



# LHT65 Temperature & Humidity Sensor User Manual

# Document Version: 1.8.0

# Image Version: v1.8

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1.0	Release	2019-Jun-15
1.1	Modify activation process, Add TTN Payload Decode	2019-Aug-28
1.2	Fix ACT typo, Add cayenne photo. Battery Analyze. Add notice for single	2019-Nov-27
	channel use. Add trouble shooting.	
1.3	Add External Temperature Sensor pin connection, Improve ST-Link v2	2019-Dec-29
	connection description.	
1.3.1	Correct myDevices description	2019-Dec-31
1.3.2	Add how to reset device	2020-Jan-17



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1.5.0	Update Alarm mode description from firmware v1.5	2020-Feb-25
1.7.0	Update Battery Report, FAQ, Update Payload and connection for v1.7 firmware	2020-May-31
1.7.1	Add Sensor probe E3	2020-Jun-9
1.7.2	Fix typo for A2 downlink command to change Interrupt	2020-Jun-30
1.7.3	Fix typo for uplink interval, it should be 20 minutes in default settings	2020-Jul-15
1.8.0	Upgrade to v1.8 firmware,	2021-Jan-29
	Add Datalog feature, update to LoRaWAN stack DR-LWS-005	



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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
- $\blacktriangleright$  Accuracy Tolerance : Typ ±0.3 °C
- Long Term Drift: < 0.02 °C/yr</p>
- Operating Range: -40 ~ 125 °C

#### **Built-in Humidity Sensor:**

- Resolution: 0.04 %RH
- Accuracy Tolerance : Typ  $\pm 3$  %PH
- Long Term Drift: < 0.02 °C/yr</p>
- Operating Range: 0 ~ 100 °C

### External Temperature Sensor – E1:

- Resolution: 0.0625 °C
- $\blacktriangleright$  ±0.5°C accuracy from -10°C to +85°C
- $\blacktriangleright$  ±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:

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

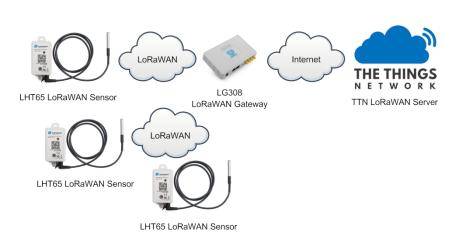
In case user can't set the OTAA keys in the network server and has to use the existing keys from server. User can <u>use AT Command</u> to set the keys in LHT65.

## 2.3 Example to join LoRaWAN network

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







Assume the LG308 is already set to connect to <u>TTN network</u>. We need to add the LHT65 device in TTN:

**Step 1**: Create a device in TTN 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 screen shot: Add APP EUI in the application.

NSOLE NUMBER OF CONTRACT OF CONTRACT.	Applications	Gateways	Suppo
Applications > 🤤 dragino_test_application1			
Application ID dragino_test_application1 Description a test application for Dragino Created 2 years ago Handler ttn-handler-eu (current handler)		documentar	tion
APPLICATION EUIS		O manage e	uis
☆ 二 70 83 D5 7E F0 00 46 18 回     ☆ 二 3F 77 AD E3 68 CA A8 65 回			

Add APP KEY and DEV EUI



### THETHINGS CONSOLE

EGISTER DEVICE	bulk import o
Device ID This is the unique identifier for the device in this app. The device ID will be immutable.	
lt-33222-I-5480	
Device EUI The device EUI is the unique identifier for this device on the network. You can change the EUI later.	
x     A8 40 41 00 01 81 85 48	📀 8 byte
App Key The App Key will be used to secure the communication between you device and the network.	
22 57 4E 37 E6 8A EC FC CD B3 B9 3D 87 A9 3B 4B 2C	🥥 16 by
App EUI	
3F 77 AD E3 6B CA AB 65	

**Step 2**: Use ACT button to activate LHT65 and it will auto join to the TTN network. After join success, it will start to upload sensor data to TTN and user can see in the panel.

		SOLE	EDITION							Appli	cations	Gateway	/s Su	ipport
A	Applications	>			>	Devices 🔾	🗧 📰 001 > Data							
											Over	view	Data	Settings
	APPLIC	ATION	DATA										II paus	se 🛍 <u>clea</u>
	Filters	uplink	downlink	activation	ack	error								
		time	counter	port										
	<b>•</b> 10	:29:25		0										<b>^</b>
	▲ 10	):29:24	0	2	retry	payload: 🕻	BD60A7D028B017FF	F 7F FF	BatV: 3.03	Hum_SHT: "65.:	L" TempC_I	DS: "327	.67" Te	mpC_
	•													
	≁ 10	):29:18				dev addr:	26 01 20 16 app eui: 70	B3D57E	D0 01 5E 13	dev eui:				

### 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 <u>BLUE LED</u> will blink once.

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

First 6 bytes: has fix meanings for every device.

