitable for scenarios where external antennas are needed to optimize long-distance communication.

For enclosure dimensions:

- **LHT65N**



- **LHT65S (Unit: mm)**



2. Connect LHT65N/S to IoT Server

2.1 How does LHT65N/S work?

LHT65N/S is configured as LoRaWAN OTAA Class A mode by default. Each LHT65N/S is shipped with a worldwide unique set of OTAA keys. To use LHT65N/S in a LoRaWAN network, first, we need to put the OTAA keys in LoRaWAN Network Server and then activate LHT65N/S.

If LHT65N/S is under the coverage of this LoRaWAN network. LHT65N/S can join the LoRaWAN network automatically. After successfully joining, LHT65N/S will start to measure environment temperature and humidity, and start to transmit sensor data to the LoRaWAN server. The default period for each uplink is 20 minutes.

2.2 How to Activate LHT65N/S?

The LHT65N/S has two working modes:

- **Deep Sleep Mode**: LHT65N/S doesn't have any LoRaWAN activation. This mode is used for storage and shipping to save battery life.
- **Working Mode**: In this mode, LHT65N/S works as LoRaWAN Sensor mode to Join LoRaWAN network and send out the sensor data to the server. Between each sampling/tx/rx periodically, LHT65N will be in STOP mode (IDLE mode), in STOP mode, LHT65N/S has the same power consumption as Deep Sleep mode.

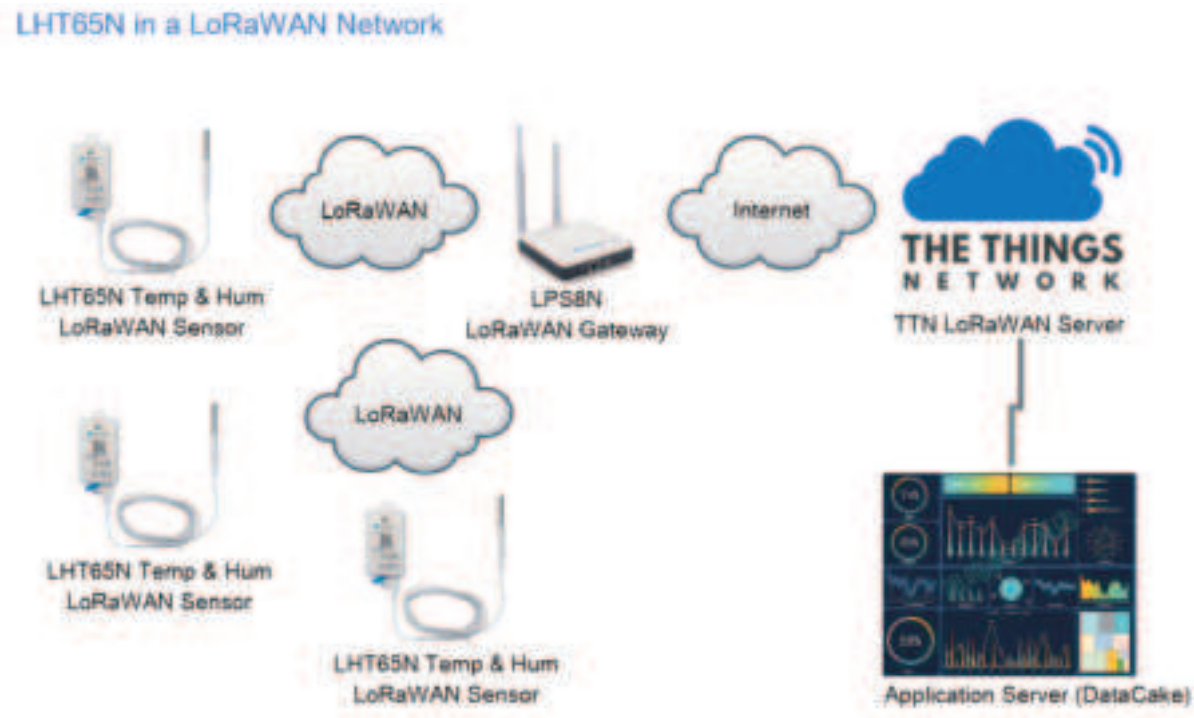
The LHT65N/S is set in deep sleep mode by default; The ACT button on the front is to switch to different modes:

Behavior on ACT	Function	Action
Pressing ACT between 1s < time < 3s	Test uplink status	If LHT65N/S is already Joined to rhe LoRaWAN network, LHT65N/S will send an uplink packet, if LHT65N/S has external sensor connected,**Blue led** will blink once. If LHT65N/S has not external sensor, **Red led** will blink once.

Pressing ACT for more than 3s	Active Device	**Green led** will fast blink 5 times, LHT65N/S will enter working mode and start to JOIN LoRaWAN network. **Green led** will solidly turn on for 5 seconds after join in network.
Fast press ACT 5 times.	Deactivate Device	**Red led** will solid on for 5 seconds. Means LHT65N/S is in Deep Sleep Mode.

2.3 Example to join LoRaWAN network

This section shows an example of how to join the TTN V3 LoRaWAN IoT server. Use with other LoRaWAN IoT servers is of a similar procedure.

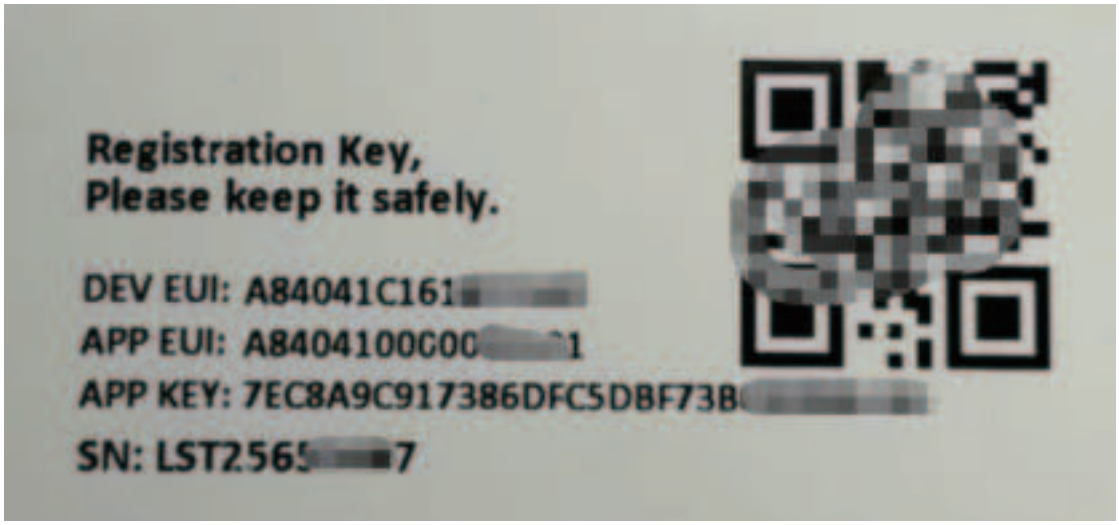


Assume the LPS8N is already set to connect to TTN V3 network, So it provides network coverage for LHT65N/S. Next we need to add the LHT65N/S device in TTN V3:

2.3.1 Step 1: Create Device on TTN

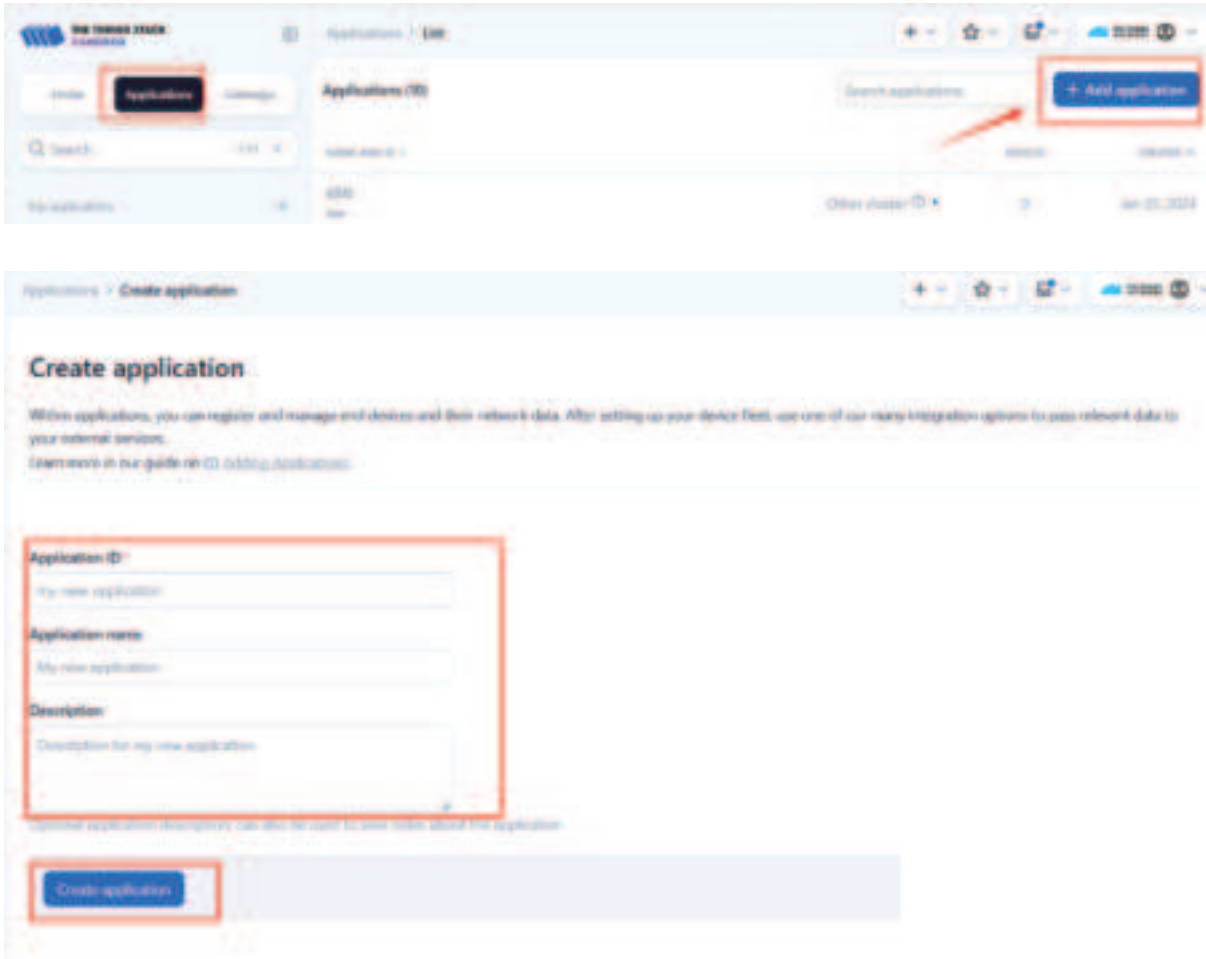
Create a device in TTN V3 with the OTAA keys from LHT65N/S.

Each LHT65N/S is shipped with a sticker with its device EUI, APP Key and APP EUI as below:

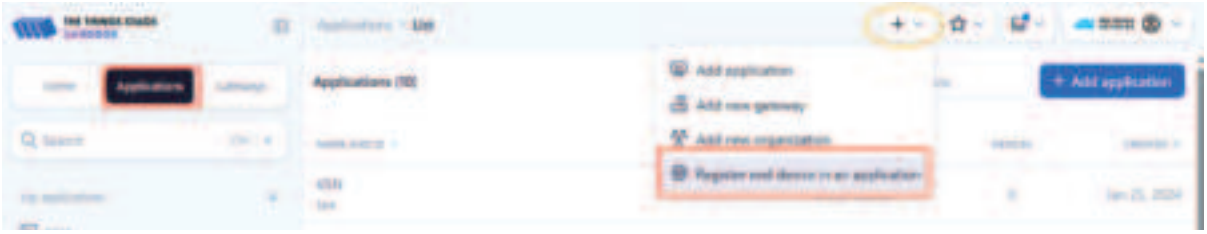


User can enter these keys in the LoRaWAN Server portal. Below is TTN V3 screenshot:

1. Create application

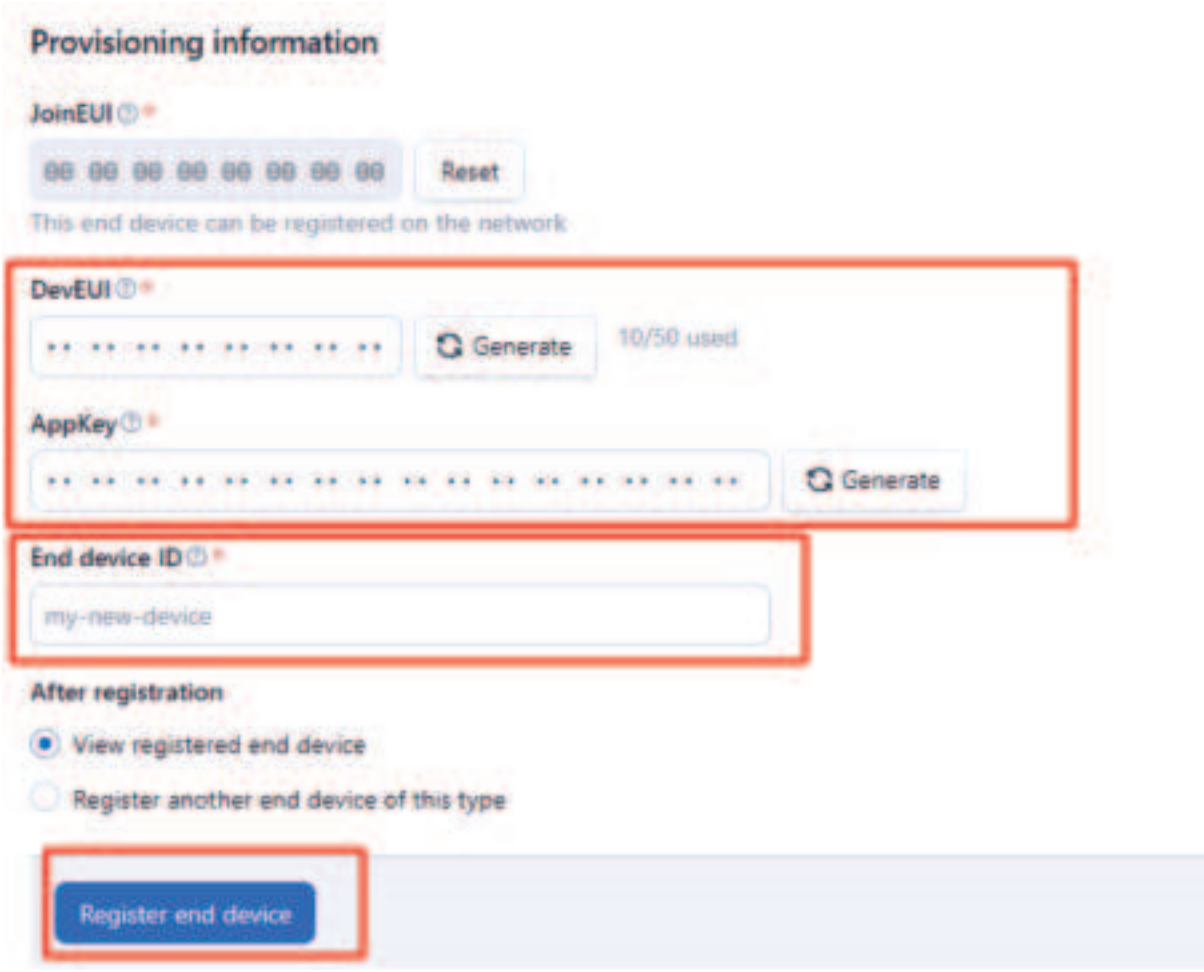


2. Add devices to the created Application.



3. Enter end device specifics manually.


Register end device
Does your end device have a LoRaWAN® Device Identification QR Code? Scan it to speed up onboarding.
Scan end device QR code
End device type
Input method
Select the end device in the LoRaWAN Device Repository
Enter end device specifics manually
Frequency plan
Europe 863-870 MHz (SF12 for RX2)
Select the frequency corresponding to the node
LoRaWAN version
LoRaWAN Specification 1.0.3
Regional Parameters version
Show advanced activation, LoRaWAN class and cluster settings
Provisioning information
JoinEUI
00 00 00 00 00 00 00 00
Confirm
AppEUI
To continue, please enter the JoinEUI of the end device so we can determine onboarding options



