

LHT65 Temperature & Humidity Sensor User Manual

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1.8.2	Fix typo for Set System Time Command	2021-Mar-25
1.8.3	Change to use TTN V3 as example	2021-May-10
1.8.4	Change Battery Life Analyze part	2022-Jan-26

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1. Introduction

1.1 What is LHT65 Temperature & Humidity Sensor



The Dragino LHT65 Temperature & Humidity sensor is a Long Range LoRaWAN Sensor. It includes a **built-in SHT20 Temperature & Humidity sensor** and has an external sensor connector to connect to external sensors such as **Temperature Sensor, Illumination sensor, Interrupt Sensor, ADC sensor etc** .

The LHT65 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.

LHT65 has a built-in 2400mAh non-chargeable battery which can be used for more than 10 years*.

LHT65 is full compatible with LoRaWAN v1.0.3 Class A protocol, it can work with standard LoRaWAN gateway.

LHT65 has 3200 data records with datetime which can be retrieved with datetime for further analyze.

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

1.2 Features

- ✓ Wall mountable
- ✓ 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 upgradable via program port
- ✓ Built-in 2400mAh battery for more than 10 year use.
- ✓ Built-in Temperature & Humidity sensor
- ✓ Optional External Sensors
- ✓ Tri-color LED to indicate status
- ✓ Datalog feature

1.3 Specifications

Built-in Temperature Sensor:

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

Built-in Humidity Sensor:

- ➢ Resolution: 0.04 %RH
- ➢ Accuracy Tolerance : Typ ±3 %PH
- ➢ Long Term Drift: < 0.02 °C/yr
- ➢ Operating Range: 0 ~ 96 %PH

External Temperature Sensor – E1:

- ➢ 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

External Illumination Sensor – E5:

- ➢ Resolution: 1 lx
- ➢ Range: 0-65535 lx
- ➢ Operating Range: -40 °C ~ 85 °C

1.4 Power Consumption

LHT65 (without external sensor): Idle: 3uA. Transmit: max 130mA.

LHT65 + E1 Temperature Sensor: Idle: 4uA, Transmit: max 130mA.

LHT65 + E5 Illumination Sensor: Idle: 4uA, Transmit: max 130mA.

1.5 Storage & Operation Temperature

-40°C to +85°C

1.6 Applications

- ✓ Smart Buildings & Home Automation
- ✓ Logistics and Supply Chain Management
- ✓ Smart Metering
- ✓ Smart Agriculture
- ✓ Smart Cities
- ✓ Smart Factory

2. Operation Mode

2.1 How to activate LHT65?

The LHT65 has two working modes:

- ✓ Deep Sleep Mode: LHT-65 doesn't have any LoRaWAN activate. This mode is used for storage and shipping to save battery life.
- ✓ Working Mode: In this mode, LHT65 will works as LoRaWAN Sensor mode to Join LoRaWAN network and send out the sensor data to server. Between each sampling/tx/rx periodically, LHT65 will be in STOP mode (IDLE mode), in STOP mode, device has the same power consumption as Deep Sleep mode.

The LHT65 is set in deep sleep mode by default; The ACT button on the bottom of device is used to switch to different modes:

Behavior on ACT	Function	Action
Pressing ACT between 1s < time < 3s	Test uplink status	If LHT65 is already Joined to LoRaWAN network, LHT65 will send an uplink packet, if LHT65 has external sensor connected, blue led will blink once. If LHT65 has not external sensor, red led will blink once.
Pressing ACT for more than 3s	Active Device	green led will fast blink 5 times, device will enter working mode and start to JOIN LoRaWAN network. green led will solid turn on for 5 seconds after joined in network.
Fast press ACT 5 times.	Deactivate Device	red led will solid on for 5 seconds. Means LHT65 are in Deep Sleep Mode.

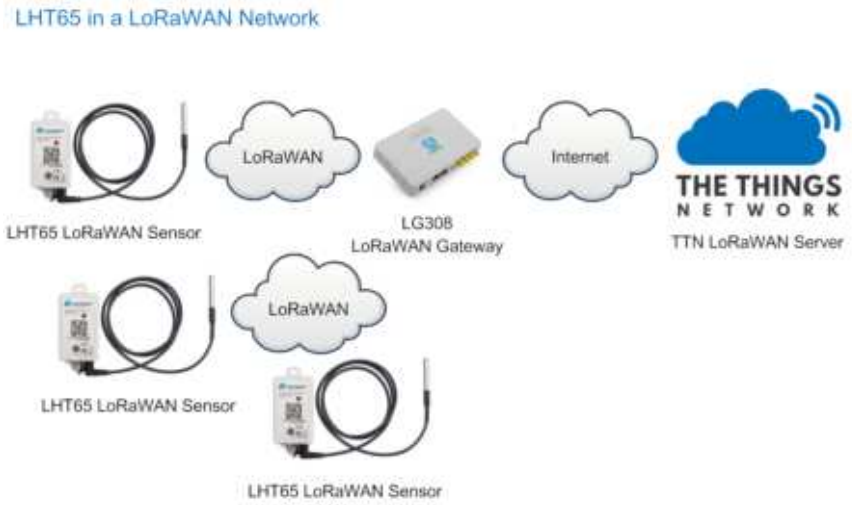
2.2 How it works?

The LHT65 is configured as LoRaWAN OTAA Class A mode by default. Each LHT65 is shipped with a worldwide unique set of OTAA and ABP keys. To use LHT65 in a LoRaWAN network, user needs to input the OTAA or ABP keys in the network server. So LHT65 can join the LoRaWAN network and start to transmit sensor data. The default period for each uplink is 20 minutes.

In case user can't set the OTAA keys in the network server and has to use the existing keys from server. User can use AT Command to set the keys in LHT65.

2.3 Example to join LoRaWAN network

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

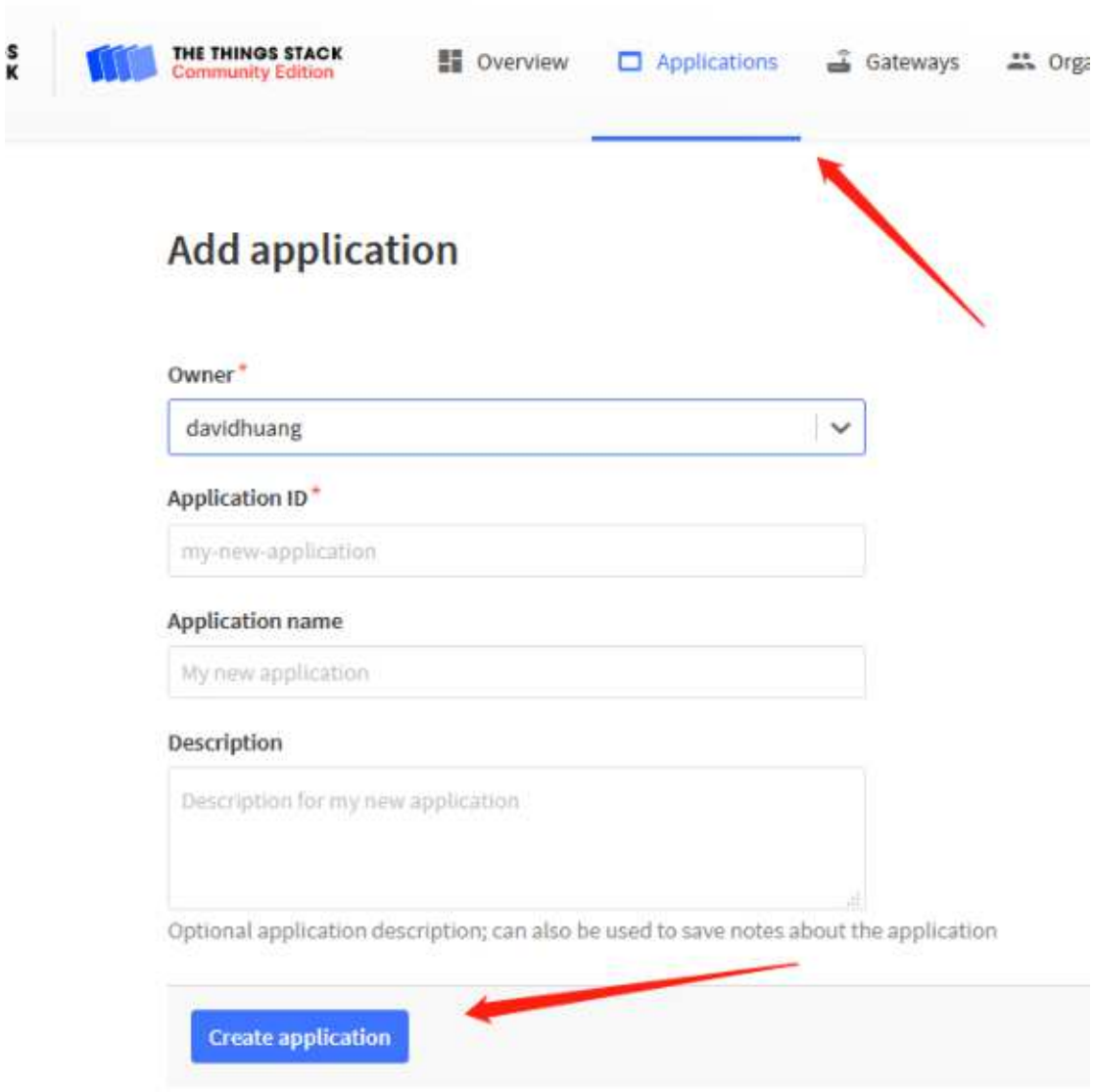


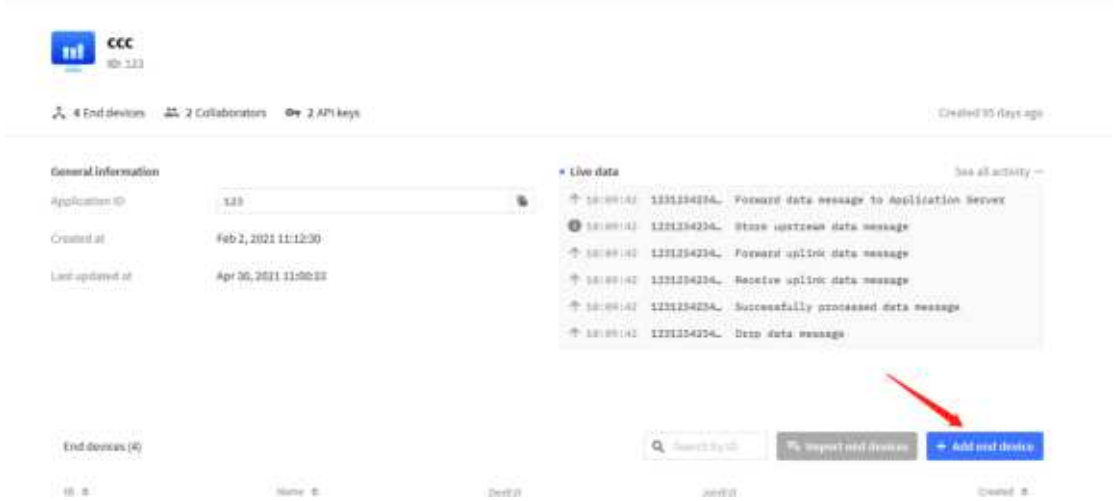
Assume the LG308 is already set to connect to TTN V3 network . We need to add the LHT65 device in TTN V3:

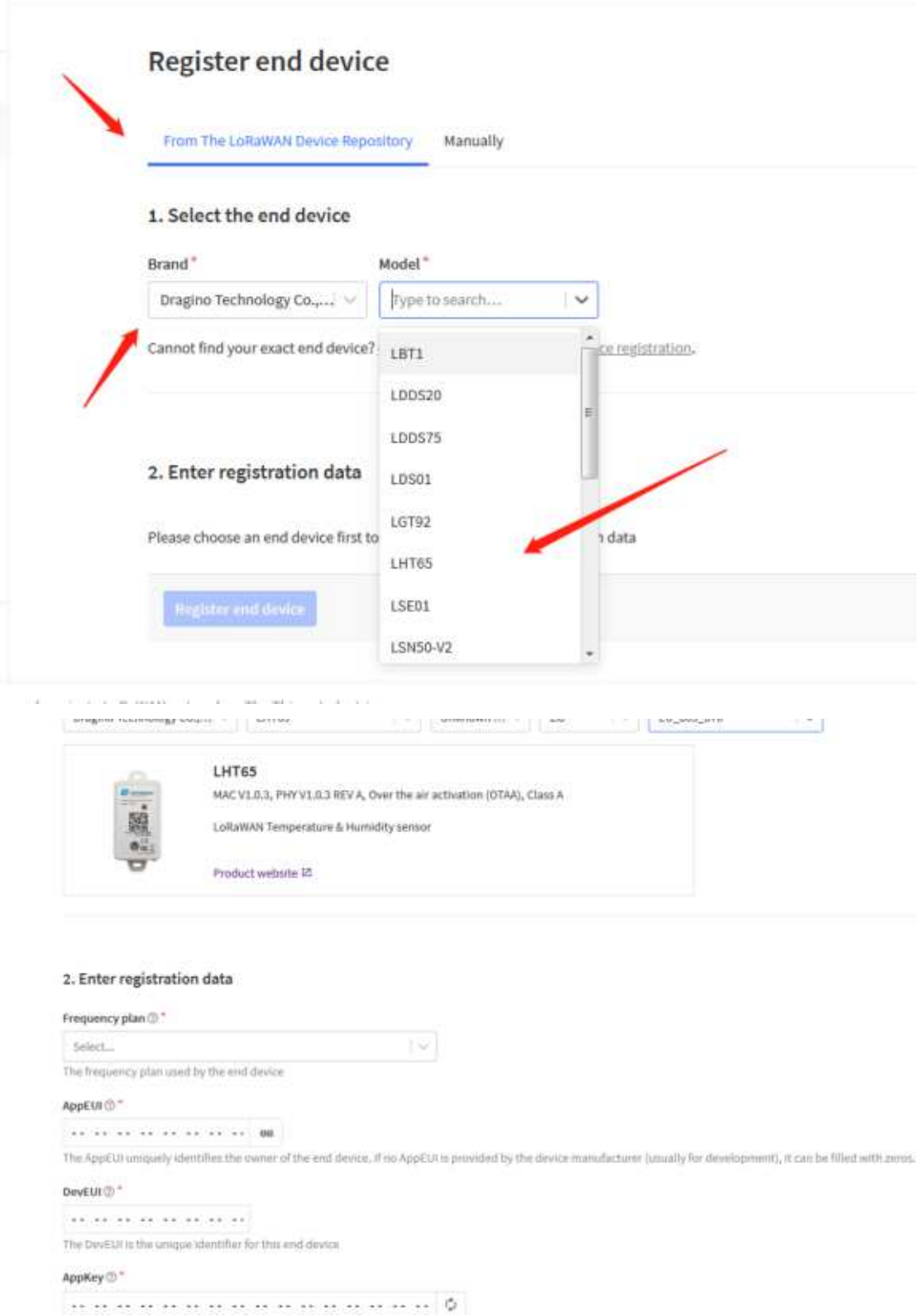
Step 1: Create a device in TTN V3 with the OTAA keys from LHT65.
Each LHT65 is shipped with a sticker with the default device EUI as below:



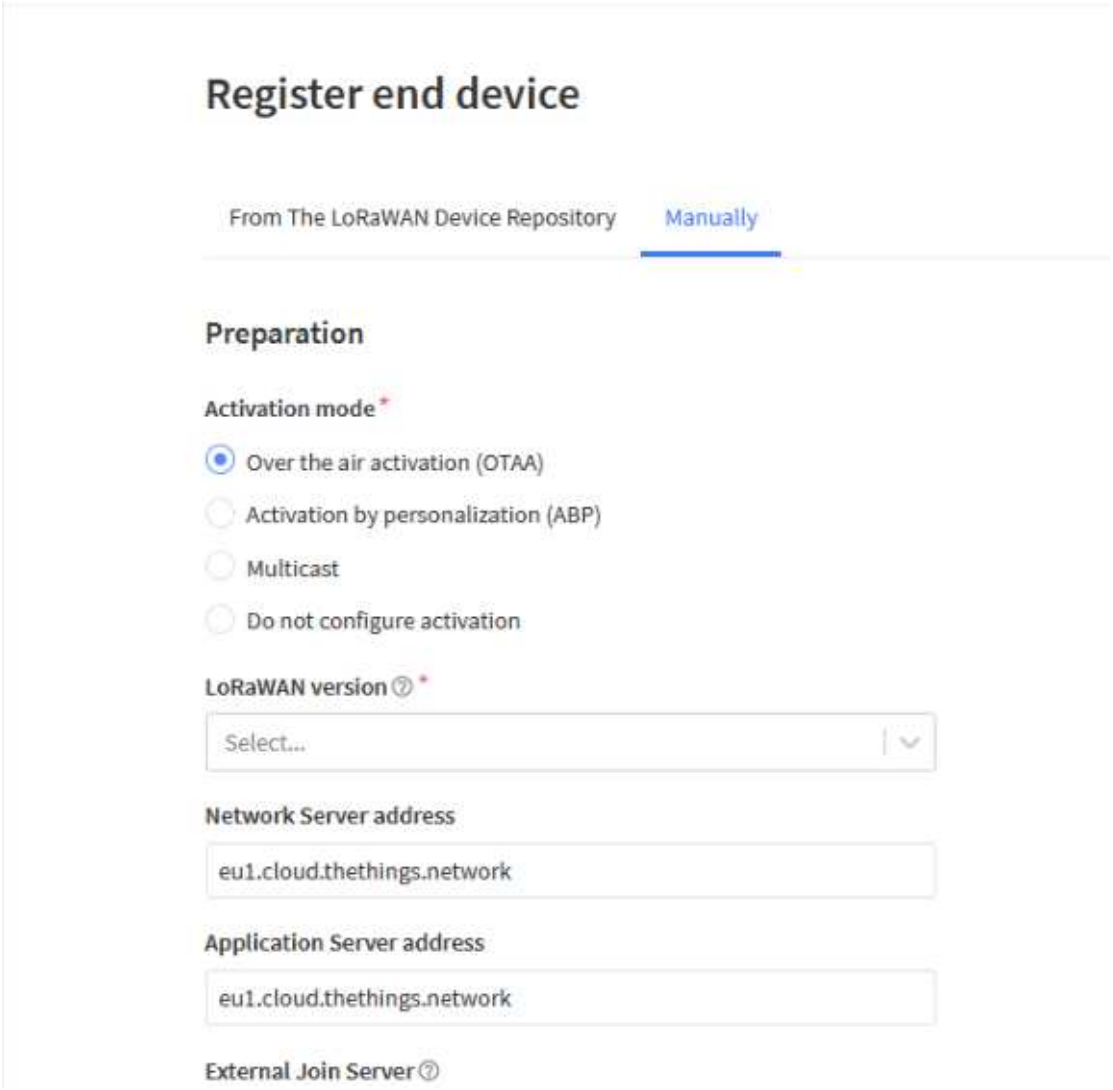
User can enter these keys in the LoRaWAN Server portal. Below is TTN V3 screen shot:
Add APP EUI in the application.


THE THINGS STACK
Community Edition
Overview
Applications
Gateways
Add application
Owner *
davidhuang
Application ID *
my-new-application
Application name
My new application
Description
Description for my new application
Optional application description; can also be used to save notes about the application
Create application


ccc
4 End devices
2 Collaborators
2 API keys
General information
Application ID
123
Created at
Feb 2, 2021 11:12:30
Last updated at
Apr 30, 2021 11:00:33
Live data
End devices (4)
+ Add end device


Register end device
From The LoRaWAN Device Repository
Manually
1. Select the end device
Brand *
Dragino Technology Co.,...
Model *
Type to search...
Cannot find your exact end device?
LBT1
LDDS20
LDDS75
LDS01
LGT92
LHT65
LSE01
LSN50-V2
2. Enter registration data
Please choose an end device first to
data
Register end device
LHT65
MAC V1.0.3, PHY V1.0.3 REV A, Over the air activation (OTAA), Class A
LoRaWAN Temperature & Humidity sensor
Product website
2. Enter registration data
Frequency plan *
Select...
The frequency plan used by the end device
AppEUI *
DevEUI *
The DevEUI is the unique identifier for this end device
AppKey *

You can also choose to create the device manually.