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

The  $8^{th} \sim 11^{th}$  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

oplications > 🥪 Iht65 > Payload Formats						
	Overview	Devices	Payload Formats	Integrations	Data	Settings
PAYLOAD FORMATS						
Payload Format The payload format sent by your devices						
Custom						\$
decoder converter validator encoder					remove	decoder
<pre>1 function Decoder(bytes, port) { 2 // Decode an uplink message from a buffer 3 // (array) of bytes to an object of fields. 4 var value=(bytes[0]&lt;8   bytes[1]) &amp; 0x3FFF; 5 var batV=value/1000;//Battery.units:V 6 7 value=bytes[2]&lt;8   bytes[3].</pre>						

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	Actually BAT voltage
	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)	

## APPLICATION DATA

Filters	uplink	downlink	activation	ack	error
	time	counter	port		
<b>a</b> 08	:38:57	375	2		payload: CB

#### Check the battery voltage for LHT65.

- BAT status=(0xCBF6>>14)&0xFF=11(B), very good
- Battery Voltage =0xCBF6&0x3FFF=0x0BF6=3062mV



#### 2.4.3 Built-in Temperature

## APPLICATION DATA

	Filters	uplink	downlink	activation	ack	error	
		time	counter	port			
	<b>^</b> 08:	:38:57	375	2		payload: CB	F6 0B 0D 03 76 01 0ADD7F FF
	Temper	ature: C	)x0B0D/100=	<b>=28.29</b> ℃			
•	10:02:5	54	1559	2	pay	load: CBB	DF5 C6 02 2E 01 F5 4F 7F FF
$\triangleright$	Temper	ature: (	0xF5C6-6553	36)/100=-26	5. <b>18</b> ℃		

## 2.4.4 Built-in Humidity

## **APPLICATION DATA**

Filters	uplink	downlink	activation	ack	error	
	time	counter	port			
<b>a</b> 08	:38:57	375	2		payload: CB	F6 0B 0D 03 76 01 0A DD 7F

➢ Humidity: 0x0376/10=88.6%

## 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

		DATA					
Filters	uplink	downlink	activation	ack	error		
	time	counter	port				
<b>A</b> 08	3:38:57	375	2	р	ayload: CB	F6 0B 0D 03 76 01 0A	DD7F
DS18B	20 temp=0>	x0ADD/100	<b>=27.81</b> ℃				
The las	t 2 bytes o	f data are m	neaningless				
The las 10:02:		f data are m 1559	neaningless 2	payle	oad: CBBI	DF5 C6 02 2E 01 F5 4	F 7F F

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



### 2.4.8 Ext=4, Interrupt Sensor

In this mode, user can connect external interrupt sensor to the <u>E2 Extension Cable</u> 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 <u>mercury switch</u> to detect the titling. (NOTE: This feature only supported by SN number > LHT65307029)



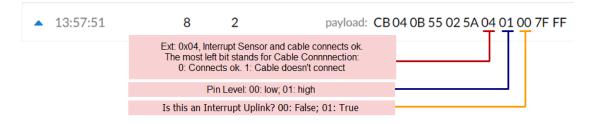
Above is connection to a mercury switch, rotate the mercury will generate interrupt. LHT65 will detect it and send an uplink package to sever. User can also connect PA9 and PA10 together, with these two pins shortcut, LHT65 will know if the probe is connected well in the socket.

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:





<u>Means</u>: 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.

<ul><li>13:59:38</li></ul>	10	2	payload: CB 06 0B 5B 02 77 04 00 01 7F FF
<u>Means</u> : The device is a packet is for a Interrup			an Interrupt Sensor, the cable connection is fine. This is low.
<ul> <li>11:33:52</li> </ul>	0	2	payload: CBDC0B 1C 02 E3 84 00 00 7F FF

<u>Means</u>: 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.).



