DS01920-3

Home Health Sensor RHF1S020HHS specification

Version 1.5

Document information

Info	Content
Keywords	*RHF1S020HHS, specification, Temperature, humidity, air quality*
Abstract	This doc describe the specification of Home Health Sensor RHF1S020HHS

Content

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1 General description

RisingHF RHF1S020 Series sensors are designed for indoor intelligent building and Healthy Home applications, it features excellent wireless coverage with LoRa technology, easy to deploy. This documentation describe the detail specification of Home Health Sensor.

PIR Motion Sensor RHF1S020PMS includes a pyro-electric Elements based passive infrared detector and a matched Fresnel lens, The ideal using case is to place the sensor in a room to detect if there is person motion or not.
The sensor includes a pyro-electric Elements which can measure human movement and transmit any changes to a LoRaWAN network.

Home Health Sensor device includes a Temperature Humidity sensor and a Volatile Organic Compound sensor. The VOC sensor requires the first sensor Temperature Humidity to compensate for its operating conditions. The ideal using case is to place the sensor in a room to detect temperature, humidity and if the air quality is in good range.
The sensor measure the Temperature Humidity,CO_2 and Volatile Organic Compound data, transmit to a LoRaWAN network.

2 Specification

2.1 Mechanical

Sensor part:

Dimension	50mm x 20mm x 50mm
Weight	40g with battery 30g without battery

2.2 Environmental

Temperature	-20~70℃
IP Rating	IP 40
Power supply	3.6V ½ AA Li-SOCl2, 1200mAh
Power consumption	120mA maximum, 33uA minimum
Battery life*	Typical 1 years

Note: * Typical using case: 20 data reports every day.

2.3 RF specification

Frequency	470MHz~930MHz Range Support global LoRaWAN frequency band

TX Power	Maximum 19dBm conduction
RX sensitivity	-140dBm
Antenna Gain	Peak -2dBi@868/915MHz, -4dBi @470MHz

2.4 User interface

LEDs	Red-Blue Bi-Color LED
Sensor	Temperature Humidity sensor Volatile Organic Compound sensor

2.5 Sensor specification

2.5.1 Temperature Humidity sensor

Temperature range	-20~70℃
Temperature resolution	0.015℃
Temperature tolerance	±0.3℃ (0 to 65°C) ±0.5℃ (-20 to 70°C)
Temperature response time	2s
Humidity range	0 ~ 100 %RH
Humidity resolution	0.01 %RH
Humidity tolerance	±3 %RH (10 to 90 %RH) ±4 %RH (0 to 100 %RH)
Humidity response time	4s

2.5.2 Air quality sensor

Air quality sensor will measure the Volatile Organic Compound in the air with its sensor inside, and then calculate the relative CO2 and VOC concentration, this data is based on the change against the background , so the value maybe different according to the background air condition when it is starting up.

The table below shows the common air quality Class, and default threshold setting in RHF1S020HHS.

Air Quality	VOC Level	CO2 Concentration	harm to human body
Bad	High	>2500ppm	Exposure under this condition over a long period of time, may cause cancer, lungs, liver, kidney, central nervous system harm. Irritation on eyes, noses and throat, headache, nauseated,

			giddiness. Impair ability of act and thinking
Moderate	Middle	1500-2500ppm	Irritation on eyes, noses and throat, headache, nauseated, giddiness. Feel tired and difficult to concentrate
Good	Low	<1500ppm	Feel comfortable

2.6 Operation mode

1) Periodic reporting mode:

This mode will report the measuring data according to the configured period (default 1 hour, configurable), including temperature, humidity, CO2, VOC concentration.

2) threshold Alarm mode:

This mode will detect the measuring data according to the configured period (default 3 hour, configurable), including temperature, humidity, CO2, VOC concentration to determine if they are out of the range of threshold, and will report an alarm if threshold exceeded.

2.7 Certifications and Conformity

CE/FCC, ROHS compliant.