Add APP KEY and DEV EUI



Step 2: Use ACT button to activate LHT65 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

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.

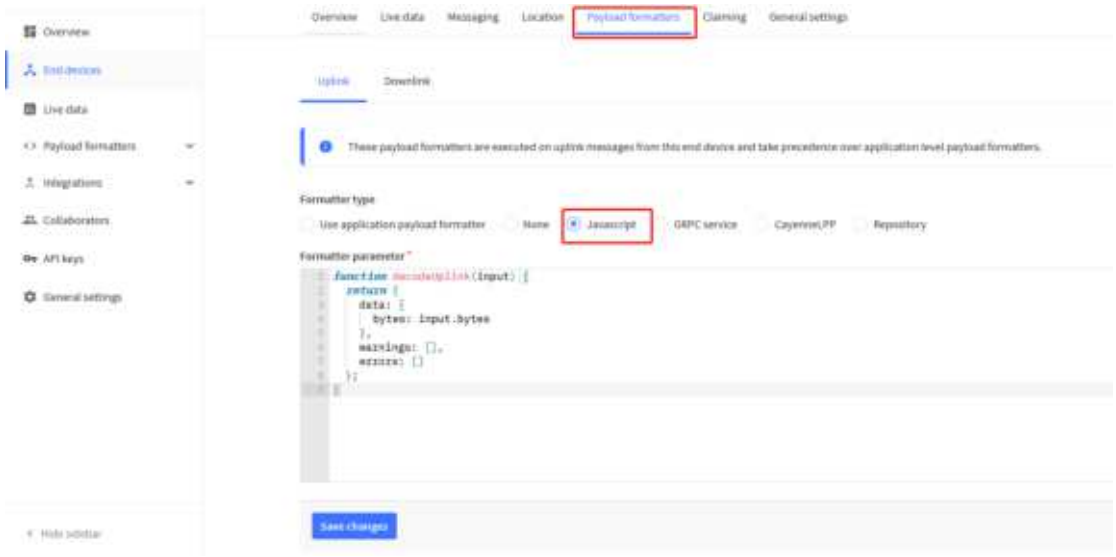
Size(bytes)	2	2	2	1	4
Value	BAT	Built-In Temperature	Built-in Humidity	Ext #	Ext value

First 6 bytes: has fix meanings for every device.

The 7th byte (EXT #): defines the external sensor model.

The 8th ~ 11th 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



Please check the decoder from this link:

http://www.dragino.com/downloads/index.php?dir=LHT65/payload_decode/

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



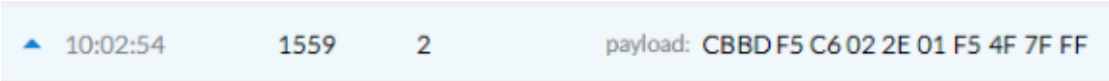
Check the battery voltage for LHT65.

- BAT status=(0Xcba4>>14)&0xFF=11(B)，very good
- Battery Voltage =0xCBF6&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%

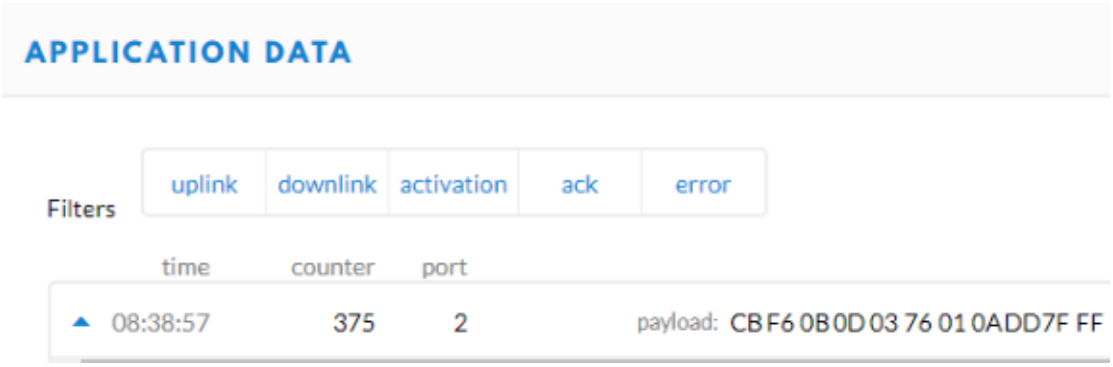
2.4.5 Ext

Bytes for External Sensor:

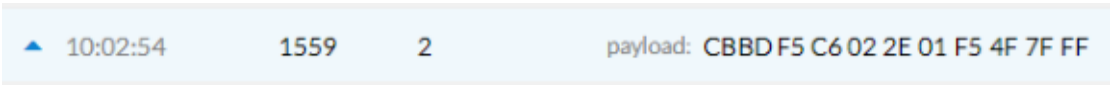
EXT # Value	External Sensor Type
0x01	Sensor E1, Temperature Sensor
0x04	Sensor E4, Interrupt Sensor
0x05	Sensor E5, Illumination Sensor
0x06	Sensor E6, ADC Sensor
0x07	Sensor E7, Counting Senor,16 bit count
0x08	Sensor E7, Counting Senor,32 bit count
0x09	Sensor E1, Temperature Sensor, Datalog Mod

2.4.6 Ext value

2.4.7 Ext=1, E1 Temperature Sensor



- DS18B20 temp=0x0ADD/100=27.81℃
  The last 2 bytes of data are meaningless



- DS18B20 temp= (0xF54F-65536)/100=-27.37℃
  The last 2 bytes of data are meaningless

If the external sensor is 0x01, and there is no DS18B20 connected. The temperature will be set to 7FFF which is 327.67℃

2.4.8 Ext=4, Interrupt Sensor

In this mode, user can connect external interrupt sensor to the **E2 Extension Cable** to check the open/close status from the sensor. For example, it can be used to connect to a door sensor to check the open / close status, or connect to a mercury switch to detect the titling.
(NOTE: This feature only supported by SN number > LHT65307029)



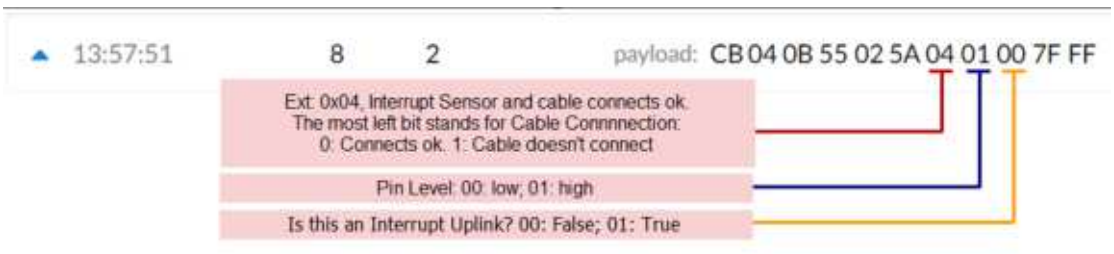
Above is connection to a mercury switch, rotate the mercury will generate interrupt. LHT65 will detect it and send an uplink package to sever. User can also connect PA9 and PA10 together, with these two pins shortcut, LHT65 will know if the probe is connected well in the socket.

User can use AT Command to set the method to detect Interrupt:

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

Or use downlink command A2

Payload explain:



Means: The device is set to connect to an Interrupt Sensor, the cable connection is **fine**. This packet is for a **normal uplink**, pin level is **high**.



Means: The device is set to connect to an Interrupt Sensor, the cable connection is **fine**. This packet is for a Interrupt uplink, pin level is low.



Means: The device is set to connect to an Interrupt Sensor, the cable connection is **losing**. (Notice: PA9 and PA10 must be connected to detect if cable is losing or fine.).

2.4.9 Ext=5, E5 Illumination Sensor





Means: The device is set to connect to an Illumination sensor, the cable connection is **fine**.
This strength of illumination is 401 lux



Means: The device is set to connect to an Illumination sensor, the cable connection is **losing**.

2.4.10 Ext=6, ADC Sensor

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

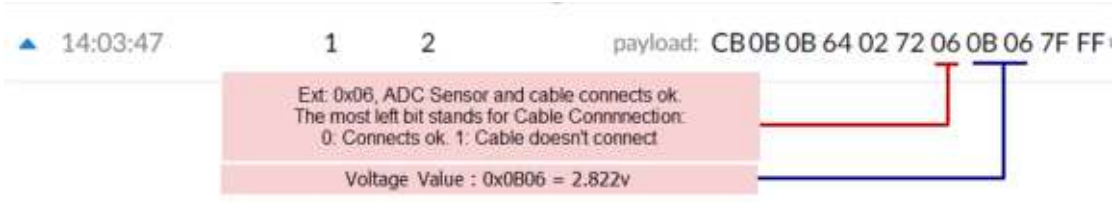
For example:

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

Or use downlink command A2 to set the same.



User can also connect PA9 and PA10 together, with these two pins shortcut, LHT65 will know if the probe is connected well in the socket.



Means: The device is set to connect to an ADC sensor, the cable connection is **fine**. This voltage detected is 2.822v.



Means: The device is set to connect to an ADC Sensor, but the cable connection is **losing**. (Notice: PA9 and PA10 must be connected to detect if cable is losing or fine.).

2.4.11 Ext=7, Counting Sensor

In this mode, user can connect external interrupt sensor to the **E2 Extension Cable** for counting purpose. Whenever there is an interrupt from this sensor, the ext value will increase by 1.