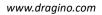
## 2.4.9 Ext=5, E5 Illumination Sensor

	ater Frebe				
<ul><li>13:50:36</li></ul>	4	2	payload:	CB	03 0B 2D 02 7C 05 01 91 7F FF
	The most left	bit stands	nsor and cable connects ok. for Cable Connnection: Cable doesn't connect		
	strength o	ofilluminat	tion=0x0191=401 lux		

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

<ul><li>11:36:08</li></ul>	0	2	payload: CBDC0B 6B 02 EE 85 FF FF 7F FF

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





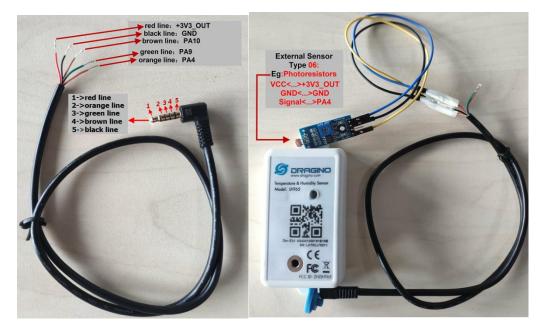
### 2.4.10 Ext=6, ADC Sensor

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 <u>downlink command A2</u> 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.

▲ 14:03:47	1 2	payload: CB0B0B640272060B067FFF
	Ext: 0x06, ADC Sensor and The most left bit stands for Ca 0: Connects ok. 1: Cable	able Connnection:
	Voltage Value : 0x0B0	06 = 2.822v

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

-	11:36:51	0	2	payload: CBD80B 68 02 D7 86 FF FF 7F FF
---	----------	---	---	---

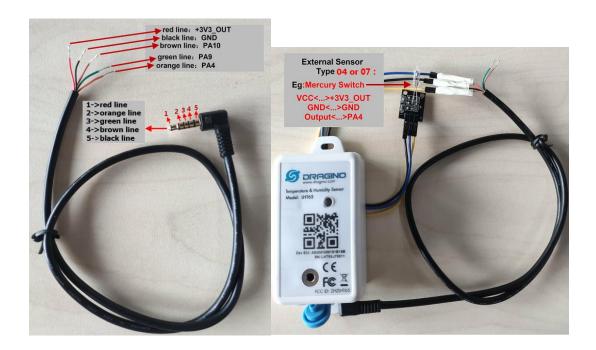
<u>Means</u>: The device is set to connect to an ADC Sensor, but the cable connection is losing. (Notice: PA9 and PA10 must be connected to detect if cable is losing or fine.).



## 2.4.11 Ext=7, Counting Sensor

In this mode, user can connect external interrupt sensor to the <u>E2 Extension Cable</u> 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 <u>downlink command A2</u>



#### Payload explain:

▲ 11:32:08	4 2	payload: CBE	D5 0B 05 02 E6 07	7 00 06 7F FF
	Ext: 0x07, Countinng Sensor and The most left bit stands for Ca 0: Connects ok. 1: Cable of	able Connnnection:		
	How many counts so far : 0:	x0006 = 6 count		

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

▲ 11:33:05 0 2	payload: CBDC0B 0F 02 FE 87 00 00 7F FF
----------------	---

**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 <u>E2 Extension Cable</u> 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:	User can use AT	Command to set the method to detect count	ting:
---	-----------------	---	-------

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:

• 09:23:31	6	2	payload: CBCB 09 E7 02 14 08 00 01 00 05
------------	---	---	--

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

O9:26:01 11 2 payload: CBCB 09 F2 02 1F 88 00 01 00 05

**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



## 2.4.13 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	<u>External</u>	<u>Built-In</u>	BAT Status &	Status &	<u>Unix</u>
	temperature	<u>Temperature</u>	<u>Built-in</u>	<u>Ext</u>	Time Stamp
			<u>Humidity</u>		

#### Battery status & Built-in Humidity

Bit(bit)	[15:14]	[11:0]
Value	BAT Status	Built-in Humidity
	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)	

#### Status & Ext Byte

Bits	7	6	5	4	[3:0]
Status & Ext	Not Defined	Poll Message	Sync time	Unix Time	Ext:
		Flag	ОК	Request	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 MyDevices

<u>myDevices</u> IoT platform provides a human friendly interface to show the sensor data, once we have sensor data in TTN, we can use myDevices to connect to TTN and see the data in myDevices. Below are the steps:

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



<u>Step 2</u>: Configure your Application to forward data to myDevices you will need to add integration. Go to TTN Console --> Applications --> Integrations --> Add Integrations.