2.3.2 Step 2: Add decoder

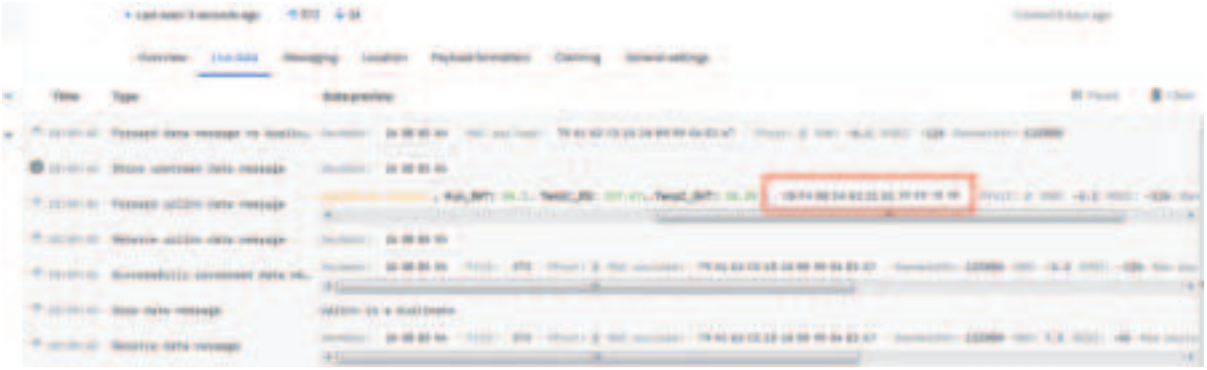
In TTN, user can add a custom payload so it shows friendly reading.

Click this link to get the decoder: LHT65N decoder.

Below is TTN screen shot

2.3.3 Step 3: Activate LHT65N/S by pressing the ACT button for more than 5 seconds.

Use ACT button to activate LHT65N/S and it will auto-join to the TTN V3 network. After join success, it will start to upload sensor data to TTN V3 and user can see in the panel.



2.4 Uplink Payload (Fport=2)

The uplink payload includes totally 11 bytes. Uplink packets use FPORT=2 and **every 20 minutes** send one uplink by default.

After each uplink, the **BLUE LED** will blink once.

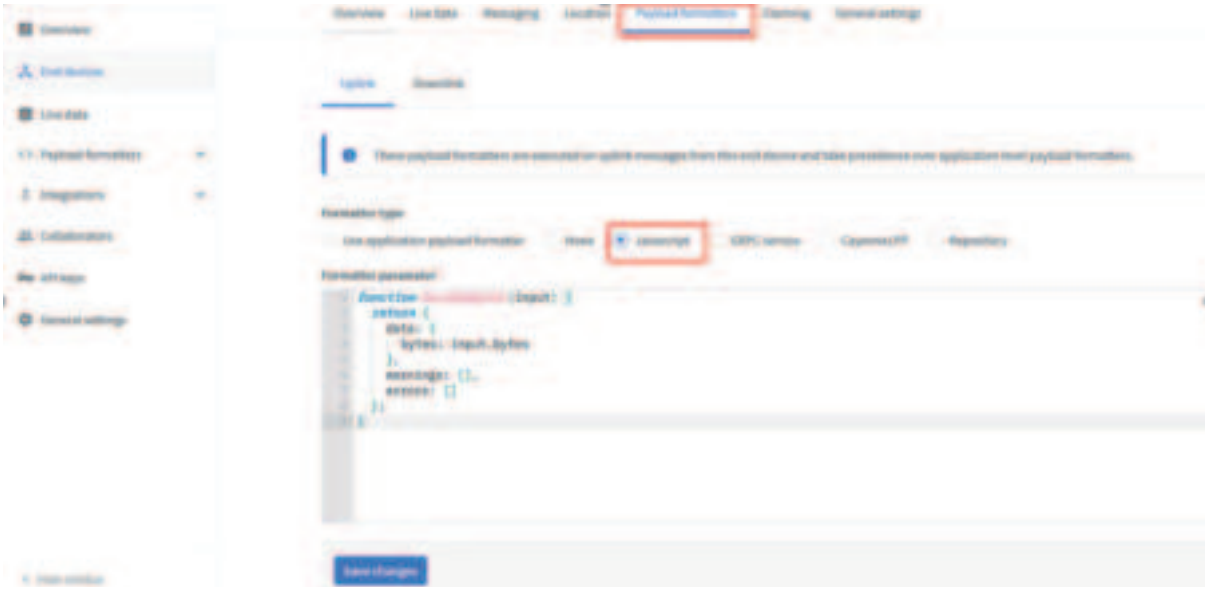
Size(bytes)	2	2	2	1	4
Value	BAT	Built-In Temperature	Built-in Humidity	Ext #	Ext value

- The First 6 bytes: has fix meanings for every LHT65N/S.
- The 7th byte (EXT #): defines the external sensor model.
- The 8^{th} ~ 11^{th} byte: the value for external sensor value. The definition is based on external sensor type. (If EXT=0, there won't be these four bytes.)

2.4.1 Decoder in TTN V3

When the uplink payload arrives TTNv3, it shows HEX format and not friendly to read. We can add LHT65N/S decoder in TTNv3 for friendly reading.

Below is the position to put the decoder and LHT65N/S decoder can be download from here: https://github.com/dragino/dragino-end-node-decoder

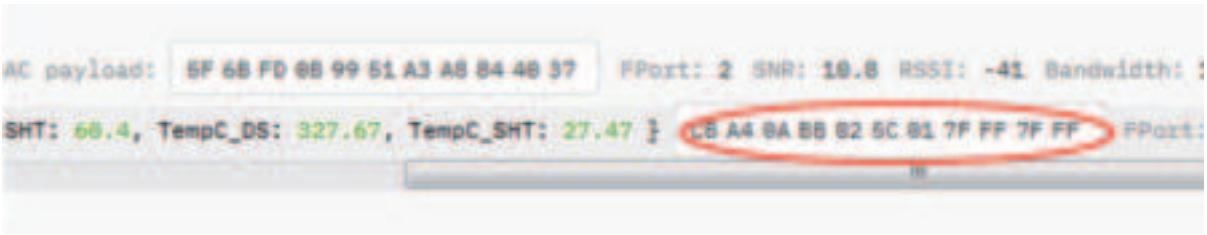


2.4.2 BAT-Battery Info

These two bytes of BAT include the battery state and the actually voltage.

Bit(bit)	[15:14]	[13:0]
Value	BAT Status 00(b): Ultra Low (BAT <= 2.50v) 01(b): Low (2.50v <=BAT <= 2.55v) 10(b): OK (2.55v <= BAT <=2.65v) 11(b): Good (BAT >= 2.65v)	Actually BAT voltage

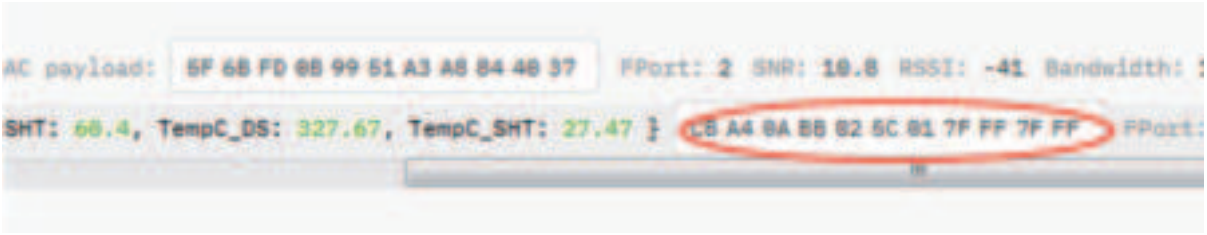
(b)stands for binary



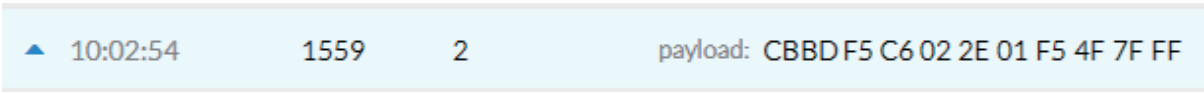
Check the battery voltage for LHT65N/S.

- BAT status=(0Xcba4>>14)&0xFF=11 (BIN)， very good
- Battery Voltage =0xCBA4&0x3FFF=0x0BA4=2980mV

2.4.3 Built-in Temperature

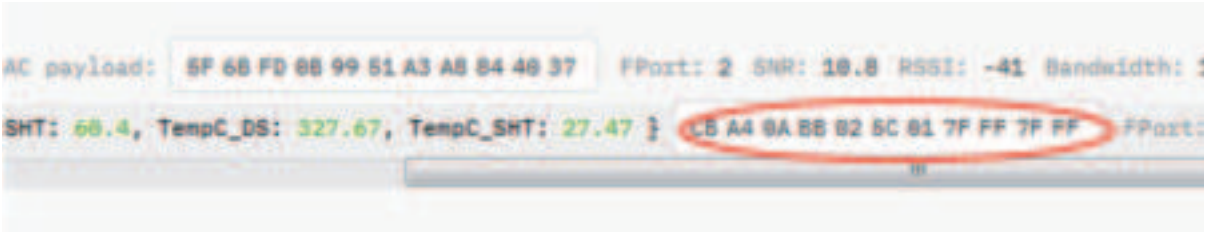


- Temperature: 0x0ABB/100=27.47℃



- Temperature: (0xF5C6-65536)/100=-26.18℃

2.4.4 Built-in Humidity



- Humidity: 0x025C/10=60.4%

2.4.5 Ext

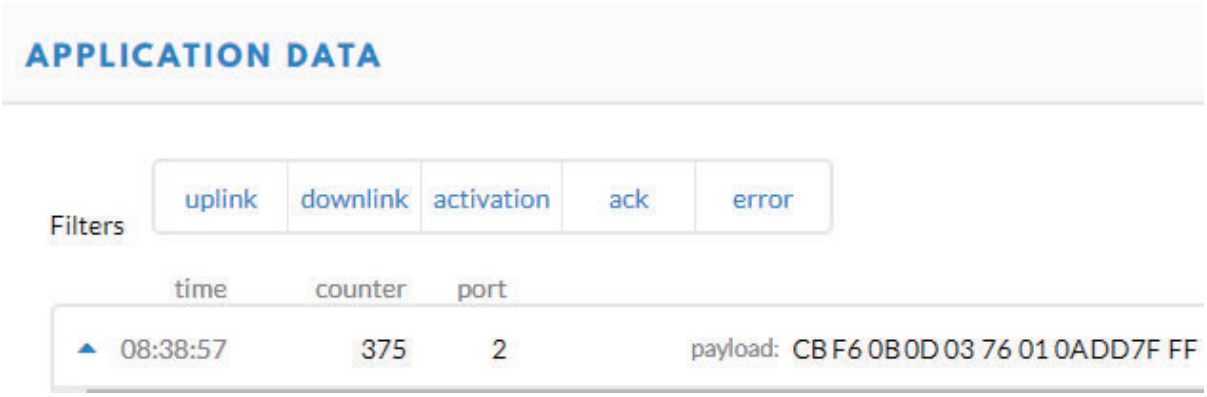
Bytes for External Sensor:

EXT # Value	External Sensor Type
0x01	Sensor E3, Temperature Sensor
0x09	Sensor E3, Temperature Sensor, Datalog Mod
0x06	ADC Sensor(use with E2 Cable)
0x02	TMP117 Sensor
0x11	SHT31 Sensor
0x04	Interrupt Mode
0x08	Counting Mode
0x10	E2 sensor (TMP117)with Unix Timestamp

2.4.6 Ext value

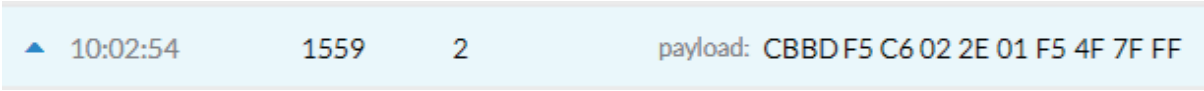
2.4.6.1 Ext=1, E3 Temperature Sensor

Size(bytes)	2	2	2	1	2	2
Value	BAT & BAT Status	TempC_SHT	Hum_SHT	Status & Ext	TempC_DS	senseless



- DS18B20 temp=0x0ADD/100=27.81℃

The last 2 bytes of data are meaningless



- External temperature= (0xF54F-65536)/100=-27.37℃

F54F : (F54F & 8000 == 1) , temp = (F54F - 65536)/100 = 27.37℃

(0105 & 8000: Judge whether the highest bit is 1, when the highest bit is 1, it is negative)

The last 2 bytes of data are meaningless

If the external sensor is 0x01, and there is no external temperature connected. The temperature will be set to 7FFF which is 327.67℃

2.4.6.2 Ext=9, E3 sensor with Unix Timestamp

Timestamp mode is designed for LHT65N/S with E3 probe, it will send the uplink payload with Unix timestamp. With the limitation of 11 bytes (max distance of AU915/US915/AS923 band), the time stamp mode will be lack of BAT voltage field, instead, it shows the battery status. The payload is as below:

Size(bytes)	2	2	2	1	4
Value	External temperature	Built-In Temperature	BAT Status & Built-in Humidity	Status & Ext	Unix Time Stamp

- **Battery status & Built-in Humidity**

Bit(bit)	[15:14]	[11:0]
Value	BAT Status 00(b): Ultra Low (BAT <= 2.50v) 01(b): Low (2.50v <=BAT <= 2.55v) 10(b): OK (2.55v <= BAT <=2.65v) 11(b): Good (BAT >= 2.65v)	Built-in Humidity

- **Status & Ext Byte**

Bits	7	6	5	4	[3:0]
Status&Ext	None-ACK Flag	Poll Message FLAG	Sync time OK	Unix Time Request	Ext: 0b(1001)

- **Poll Message Flag**: 1: This message is a poll message reply, 0: means this is a normal uplink.
- **Sync time OK**: 1: Set timeok, 0: N/A. After time SYNC request is sent, LHT65N/S will set this bit to 0 until got the time stamp from the application server.

