DS01588

Outdoor IP64 Temperature and Humidity LoRaWAN Sensor RHF1S001

V1.4

Document information

Info	Content
Keywords	*RisingHF, LoRaWAN, Temperature and Humdity, IP64,*
Abstract	This doc will describe the specifications of RHF1S001, and some necessary application information is also included.

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Outdoor IP64 Temperature and Humidity LoRaWAN Sensor RHF1S001

General description

RisingHF temperature and humidity sensor offers cost effective LoRaWAN end node solution for a variety of applications. Its reliable and low power design allows a battery operation up to 5 years without any maintenance. IP64 enclosure concept and water splash proof unique sensor design are ideal for outdoor use and installation in low accessibility locations.

Sensor acquisition rate could be adjusted via LoRaWAN Class A downlink capability and permit to manage the battery life or the measurements capacity according to the needs of the application.

RisingHF sensors family is fully compatible and plug & play for LoRaWAN network operation.

Applications

● Weather station
● Heating
● Drying
● Ventilation & air conditioning systems
● Refrigeration equipment
● Building automation

Key features

● Powered by lithium thionyl chloride battery:
  5 years of operation for 1 uplink 2 minutes.
● Extended industrial operating temperature:
  -40°C to +85°C.
● Outdoor use:
  IP64 enclosure.
● Accuracy:
  ±5% RH typically from 20% RH to 80% RH at 25°C.
  ±0.5°C typically from +5°C to +60°C.
● LoRaWAN compatible:
  Class A, uplink rate programmable from 2 minutes to 24 hours.
● Change uplink cycle via wireless, i.e. could be configured by server via downlink command
● High performance internal antenna used
● Operating frequency bands (Option at order):
  434MHz, < 10mW radiated power.
  868MHz, < 25mW radiated power
  920MHz, < 25mW radiated power.
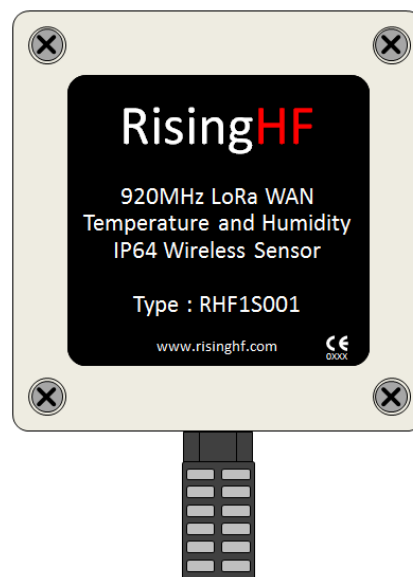
Figure 1 Outside view of RHF1S001

1 General description

The RisingHF's Temperature and humidity LoRaWAN sensor node RHF1S001 is aimed at outdoor application with it's IP64 protection level. And thanks to it's high performance internal antenna and LoRa technology used, the sensor could operate in extremely hard environment or ultra-long range application. In addition to all above, the ultra-low sleep current help it to work in a long life, 5 years or even 10 years are possible[1].

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[1] Transmitting period decides life of RHF1S001

2 Product specifications

The tables below give the electrical specifications and performance of the temperature and humidity measurement.

Table 1 General electrical characteristic

ITEMs	Parameter	Specifications	Unit
Structure	Size	84 X 114 X 55	mm
Electrical Characteristics	power supply	3.6V battery	V
	Sleep current	1.5uA	uA
	Transmit current	120mA@20dBm set	mA
		45mA@14dBm set	mA
	Uplink cycle	2 minutes default	minutes
		Set by downlink command from server	
	Battery life	more than 5 years with 2minutes cycle	years
		more than 10 years with 5minutes cycle	years
Operating Range	Temperature	-40 to 85	℃
	Humidity	0 to 100	%RH

Table 2 Temperature measurement performance

Parameter	Condition	min	typ	max	Units
Resolution	14bit		0.01		℃
Accuracy	typ		+/-0.3		℃
Operating Range	extended	-40		85	℃
Long Term Drift	normal		<0.04		℃

Table 3 Humidity measurement performance

Parameter	Condition	min	typ	max	Units
Resolution	12bit		0.04		%RH
Accuracy	typ		+/-3.0		%RH
Nonlinearity			<0.1		%RH
Operating Range	extended	0		100	%RH
Long Term Drift	normal		<0.5		%RH

3 Application Information

3.1 Function

RHF1Sxxx software implements LoRaWAN ABP mode with ADR enabled, it is a LoRaWAN Class A device, DevAddr, NwkSKey, AppSKey are stored in the node. This 3 information is necessary for node to connect a network. DevAddr will be labeled to the surface of the device, however NwkSKey and AppSKey will be kept secret to make node safe. RisingHF promises only expose to this 2 session keys device owner. RisingHF will supply key in in the form of information list.