	GS CONSOLE R K COMMUNITY EDITION	C				ations Gatew	rays Supj	port	👔 edwin
A	Applications > 🥪 Iht65 > Integrations								
			Overview	Devices	Payload Formats	Integrations	Data	Settings	
	ADD INTEGRATION								
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#### Add myDevices:

THETHINGS CONSOLE 🍘 edwin Applications Gateways Support Applications > <a> Integrations</a> EVRYTHNG The Things Industries B.V. The Things Industries B.V. OpenSensors.io *my* Devices MyDevices OpenSensors TTN Mapper /2.6.0 nyDevi v2.6.0 The Things Industries B.V. JP Meijers

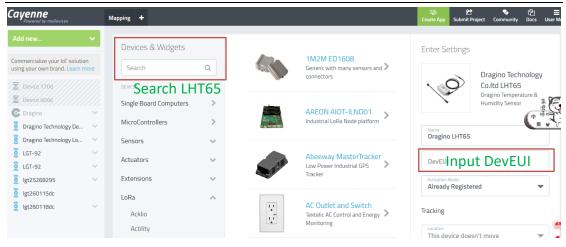
#### Select default key as Access Key:

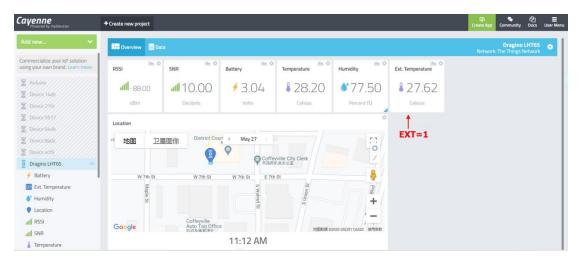
Applications > 😂 Iht65 > Integrations > 001	
Process ID 001 Status • Running Platform Gamma MyDevices (v2.6.0) documentation	
Author myDevices	
Description Quickly design, prototype and commercialize IoT solutions with myDevices Cayenne	
SETTINGS	
Access Key The access key used for downlink	
default key devices messages	¢

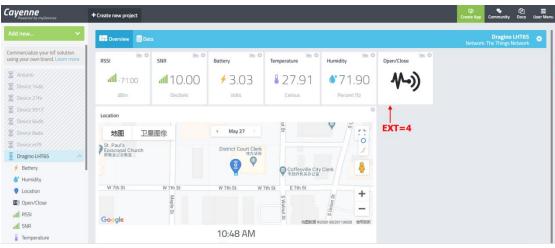
In myDevices console (<u>https://cayenne.mydevices.com</u>) , add LHT65:



#### www.dragino.com



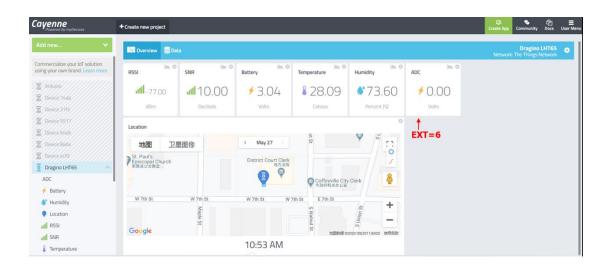






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Commercialize your IoT solution using your own brand. Learn more	RSSI Int O SNR Int O Battery Int O Temperature Int O Humidity Int O Illumination Int O	
室 Arduino 窗 Device 14ab 窗 Device 21fe	all-83.00         all 10.80         # 3.04         \$ 28.81         \$ 67.80         \$ 371.00           dBm         Decibels         Voits         Celsius         Percent (k)         Lux	
Device 5517	Location 地图 卫星图像 < May 27 5 5 9 7 5: EXT=5	
Device ecf9     Dragino LGT92 v1.5     Dragino LHT65	St. Paul's District Court Clerk ±5,12,8 3 3 3 4 5 5 6 6 6 1 1 1 1 1 1 1 1 1 1 1 1 1	
<ul> <li>Battery</li> <li>Humidity</li> <li>Illumination</li> </ul>	W 7th St W 7th St W 7th St W 7th St B W 7th	
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Temperature		I



Cayenne Powered by myDevices	+Create new project Community Docs User M
Add new 👻	Dragino LHT65 O Network The Things Network
Commercialize your IoT solution using your own brand. Learn more	RSSI SNR Battery Into Temperature Humidity Count
Arduino  Control Ardui	III-79.00         IIII8.80         # 3.04         \$ 28.07         \$ 73.80         0 0 0 0 0 5.00           dBm         Decideds         Voits         Celsus         Percent (t)         Analog
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att RSSI att SNR	Google 11:07 AM



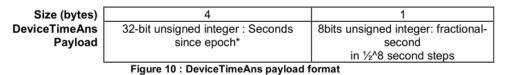
#### 2.6 Datalog Feature

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

This feature is <u>always enabled</u>, 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