- **Unix Time Request**: 1: Request server downlink Unix time, 0 : N/A. In this mode, LHT65N/S will set this bit to 1 every 10 days to request a time SYNC. (AT+SYNCMOD to set this)

2.4.6.3 Ext=6, ADC Sensor(use with E2 Cable)

Size(bytes)	2	2	2	1	2	2
Value	BAT & BAT Status	TempC_SHT	Hum_SHT	Status & Ext	ADC_Value	senseless

In this mode, user can connect external ADC sensor to check ADC value. The 3V3_OUT can

be used to power the external ADC sensor; user can control the power on time for this

sensor by setting:

AT+EXT=6,timeout **Time to power this sensor, from 0 ~ 65535ms**

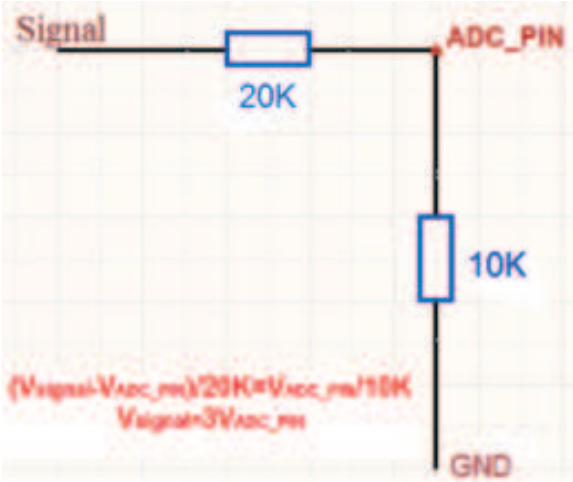
For example:

AT+EXT=6,1000 will power this sensor for 1000ms before sampling the ADC value.

Or use **downlink command A2** to set the same.

The measuring range of the node is only about 0.1V to 1.1V The voltage resolution is about 0.24mv.

When the measured output voltage of the sensor is not within the range of 0.1V and 1.1V, the output voltage terminal of the sensor shall be divided The example in the following figure is to reduce the output voltage of the sensor by three times If it is necessary to reduce more times, calculate according to the formula in the figure and connect the corresponding resistance in series.



When ADC_IN1 pin is connected to GND or suspended, ADC value is 0

```
Payload: { ADC_V: 0, BatV: 3.186, Bat_status: 3, Hum_SHT: 45.2, TempC_SHT: 28.11, Work_mode: "ADC Sensor" }
```

When the voltage collected by ADC_IN1 is less than the minimum range, the minimum range will be used as the output; Similarly, when the collected voltage is greater than the maximum range, the maximum range will be used as the output.

1) The minimum range is about 0.1V. Each chip has internal calibration, so this value is close to 0.1V

```
Payload: { ADC_V: 0.084, BatV: 3.186, Bat_status: 3, Hum_SHT: 44.9, TempC_SHT: 28.13, Work_mode: "ADC Sensor" }
```

2) The maximum range is about 1.1V. Each chip has internal calibration, so this value is close to 1.1v

Payload: { ADC_V: 1.805, BatV: 3.100, Bat_status: 3, Hum_SHT: 46.5, TempC_SHT: 28.16, Work_mode: "ADC Sensor" }

3) Within range

Payload:) ADC_V: 0.427, BatV: 3.099, Bat_status: 3, Hum_SHT: 45.1, TempC_SHT: 27.47, Work_mode: "ADC Sensor" (

2.4.6.4 Ext=2 TMP117 Sensor(Since Firmware v1.3)

Ext=2,Temperature Sensor(TMP117):

Size(bytes)	2	2	2	1	2	2
Value	BAT & BAT Status	TempC_SHT	Hum_SHT	Status & Ext	TempC_Temp117	senseless

[illegible]

Interrupt Mode and Counting Mode:

The external cable NE2 can be use for MOD4 and MOD8

2.4.6.5 Ext=11 SHT31 Sensor (Since Firmware v1.4.1)

Ext=11,Temperature & Humidity Sensor(SHT31):

Size(bytes)	2	2	2	1	2	2
Value	BAT & BAT Status	TempC_SHT	Hum_SHT	Status & Ext	Ext_TempC_SHT	Ext_Hum_SHT

2.4.6.6 Ext=4 Interrupt Mode(Since Firmware v1.3)

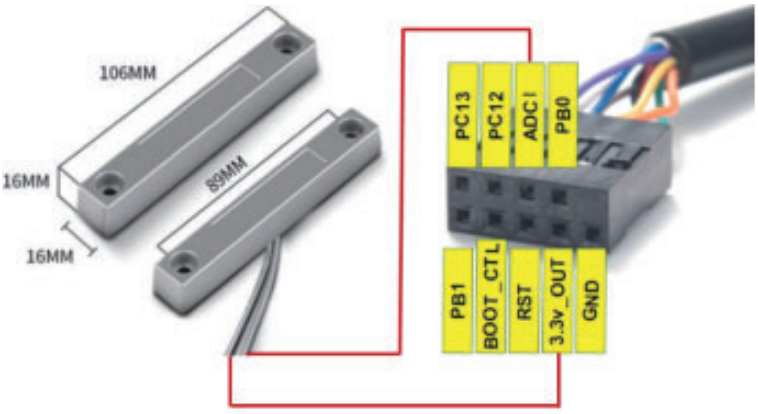
Note: In this mode, 3.3v output will be always ON. LHT65N/S will send an uplink when there is a trigger.

Interrupt Mode can be used to connect to external interrupt sensors such as:

Case 1: Door Sensor. 3.3v Out for such sensor is just to detect Open/Close.

In Open State, the power consumption is the same as if there is no probe

In Close state, the power consumption will be 3uA higher than normal.



Ext=4,Interrupt Sensor:

AT+EXT=4,1	**Sent uplink packet in both rising and falling interrupt**
AT+EXT=4,2	**Sent uplink packet only in falling interrupt**
AT+EXT=4,3	**Sent uplink packet only in rising interrupt**

Size(bytes)	2	2	2	1	1	1	2
Value	BAT & BAT Status	TempC_SHT	Hum_SHT	Status & Ext	Exti_pin_level	Exti_status	senseless

Trigger by falling edge:

Trigger by raising edge:

BAT & BAT Status :

Check the battery voltage.

Ex1: 0x0B45 = 2885mV

Ex2: 0x0B49 = 2889mV

TempC_SHT :

The temperature detected by the built-in temperature and humidity sensor SHT31.

If payload is: 0105H: (0105 & 8000 == 0), temp = 0105H /10 = 26.1 degree

If payload is: FF3FH : (FF3F & 8000 == 1) , temp = (FF3FH - 65536)/10 = -19.3 degrees.

(FF3F & 8000: Judge whether the highest bit is 1, when the highest bit is 1, it is negative)

Hum_SHT :

The humidity detected by the built-in temperature and humidity sensor SHT31.

Read:0295(H)=661(D) Value: 661 / 10=66.1, So 66.1%

Status & Ext :

Bits	7	6	5	4	[3:0]

Status&Ext	None-ACK Flag	Poll Message FLAG	Sync time OK	Unix Time Request	Ext: 0b(1001)

- **Poll Message Flag:** 1: This message is a poll message reply, 0: means this is a normal uplink.
- **Sync time OK:** 1: Set timeok, 0: N/A. After time SYNC request is sent, LHT65N/S will set this bit to 0 until got the time stamp from the application server.
- **Unix Time Request:** 1: Request server downlink Unix time, 0 : N/A. In this mode, LHT65N/S will set this bit to 1 every 10 days to request a time SYNC. (AT+SYNCMOD to set this)

Exti_pin_level :

- **Wet contacts:** high and low levels . 1: high level; 0: low level.
- **Dry contacts:** 1: closed; 0: open

Exti_status :

Determines whether the uplink packet is generated by an interrupt.

1: Interrupt packet

0: Normal TDC uplink packet

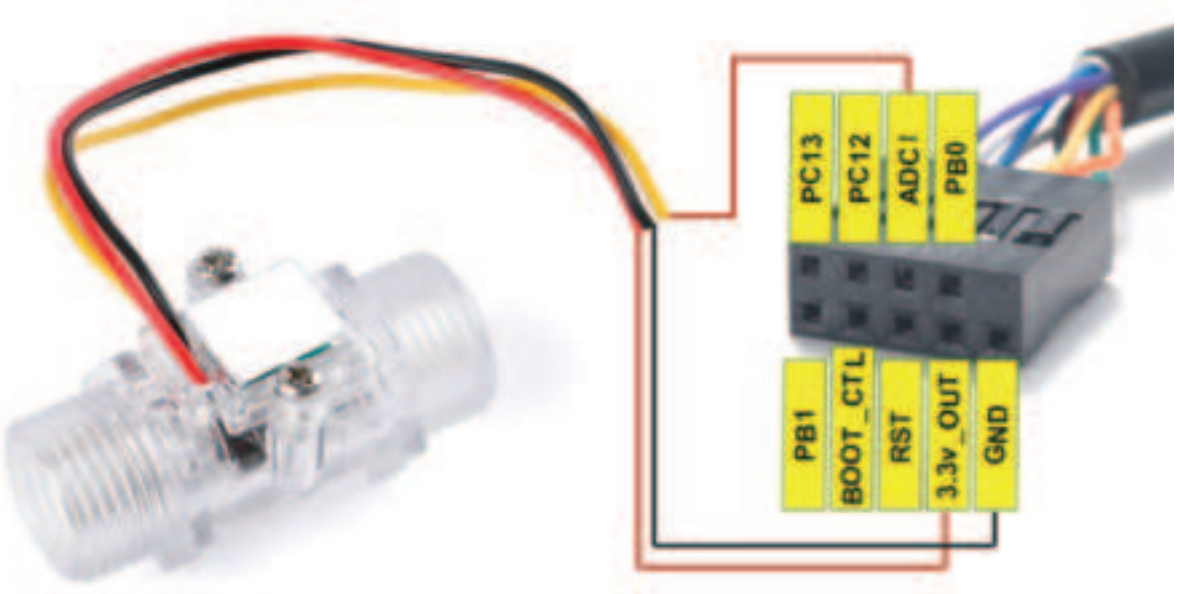
senseless :

Reserved position, meaningless. The value is fixed to 0x7FFF.

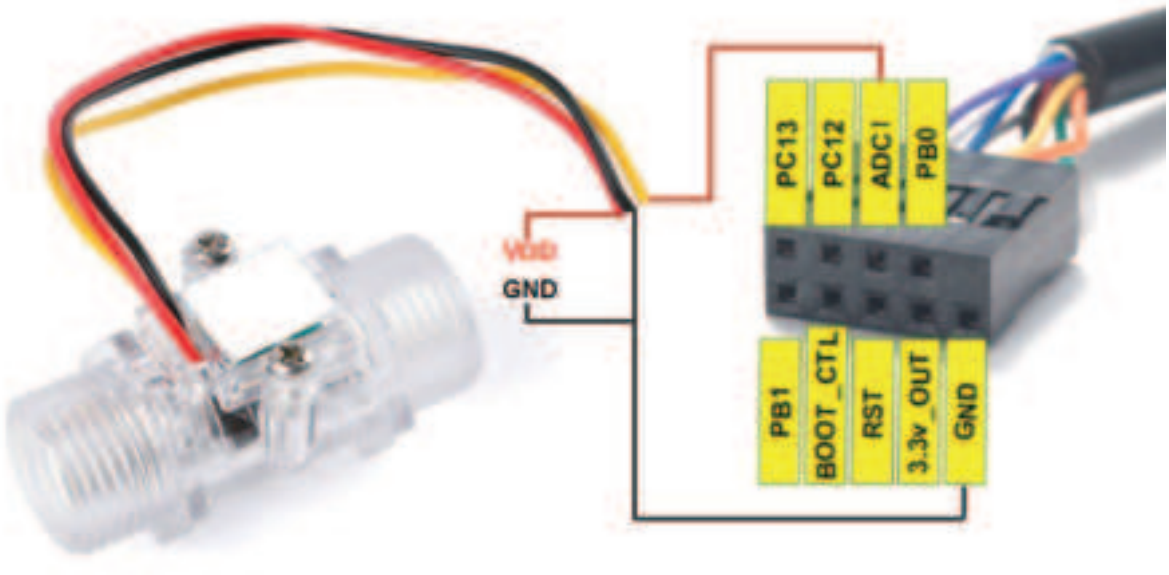
2.4.6.7 Ext=8 Counting Mode(Since Firmware v1.3)

Note: In this mode, 3.3v output will be always ON. LHT65N/S will count for every interrupt and uplink periodically.

Case 1: Low power consumption Flow Sensor, such flow sensor has pulse output and the power consumption in uA level and can be powered by LHT65N/S.



Case 2: Normal Flow Sensor: Such flow sensor has higher power consumption and is not suitable to be powered by LHT65N. It is powered by external power and output <3.3v pulse



Ext=8, Counting Sensor (4 bytes):

AT+EXT=8,0	**Count at falling interrupt**
AT+EXT=8,1	**Count at rising interrupt**
AT+SETCNT=60	**Sent current count to 60**

Size(bytes)	2	2	2	1	4
Value	BAT & BAT Status	TempC_SHT	Hum_SHT	Status & Ext	Exit_count

A2 downlink Command:

A2 02: Same as AT+EXT=2 (AT+EXT= second byte)

A2 06 01 F4: Same as AT+EXT=6,500 (AT+EXT= second byte, third and fourth bytes)

A2 04 02: Same as AT+EXT=4,2 (AT+EXT= second byte, third byte)

A2 08 01 00: Same as AT+EXT=8,0 (AT+EXT= second byte, fourth byte)

A2 08 02 00 00 00 3C: Same as AT+ SETCNT=60 (AT+ SETCNT = 4th byte and 5th byte and 6th byte and 7th byte)

2.4.6.8 Ext=10, E2 sensor (TMP117)with Unix Timestamp(Since firmware V1.3.2)

Timestamp mode is designed for LHT65N/S with E2 probe, it will send the uplink payload with Unix timestamp. With the limitation of 11 bytes (max distance of AU915/US915/AS923 band), the time stamp mode will be lack of BAT voltage field, instead, it shows the battery status. The payload is as below:

Size(bytes)	2	2	2	1	4
Value	External temperature	Built-In Temperature	BAT Status & Built-in Humidity	Status & Ext	Unix Time Stamp

- **Battery status & Built-in Humidity**

Bit(bit)	[15:14]	[11:0]
Value	BAT Status 00(b): Ultra Low (BAT <= 2.50v) 01(b): Low (2.50v <=BAT <= 2.55v) 10(b): OK (2.55v <= BAT <=2.65v) 11(b): Good (BAT >= 2.65v)	Built-in Humidity

- **Status & Ext Byte**

Bits	7	6	5	4	[3:0]
Status&Ext	None-ACK Flag	Poll Message FLAG	Sync time OK	Unix Time Request	Ext: 0b(1001)

- **Poll Message Flag**: 1: This message is a poll message reply, 0: means this is a normal uplink.
- **Sync time OK**: 1: Set time ok, 0: N/A. After time SYNC request is sent, LHT65N/S will set this bit to 0 until got the time stamp from the application server.
- **Unix Time Request**: 1: Request server downlink Unix time, 0 : N/A. In this mode, LHT65N/S will set this bit to 1 every 10 days to request a time SYNC. (AT+SYNCMOD to set this)