2.8 Device ID

Each device will have a unique identifier DEVEUI，which is the identity to Join LoRaWAN network and as a device recognition.

This DEVEUI ID information will be shown as a QR Code on the product cover. Picture below is an example：8CF957E000000002

HEALTHY HOME
8CF957E000000002
MODEL:RHF1S020HHS
1919-470

2.9 Additional features

Battery capacity report to Network server.
Device status Local LED indications.
Device fault alert report to Network server.
Rapid change on temperature (1℃/min) and Humidity(10%RH/min) will trigger an uplink report.

2.10 Installation

3M adhesive pad, there are two adhesive pads packaged with the device, user can have different installation method according to the requirement.
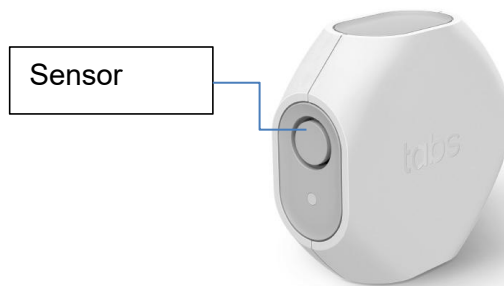
1) Side-mount installation
Use the smaller 3M adhesive pad (12x20mm), put the adhesive pad on the side panel and paste against wall.

2）Bottom-mount installation
Use the larger 3M adhesive pad (25x25mm), put the adhesive pad on the bottom cover of device and paste against wall.

3 User Operations

3.1 Transport Mode

Devices are shipped with a plastic battery isolation tab, when start to use, this tab must be removed to power up, Please directly pull out to remove it.

3.2 Device work flow diagram

This device will work as the diagram below.
RHF1S020 sensors will need a LoRaWAN gateway support to connect with Network server.
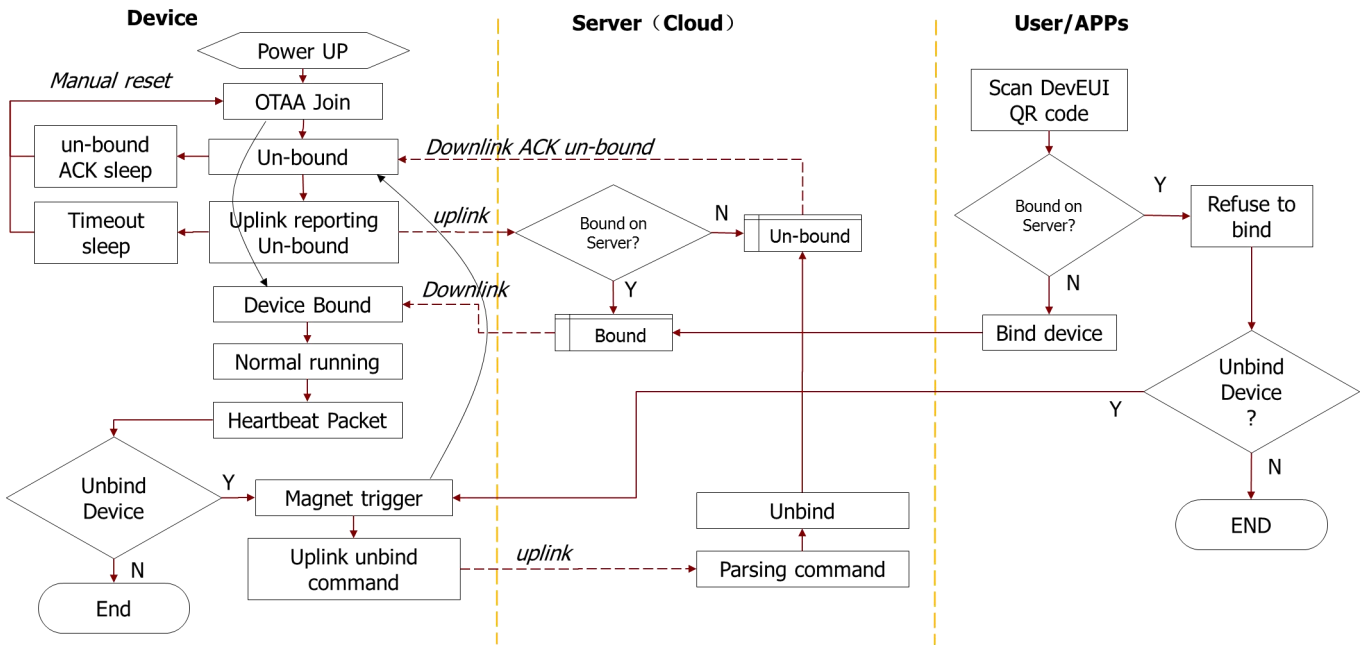
```
        Device                          Server（Cloud）              User/APPs

         Power UP                                              Scan DevEUI
Manual reset                                                    QR code
         OTAA Join
                          Downlink ACK un-bound
un-bound     Un-bound  ◄- - - - - - - - - - - - - - -                  │
ACK sleep                                                            Y
                            uplink                          Bound on ──────► Refuse to
Timeout   Uplink reporting - - - ►  Bound on   ──N──► Un-bound  Server?          bind
 sleep     Un-bound                 Server?                         │
                            Downlink              Y                 N
         Device Bound  ◄- - - - -              Bound  ◄─────── Bind device
                                                                              Unbind
         Normal running                                                       Device
                                                                                ?
         Heartbeat Packet                                          Y
                                                                                N
 Unbind      Y                              Unbind
 Device ──────► Magnet trigger ◄────────────                              END
                            uplink
    N      Uplink unbind  - - - ► Parsing command
         command
   End
```