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

Below is the converter example

EpochConverter	Code Beautify	JSON Formatter He
Epoch & Unix Timestamp Conversion To	All Numbers Converter Numbers to Words Converter	Decimal to Hex
	Decimal to Binary Converter	Enter the Decimal number to decode Sample 49
	Decimal to Hex Converter	4644000405
The current Unix epoch time is 1611889418	Decimal to Octal Converter	1611889405
	Binary to Decimal Converter	
Convert epoch to human-readable date and vice ver	Binary to Hex Converter	
1611889090 Timestamp to Human date [batch convert]	Binary to Octal Converter	
Supports Unix timestamps in seconds, milliseconds, microseconds and nanoseconds.	Binary to Text Converter	
Assuming that this timestamp is in seconds:	Text to Binary Converter	🗹 Auto 😏 Convert 📑 File 🖙 I
GMT: 2021年1月29日Friday 02:58:10 Your time zone: 2021年1月29日星朝五 10:58:10 GMT+08:00	Hex to Decimal Converter	The number in hex (base 16)
Relative: 3 minutes ago	Hex to Binary Converter	representation:
	Hex to Octal Converter	60137afd
Mon Day Yr Hr Min Sec	Octal to Decimal Converter	00157810

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 and loriot support but TTN 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 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 A9 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	<u>External</u>	<u>Built-In</u>	Built-in	Poll message	<u>Unix Time</u>
	<u>sensor data</u>	<u>Temperature</u>	<u>Humidity</u>	<u>flag &amp; Ext</u>	<u>Stamp</u>

#### Poll message flag & Ext

Bit(bit)	14	[7:0]
Value	Poll message flag	Ext
		Extension Sensor Type

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) DRO: 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 v	oltage	Val	ue	
80196E0 21/1	/19 04:27:03	1 3145 sht_	_temp=22.00	) sht_l	hum=32.6 d	s_temp=327.67
80196F0 21/1	/19 04:28:57	1 3145 sht_	_temp=21.90	) sht_l	hum=33.1 d	s_temp=327.67
8019700 21/1	/19 04:30:30	1 3145 sht_	_temp=21.82	1 sht_	hum=33.4 d	s_temp=327.67
8019710 21/1	/19 04:40:30	1 3145 sht_	_temp=21.65	5 sht_	hum=33.7 d	s_temp=327.67
8019720 21/1	/19 04:50:30	1 3147 sht_	_temp=21.5	5 sht_	hum=34.1 d	s_temp=327.67
8019730 21/1	/19 05:00:30	1 3149 sht_	_temp=21.50	) sht_l	hum=34.1 d	s_temp=327.67
8019740 21/1	/19 05:10:30	1 3149 sht_	_temp=21.43	3 sht_	hum=34.6 d	s_temp=327.67
8019750 21/1	/19 05:20:30	1 3151 sht_	_temp=21.35	5 sht_l	hum=34.9 d	s_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.

• 09:57:27	102	2	payload: 7F FF 08 98 01 46 41 60 06 5F 97 7F FF 08 8E 01 4B 41 6	0 06 60 09 7F FF
Uplink				
Payload				
	<b>1</b> 16 11 69 96	5E 07 7E EE	- 08 8E 01 4B 41 60 06 60 09 7F FF 08 85 01 4E 41 60 06 60 66 7F FF 08	75 01 51 /1 60 0
4	1 40 41 00 00	, 51 57 71 11		75 01 51 41 00 0
Fields				
no fields				
Metadata				
Wetadata				
{ "time": "202 "frequency" "modulation" "data rate"	: 904.5,		35935Z",	
"coding_rate	e": "4/5",	5		
"gateways":				
	": "eui-a840 amp": 327099		5c",	
	2021-01-20		544057Z",	
"rssi": "snr":	-55,			
}	10			
FF089801464	160065F	977FFF0	88E014B41600660097FFF0885014E41600660667FF	F087501514

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 <u>BLUE LED</u> or <u>RED LED</u> will blink once.
  - ♦ <u>BLUE LED</u> when external sensor is connected
  - ♦ <u>RED LED</u> when external sensor is not connected
- ✓ For each success downlink, the <u>PURPLE LED</u> 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 <u>FAQ</u>.
- 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	d falling interrupt
AT+EXT=4,2	Set to use Interrupt Mode. Sent uplink packet only in falling int	errupt
AT+EXT=4,3	Set to use Interrupt Mode. Sent uplink packet only in rising inte	errupt
AT+EXT=5	Set to use illumination sensor	
AT+EXT=6,1000	Set to use ADC sensor mode and LH sensor for 1000ms before sampling 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 c	ount at falling interrupt
AT+EXT=8,1	Set to 4 bytes counting mode and c	ount at rising interrupt
AT+EXT=9	Set to external DS18B20 with times	tamp