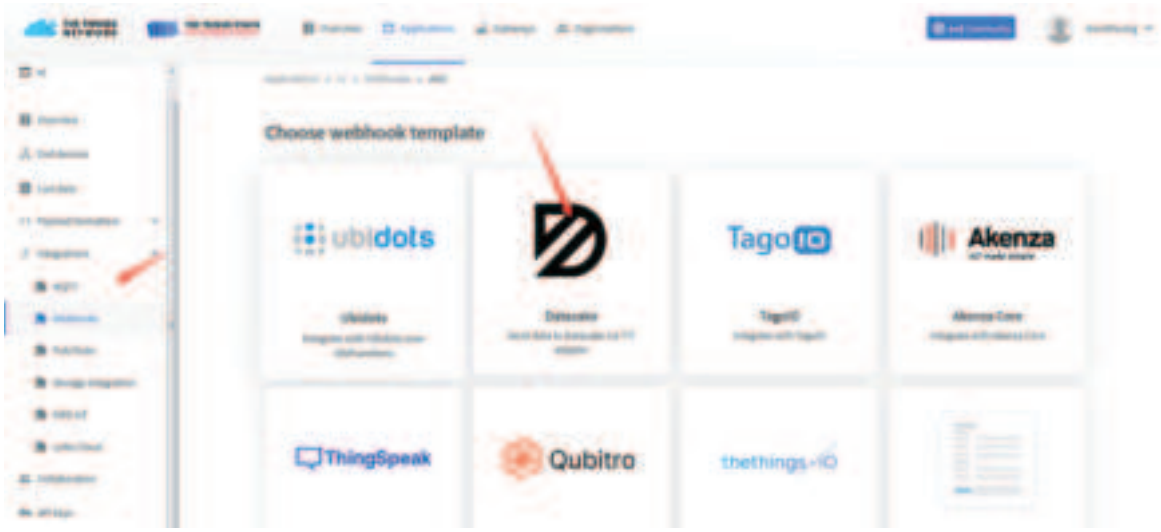
2.5 Show data on Datacake

Datacake IoT platform provides a human-friendly interface to show the sensor data, once we have sensor data in TTN V3, we can use Datacake to connect to TTN V3 and see the data in Datacake. Below are the steps:

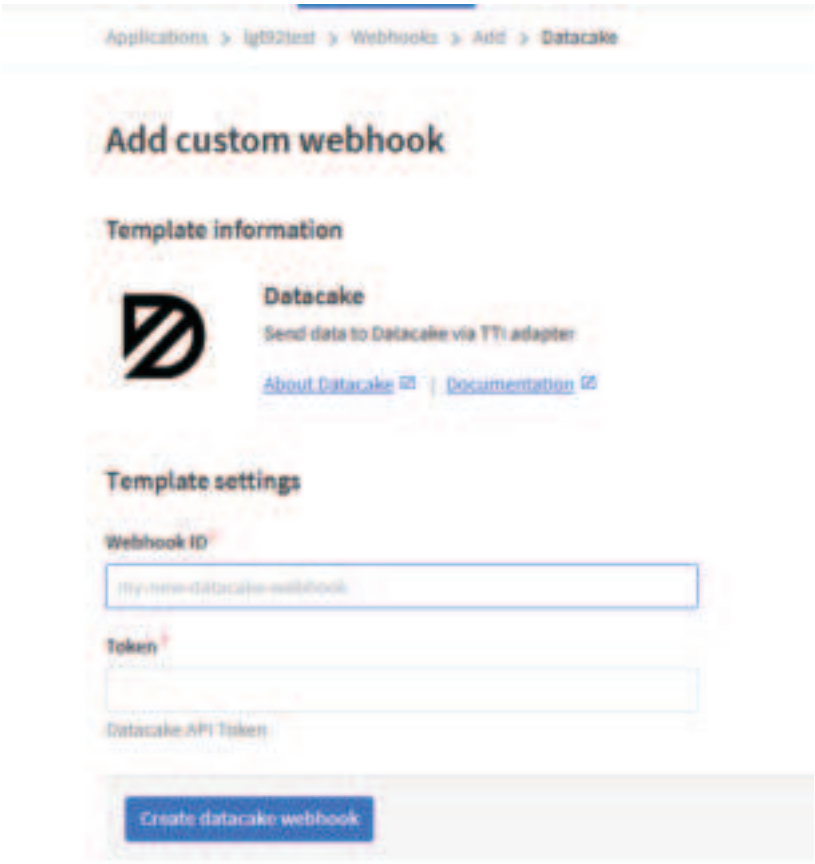
Step 1: Be sure that your device is programmed and properly connected to the LoRaWAN network.

Step 2: Configure your Application to forward data to Datacake you will need to add integration. Go to TTN V3 Console --> Applications --> Integrations --> Add Integrations.

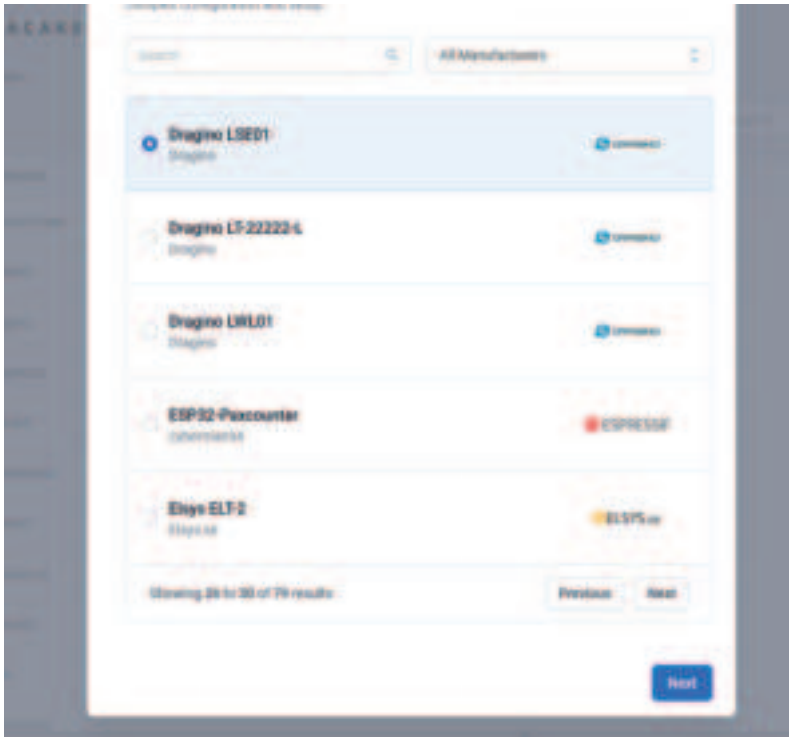
Add Datacake:



Select default key as Access Key:



In Datacake console (https://datacake.co/) , add LHT65 device.



2.6 Datalog Feature

Datalog Feature is to ensure IoT Server can get all sampling data from Sensor even if the LoRaWAN network is down. For each sampling, LHT65N/S will store the reading for future retrieving purposes. There are two ways for IoT servers to get datalog from LHT65N/S.

2.6.1 Ways to get datalog via LoRaWAN

There are two methods:

Method 1: IoT Server sends a downlink LoRaWAN command to poll the value for specified time range.

Method 2: Set PNACKMD=1, LHT65N/S will wait for ACK for every uplink, when there is no LoRaWAN network, LHT65N/S will mark these records with non-ack messages and store the sensor data, and it will send all messages (10s interval) after the network recovery.

Note for method 2:

- a) LHT65N/S will do an ACK check for data records sending to make sure every data arrive server.
- b) LHT65N/S will send data in **CONFIRMED Mode** when PNACKMD=1, but LHT65N/S won't re-transmit the packet if it doesn't get ACK, it will just mark it as a NONE-ACK message. In a future uplink if LHT65N gets a ACK, LHT65N/S will consider there is a network connection and resend all NONE-ACK Message.

Below is the typical case for the auto-update datalog feature (Set PNACKMD=1)

2.6.2 Unix TimeStamp

LHT65N/S uses Unix TimeStamp format based on

Size (bytes)	4	1
DeviceTimeAns Payload	32-bit unsigned integer : Seconds since epoch"	8bits unsigned integer: fractional-second in 1/2^8 second steps

Figure 10 : DeviceTimeAns payload format

User can get this time from link: https://www.epochconverter.com/ :

Below is the converter example

So, we can use AT+TIMESTAMP=1611889405 or downlink 3060137afd00 to set the current time 2021 – Jan -- 29 Friday 03:03:25

2.6.3 Set Device Time

There are two ways to set device's time:

1. Through LoRaWAN MAC Command (Default settings)

User need to set SYNCMOD=1 to enable sync time via MAC command.

Once LHT65N/S Joined LoRaWAN network, it will send the MAC command (DeviceTimeReq) and the server will reply with (DeviceTimeAns) to send the current time to LHT65N/S. If LHT65N/S fails to get the time from the server, LHT65N/S will use the internal time and wait for next time request (AT+SYNCTDC to set the time request period, default is 10 days).

Note: LoRaWAN Server need to support LoRaWAN v1.0.3(MAC v1.0.3) or higher to support this MAC command feature, Chirpstack,TTN V3 v3 and loriot support but TTN V3 v2 doesn't support. If server doesn't support this command, it will through away uplink packet with this command, so user will lose the packet with time request for TTN V3 v2 if SYNCMOD=1.

2. Manually Set Time

User needs to set SYNCMOD=0 to manual time, otherwise, the user set time will be overwritten by the time set by the server.

2.6.4 Poll sensor value

User can poll sensor value based on timestamps from the server. Below is the downlink command.

1byte	4bytes	4bytes	1byte
31	Timestamp start	Timestamp end	Uplink Interval

Timestamp start and Timestamp end use Unix TimeStamp format as mentioned above. Devices will reply with all data log during this time period, use the uplink interval.

For example, downlink command **31 5FC5F350 5FC6 0160 05**

Is to check 2020/12/1 07:40:00 to 2020/12/1 08:40:00's data

Uplink Internal =5s, means LHT65N/S will send one packet every 5s. range 5~255s.

2.6.5 Datalog Uplink payload

The Datalog poll reply uplink will use below payload format.

Retrieval data payload:

Size(bytes)	2	2	2	1	4
Value	External sensor data	Built In Temperature	Built-in Humidity	Poll message flag & Ext	Unix Time Stamp

Poll message flag & Ext:

Bits	7	6	5	4	[3:0]
Status&Ext	No ACK Message	Poll Message Flag	Sync time OK	Unix Time Request	Ext: 0b(1001)

No ACK Message: 1: This message means this payload is fromn Uplink Message which doesn't get ACK from the server before (for PNACKMD=1 feature)

Poll Message Flag: 1: This message is a poll message reply.

- Poll Message Flag is set to 1.
- Each data entry is 11 bytes, to save airtime and battery, devices will send max bytes according to the current DR and Frequency bands.

For example, in US915 band, the max payload for different DR is:

a) DR0: max is 11 bytes so one entry of data

b) DR1: max is 53 bytes so devices will upload 4 entries of data (total 44 bytes)

c) DR2: total payload includes 11 entries of data

d) DR3: total payload includes 22 entries of data.

If devise doesn't have any data in the polling time. Device will uplink 11 bytes of 0

Example:

If LHT65N/S has below data inside Flash:

Flash Add	Unix Time	Ext	BAT voltage	Value
80196E0	21/1/19 04:27:03	1	3145	sht temp=22.00 sht hum=32.6 ds temp=327.67
80196F0	21/1/19 04:28:57	1	3145	sht temp=21.90 sht hum=33.1 ds temp=327.67

8019600	21/1/19 04:30:30	1	3145	sht temp=21.81 sht hum=33.4 ds temp=327.67
8019610	21/1/19 04:40:30	1	3145	sht temp=21.65 sht hum=33.7 ds temp=327.67
8019620	21/1/19 04:50:30	1	3147	sht temp=21.55 sht hum=34.1 ds temp=327.67
8019630	21/1/19 04:00:30	1	3149	sht temp=21.50 sht hum=34.1 ds temp=327.67
8019640	21/1/19 04:10:30	1	3149	sht temp=21.43 sht hum=34.6 ds temp=327.67
8019650	21/1/19 04:20:30	1	3151	sht temp=21.35 sht hum=34.9 ds temp=327.67

If user sends below downlink command: 3160065F9760066DA705

Where : Start time: 60065F97 = time 21/1/19 04:27:03

Stop time: 60066DA7= time 21/1/19 05:27:03

LHT65N/S will uplink this payload.

7FFF089801464160065F97 7FFF 088E 014B 41 60066009

7FFF0885014E41600660667FFF0875015141600662BE7FFF086B015541600665167FFF0866015541600676E7FFF085F015A41

Where the first 11 bytes is for the first entry:

7FFF089801464160065F97

Ext sensor data=0x7FFF/100=327.67

Temp=0x088E/100=22.00

Hum=0x014B/10=32.6

poll message flag & Ext=0x41,means reply data,Ext=1

Unix time is 0x60066009=1611030423s=21/1/19 04:27:03

2.7 Alarm Mode & Feature "Multi sampling, one uplink"

when the device is in alarm mode, it checks the built-in sensor temperature for a short time. if the temperature exceeds the preconfigured range, it sends an uplink immediately.

Note: alarm mode adds a little power consumption, and we recommend extending the normal read time when this feature is enabled.

2.7.1 ALARM MODE (Since v1.3.1 firmware)

AT+LEDALARM=1 : Enable LED visual Alarm. **Downlink Command: 3601**

DS18B20 and TMP117 Threshold Alarm(The mod1 use for external sensors (DS18B20 **and TMP117)**

AT+WMOD=1,60,-10,20

Explain:

- **parameter1:** Set Working Mode to **Mode** 1, Threshold Alarm (Out **of range** alarm)
- **parameter2:** Sampling Interval is **60**s.
- **parameter3 & parameter4:** Temperature alarm range is **-10** to 20°C (Set the temperature range value with a coefficient of 100)

Downlink Command:

Example: A5013CFC1807D0

MOD=01

CITEMP=3C(S) =60(S)

TEMPlow=FC18 = -1000/100=-10(℃)

TEMPhigh=07D0=2000/100=20(℃)

Fluctuation alarm for DS18B20 and TMP117(Acquisition time: minimum 1s)(The mod2 use for external sensors (DS18B20 **and TMP117)**

AT+WMOD=2,60,5

Explain:

- **parameter1:** Set Working Mode to **Mode** 2, Fluctuation **alarm**
- **parameter2:** Sampling Interval is **60**s.
- **parameter3:** The temperature fluctuation is +-5 °C

Downlink Command

Example: A5023C05

MOD=02

CITEMP=3C(S)=60(S)

temperature fluctuation=05(℃)

Sampling multiple times and uplink together(The mod3 can be used for internal and external sensors)
(Internal **GXHT30 temperature alarm(Acquisition time: fixed at one minute)**

AT+WMOD=3,1,60,20,-16,32,1

Explain:

- **parameter1:** Set Working Mode to **Mode** 3, Sampling **multiple times and uplink together**
- **parameter2:** Set the temperature sampling mode to **1**(1:DS18B20;2:TMP117;3: Internal GXHT30).
- **parameter3:** Sampling Interval is **60**s.(This parameter has no effect on internal sensors)
- **parameter4:** When there is **20** sampling dats, Device will send these data via one uplink. (max value is 60, means max 60 sampling in one uplink)
- **parameter5 & parameter6:** Temperature alarm range is **-16** to **32**°C,
- **parameter7:** 1 to enable temperature alarm, **0** to disable the temperature alarm. If alarm is enabled, a data will be sent immediately if temperate exceeds the Alarm range.

Downlink Command:

Example: A50301003C14FFF0002001

MOD=03

TEMP=DS18B20

CITEMP=003C(S)=60(S)

Total number of acquisitions=14

TEMPlow=FFF0=-16(℃)

TEMPhigh=0020=20(℃)

ARTEMP=01

Uplink payload(Fport=3)

Example: CBEA01**0992***0A41***09C4**

BatV=CBEA

TEMP=DS18B20

Temp1=0992 // 24.50℃

Temp2=0A41 // 26.25℃

Temp3=09C4 // 25.00℃

Note: This uplink will automatically select the appropriate DR according to the data length

In this mode, the temperature resolution of ds18b20 is 0.25℃ to save power consumption

2.7.2 ALARM MODE (Before v1.3.1 firmware)

AT+WMOD=1: Enable/disable alarm mode. (0: Disabled, 1: Enabled Temperature Alarm for onboard temperature sensor)

AT+CITEMP=1: The interval between checking the alarm temperature. (In minutes)

AT+ARTEMP: Gets or sets the alarm range of the internal temperature sensor

AT+ARTEMP=? : Gets the alarm range of the internal temperature sensor

AT+ARTEMP=45,105: Set the internal temperature sensor alarm range from 45 to 105.