Note: Device bound status means this device has host owner. User scan the DevEUI QR code on server or APPs will become the host owner, called Bind process. On the contrary, User magnet trigger unbind process, Device will switch bound status to un-bound status.

3.3 Device Power UP

When device power up, the voltage above 2.8v, the device will Join network automatically, and then Judge the bound status, run as the work flow diagram above.
Anytime if the voltage is below 2.7v, the device will switch to sleep until voltage return above 2.8v.

3.4 Device bound

Suggest Bind the device on Server or APPs before power up the device.
After powered up, device will Join LoRaWAN network and confirm the bound status with Server, and switch status to bound status after that, Device will work on default operation mode.

3.5 Device unbound

If device unbound, power up device will make it uplink report the unbound status to Server several times (every 20seconds) until 3 minutes timeout. Meanwhile the Red LED and Blue LED will blink alternately, User also can bind device on server or APPs during this time.

If device receive bound ACK from server during this 3 minutes, it will switch status to bound status and work on default operation mode.

If device have not received bound ACK during this 3 minutes and timeout, Device will go into sleep mode to save power.

When going into sleep mode, it can be activated by manually reset process.

3.6 Default operation mode

When device first time powered up, it work on Periodic reporting mode by default. In this mode, it will report the measuring data according to the configured period (default 1 hour, configurable), including temperature, humidity, CO2, VOC concentration, and also including the battery capacity.

Every 1 hour period, device will also check if the voltage and battery capacity is lower than the configured alert threshold, if yes than the alert LoRaWAN message will be reported to server, remind user to replace battery.

Besides, device will self-checking the sensor working status and network connecting status every 24 hours, if any abnormality happened, there will be alert message uplink. And corresponding local LED indication will shows.

User can switch the device operation mode by downlink from Server or Apps, Please refer to Chapter 5 for more detail downlink message command.

3.6.1 Periodic reporting mode

This is the default operation mode.

3.6.2 Threshold Alarm mode

This mode will detect the measuring data according to the configured period (default 3 hour, configurable), including temperature, humidity, CO2, VOC concentration to determine if they are out of the range of threshold, and will report an alarm if threshold exceeded.