### 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	ОК

#### **Downlink Command:**

- ↔ 0xA800  $\rightarrow$  AT+PID=0
- ↔ 0xA801  $\rightarrow$  AT+PID=1

#### 3.4 Set Password

Feature: Set device password, max 9 digits

#### AT Command: AT+PWORD

Command Example	Function	Response
	Chau passuard	123456
AT+PWORD=?	Show password	ОК
AT+PWORD=999999	Set password	ОК

#### **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
·		



www.dragino.com

+DISAT Quit AT Commands mod
-----------------------------

#### **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. 请确认

#### 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:**

0xA86007806000 // 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:



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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
	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
AT+PDTA=1,3	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
Print page 1 to 3	8019580
	8019590
	80195A0
	80195B0
	80195C0
	80195D0



	80195E0
	80195F0
	ок

#### **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				
	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				
AT+PLDTA=5	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				
Print last 5 entries	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				
	ОК				

#### **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



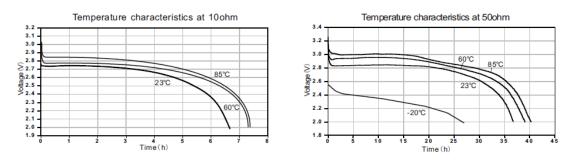
## 4. Battery & How to replace

## 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

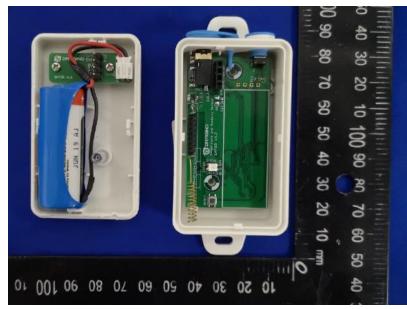


Minimum Working Voltage for the LHT65:

- ✓ 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 Power Consumption Analyze

Please refer the battery test report from below link:

http://www.dragino.com/downloads/index.php?dir=LHT65/Test\_Report/

It includes the power consumption test base on EU868 and US915 on given transmit interval and working mode. It also includes the formula for how to calculate the power consumption. User can calculate the battery life base on a different uplink interval and network coverage on field to get a reference battery life.



## 5. Sensors & Accessories

#### 5.1 E1 Temperature Probe

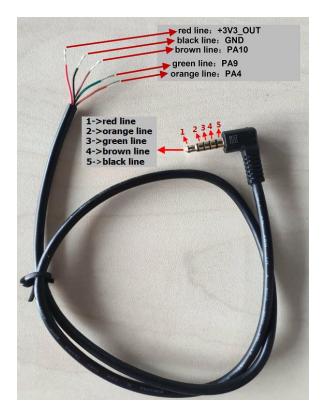
With DS18B20 Temperature sensor with 1 meter cable long

- Resolution: 0.0625 °C
- $\blacktriangleright$  ±0.5°C accuracy from -10°C to +85°C
- $\rightarrow$  ± 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
- $\blacktriangleright$  ±0.5°C accuracy from -10°C to +85°C
- $\blacktriangleright$  ± 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.

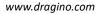


Connection:

- ✓ 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 <u>putty</u>, 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:





文化の 編編(5) 祝聞(Y) 工具(T) 控制(C) 操助(H)            ・ ・ ・ ・ ・ ・ ・ ・ ・ ・ ・ ・ ・ ・ ・	☑ 友善串□调试助手	
申口设置       [28]***** UpLinkCounter= 0 *****         239] TX on freq 868500000 Hz at DR 5         [39] HX on freq 868500000 Hz at DR 5         [39] BX on freq 868500000 Hz at DR 5         [39] BX on freq 868500000 Hz at DR 5         [38] DX on freq 868500000 Hz at DR 5         [38] TX on freq 868500000 Hz at DR 5         [38] TX on freq 868500000 Hz at DR 5         [38] TX on freq 868500000 Hz at DR 5         [38] TX on freq 868500000 Hz at DR 6         [543] ***** UpLinkCounter= 0         ******         ******         ******         ******         *******         *******         ************************************		) 帮助(H)
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端口       COM9       「304 jt kobne         波特率       9600       「5381 jt xobne         数据位       1       「5381 jt xobne         放验位       None       」         方       拉       None         プ       join Accept:         Devaddr:26 01 2a a6       Rx2Dotfract:0         Rx2Dotfract:0       Rx2Dotfract:0         Rx2Dotfract:0       Rx2Dotfract:0         Rx2Dotfract:0       ReceiveDelay:1:000 ms         ReceiveDelay:2:2000 ms       ReceiveDelay:2:2000 ms         EdvigE       [5493] ***** UpLinkCounter= 0 *****         [5494] ***** UpLinkCounter= 0 *****       [5494] ***** UpLinkCounter= 0 *****         [5494] ****** UpLinkCounter= 0 *****       [5494] ******         [5493] ************************************		
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傳止位       1       」         液 控       None       」         液 控       None       」         水 Zbotarate:3       Receiveblay1:1000 ms         Receiveblay1:1000 ms       Receiveblay2:2000 ms         「S493]***** UpLinkCounter= 0 *****       [S494]TX on freq 868500000 Hz at DR 0         [S494]TX on freq 868500000 Hz at DR 0       [8010]RX on freq 868500000 Hz at DR 0         [B301]RX on freq 869525000 Hz at DR 0       [8210]rxTimeOut         [B305]RX on freq 869525000 Hz at DR 3       ADR Message:         次 发送设置       Tx Datarate 0 change to 3         C ASCII       C Hex         「自动重发 10000 ** ms       [9151]rxDone         Rssi= -70       Incorrect Password         Incorrect Password		JOINED
停止位       1       ▼         流 控 None       ▼         決 按 心没置       ▼         ◆ ASCII       C Hex         「自动换行       [5493]***** UpLinkCounter= 0 ******         [810]RX on freq 868590000 Hz at DR 0         [8210]RX on freq 8685925000 Hz at DR 3         ADR Message:         TX Doarate 0 change to 1         [9151]rxDone         Rssi= -70         Incorrect Password         [123456         [123456         [123456         [123456	校验位│None	
流 控 None       Image: Constraint of the state of the st	停止位 1 🔹	Rx1DrOffset:0
接收设置       [5493]***** UpLinkCounter= 0 *****         · ASCII       · Hex         「自动换行       [5493]***** UpLinkCounter= 0 *****         「目动换行       [5808]tx on freq 868590000 Hz at DR 0         [8010]RX on freq 868590000 Hz at DR 0       [8010]RX on freq 868590000 Hz at DR 0         [810]RX on freq 869525000 Hz at DR 3       ADR Message:         TX Datarate 0 change to 3       TxPower 0 change to 1         · ASCII       · Hex         「9151]rxDone       Rssi= -70         Incorrect Password       Correct Password         Correct Password       Correct Password         (23456       after each command		
<ul> <li>ASCII C Hex</li> <li>自动换行</li> <li>显示发送</li> <li>显示时间</li> <li>发送设置</li> <li>自动重发 1000 → ms</li> <li>[9151] rxDone</li> <li>Rassword</li> <li>There must be a new line after each command</li> <li>发送</li> <li>123456</li> </ul>		
<ul> <li>ASCII C Hex</li> <li>自动换行</li> <li>显示发送</li> <li>显示状间</li> <li>发送设置</li> <li>ADR Message: TX Datarate 0 change to 3 TxPower 0 change to 1</li> <li>MbRep 1 change to 1</li> <li>Incorrect Password</li> <li>In</li></ul>	接收设置	[5493]***** UpLinkCounter= 0 *****
□ 自动换行 □ 显示发送 □ 显示时间	© ASCTT O Hex	
□ 显示时间 □ 显示时间 □ 显示时间 □ 显示时间 □ 显示时间 □ 公式设置 ○ ASCII ○ Hex □ 自动重发 1000 ① ms □ 123456		[8010]RX on freq 868500000 Hz at DR 0
□ 显示反应 □ 显示时间		
● 並小时间       TX Datarate 0 change to 3 TXPOwer 0 change to 1 NbRep 1 change to 1         ● ASCII       ● Hex         「自动重发 1000       ① ms         123456       There must be a new line after each command         123456       ①	□ 显示发送	
发送设置       TxPower 0 change to 1         ◇ ASCII       ○ Hex         □ 自动重发       1000         ① 二       ms         □ 目动重发       1000         ① 1       1000         ① 1       1000         ① 1       1000         ① 1       123456         ① 123456       ①         ① 123456       ①	□ 显示时间	
☆ ASCII C Hex □ 自动重发 1000 ÷ms       [9151]rxDone Rssi= -70 Incorrect Password Correct Password       123456       123456		TxPower 0 change to 1
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□ 自动重发 1000 ÷ ms Incorrect Password Correct Password 123456 after each command 发送 123456 · · · · · ·	• ASCII • Hex	
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123456     after each command     发送       123456		
123456		
123456		23456 atter each command 发送
		123456
	COM9 OPENED, 9600, 8, NONE, 1, OFF	Rx: 778 Bytes Tx: 26 Bytes