Downlink Command: AAXXXXXXXXXXXXXX

Total bytes: 8 bytes

Example:AA0100010001003C

WMOD=01

CITEMP=0001

TEMPlow=0001

TEMPhigh=003C

2.8 LED Indicator

The LHT65 has a triple color LED which for easy showing different stage .

While user press ACT button, the LED will work as per LED status with ACT button.

In a normal working state:

- For each uplink, the BLUE LED or RED LED will blink once.
  BLUE LED when external sensor is connected.
- RED LED when external sensor is not connected
- For each success downlink, the PURPLE LED will blink once

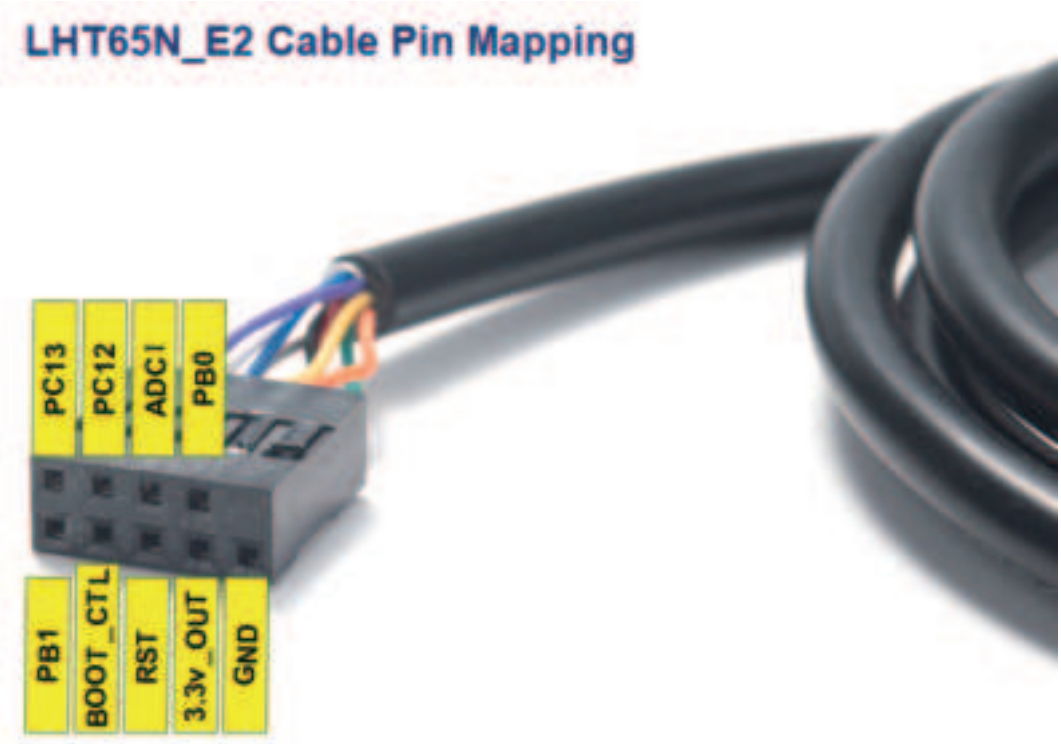
2.9 installation

3. Sensors and Accessories

3.1 E2 Extension Cable

1m long breakout cable for LHT65N/S. Features:

- Use for AT Command, works for both LHT52, LHT65N/S
- Update firmware for LHT65N/S, works for both LHT52, LHT65N/S
- Supports ADC mode to monitor external ADC
- Supports Interrupt mode
- Exposed All pins from the LHT65N/S Type-C connector.



3.2 E3 Temperature Probe

Temperature sensor with 2 meters cable long

- Resolution: 0.0625 °C
- ±0.5°C accuracy from -10°C to +85°C
- ±2°C accuracy from -55°C to +125°C
- Operating Range: -40 ~ 125 °C
- Working voltage 2.35v ~ 5v

3.3 E31F Temperature Probe

Temperature sensor with 1 meters cable long

Built-in Temperature Sensor:

- Resolution: 0.01 °C
- Accuracy Tolerance : Typ ±0.3 °C
- Long Term Drift: < 0.02 °C/yr
- Operating Range: -40 ~ 80 °C

Built-in Humidity Sensor:

- Resolution: 0.04 % RH
- Accuracy Tolerance : Typ ±3 % RH
- Long Term Drift: < 0.25 RH/yr
- Operating Range: 0 ~ 96 % RH

External Temperature Sensor :

- Resolution: 0.01 °C
- Accuracy Tolerance : Typical ±0.3 °C
- Long Term Drift: < 0.02 °C/yr
- Operating Range: -40 ~ 125 °C

External Humidity Sensor :

- Resolution: 0.04 % RH
- Accuracy Tolerance : Typ ±3 % RH
- Long Term Drift: < 0.25 RH/yr
- Operating Range: 0 ~ 96 % RH

3.4 NE117 Temperature Probe (Model: LHT65N/S-NE117)

External Temperature Sensor – NE117:
Equip with TMP117A temperature sensor. TMP117 IC is NIST traceability Sensor by TI.

- Silica gel cable
- ±0.1 °C (maximum) from –20 °C to 50 °C
- ±0.2 °C (maximum) from –40 °C to 100 °C
- ±0.3 °C (maximum) from –55 °C to 150 °C

3.5 Dry Contact Probe (Model: LHT65N/S-DC)

- Design for Pulse Counting(Ext=8), Alarm (Ext=4),Open/Close Detect (Ext=4)
- 3 wires: VCC/GND/INT
- Cable Lenght: 1 meter

LHT65N/S-DC can be used to connect various types of external sensor. below.

User can refer this link for the instructions: LHT65-DC Connection Instruction.

3.6 Door Sensor (Model: LHT65N/S-DS)

- Aluminum Alloy Door Sensor
- Detect Distance: ~3cm
- Cable Lenght: 1 meter

Notice: When order LHT65N/S-DS, the device is by default set to: a) AT+EXT=4,1 ; b) Default Uplink Interval TDC is 12 hour.

4. Configure LHT65N/S via AT command or LoRaWAN downlink

Use can configure LHT65N/S via AT Command or LoRaWAN Downlink.

- AT Command Connection: See FAQ.
- LoRaWAN Downlink instruction for different platforms: IoT LoRaWAN Server

There are two kinds of commands to configure LHT65N/S, they are:

- **General Commands**.

These commands are to configure:

1. General system settings like: uplink interval.
2. LoRaWAN protocol & radio-related commands.

They are the same for all Dragino Devices which supports DLWS-005 LoRaWAN Stack(Note**). These commands can be found on the wiki: End Device Downlink Command

- **Commands special design for LHT65N/S**

These commands are only valid for LHT65N/S, as below:

4.1 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

4.2 Set External Sensor Mode

Feature: Change External Sensor Mode.

AT Command: AT+EXT

Command Example	Function	Response	Dowlink Command
AT+EXT=?	Get current external sensor mode	1 OK External Sensor mode =1	
AT+EXT=1	Set external sensor mode to 1		A201
AT+EXT=9	Set to external DS18B20 with timestamp		A209
AT+EXT=6	Set to external ADC Sensor(use with E2 Cable)		A206
AT+EXT=2	Set to external TMP117 Sensor(Since Firmware v1.3)		A202
AT+EXT=11	Set to external SHT31 Sensor (Since Firmware v1.4.1)		A20B
AT+EXT=4	Set to external Interrupt Mode(Since Firmware v1.3)		A204
AT+EXT=8	Set to external Counting Mode(Since Firmware v1.3)		A208
AT+EXT=10	Set to external E2 sensor (TMP117)with Unix Timestamp(Since firmware V1.3.2)		A20A

Response

Downlink Command: 0xA2

Total bytes: 2 ~ 5 bytes

Example:

- 0xA201: Set external sensor type to E1
- 0xA209: Same as AT+EXT=9
- 0xA20702003c: Same as AT+SETCNT=60

4.3 Enable/Disable uplink DS18B20 Temperature probe ID

Feature: If PID is enabled, LHT65N/S will send the DS18B20 temperature probe ID on:

- First Packet after OTAA Join
- Every 24 hours since the first packet.

PID is default set to disable (0)

Notice: This feature only valid when EXT=1 or EXt=9

AT Command:

Command Example	Function	Response
AT+PID=1	Enable PID uplink	OK

Downlink Command:

- **0xA800** --> AT+PID=0
- **0xA801** --> AT+PID=1

4.4 Set Password

Feature: Set device password, max 9 digits

AT Command: AT+PWORD

Command Example	Function	Response
AT+PWORD=?	Show password	123456 OK
AT+PWORD=999999	Set password	OK

Downlink Command:

No downlink command for this feature.

4.5 Quit AT Command

Feature: Quit AT Command mode, so user needs to input password again before use AT Commands.

AT Command: AT+DISAT

Command Example	Function	Response
AT+DISAT	Quit AT Commands mode	OK

Downlink Command:

No downlink command for this feature.

4.6 Set to sleep mode

Feature: Set device to sleep mode

- **AT+Sleep=0** : Normal working mode, device will sleep and use lower power when there is no LoRa message
- **AT+Sleep=1** : Device is in deep sleep mode, no LoRa activation happen, used for storage or shipping.

AT Command: AT+SLEEP

Command Example	Function	Response
AT+SLEEP	Set to sleep mode	Clear all stored sensor data... OK

Downlink Command:

- There is no downlink command to set to Sleep mode.

4.7 Set system time

Feature: Set system time, unix format. See here for format detail.

AT Command:

Command Example	Function

AT+TIMESTAMP=1611104352	OK Set System time to 2021-01-20 00:59:12

Downlink Command:

0x306007806000 // Set timestamp to 0x(6007806000),Same as AT+TIMESTAMP=1611104352

4.8 Set Time Sync Mode

Feature: Enable/Disable Sync system time via LoRaWAN MAC Command (DeviceTimeReq), LoRaWAN server must support v1.0.3 protocol to reply this command.

SYNCMOD is set to 1 by default. If user want to set a different time from LoRaWAN server, user need to set this to 0.

AT Command:

Command Example	Function
AT+SYNCMOD=1	Enable Sync system time via LoRaWAN MAC Command (DeviceTimeReq)

Downlink Command:

0x28 01 // Same As AT+SYNCMOD=1
0x28 00 // Same As AT+SYNCMOD=0

4.9 Set Time Sync Interval

Feature: Define System time sync interval. SYNCTDC default value: 10 days.

AT Command:

Command Example	Function
AT+SYNCTDC=0x0A	Set SYNCTDC to 10 (0x0A), so the sync time is 10 days.

Downlink Command:

0x29 0A // Same as AT+SYNCTDC=0x0A

4.10 Get data

Feature: Get the current sensor data.

AT Command:

- **AT+GETSENSORVALUE=0** // The serial port gets the reading of the current sensor
- **AT+GETSENSORVALUE=1** // The serial port gets the current sensor reading and uploads it.

4.11 Print data entries base on page

Feature: Print the sector data from start page to stop page (max is 416 pages).

AT Command: AT+PDTA

Command Example	Function
AT+PDTA=1,3 Print page 1 to 3	8019500 19/6/26 16:48 1 2992 sht temp=28.21 sht hum=71.5 ds temp=27.31 8019510 19/6/26 16:53 1 2994 sht temp=27.64 sht hum=69.3 ds temp=26.93 8019520 19/6/26 16:58 1 2996 sht temp=28.39 sht hum=72.0 ds temp=27.06 8019530 19/6/26 17:03 1 2996 sht temp=27.97 sht hum=70.4 ds temp=27.12

8019540 19/6/26 17:08 1 2996 sht temp=27.80 sht hum=72.9 ds temp=27.06
8019550 19/6/26 17:13 1 2998 sht temp=27.30 sht hum=72.4 ds temp=26.68
8019560 19/6/26 17:22 1 2992 sht temp=26.27 sht hum=62.3 ds temp=26.56
8019570
8019580
8019590
80195A0
80195B0
80195C0
80195D0
80195E0
80195F0

OK

Downlink Command:

No downlink commands for feature

4.12 Print last few data entries

Feature: Print the last few data entries

AT Command: AT+PLDTA

Command Example	Function
AT+PLDTA=5 Print last 5 entries	Stop Tx and RTP events when read sensor data 1 19/6/26 13:59 1 3005 sht temp=27.09 sht hum=79.5 ds temp=26.75 2 19/6/26 14:04 1 3007 sht temp=26.65 sht hum=74.8 ds temp=26.43 3 19/6/26 14:09 1 3007 sht temp=26.91 sht hum=77.9 ds temp=26.56 4 19/6/26 14:15 1 3007 sht temp=26.93 sht hum=76.7 ds temp=26.75 5 19/6/26 14:20 1 3007 sht temp=26.78 sht hum=76.6 ds temp=26.43 Start Tx and RTP events OK

Downlink Command:

No downlink commands for feature

4.13 Clear Flash Record

Feature: Clear flash storage for data log feature.

AT Command: AT+CLRDTA

Command Example	Function	Response
AT+CLRDTA	Clear date record	Clear all stored sensor data... OK

Downlink Command: 0xA3

- Example: 0xA301 // Same as AT+CLRDTA

4.14 Auto Send None-ACK messages

Feature: LHT65N/S will wait for ACK for each uplink, If LHT65N/S doesn't get ACK from the IoT server, it will consider the message doesn't arrive server and store it. LHT65N/S keeps sending messages in normal periodically. Once LHT65N/S gets ACK from a server, it will consider the network is ok and start to send the not-arrive message.

AT Command: AT+PNACKMD

The default factory setting is 0

Command Example	Function	Response
AT+PNACKMD=1	Poll None-ACK message	OK

Downlink Command: 0x34

- Example: 0x3401 // Same as AT+PNACKMD=1

4.15 Modified WMOD command for external sensor TMP117 or DS18B20 temperature alarm(Since firmware 1.3.0)

Feature: Set internal and external temperature sensor alarms.

Command Example	Function	Response
AT+WMOD=parameter1,parameter2,parameter3,parameter4	Set internal and external temperature sensor alarms	OK

AT+WMOD=parameter1,parameter2,parameter3,parameter4

Parameter 1: Alarm mode:

0): Cancel

1): Threshold alarm

2): Fluctuation alarm

3): Sampling multiple times and uplink together

Parameter 2: Sampling time. Unit: seconds, up to 255 seconds.

Note: When the collection time is less than 60 seconds and always exceeds the set alarm threshold, the sending interval will not be the collection time, but will be sent every 60 seconds.

Parameter 3 and parameter 4:

1): If Alarm Mode is set to 1: Parameter 3 and parameter 4 are valid, as before, they represent low temperature and high temperature.

Such as AT+WMOD=1,60,45,105, it means high and low temperature alarm.

2): If Alarm Mode is set to 2: Parameter 3 is valid, which represents the difference between the currently collected temperature and the last uploaded temperature.

Such as AT+WMOD=2,10,2,it means that it is a fluctuation alarm.

If the difference between the current collected temperature and the last Uplin is ±2 degrees, the alarm will be issued.