(NOTE: This feature only supported by SN number > LHT65307029)



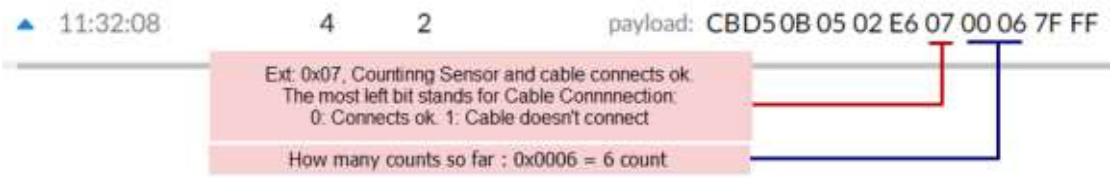
Above is connection to a mercury switch, rotate the mercury will generate interrupt. LHT65 will count it. It will periodically the counting value to server. User can also connect PA9 and PA10 together, with these two pins shortcut, LHT65 will know if the probe is connected well in the socket.

User can use AT Command to set the method to detect counting:

AT+EXT=7,0	Count at falling interrupt
AT+EXT=7,1	Count at raising interrupt
AT+SETCNT=60	Sent current count to 60

Or use downlink command A2

Payload explain:



Means: The device is set to connect to a counting sensor, the cable connection is **fine**. It detects 6 times event so far.



Means: The device is set to connect to a counting sensor, but the cable connection is **losing**.

Note: MAX count is FFFF, and then it will go back to 0001

2.4.12 Ext=8, Counting Sensor (4 bytes)

In this mode, user can connect external interrupt sensor to the **E2 Extension Cable** for counting purpose. Whenever there is an interrupt from this sensor, the ext value will increase by 1.



Above is connection to a mercury switch, rotate the mercury will generate interrupt. LHT65 will count it. It will periodically the counting value to server. User can also connect PA9 and

PA10 together, with these two pins shortcut, LHT65 will know if the probe is connected well in the socket.

User can use AT Command to set the method to detect counting:

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

Or use downlink command A2

Payload explain:



Means: The device is set to connect to a counting sensor, the cable connection is **fine**. It detects 0x00010005=65541 times event so far.



Means: The device is set to connect to a counting sensor, but the cable connection is **losing**.

Note: MAX count is FFFFFFFF, and then it will go back to 00000001

2.4.13 Ext=9, E1 sensor with Unix Time stamp

This feature is added since firmware v1.8.0.

Time stamp mode is designed for LHT65 with E1 (DS18B20) probe, it will send the uplink payload with unix time stamp. 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	Not Defined	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 send, device will set this bit to 0 until got the time stamp from application server.
- Unix Time Request:1: Request server downlink Unix time, 0 : N/A. In this mode, LHT65 will set this bit to 1 every 10 day to request a time SYNC. (AT+SYNCMOD to set this)

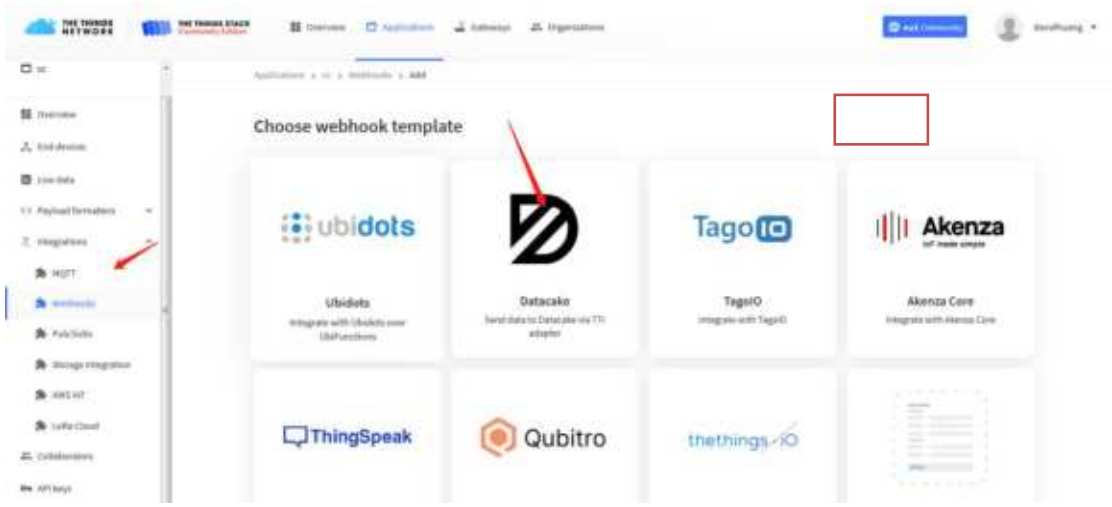
2.5 Show data on Datacake

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:

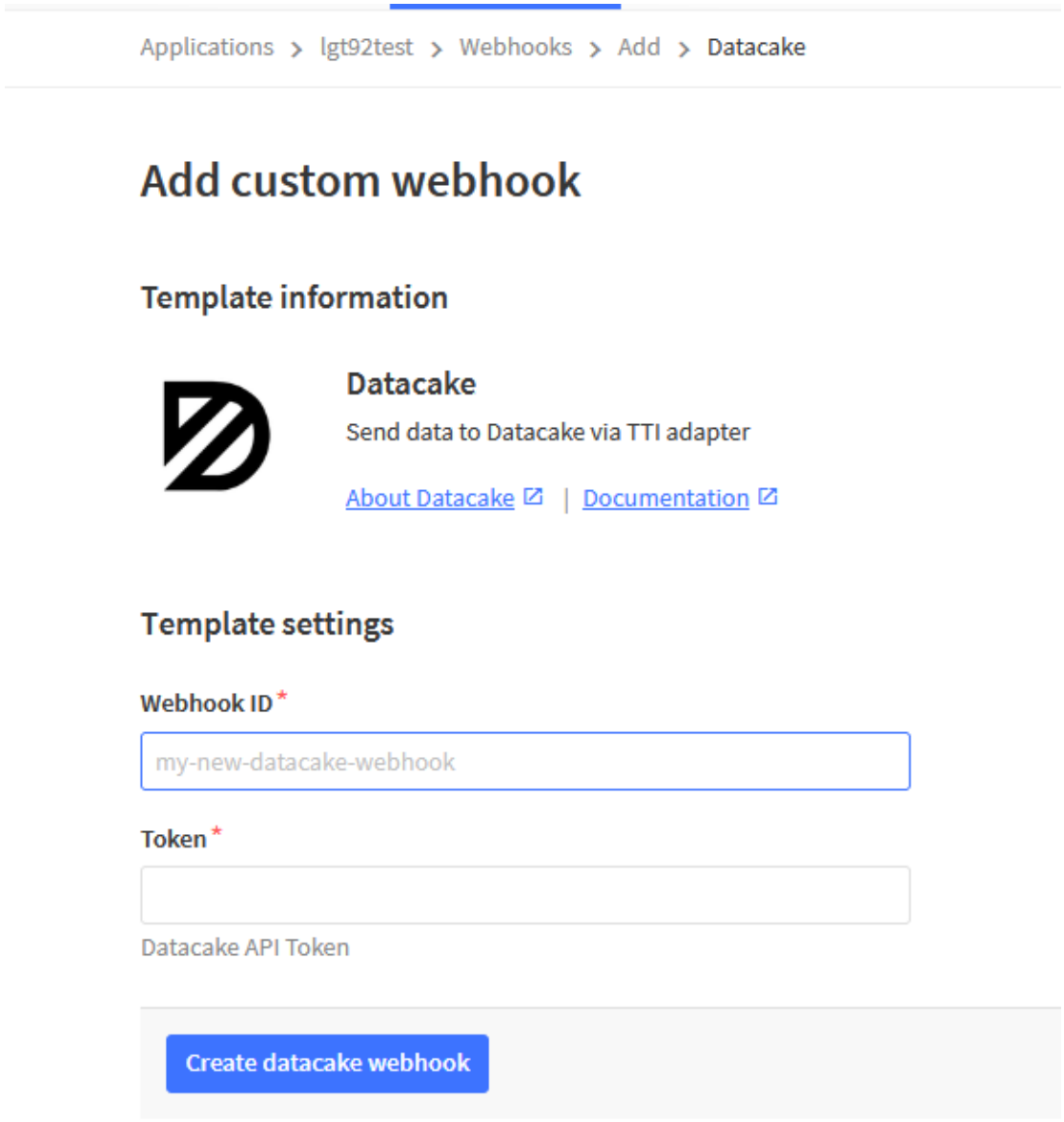
Step 1: Be sure that your device is programmed and properly connected to the LoRaWAN network.

Step 2: Configure your Application to forward data to Datacake you will need to add integration.