Every 3 hours period, device will uplink report one heartbeat message to server, to report the temperature, humidity, CO2, VOC concentration measuring data, and also including the battery capacity.

Every 1 hour period, device will also check if the voltage and battery capacity is lower than the configured alert threshold, if yes than the alert LoRaWAN message will be reported to server, remind user to replace battery.

Besides, device will self-checking the sensor working status and network connecting status every 24 hours, if any abnormality happened, there will be alert message uplink. And corresponding local LED indication will shows.

3.7 Field installation mode

Anytime user want to know the LoRa signal strength or if the installation position is good, field installation mode will help.

Field installation mode will exit automatically after process is completed.

In field installation mode, RHF1S020 device will communicate with network server (the Red and Blue LED will blink alternatively) and Give the LED indication to show the LoRa signal strength at the end.

1) Blue LED on for 10s: Signal Strong
2) Blue/Red Dual LED on for 10s: Signal Good
3) Red LED on for 10s: Signal Weak

If RHF1S020 Device is not joined in LoRa network, then it will failed to enter field installation mode, it will try to join network automatically.

Please following the steps below to enter field installation mode.

Approach a Magnet in the position(Behind the CE mark) and direction as the picture, then observe the Red LED indication status change, the LED will blink slowly firstly for about 5s, then blink more fast, any time when the LED blink fast observed (about 6s), release the magnet, then the device will enter into field installation mode, meanwhile red/blue LED blink alternatively.

Note: LED status definition is detailed in the table of ANNEX.

3.8 OTA Firmware upgrade

Note: Don't execute Firmware upgrade unless special in need!

If you confirm firmware upgrade needed, Please use magnet trigger to enter OTA firmware upgrade. Approach a Magnet in the position(Behind the CE mark) and direction as the picture, then observe the Red LED indication status change, the LED will blink slowly firstly (for about 5s) →then blink more fast (for about 5s)→then the Red LED will be keep light on, any time when the Red LED status change to always light on , release the magnet, then the device will enter into OTA firmware upgrade, meanwhile the blue LED will blink fast.

Note: LED status definition is detailed in the table of ANNEX.

OTA firmware upgrade will need special tools and software, please refer to user manual *[RHF-UM11999] end device OTA firmware upgrade User manual for detail.*

Please contact RisingHF sales for the OTA tools and software.

If there is no any operation after device enter into OTA firmware upgrade for 10 seconds, then device will soft reset automatically.

3.9 Unbind device

NOTE: Don't execute Unbind process unless special in need!

The unbind process will remove the owner relationship, this is used to transfer the device to another owner, when trigger unbind process, device will uplink the unbind request to server, then device *will switch bound status to un-bound status*. And this will allow new owner bind this device, User scan the DevEUI QR code on server or APPs will become the new host owner.

The Unbind process is triggered by magnet operation.

Approach a Magnet in the position(Behind the CE mark) and direction as the picture, then observe the LED indication status change, the red LED will blink slowly firstly (for about 5s) →then red LED blink more fast (for about 5s)→then the Red LED will be keep light on (for about 5s)→then Red and Blue LED will be Both keep light on, any time when the Red and Blue LED Both keep light on, release the magnet, then the device will uplink the unbind request to server and change to unbound status, device behavior refer to chapter 33.5.

Note: LED status definition is detailed in the table of ANNEX.

After unbind process, other user can bind the device and become the new owner, Manually Reset the device will make it work normally again.

3.10 Manually Reset

Anytime user want to reset the device, the following process is applicable, please let the device enter into OTA firmware upgrade using a magnet as shown in chapter OTA Firmware upgrade, with no any operation after device enter into OTA firmware upgrade for 10 seconds, then device will soft reset automatically.