After power on, RHF1Sxxx will keep detect the status of magnet sensor, when magnet stays the same, then RHF1Sxxx will reports magnet status and temperature and humidity to server in a fixed duty cycle which could be customized by user through downlink. Magnet status change will trigger a report immediately, depends on current data rate, response time could range from 100ms to 2s.

According to LoRaWAN specification, downlink response time is decided by uplink duty cycle, user should refer the needed response time to choose uplink duty cycle. Detailed downlink and uplink definition are described below.

Note: For prototype device, Semtech's default NwkSKey, AppSKey and AppKey are used, so that user could connect device to Semtech IoT server easily.
Default NwkSKey: 0x2B, 0x7E, 0x15, 0x16, 0x28, 0xAE, 0xD2, 0xA6, 0xAB, 0xF7, 0x15, 0x88, 0x09, 0xCF, 0x4F, 0x3C
Default APPSKey: 0x2B, 0x7E, 0x15, 0x16, 0x28, 0xAE, 0xD2, 0xA6, 0xAB, 0xF7, 0x15, 0x88, 0x09, 0xCF, 0x4F, 0x3C
Default APPKey: 0x2B, 0x7E, 0x15, 0x16, 0x28, 0xAE, 0xD2, 0xA6, 0xAB, 0xF7, 0x15, 0x88, 0x09, 0xCF, 0x4F, 0x3C

3.2 Uplink

Table 4 Payload Format

Bytes	1	2	1	2	1	1	1
Item	Header	Temperature	Humidity	Period	RSSI	SNR	Battery

For example, get payload 01 6c 68 9d 39 30 90 29 C8, then extract payload information like below.

Header: 01
Temperature: 6c 68
Humidity: 9d
Period: 39 30
RSSI: 90
SNR: 29
Battery: C8

3.2.1 Header

D7: Toggle when receive a downlink.

D6: Current status. When door sensor status changed, this bit would be changed also and trigger a transmit.

D5~D2: Reserved.

D1~D0: Header type, 1: normal, others: reserved.

3.2.2 Temperature

Get payload `6c 68`(little endian), convert to HEX format 0x686c, it is 26732 in decimal. Use formula below to calculate.

$$T = \frac{175.72 * t}{2^{16}} - 46.85\,℃$$

t=26732 (0x686C), then T=24.8℃.

3.2.3 Humidity

Get payload `9d`, convert to HEX format 0x9d, it is 157 in decimal. Use formula below to calculate.

$$RH = (\frac{125 * rh}{2^{8}} - 6)\%$$

rh=157 (0x9d), then RH=71%

==*Note: The Humidity would be reserved in future product if no need in future.*==

3.2.4 Period

Get payload `30 00`(little endian), convert to HEX format 0x0030, it is 48 in decimal, the unit is 2s. So the period is 96s.

==*Note: LoRaWAN is an Aloha protocol, the real transmitting period will have a random offset each time, random offset default value -10 ~ 10s, read device configuration through RCFG tool to know the exact value.*==

$$PERIOD = (period * 2)s$$

3.2.5 RSSI & SNR

RSSI and SNR of last received payload, 0xFF means RHF1Sxxx never gets downlink and RSSI/SNR is unknown, server could use this information to estimate downlink link budget.

Formula:

$$RSSI = -180 + rssi\text{ dBm}$$

$$SNR = \frac{snr[2's\ complement]}{4}$$

From the example:

RSSI is 0x90, SNR is 0x29. RSSI = -180+144 = -36dBm; SNR = 41/4 = 10.25dB

==*Note: SNR is a signed value, if D7 is 1, then SNR is negative. eg: snr = 0xFE = -2; SNR = -0.5dB*==

3.2.6 Battery level

Battery voltage level unit is 0.01V. Get payload `c8`, covert to decimal 200.