3): If Alarm Mode is set to 3:

- **parameter1:** Set Working Mode to **Mode 3**
- **parameter2:** Set the temperature sampling mode to **1**(1:DS18B20;2:TMP117;3: Internal GXHT30).
- **parameter3:** Sampling Interval is **60**s.
- **parameter4:** When there is **20** sampling dats, Device will send these data via one uplink. (max value is 60, means max 60 sampling in one uplink)
- **parameter5 & parameter6:** Temperature alarm range is **-16** to **32**°C,
- **parameter7:** 1 to enable temperature alarm, **0** to disable the temperature alarm. If alarm is enabled, a data will be sent immediately if temperate exceeds the Alarm range.

Downlink Command: 0xA5

0xA5 00 -- AT+WMOD=0.

0xA5 01 0A 11 94 29 04 -- AT+WMOD=1,10,45,105 (AT+WMOD = second byte, third byte, fourth and fifth bytes divided by 100, sixth and seventh bytes divided by 100)

0XA5 01 0A F9 C0 29 04 --AT+WMOD=1,10,-16,105(Need to convert -16 to -1600 for calculation, -1600(DEC)=FFFFFFFFFFFFF9C0(HEX) FFFFFFFFFFFF9C0(HEX) +10000(HEX)=F9C0(HEX))

0xA5 02 0A 02 -- AT+WMOD=2,10,2 (AT+WMOD = second byte, third byte, fourth byte)

0xA5 03 01 00 3C 14 FF F0 00 20 01--AT+WMOD=3,1,60,20,-16,32,1

0xA5 FF -- After the device receives it, upload the current alarm configuration (FPORT=8). Such as 01 0A 11 94 29 04 or 02 0A 02.

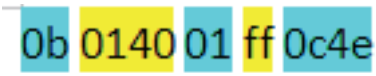
4.16 Get Firmware Version Info(Since V1.4.0)

Feature: use downlink to get firmware version.

Downlink Command: 0x2601

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

Device will reply with firmware version info, device info. frequency band info. detail please check device user manual.

Total 7 bytes Example(**FPort=5**): 

Sensor model

0x0b: LHT65N/S

Firmware version

firm_ver=(bytes[1]&0x0f)+'.'+(bytes[2]>>4&0x0f)+'.'+(bytes[2]&0xOf);

Example: 0x0140=V1.4.0

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

Subband

value 0x00 ~ 0x08

Example: 0xFF ---> " NULL"

Battery

Ex1: 0x0C4E(H) = 3150(D) = 3150mV =3.15V

Ex2: 0x0CF8(H) = 3320(D) = 3320mV =3.32V

4.17 Setting LEDAlarm

Feature: Setting LEDAlarm

The default factory setting is 0

Command Example	Function	Response
AT+LEDALARM=1	Setting LEDAlarm	OK

Downlink Command: 0x3601

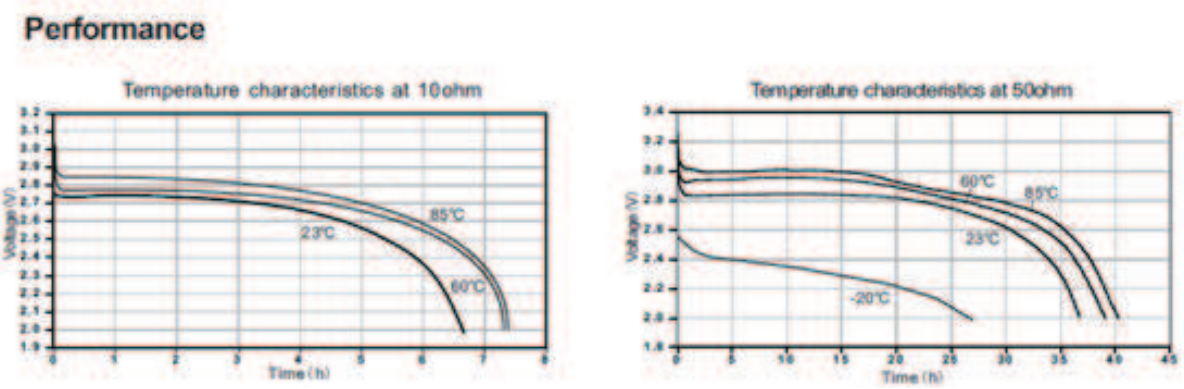
Note: This alarm range is controlled by AT+ARTEMP. You need to set AT+WMOD=1 before use.

5. Battery & How to replace

5.1 Battery Type

LHT65N/S is equipped with a 2400mAH Li-MnO2 (CR17505) battery . The battery is an un-rechargeable battery with low discharge rate targeting for up to 8~10 years use. This type of battery is commonly used in IoT devices for long-term running, such as water meters.

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



The minimum Working Voltage for the LHT65N/S is ~ 2.5v. When battery is lower than 2.6v, it is time to change the battery.

5.2 Replace Battery

LHT65N has two screws on the back, Unscrew them, and changing the battery inside is ok. The battery is a general CR17450 battery. Any brand should be ok.

5.3 Battery Life Analyze

Dragino battery-powered products are all run in Low Power mode. User can check the guideline from this link to calculate the estimated battery life:
https://www.dragino.com/downloads/downloads/LoRa_End_Node/Battery_Analyze/DRAGINO_Battery_Life_Guide.pdf

A full detail test report for LHT65N/S on different frequency can be found at : https://www.dropbox.com/sh/r2i3zlhsyrpavla/AAB1sZw3mdT0K7XjpHCITt13a?dl=0

6. FAQ

6.1 How to connect to LHT65N/S UART interface?

The LHT65N/S has the UART interface in its Type-C. The UART Interface can be used for

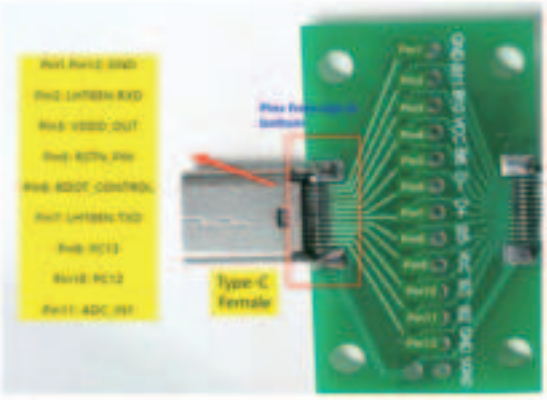
- Send AT Commands, and get output from LHT65N/S
- Upgrade firmwre of LHT65N/S.

The hardware connection is: **PC <--> USB to TTL Adapter <--> Jump wires <--> Type-C Adapter <--> LHT65N/S**

Option of USB TTL adapter:

- CP2101 USB TTL Adapter
- CH340 USB TTL Adapter
- FT232 USB TTL Adapter

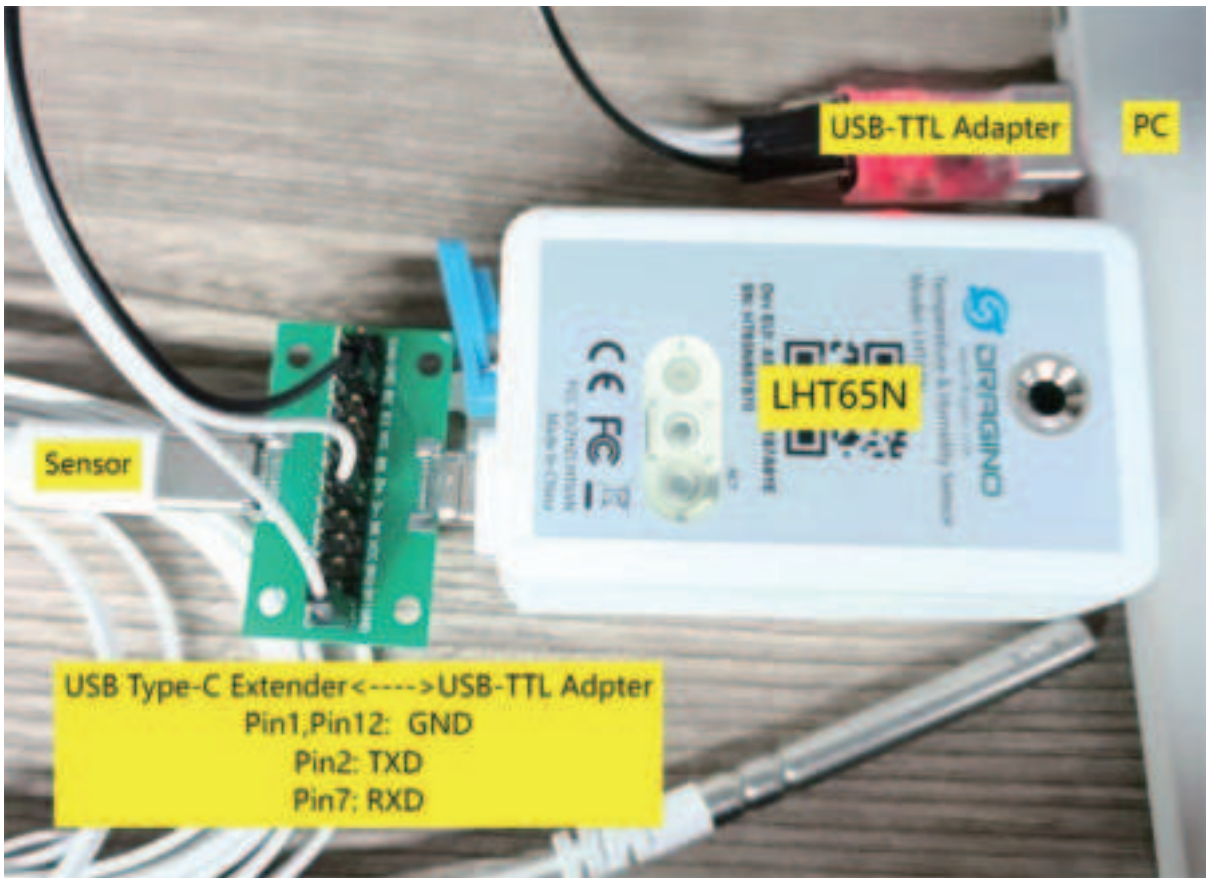
Option of Type-C Adapter:

Description	Photo	Pin Out
E2 Extension Cable for LHT65N		
USB Type C extension Board		

Connection:

- **USB to TTL GND <--> LHT65N/S GND**
- **USB to TTL RXD <--> LHT65N/S TXD**
- **USB to TTL TXD <--> LHT65N/S RXD**

Connection Example:



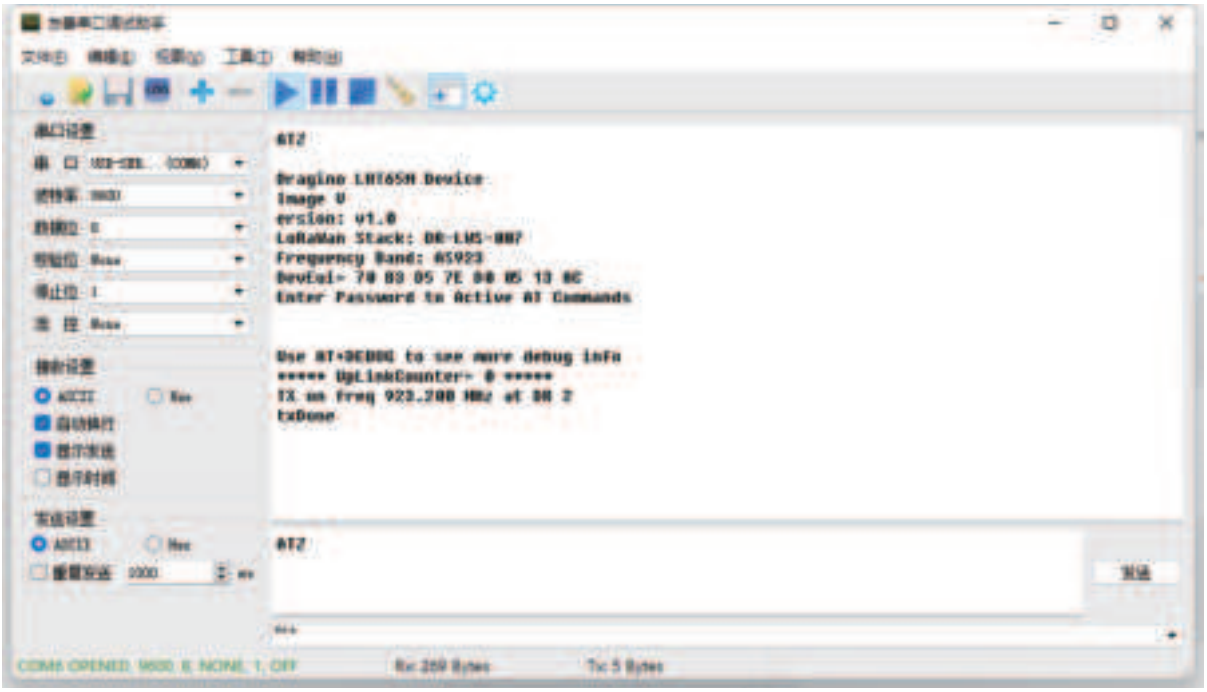
6.2 How to use AT Commands?

First, Connect PC and LHT65N/S via USB TTL adapter as **FAQ 6.1**

In PC, User needs to set serial tool(such as **putty**, SecureCRT) baud rate to **9600** to access to access serial console for LHT65N/S. The AT commands are disable by default and need to enter password (default:**123456**) to

active it. Timeout to input AT Command is 5 min, after 5-minute, user need to input password again. User can use AT+DISAT command to disable AT command before timeout.