3.11 Replace battery

The device is powered by a 3.6V ½ AA Li-SOCl2 battery, when low battery capacity is alerted, please replace the battery.

when low battery capacity is alerted, device may also work for some period of time, but some packet loss may happened, suggest replace new battery in time, just open the top cover, and replace new battery, please pay attention to the "+" and "-" battery polarity marking.

But if device lose LoRaWAN connection or Sensor malfunction because of low battery, please manually reset the device after replace the new batter, please refer to chapter Manually Reset.

4 Attention and Safety

For safety, please read the items below carefully before use RHF1S020 series sensor.

⚠ Don't use the sensors under extremely high temperature and low temperature, it may cause device work abnormal, or short battery life time.

⚠ the devices contain magnet，please keep them out of the reach of kids, Swallow magnet may cause serious injury or dead, please seek for Medical help immediately if accident happened.

⚠ Device contains Small part, don't give them to kids or pets as toy

⚠ Avoid direct sunlight on device

⚠ When using batteries, please following the instructions, don't let batteries Positive and negative pole in short or transposition.
Please keep the device away from fire

⚠ When storing batteries, keep away from the metalwork in the container to avoid batteries in short

⚠ Battery is non-rechargeable, don't charge the battery

⚠ In case of battery leakage, please prevent eyes and Skin to contact the liquid, please rinse with plenty of water and seek medical advice in time if accident happens

⚠ Pay attention to prevent explosion or fire:
- Do not drop, disassemble, open, crush, bend, deform, puncture, shred, microwave, incinerate or water the hardware
- Do not insert foreign objects into any opening on the sensors
- Do not Disassemble, puncture or heat the battery

5 Message

RHF1S020 is a series sensors adapting RisingHF defined LAP protocol base on LoRaWAN network, it features rich function and device management control.

Here Uplink means the message route from Sensor devices to Server.

Downlink means the message route from Server to sensor devices.

This chapter describe the supported uplink and downlink message of RHF1S020PMS.

5.1 Agreement

➢ The protocol stipulates that the multi-byte field in the data field is transmitted in **little-endian** mode. When parsing, it needs to be converted to **big-endian** mode and then compared with byte / bit parsing.

➢ The data frame format is "CMD + VAL 0 +...+ VALn"
   - ◼ CMD:Command
   - ◼ VALx:Data carried by the command

➢ There are three combinations of data frames:
   - ◼ Contains one or more fixed-length commands
   - ◼ Contains only one variable length command
   - ◼ Contains one or more fixed-length commands, and can attach a variable-length command to the end of the frame

5.2 Uplink message

5.2.1 Bound status(0xA1)

LoRaWAN port: 8

Payload length: 2 Bytes

Byte	0	1
Payload	USIGNAL	BoundSTA

The detail payload:

USIGNAL	Command (User Signal)	
	0xA1	
BoundSTA	Bound status (Device Bound status)	
	Bits[7:0]	Unsigned 0-preserved 1-unbind process 2-unbound status 3-bound status 4-255-preserve

Message example,

1) In unbound status, sensor device will uplink A102（Hex format） message to Server every 20seconds，maximal 9 repeated uplinks. In the meantime, device waiting to receive the downlink bound status message (A103) from server.
2) Once received a Downlink A103 message from server, sensor device will return an uplink message A103 to show that it changed to bound status
3) If user use a magnet to trigger a unbind process, Sensor device will uplink A101 message to server to inform that the device is changed to unbound status， device will then jump to Step 1 above.

Note: Device bound status means this device has host owner. User scan the DevEUI QR code on server or APPs will become the host owner, called Bind process. On the contrary, User magnet trigger unbind process, Device will switch bound status to un-bound status.

5.2.2 Device Parameter(0X07)

LoRaWAN port: 8
Payload length: 26 Bytes

Byte	0	1	2	3	4-6	7	8-9	10	11-18	19	20-25
Payload	DPARAM	MODE	DATA	VER	DATA	ULPRD	DATA	DINFO	DATA	PPAT	DATA

Note：It will uplink one massage of this Device Parameter only after bind process completed，this is aimed to identify the device and synchronize the device parameter with Server.