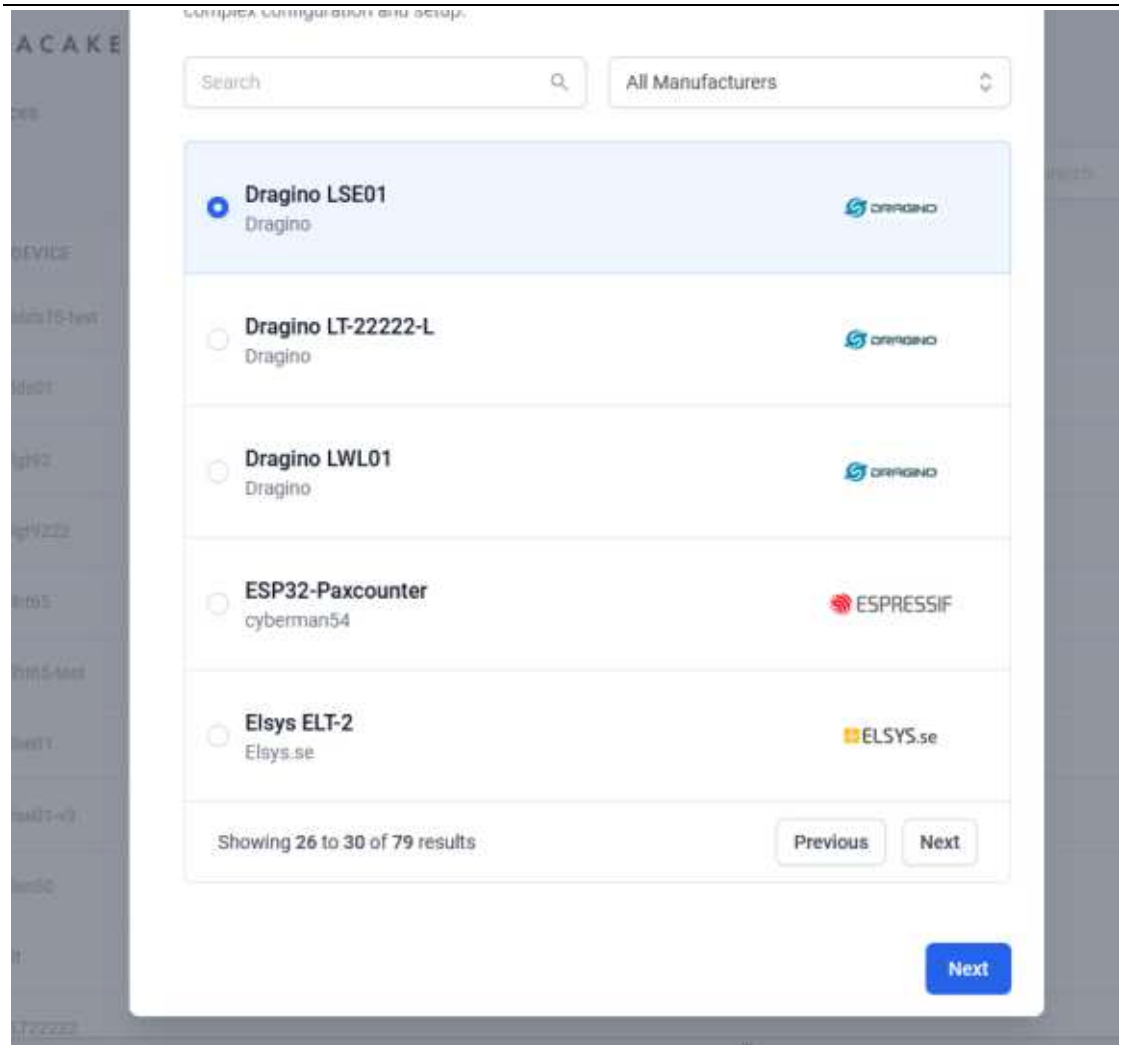
Go to TTN V3 Console --> Applications --> Integrations --> Add Integrations.



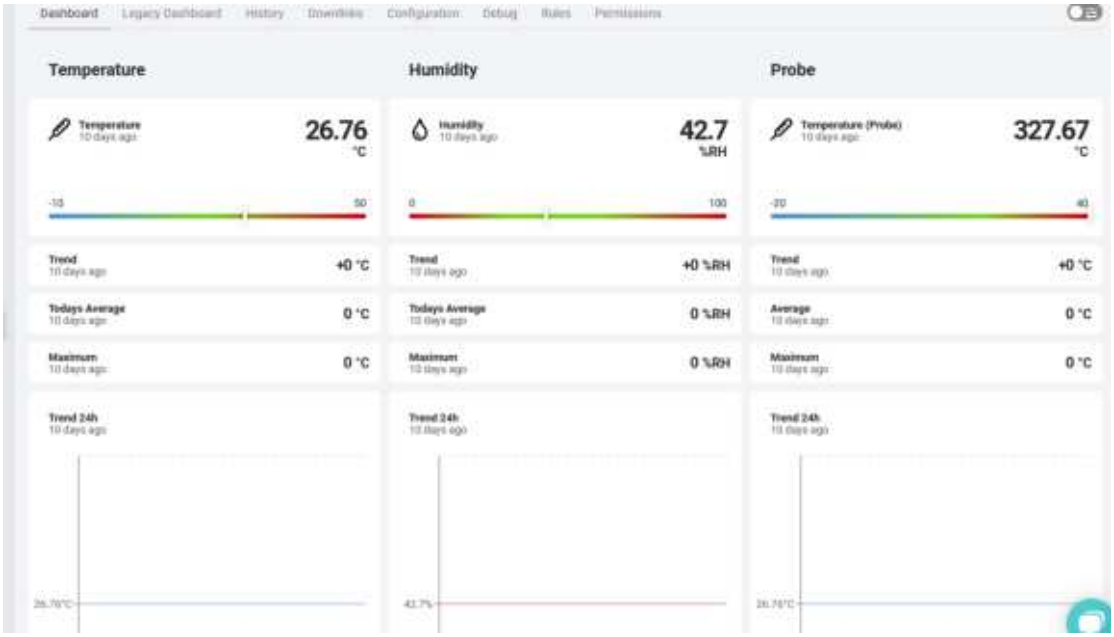
Add Datacake:



Select default key as Access Key:



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


Dashboard
Legacy Dashboard
History
Downlinks
Configuration
Debug
Rules
Permissions
Temperature
Humidity
Probe
Temperature
26.76
°C
Humidity
42.7
%RH
Temperature (Probe)
327.67
°C
Trend
+0 °C
Todays Average
0 °C
Maximum
0 °C
Trend
+0 %RH
Todays Average
0 %RH
Maximum
0 %RH
Trend
+0 °C
Average
0 °C
Maximum
0 °C
Trend 24h
Trend 24h
Trend 24h

2.6 Datalog Feature

Since firmware v1.8.0, LHT65 supports data log feature.

This feature is always enabled, it supports all external sensors. To use this feature, user need to downlink a UTC time to LHT65 to set it to use the correct time. When user want to retrieve sensor value, he can send a poll command from the IoT platform to ask sensor to send value in the required time slot.

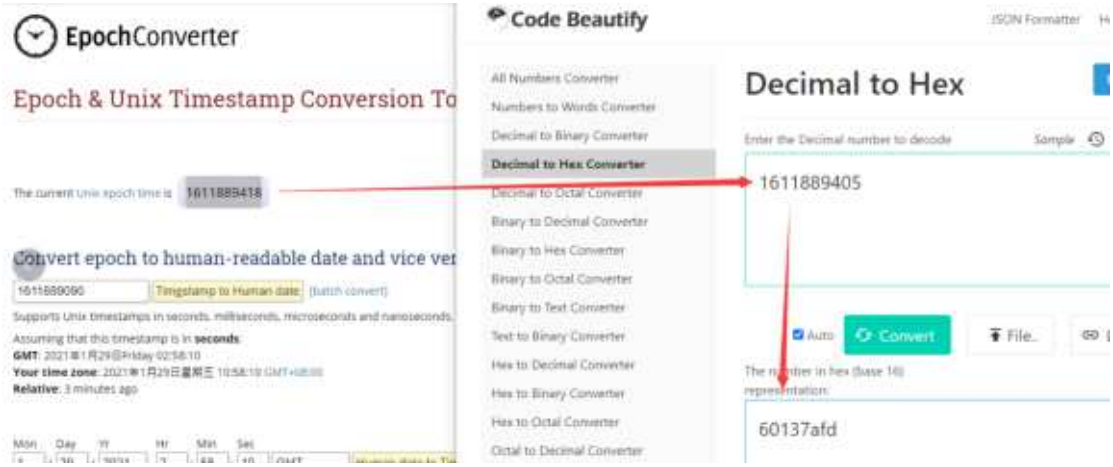
2.6.1 Unix TimeStamp

LHT65 use Unix TimeStamp format base on

Size (bytes)	4	1
DeviceTimeAns Payload	32-bit unsigned integer : Seconds since epoch*	8bits unsigned integer: fractional-second in ½^8 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 current time 2021 – Jan -- 29 Friday 03:03:25

2.6.2 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 LHT65 Joined LoRaWAN network, it will send the MAC command (DeviceTimeReq) and server will reply with (DeviceTimeAns) to send the current time to LHT65. If LHT65 fails to get the

time from server, LHT65 will use the internal time and wait for next time request (AT+SYNCTDC to set 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 need to set SYNCMOD=0 to manual time, otherwise the user set time will be overwrite by the time set by server.

2.6.3 Poll sensor value

User can poll sensor value base on timestamps from 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 LHT65 will send one packet every 5s. range 5~255s.

2.6.4 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	Not Defined	Poll Message Flag	Sync time OK	Unix Time Request	Ext: 0b(1001)

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 LHT65 has below data inside Flash:

Flash Addr	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
8019700	21/1/19 04:30:30 1 3145 sht_temp=21.81 sht_hum=33.4 ds_temp=327.67
8019710	21/1/19 04:40:30 1 3145 sht_temp=21.65 sht_hum=33.7 ds_temp=327.67
8019720	21/1/19 04:50:30 1 3147 sht_temp=21.55 sht_hum=34.1 ds_temp=327.67
8019730	21/1/19 05:00:30 1 3149 sht_temp=21.50 sht_hum=34.1 ds_temp=327.67
8019740	21/1/19 05:10:30 1 3149 sht_temp=21.43 sht_hum=34.6 ds_temp=327.67
8019750	21/1/19 05:20:30 1 3151 sht_temp=21.35 sht_hum=34.9 ds_temp=327.67

If user send 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

LHT65 will uplink this payload.



7FFF089801464160065F977FFF088E014B41600660097FFF0885014E41600660667FFF087501514
1600662BE7FFF086B015541600665167FFF08660155416006676E7FFF085F015A41600669C67FF
F0857015D4160066C1E

Where the first 11 bytes is for the first entry:

7FFF089801464160065F97

Ext sensor data=0x7FFF/100=327.67

Temp=0x0898/100=22.00

Hum=0x0146/10=32.6

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

Unix time is 0x60065F97=1611030423s=21/1/19 04:27:03

2.7 Alarm Mode

Alarm mode feature is added since firmware v1.5. When device is in Alarm mode, it will check the built-in sensor temperature in a short interval. If the temperature exceeds the pre-configure range, it will send an uplink immediately.

Note: Alarm mode will increase a little big the power consumption, we recommend extending the normal reading time when enable this feature.

AT Commands for Alarm mode:

AT+WMOD=1: Enable/Disable Alarm Mode. (0:Disable, 1: Enable)

AT+CITEMP=1: The interval to check temperature for Alarm. (Unit: minute)

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

3. Configure LHT65 via AT Command or LoRaWAN Downlink

Use can configure LHT65 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

Since firmware v1.8.0(Note*), there are two kinds of commands to configure LHT65, 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(Note**). These commands can be found on the wiki:

  http://wiki.dragino.com/index.php?title=End_Device_Downlink_Command

  Note**: Please check early user manual if you don't have v1.8.0 firmware.