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

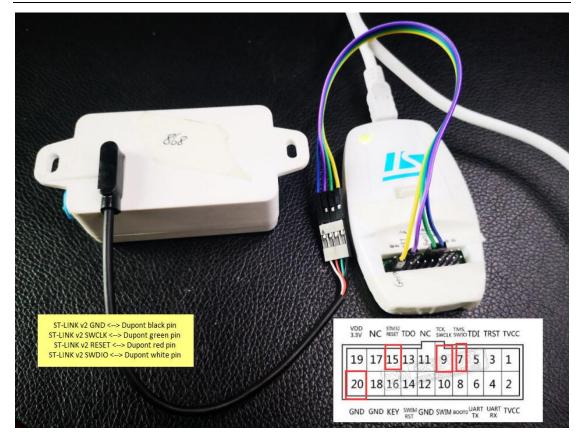
The latest firmware and changelog can be found at below link: <u>http://www.dragino.com/downloads/index.php?dir=LHT65/Firmware/</u>

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. <u>http://www.dragino.com/downloads/index.php?dir=LHT65/Firmware/</u>

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.

stm32 st-link Utility	
File Edit View Target ST-LINK External Loader Help	
🖴 🖥 🗳 🐗 🔗 🕵 👰 🔊	
Memory display	Device
Address: 0x08000000 ▼ Size: 0x129D0 Data Width: 32 bits ▼	Device ID
Address. 0x0000000 + 5/20. 0x12500 Data Width. 52 bits +	Revision ID
Device Memory File : AS923.hex	Flash size
[AS923.hex], Address range: [0x08000000 0x08012D48]	



Settings ×
ST-LINK Serial Number 48FF68068366565249131581 V Refresh
40110000000000243131301 V
Firmware Version V2J28S7
STM32 Target Information
Target STM32L07x/STM32L08x
Target Voltage 3.2 V V
Connection settings Port
◯ JTAG
Access Port
Access Fort U
Connect Under Reset V Bnable debug in Low power mode
Reset Mode Hardware Reset ~
Generate Trace LOG File Open Containing Folder
OK Cancel



#### Step4: Click Program & Verify

EU868.hex], Address Address	stange, loxoood	0000 0x000 102.	18]		Flash size
	0	4	8	с	ASCII
0x08000000	20001770	080000D5	08006A09	080052AD	p ?j?R
0x08000010	00000000	00000000	00000000	00000000	
0x08000020	00000000	00000000	00000000	08009583	
0x08000030	00000000	00000000	080075F1	0800B03D	?u=?
0x08000040	080000E7	080000E7	08007C3F	080000E7	???
0x08000050	080000E7	08001DCD	08001DDD	08001DED	???
0x08000060	080000E7	080000E7	080000E7	0800156D	??m
0x08000070	080000E7	080000E7	080000E7	080000E7	???
•					•
99:29:25 : [EU868.he 19:29:25 : [EU868.he	ex] opened succe ex] checksum : 0:	esstuity. x005EFD56			

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

Download [ El	J868.hex ]	×
Start address File path	0x08000000	Browse
Extra options	Skip Flash Erase	Skip Flash Protection verification
Verification	• Verify while programming	O Verify after programming
Click "Start" to j	program target.	
After program	ming 🔽 Reset after programming	Full Flash memory Checksum
	Start	Cancel

**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 <u>how to upgrade image</u>. 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.

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

CONSOLE COMMUNITY EDITION	Applications Gateways	Support
Applications > 🥪 dragino_test_application1 > Devices > 🐑 23232		
Application ID dragino_test_application1 Device ID 23232 Description LT-33222-L-5645 Activation Method ABP		
Device EUI		
Device Address < 🛱 26 01 1A F1 🖹	In ABP mode, The device Address, Network Session Key, App Session	
	Key must match between the End Node and LoRaWAN server	
Status • 4 minutes ago		

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

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

123456Enter Password to have AT access.AT+FDRReset Parameters to Factory Default, Keys Reserve123456Enter Password to have AT access.AT+NJM=0Set to ABP modeAT+ADR=0Set the Adaptive Data Rate OffAT+DR=5Set Data Rate (Set AT+DR=3 for 915 band)AT+TDC=60000Set transmit interval to 60 seconds



AT+CHS=868400000 Set transmit frequency to 868.4MhzAT+DADDR=26 01 1A F1 Set Device Address to 26 01 1A F1ATZReset 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 $^{\circ}$ C?

If the external sensor is 0x01, and there is no DS18B20 connected. The temperature will be set to 7FFF which is  $327.67^{\circ}$ C. 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\_US915.2FCN470.2FAU91 5 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