Input password and ATZ to activate LHT65N/S, As shown below:



AT Command List is as below:

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

AT+<CMD> : Run <CMD>

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

AT+<CMD>=? : Get the value

AT+DEBUG: Set more info output

ATZ: Trig a reset of the MCU

AT+FDR: Reset Parameters to Factory Default, Keys Reserve

AT+DEUI: Get or Set the Device EUI

AT+DADDR: Get or Set the Device Address

AT+APPKEY: Get or Set the Application Key

AT+NWKSKEY: Get or Set the Network Session Key

AT+APPSKEY: Get or Set the Application Session Key

AT+APPEUI: Get or Set the Application EUI

AT+ADR: Get or Set the Adaptive Data Rate setting. (0: off, 1: on)

AT+TXP: Get or Set the Transmit Power (0-5, MAX:0, MIN:5, according to LoRaWAN Spec)

AT+DR: Get or Set the Data Rate. (0-7 corresponding to DR_X)

AT+DCS: Get or Set the ETSI Duty Cycle setting - 0=disable, 1=enable - Only for testing

AT+PNM: Get or Set the public network mode. (0: off, 1: on)

AT+RX2FQ: Get or Set the Rx2 window frequency

AT+RX2DR: Get or Set the Rx2 window data rate (0-7 corresponding to DR_X)

AT+RX1DL: Get or Set the delay between the end of the Tx and the Rx Window 1 in ms

AT+RX2DL: Get or Set the delay between the end of the Tx and the Rx Window 2 in ms

AT+JN1DL: Get or Set the Join Accept Delay between the end of the Tx and the Join Rx Window 1 in ms

AT+JN2DL: Get or Set the Join Accept Delay between the end of the Tx and the Join Rx Window 2 in ms

AT+NJM: Get or Set the Network Join Mode. (0: ABP, 1: OTAA)

AT+NWKID: Get or Set the Network ID

AT+FCU: Get or Set the Frame Counter Uplink

AT+FCD: Get or Set the Frame Counter Downlink

AT+CLASS: Get or Set the Device Class

AT+JOIN: Join network

AT+NJS: Get the join status

AT+SENDB: Send hexadecimal data along with the application port

AT+SEND: Send text data along with the application port

AT+RECVB: Print last received data in binary format (with hexadecimal values)

AT+RECV: Print last received data in raw format

AT+VER: Get current image version and Frequency Band

AT+CFM: Get or Set the confirmation mode (0-1)

AT+CFS: Get confirmation status of the last AT+SEND (0-1)

AT+SNR: Get the SNR of the last received packet

AT+RSSI: Get the RSSI of the last received packet

AT+TDC: Get or set the application data transmission interval in ms

AT+PORT: Get or set the application port

AT+DISAT: Disable AT commands

AT+PWORD: Set password, max 9 digits

AT+CHS: Get or Set Frequency (Unit: Hz) for Single Channel Mode

AT+CHE: Get or Set eight channels mode,Only for US915,AU915,CN470

AT+PDTA: Print the sector data from start page to stop page

AT+PLDTA: Print the last few sets of data

AT+CLRDTA: Clear the storage, record position back to 1st

AT+SLEEP: Set sleep mode

AT+EXT: Get or Set external sensor model

AT+BAT: Get the current battery voltage in mV

AT+CFG: Print all configurations

AT+WMOD: Get or Set Work Mode

AT+ARTEMP: Get or set the internal Temperature sensor alarm range

AT+CITEMP: Get or set the internal Temperature sensor collection interval in min

AT+SETCNT: Set the count at present

AT+RJTDC: Get or set the ReJoin data transmission interval in min

AT+RPL: Get or set response level

AT+TIMESTAMP: Get or Set UNIX timestamp in second

AT+LEAPSEC: Get or Set Leap Second

AT+SYNCMOD: Get or Set time synchronization method

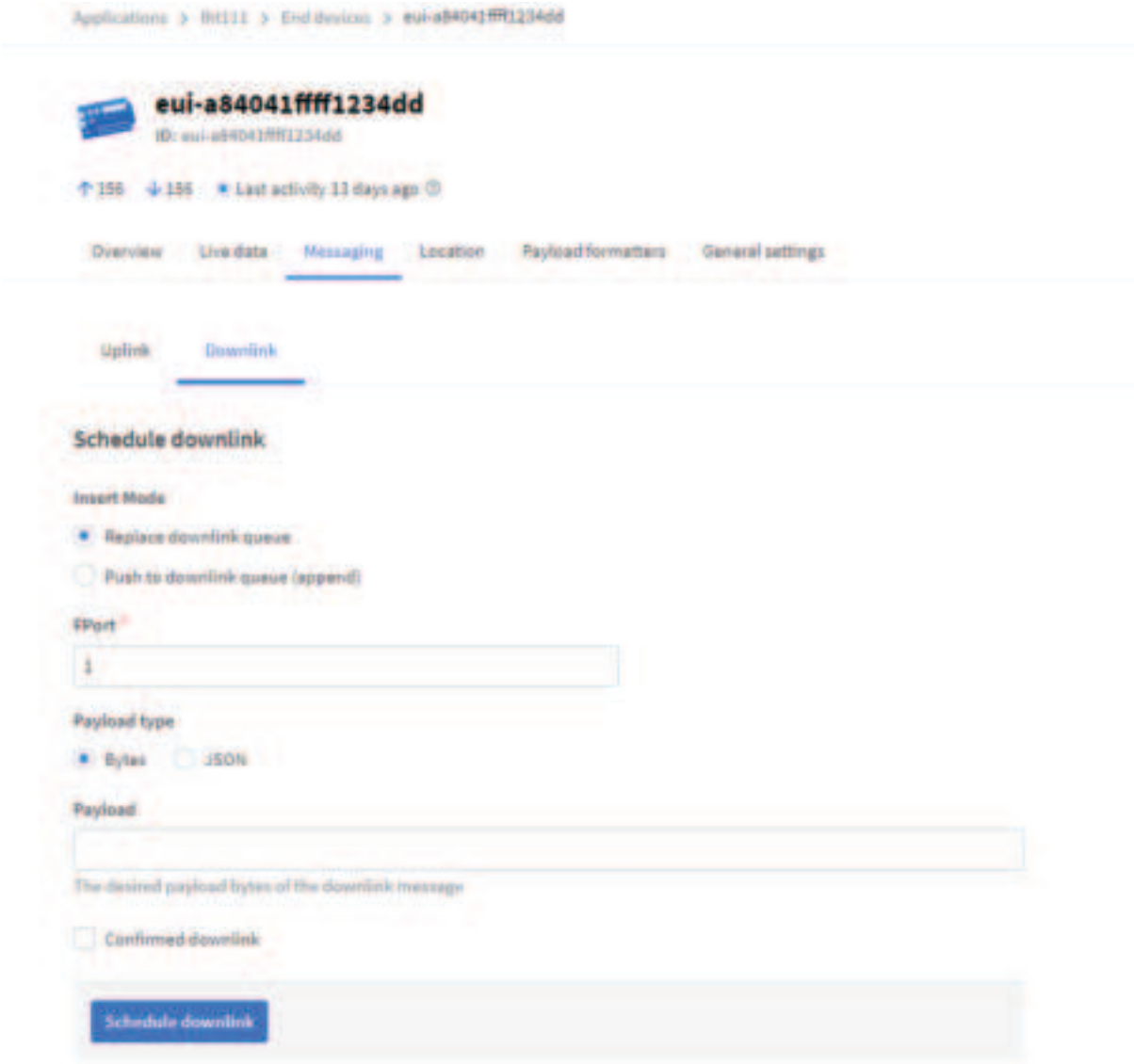
AT+SYNCTDC: Get or set time synchronization interval in day

AT+PID: Get or set the PID

6.3 How to use Downlink commands?

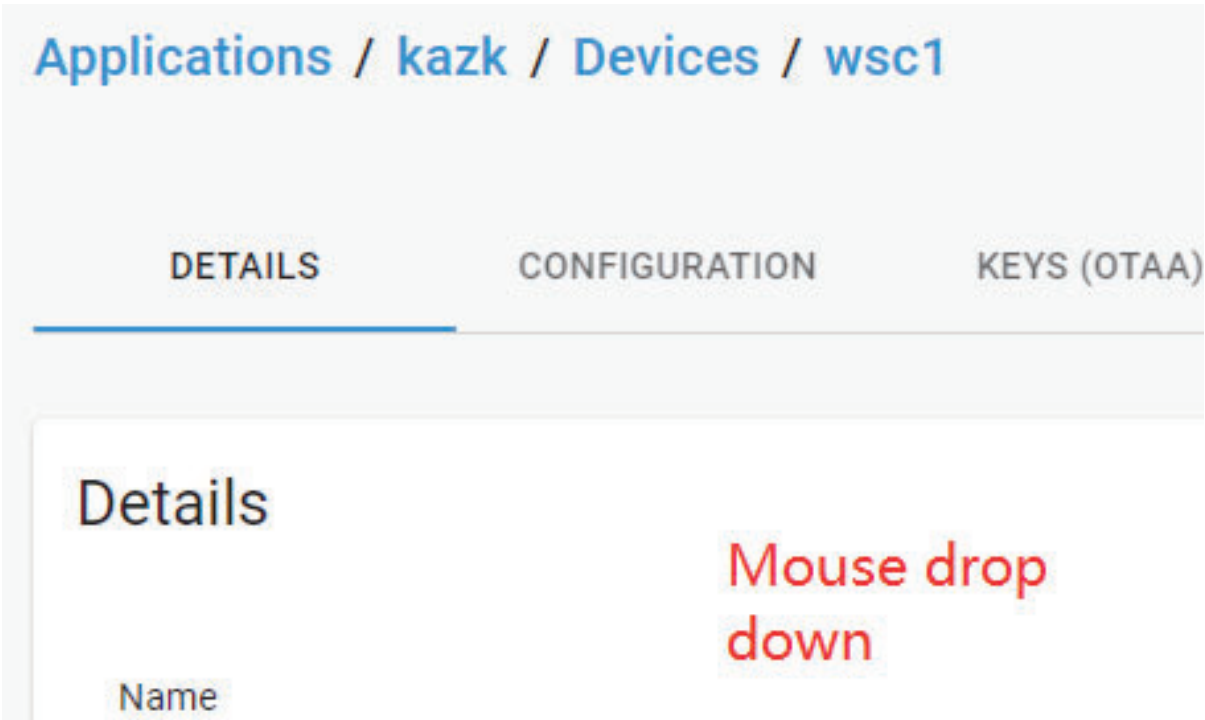
Downlink commands:

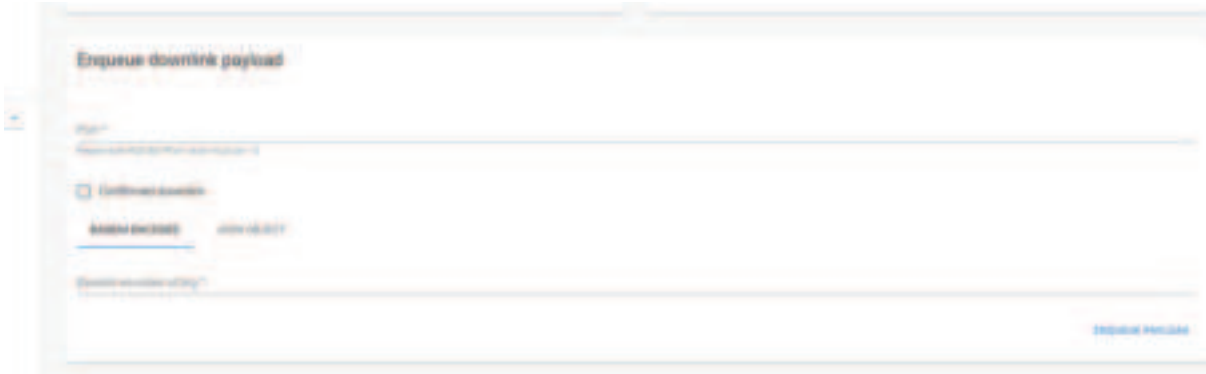
TTN:


eui-a84041ffff1234dd
Overview
Live data
Messaging
Location
Payload formatters
General settings
Uplink
Downlink
Schedule downlink
Insert Mode
Replace downlink queue
Push to downlink queue (append)
FPort
Payload type
Bytes
JSON
Payload
Confirmed downlink
Schedule downlink

Helium:

Chirpstack: The downlink window will not be displayed until the network is accessed





AWS-IOT :

6.4 How to change the uplink interval?

Please see this link: http://wiki.dragino.com/xwiki/bin/view/Main/How%20to%20set%20the%20transmit%20time%20interval/

6.5 How to upgrade firmware?

The firmware **before V1.4** does not have wireless upgrade function, and the starting address of the firmware is **0x08000000**.
Since and including V1.4, LHT65N/S supports wireless upgrade, and its firmware is divided into **bootloader + working firmware**. Burning bootloader selects address **0x08000000**, and burning working firmware selects address **0x0800D000**.

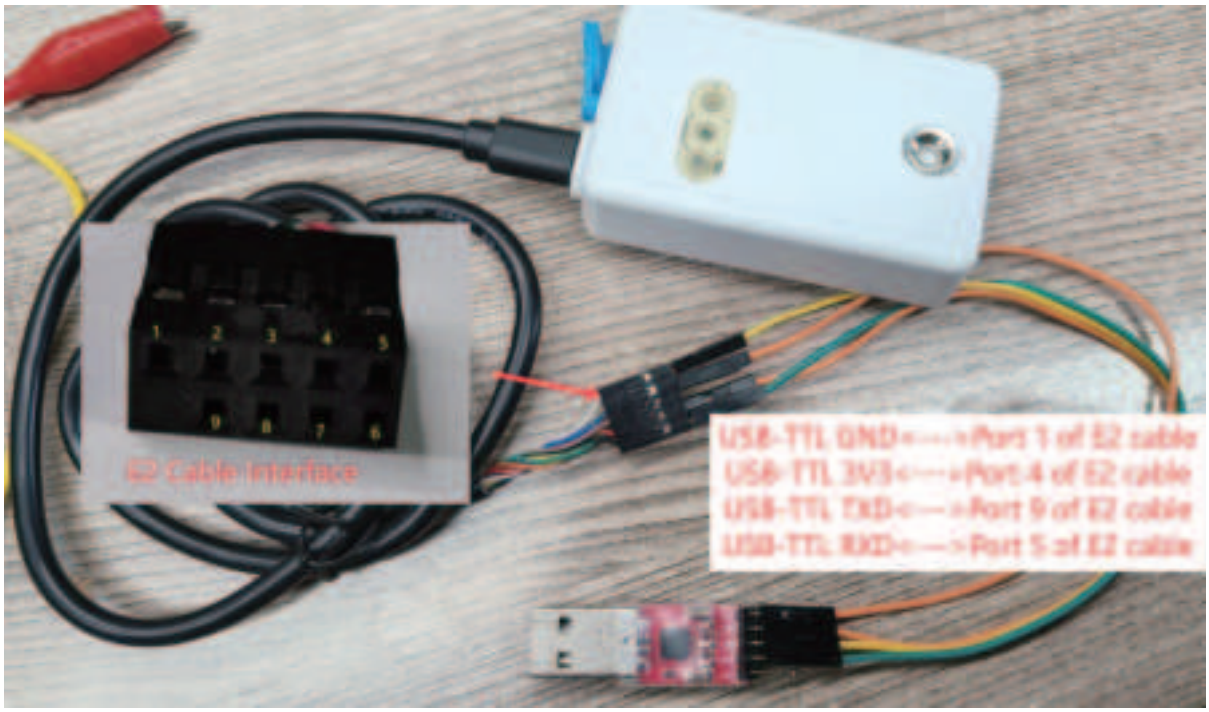
LHT65N/S has two types of firmware: **Firmware with bootloader** and **Firmware without bootloader**.
Firmware Download Link:

Use UART connection to update the firmware, detailed description of UART refer to FAQ 6.1, Connection Example:

Note: To use the TremoProgrammer the node must be put into burn mode, i.e. the USB-TTL adapter 3.3V must be connected to the BOOT_CONTROL pin of the LHT65N/S.

- For the connection **E2 cable <----> USB-TTL adapter**:

  Port 4(Blue wire)<----->USB-TTL 3V3



- For the connection **USB Type-C Extender<----->USB-TTL adapter**:

Pin 6<---->USB-TTL 3V3

6.5.1 Burning firmware before V1.3 (including V1.3)

Burning firmware prior to and including V1.3 can only be done using the TremoProgrammer, select the burn address: 0x08000000

According to the above instructions to **enter the burning mode**, re-install the battery to **reset the node**, press the ACT button LED does not light up, the node successfully entered the burning mode, **click "START".**

6.5.2 Updated firmware for V1.4 and above

Updating firmware version V1.4 and above requires distinguishing whether the firmware comes with a bootloader or not.

- For version V1.4 and above, we ship nodes with bootloader, users can directly choose firmware without bootloader to upgrade directly. Use **TremoProgrammer** to start at address **0x0800D000**. Using **Dragino Sensor Manager Utility.exe** does not require address selection, but must use firmware without bootloader.
- For nodes where the bootloader was accidentally erased, customers need to burn the bootloader and working firmware using **TremoProgrammer**.

The firmware of V1.4 and above updated on our official website will note whether it comes with bootloader or not, customers need to choose the appropriate update method according to the firmware type.