- **Commands special design for LHT65**

  These commands only valid for LHT65, 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 External Sensor Mode

Feature: Change External Sensor Mode.

AT Command: AT+EXT

Command Example	Function	Response
AT+EXT?	Get current external sensor mode	1 OK External Sensor mode =1
AT+EXT=1	Set external sensor mode to 1	
AT+EXT=4,1	Set to use Interrupt Mode. Sent uplink packet in both rising and falling interrupt	
AT+EXT=4,2	Set to use Interrupt Mode. Sent uplink packet only in falling interrupt	
AT+EXT=4,3	Set to use Interrupt Mode. Sent uplink packet only in rising interrupt	
AT+EXT=5	Set to use illumination sensor	
AT+EXT=6,1000	Set to use ADC sensor mode and LHT65 will power the external ADC sensor for 1000ms before sampling the ADC value Timeout range can be : 0 ~ 65535	
AT+EXT=7,0	Set to counting mode and count at falling interrupt	
AT+EXT=7,1	Set to counting mode and count at rising interrupt	
AT+EXT=8,0	Set to 4 bytes counting mode and count at falling interrupt	
AT+EXT=8,1	Set to 4 bytes counting mode and count at rising interrupt	
AT+EXT=9	Set to external DS18B20 with timestamp	

Downlink Command: 0xA2

Total bytes: 2 ~ 5 bytes

Example:

- 0xA201: Set external sensor type to E1
- 0xA20401: Same as AT+EXT=4,1
- 0xA20603E8, Same as AT+EXT=6,1000
- 0xA2080100, Same as AT+EXT=8,0
- 0xA2080101, Same as AT+EXT=8,1
- 0xA20702003c,Same as AT+SETCNT=60

3.3 Enable/Disable uplink DS18B20 probe ID

Feature: If PID is enable, device will send the DS18B20 probe ID on:

✓ First Packet after OTAA Join

✓ Every 24 hours since the first packet.

PID is default set to disable (0)

AT Command:

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

Downlink Command:

✧ 0xA800 → AT+PID=0

✧ 0xA801 → AT+PID=1

3.4 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.

3.5 Quit AT Command

Feature: Quit AT Command mode, so user need 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.

3.6 Set to sleep mode

Feature: Set device to sleep mode

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.

3.7 Set system time

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

3.8 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

3.9 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

3.10 Print data entries base on page.

Feature: Print the sector data from start page to stop page (max is 400 pages).

AT Command: AT+PDTA

Command Example	Response
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

3.11 Print last few data entries.

Feature: Print the last few data entries

AT Command: AT+PLDTA

Command Example	Response
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

3.12 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

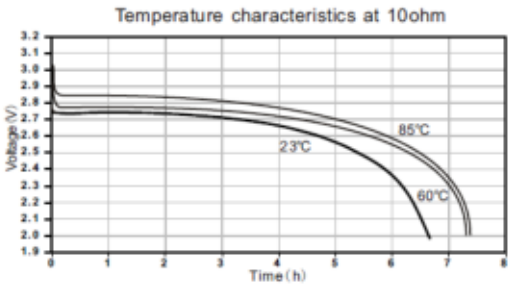
4. Battery & How to replace

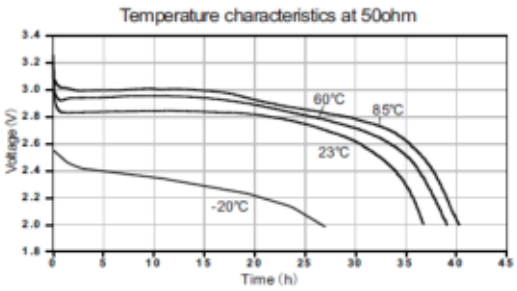
4.1 Battery Type

LHT-65 is equipped with a 2400mAH Li-MnO2 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.

Performance



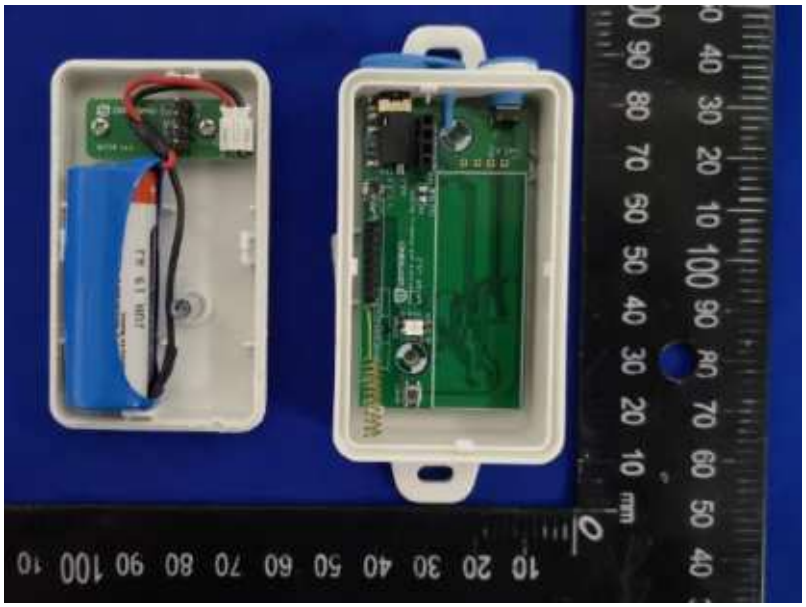


Minimum Working Voltage for the LHT65:

- ✓ LHT65: 2.45v ~ 3.6v
- ✓ ES-E1 Temperature Sensor : 2.35v ~ 5v

4.2 Replace Battery

The LHT65 has the top cover and bottom cover. User can use a knife to open the enclosure from the middle. The inner view is as below:



User can find the same type of battery to replace. Or can order our battery replace kit, which include the enclosure and the battery, the part number is LHT65-BAT-CA.

4.3 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 estimate battery life:
https://www.dragino.com/downloads/downloads/LoRa_End_Node/Battery_Analyze/DRAGINO_Battery_Life_Guide.pdf

5. Sensors & Accessories

5.1 E1 Temperature Probe

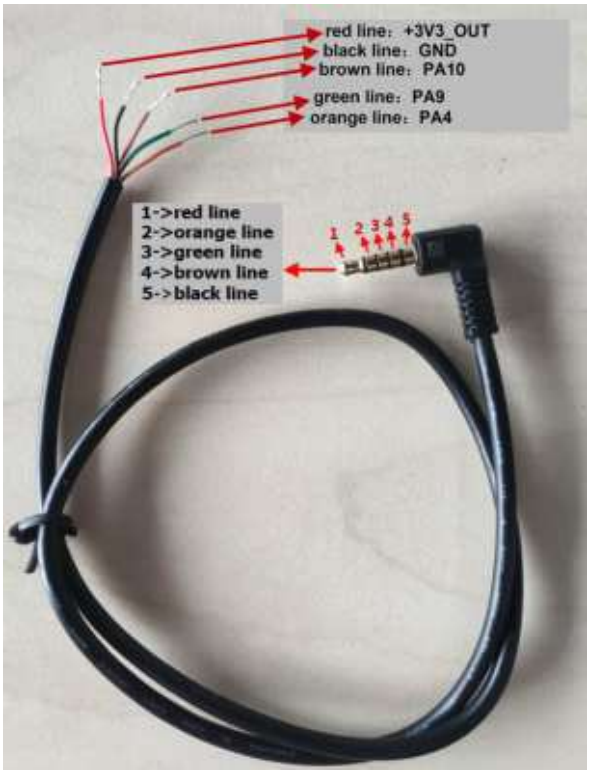
With DS18B20 Temperature sensor with 1 meter cable long

- 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
- -55°C to 125°C
- Working voltage 2.35v ~ 5v

Pin order for E1 Temperature Sensor.



5.2 E2 Extension Cable



5.3 E3 Temperature Probe



With DS18B20 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
- -55°C to 125°C
- Working voltage 2.35v ~ 5v

Note: Same payload format as E1 probe

5.4 E5 Illumination Probe



BH1750 Illumination Sensor:

- Resolution: 1 lx
- Range: 0-65535 lx
- Operating Range: -40 °C ~ 85 °C

6. FAQ

6.1 How to use AT Command to configure LHT65

LHT65 supports AT Command set. User can use a USB to TTL adapter plus the Program Cable to connect to LHT65 for using AT command, as below.

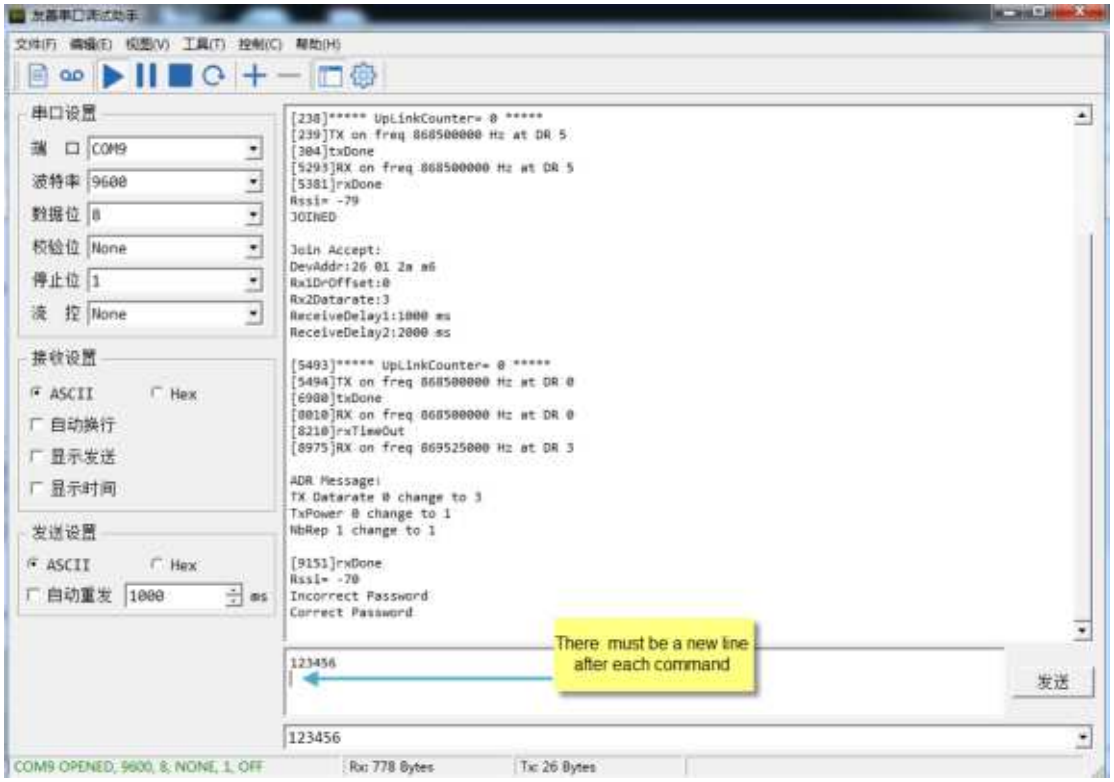


Connection:

- ✓ USB to TTL GND <--> Dupont black pin
- ✓ USB to TTL RXD <--> Dupont green pin
- ✓ USB to TTL TXD <--> Dupont white pin

In PC, User needs to set **serial tool**(such as putty, SecureCRT) baud rate to **9600** to access to access serial console for LHT65. 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 LHT65,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

6.2 How to upgrade the firmware?

The LHT65 is shipped with a program cable, which is used to upload image to LHT65 for:

- ✓ Support new features
- ✓ For bug fix
- ✓ Change LoRaWAN bands.

Video Instruction is here: https://youtu.be/0xpSWTCuDGQ

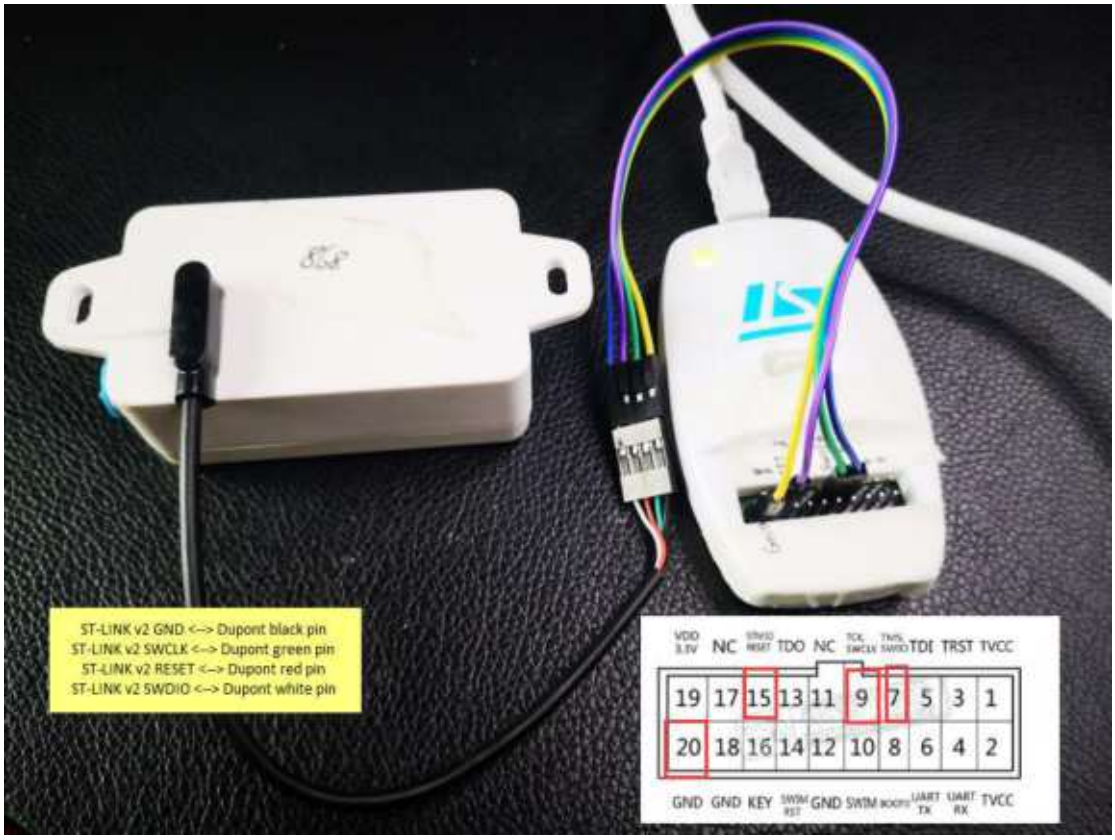
The latest firmware and changelog can be found at below link:
http://www.dragino.com/downloads/index.php?dir=LHT65/Firmware/

Below shows the hardware connection for how to upload an image to the LHT65:

Note:

1) There are different version ST-Link v2. The white one as below is the most stable and recommended one.

2) The white version ST-Link v2 such as below photo has different hardware version. The original one doesn't have 3.3v on pin 1/2 and the clone one has 3.3v on pin 1/2. User has to short pin19 (VDD 3.3v) and pin 1/2 (TVCC) for the original one so pin 1/2 has 3.3v power. Otherwise, the original one will have problem to upload firmware to LHT65.



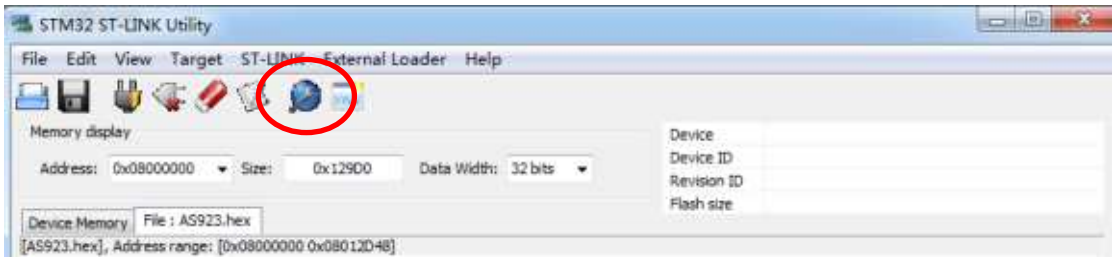
Connection:

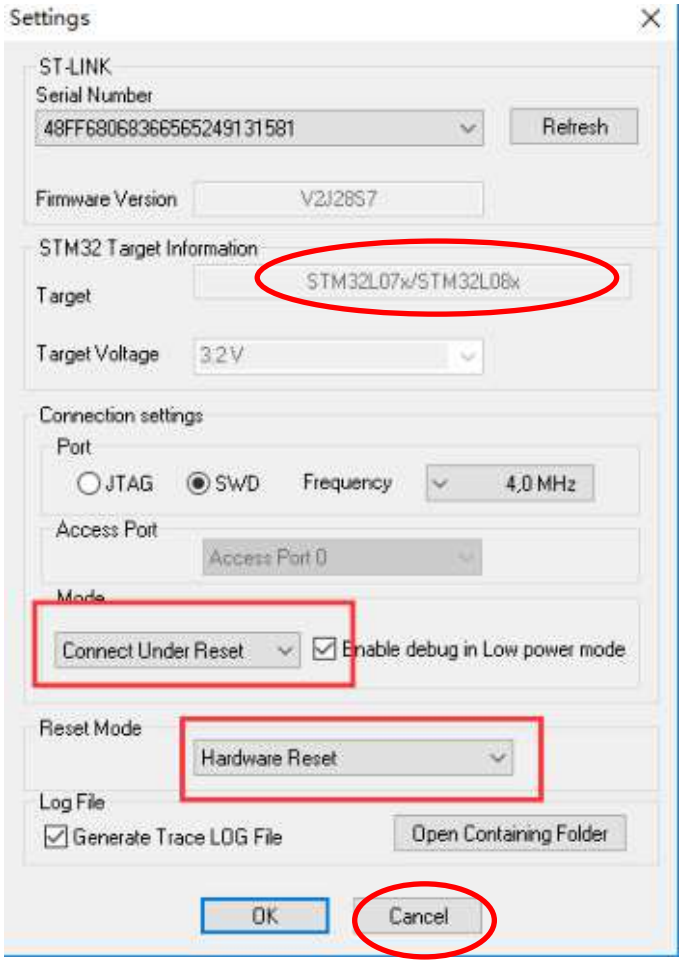
- ✓ ST-LINK v2 GND <--> Dupont black pin
- ✓ ST-LINK v2 SWCLK <--> Dupont green pin
- ✓ ST-LINK v2 RESET <--> Dupont red pin
- ✓ ST-LINK v2 SWDIO <--> Dupont white pin