In prototype, no battery is used. So the voltage level would be always same which is the level of regulator output.

$$\text{BAT} = (\text{bat} + 150) * 0.01\ V$$

`c8` means battery level is 3.5V

Note: Battery percentage value is to be defined.

3.3 Downlink

3.3.1 Change Duty Cycle

Format:

```
      PORT:  8
    Length:  2 bytes
```

RHF1Sxxx supports server to change the uplink period. Server can send a 2 bytes payload through port 8 to change the uplink duty cycle, new period will be updated with next payload after changed. The downlink must only contain 2 bytes, and with format described in **3.2.4 Period**.

3.4 Parameters configuration

With RisingHF tool **RCFG.exe**, customer could configure some parameters like frequency channel, LoRaWAN mode, key and so on. Please refer to "[RHF-AN01519]RCFG Tool Usage" for more details.

Below is an example of .json file will be used in the configuration operation. All the parameters list below could be re-configured.

```
{
    // ABP, OTAA, abp, otaa
    "mode": "ABP",

    // final_period = period ± period_offset
    // Transmit period, unit: s
    "period": 5,
    // Transmit period random offset, unit: s
    "period_offset": 0,

    // EU868, US915, RHF01
    "datarate_scheme": "EU868",

    "id":{
        "devaddr":"11 22 33 44",
        "deveui" :"0x86, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x02",
        "appeui" :"0x86, 0x73, 0x65, 0x6D, 0x74, 0x65, 0x63, 0x68"
    },

    /* nwkskey, appskey, appkey */
    "key":{
        "nwkskey":"2B 7E 15 16 28 AE D2 A6 AB F7 15 88 09 CF 4F 3c",
        "appskey":"2B 7E 15 16 28 AE D2 A6 AB F7 15 88 09 CF 4F 3C",
        "appkey" :"86 00 00 00 00 00 00 00 86 00 00 00 00 00 00 00"
    },
```

```
"rxwin2":{
    "freq":869.525000,
    "dr": 3
},

// adaptive datarate option, true: enable, false: disable
"adr":true,


"dr":  0,                 // start datarate DR0~DR15
"power": 14,              // dBm
"rept": 1,                // unconfirmed message repetition
"retry": 3,               // confirmed message retry
"port": 8,                // port
"class": "A",             // Class A, C. B is not supported.

/* Oder of the sections decides  */
"channels":[
    {
        "freq": 868.1,
        "dr_min": 0,
        "dr_max": 5
    },
    {
        "freq": 868.3,
        "dr_min": 0,
        "dr_max": 5
    },
    {
        "freq": 868.5,
        "dr_min": 0,
        "dr_max": 5
    },
    {
        "freq": 868.7,
        "dr_min": 0,
        "dr_max": 5
    },
    {
        "freq": 867.3,
        "dr_min": 0,
        "dr_max": 5
    },
    {
        "freq": 867.5,
        "dr_min": 0,
        "dr_max": 5
    },
    {
        "freq": 867.7,
        "dr_min": 0,
```

```
                "dr_max": 5
        },
        {

                "freq": 867.9,
                "dr_min": 0,
                "dr_max": 5
        }
    ]
}
```

4 Mechanical structure and Assembly

4.1 Mechanical size of RHF1S001

Figure 2 below show the outline size of the RHF1S001 TH sensor.