6.5.2.1 Update firmware (Assume device already have bootloader)

Step1 : Connect UART as per FAQ 6.1

Step2 : Update follow Instruction for update via DraginoSensorManagerUtility.exe. Make sure to use the firmware without bootloader.

(Recommanded way) OTA firmware update via wireless : **http://wiki.dragino.com/xwiki/bin/view/Main/Firmware%20OTA%20Update%20for%20Sensors/**

6.5.2.2 Update firmware (Assume device doesn't have bootloader)

In this update method, make sure to use the firmware with bootloader , **Download Link** . After update , device will have bootloader so can use above method(6.5.2.1) to update.

Step1: Install TremoProgrammer first.

Step2: Hardware Connection

Connect PC and LHT65N/S via USB TTL adapter .

Note: Burn mode: Port4 (BOOT_CTL) of E2 cable connects 3V3 of USB-TTL.

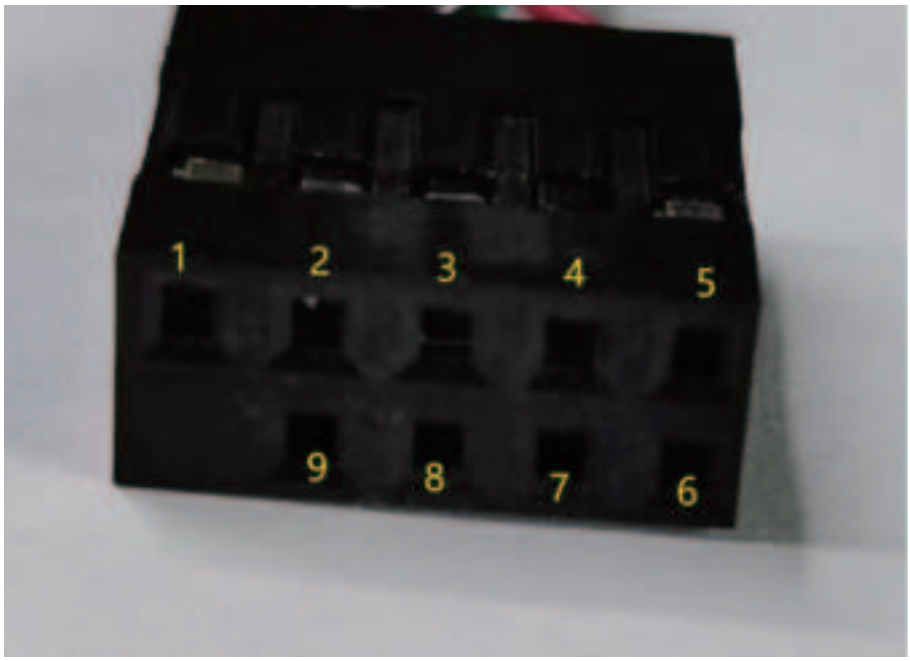
Connection method:

USB-TTL GND <--> Port 1 of E2 cable

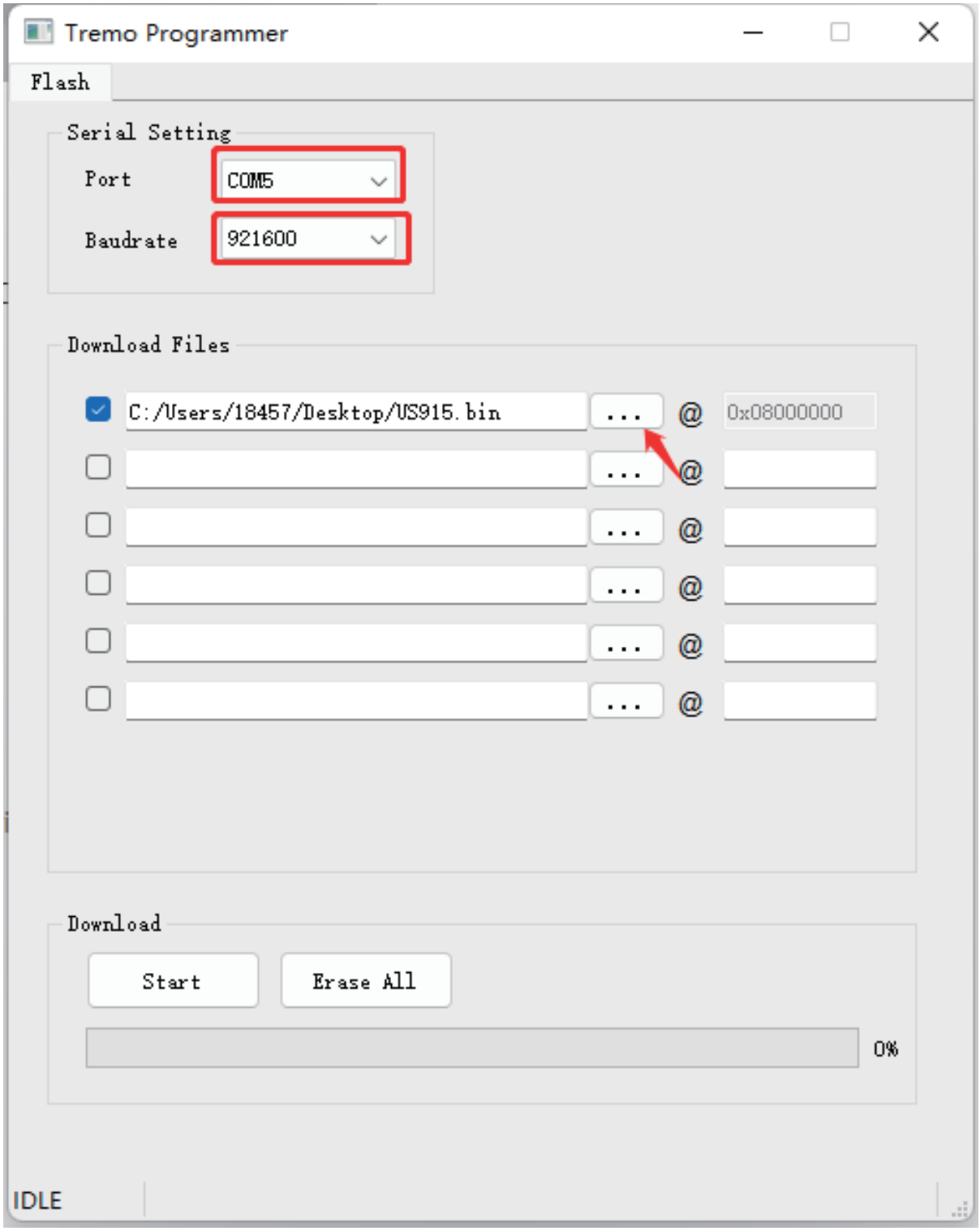
USB-TTL 3V3 <--> Port 4 of E2 cable

USB-TTL TXD <--> Port 9 of E2 cable

USB-TTL RXD <--> Port 5 of E2 cable



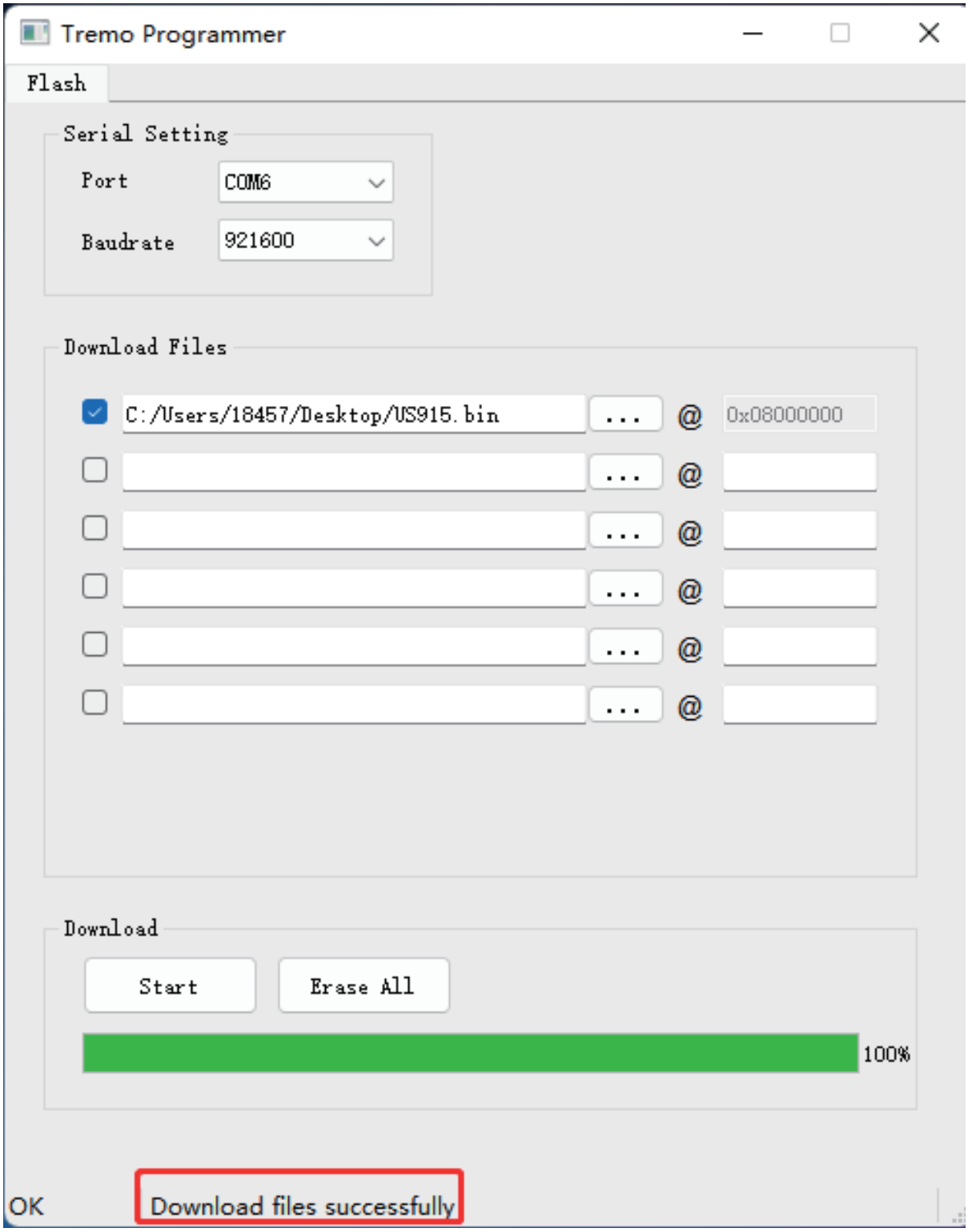
Step3: Select the device port to be connected, baud rate and bin file to be downloaded.



Reset node: Short-circuit the port3(RST) of the E2 cable to GND. /The new motherboard cancels the RST, and the **battery needs to be reinstalled** to achieve the reset effect.

Then click the **start** button to start the firmware upgrade.

When this interface appears, it indicates that the download has been completed.



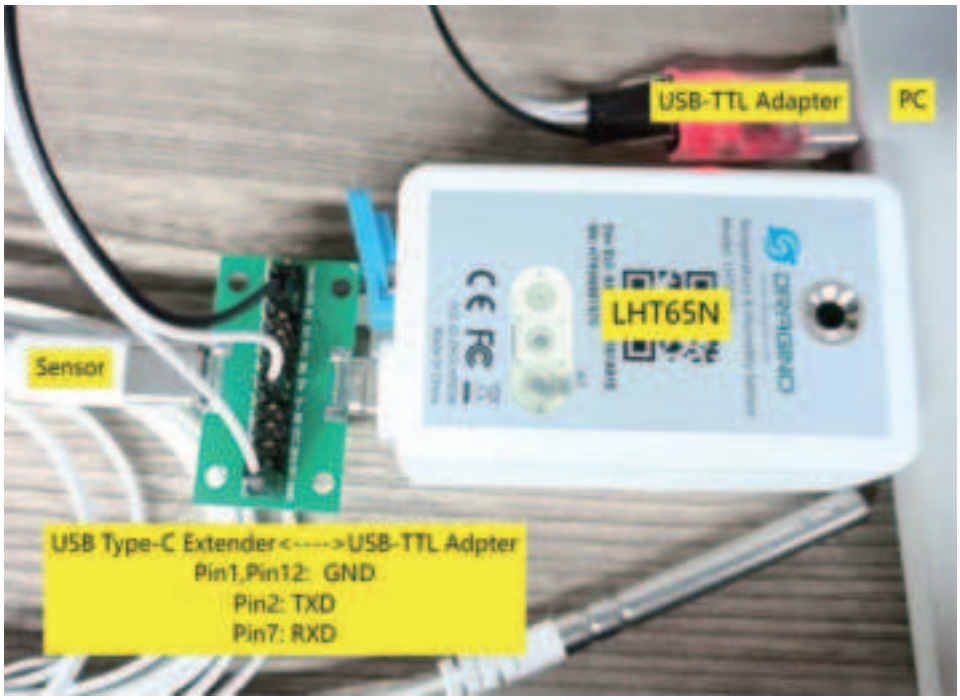
Finally, Disconnect Port4 of E2 cable, reset the node again (Port3 shorted GND/ /The new motherboard cancels the RST, and the **battery needs to be reinstalled** to achieve the reset effect.), and the node exits burning mode.

6.6 Why can't I see the datalog information

1. The time is not aligned, and the correct query command is not used.
2. Decoder error, did not parse the datalog data, the data was filtered.

6.7 How can i read sensor data without LoRaWAN? For Calibration Purpose

Some clients need to calibrate the sensor value in calibration Lab. In such case, Reading the data without LoRaWAN network is more convinient. To achieve this, use can use a USB Type-C Breakout board to expose the UART pins while still have the probe connected. See below. Detail Pin out please refer the FAQ of how to connect UART



After there is UART Connectio, run below commands:

1. **AT+NJM=0** // Set Device to ABP mode , so can works without join to LoRaWAN server.
2. **AT+GETSENSORVALUE=0** //The serial port gets the reading of the current sensor.

Example output:

```
[Tx][17:09:49.078] AT+GETSENSORVALUE=0
[Rx][17:09:49.201] Bat_voltage=3.083 V
[Rx][17:09:49.201] Sht_temp=28.27 , Sht_hum=50.9
[Rx][17:09:49.201] Ext_Sht_temp=27.36 , Ext_Sht_hum=54.1
[Rx][17:09:49.241]
[Rx][17:09:49.241] OK
[Tx][17:09:52.862] AT+GETSENSORVALUE=0
[Rx][17:09:52.991] Bat_voltage=3.083 V
[Rx][17:09:52.991] Sht_temp=28.26 , Sht_hum=50.9
[Rx][17:09:52.991] Ext_Sht_temp=27.32 , Ext_Sht_hum=53.9
[Rx][17:09:53.021]
[Rx][17:09:53.021] OK
```

7. Order Info

Part Number: **LHT65N/S-XX-YY**

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

8. Packing Info

Package Includes:

- LHT65N/S Temperature & Humidity Sensor x 1
- 1 x External Lora Antenna for LHT65S
- Optional external sensor

9. Reference material

- Datasheet, photos, decoder, firmware

10.FCC WARNING

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.
Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.
NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.
If this equipment does cause harmful interference to radio or television reception,
which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
-- Reorient or relocate the receiving antenna.
-- Increase the separation between the equipment and receiver.
-- Connect the equipment into an outlet on a circuit different
from that to which the receiver is connected.
-- Consult the dealer or an experienced radio/TV technician for help.

To maintain compliance with FCC's RF Exposure guidelines.
This equipment should be installed and operated with minimum distance between 20cm the radiator your body: Use only the supplied antenna.