Step1: Install ST-LINK driver first and then install ST-LINK Utility

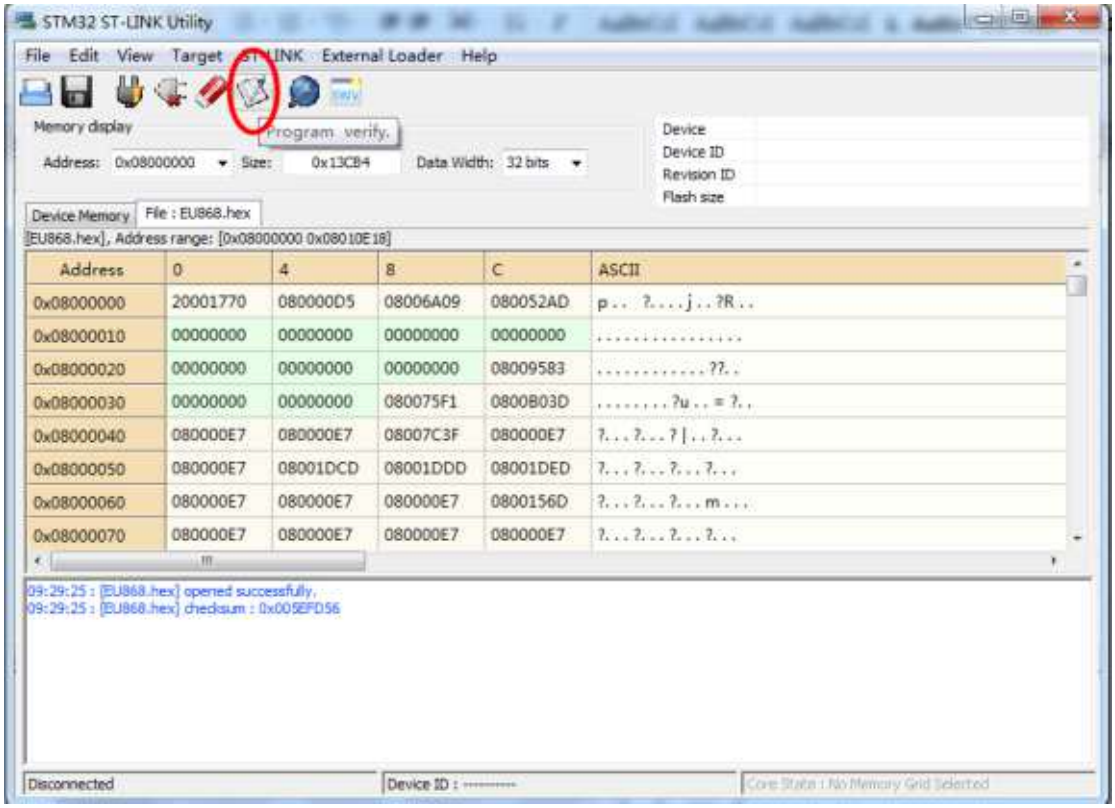
Step2: Download the LHT65 Image files.
http://www.dragino.com/downloads/index.php?dir=LHT65/Firmware/

Step3: click the blue global "**settings**" button on ST-LINK.
Make sure enable "Connect Under Reset" & "Hardware Reset".
ST-Link v2 should be able to see the STM32 chip as below.
Then Click **Cancel**.

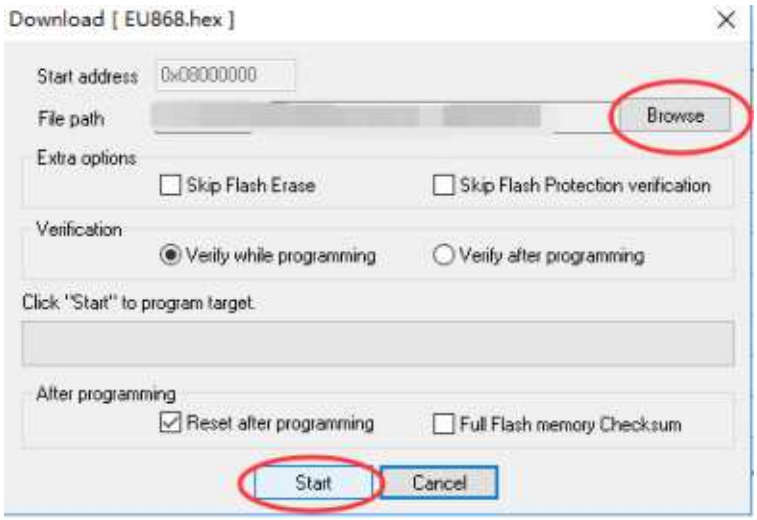



Settings
ST-LINK
Serial Number
48FF68068366565249131581
Refresh
Firmware Version
V2J28S7
STM32 Target Information
Target
STM32L07x/STM32L08x
Target Voltage
3.2 V
Connection settings
Port
JTAG
SWD
Frequency
4,0 MHz
Access Port
Access Port 0
Mode
Connect Under Reset
Enable debug in Low power mode
Reset Mode
Hardware Reset
Log File
Generate Trace LOG File
Open Containing Folder
OK
Cancel

Step4: Click Program & Verify



Step5: The led on the ST-LINK adapter will now blinking, click program verify button to select the image to be upgraded.



Step5: Click the start button to download the image to LHT65.

*If you change different LoRa Frequency Bands/Region, you need using AT+FDR command to restore factory data after program success

6.3 How to change the LoRa Frequency Bands/Region?

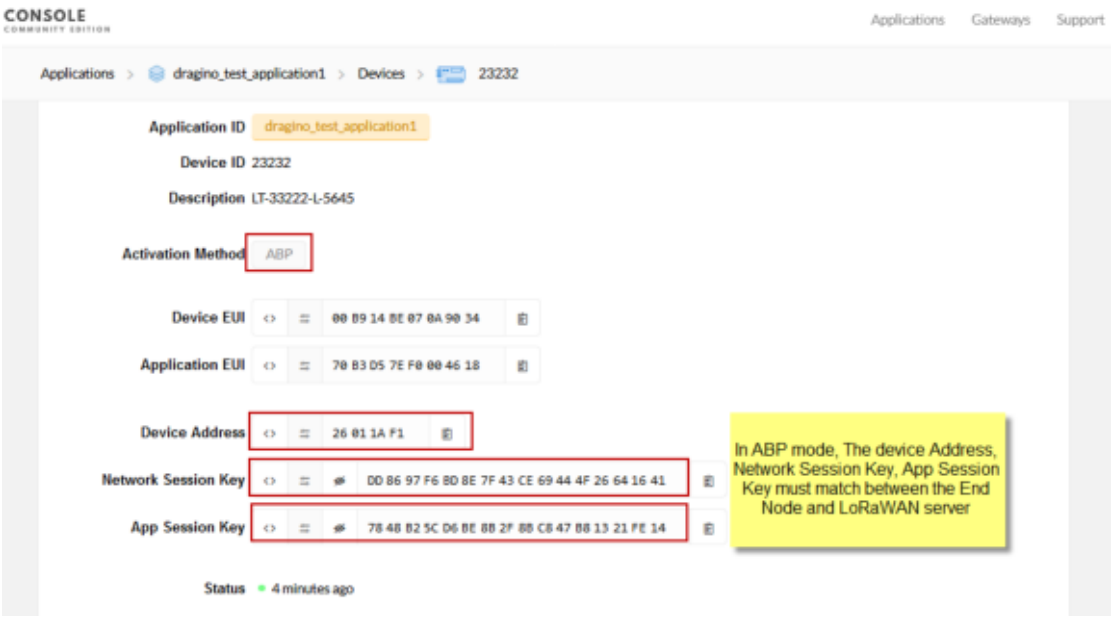
User can follow the introduction for how to upgrade image. When download the images, choose the required image file for download.

6.4 How to set up LHT65 to work with Single Channel Gateway such as LG01/LG02?

In this case, users need to set LHT65 to work in ABP mode & transmit in only one frequency. Assume we have a LG02 working in the frequency 868400000 now, below is the step.

Note: EU868 firmware can't set to Single Frequency, to use single frequency in EU, user can first upgrade the firmware to IN865 and set it to work in Single Frequency.

Step1: Log in TTN V3, Create an ABP device in the application and input the network session key (NETSKEY), app session key (APPSKEY) from the device.



Note: user just need to make sure above three keys match, User can change either in TTN V3 or Device to make then match. In TTN V3, NETSKEY and APPSKEY can be configured by user in setting page, but Device Addr is generated by TTN V3.

Step2: Run AT Command to make LHT65 work in Single frequency & ABP mode. Below is the AT commands:

123456 Enter Password to have AT access.
AT+FDR Reset Parameters to Factory Default, Keys Reserve
123456 Enter Password to have AT access.
AT+NJM=0 Set to ABP mode
AT+ADR=0 Set the Adaptive Data Rate Off
AT+DR=5 Set Data Rate (Set AT+DR=3 for 915 band)
AT+TDC=60000 Set transmit interval to 60 seconds

AT+CHS=868400000 Set transmit frequency to 868.4Mhz

AT+DADDR=26 01 1A F1 Set Device Address to 26 01 1A F1

ATZ Reset MCU

6.5 How to reset LHT65?

The LHT65 has below pins in the back.



Use a metal wire to short NRST and GND pin will reset the LHT65.

6.6 What is the frequency plan of LHT65?

LHT65 use the same frequency as other Dragino products. User can see the detail from this link:
http://wiki.dragino.com/index.php?title=End_Device_Frequency_Band#Introduction

6.7 Why I see packet payload is 00?

Since firmware v1.8, LHT65 will send MAC command to request time, in the case if DR only support max 11 bytes, this MAC command will be bundled to a separate uplink payload with 0x00.

7. Trouble Shooting

7.1 AT Command 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>** after press the send key, user need to add <ENTER> in their string.

7.2 Why the temperature shows 327.67℃?

If the external sensor is 0x01, and there is no DS18B20 connected. The temperature will be set to 7FFF which is 327.67℃. In this case, please check the connection between the

DS18B20 and the LHT65. User need to push the DS18B20 Audio jack hard to make the connection firmly. User will feel a click sound if connection is good.

7.3 Device no responses after Interrupt during upload or configure?

Possible the LHT65 are in program mode, try to short the NRST pin to GND to make it reset.



7.4 Have trouble to register to US915 or AU915 frequency band

Please see if related to the channel selection issue as shown here.

http://wiki.dragino.com/index.php?title=LoRaWAN_Communication_Debug#Notice_of_US915.2FCN470.2FAU915_Frequency_band

8. Order Info

Part Number: **LHT65-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

YY:

- ✓ **00**: no external sensor
- ✓ **E1**: with model E1, temperature Probe (Default version)
- ✓ **E2**: with 3.5mm to 5 wire cable (For Interrupt, ADC, Counting)
- ✓ **E3**: Flat Temperature Probe (DS18B20)
- ✓ **E5**: with illumination Probe

Battery Replacement Kit: LHT65-BAT-CA

Includes: LHT65 battery + Enclosure + Sticker without Dev EUI.

External sensor can be ordered separately by using the sensor model + ES as prefix:

Part Number: **ES-YY**

Example: ES-E1

9. Packing Info

Package Includes:

- ✓ LHT65 Temperature & Humidity Sensor x 1
- ✓ Program cable x 1
- ✓ Optional external sensor

Dimension and weight:

- ✓ Device Size: 13.5 x 7 x 3 cm
- ✓ Device Weight: 105g
- ✓ Package Size / pcs : 14.5 x 8 x 5 cm
- ✓ Weight / pcs : 170g

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

11. 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