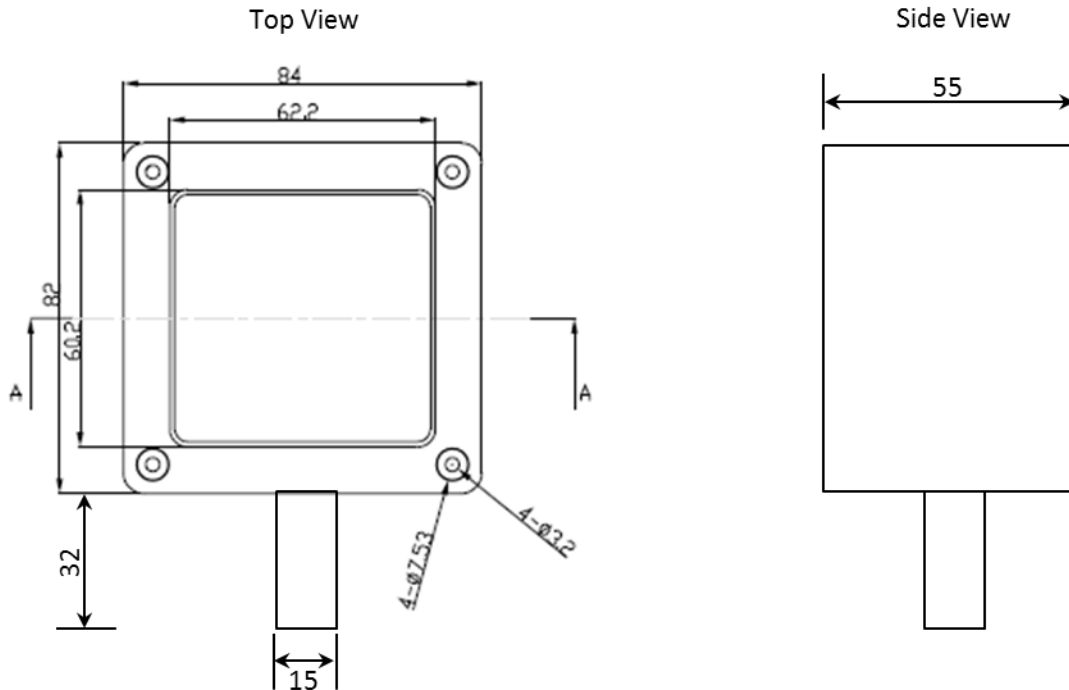Top View   Side View

Figure 2 Mechanical size of the RHF1S001

4.2 Battery installation

A D size battery holder is inside the RHF1S001. Just insert the 3.6V battery to the holder, the RHF1S001 would start work with a default cycle. Please follow step below when install a new battery.

Step1: Remove the cover.

Step2: Install the battery.

Step3: Reset the device.

Step4: Close and fix the cover again.

Note: Don't inverse the polarity of the battery when insert the holder!!!

4.3 RHF1S001 fixture outdoor

On the back of the enclosure, there are 4 screw mounting holes which are isolated from inside of the device. With this delicate design, the RHF1S001 could work in IP64 condition. Customer can use these

4 screw mounting holes for outdoor fixture. Refer to Figure 3 below for the detailed information of the screw mounting holes.
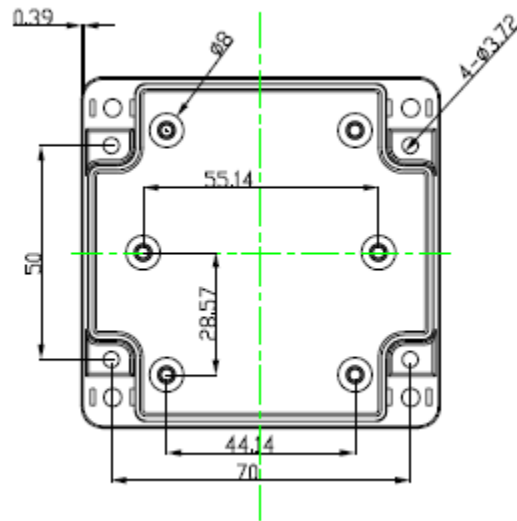
Figure 3 Screw mounting holes for outdoor fixture

5 Battery information

Lithium/thionyl chloride battery with PN ER34615 is used in RHF1S001 TH sensor node, which could operate in -55 to +85℃. Table below is key features of this battery.

Table 5 Battery information

Item	Value
Part No	ER34615
Voltage Range	2.0 to 3.7 V
Nominal Voltage	3.6 V
Capacity	19000 mAh
Max. Discharge	200mA
Pulse Capability	up to 400mA
Operating Temp	-55° C to 85° C
Safety	Material Safety Datasheet – MSDS
Transportation	Class 9

Revision

V1.4 2016-01-22
+ update data format

V1.2 2015-12-08
+ Sync to new firmware with configuration function

V1.1 2015-10-10
+ Fix application information

V1.0 2015-08-21
+ Documents Creation

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