Message example：

07 05 00 90 00 08 04 9D 10 0E 9F 13 26 31 53 30 32 30 10 02 05 10 11 16 17 95（HEX format）

Here：

07 → Device parameter command 07

05 00 → 05 represent working mode, its content data is 00, i.e. Periodic reporting mode

90 000804 → 90 represent hardware and firmware version, its content data is 000804（little-endian），i.e. LAP protocol v0, Hardware v1.0, firmware v0.8.0

9D 10 0E → 9D represent uplink period, its content data is 100E (little-endian), convert to 3600 second, means 1 hour

9F 1326315330323010 → 9F represent device information,its content data is 1326315330323010,1326 means year 2019 week 38, 3153303230 is ASCII means the product series is "1S020"，10 means HHS, frequency band CN470

02 051011161795 → 02 represent the correlative command code list of compressed data frame message headed by 0x00，its content data is 051011161795，means the message headed by 0x00 will include working mode (0x05), temperature(0x10), humidity(0x11), CO2(0x16), VOC(0x17), battery capacity(0x95)

5.2.3 Compressed data frame message CFRM(0x00)

The data content format and length is defined by chapter 5.2.2 by correlative command code list. Including working mode (0x05), temperature (0x10), humidity (0x11), CO2 (0x16), VOC (0x17), and battery capacity (0x95).

LoRaWAN port: 8

Payload length: 10 Bytes

Byte	0	1	2	3	4	5	6	7	8	9
Payload	CFRM	MODE	TEMP		HUM	CO2		VOC		BAT

The detail payload:

CFRM	（Compressed Frame）	
	0x00	
MODE	（Mode）	
	Bits[7:4]	Preserve
	Bits[3:0]	0- Periodic reporting mode 1- threshold Alarm mode 2- intrusion Alarm mode （PIR Motion sensor） 3- Room occupation mode （PIR Motion sensor） 4- Door window open alert mode （Door&Window） 5- Door window close alert mode （Door&Window） 6- Door window open & close monitoring mode （Door&Window） 7-15-preserve
TEMP	（Temperature）, little-endian	
	Bit[15:0]	temperature, unit 0.01℃
HUM	（Humidity）	
	Bit[7:0]	humidity, unit 0.5%
CO2	（CO2）, little-endian	
	Bit[15:0]	CO2, unit 1ppm
VOC	（VOC） , little-endian	
	Bit[15:0]	eVOC, unit 1ppb
BAT	（Battery capacity）	
	Bit[7:0]	Defined value, to indicate the battery capacity, 0 means power supply, 0xFF means unknow,battery capacity =（Defined value -1)/253, unit is 1%

Message example：

00 00 D3 0A 6B 90 01 00 00 FE

Here：

00 → 00 represent Compressed data Frame command

00 → it is working mode data 00（Periodic reporting mode）

D30A → Temperature, little-endian, value 27.71℃

6B → Humidity， value 53.5%RH

90 01→CO2, little-endian, value 400ppm

00 00→VOC, little-endian, value 0ppb

FE → battery capacity，100%

5.2.4 Device Error(0x0C)

LoRaWAN port: 8

Payload length: 2 Bytes

Byte	0	1
Payload	ERROR	ERROR CODE

The detail payload:

ERROR	(Error)	
	0x0C	
ERROR CODE	(Error Code)	
	Bit[7:0]	0xFE-Device Low voltage 0xFF-Sensor fault

Message example：

0CFE → Device Low voltage Error

0CFF → Sensor fault Error

5.2.5 Alert(0x0F)

The Alert message includes battery voltage, battery capacity alert(it will be generated in modes 0/1); Temperature, humidity, CO2 concentration，eVOC concentration alert(it will be generated in modes 1).

LoRaWAN port: 8

Payload length: 5-242 Bytes

Byte	0	1	2	3	valuable
Payload	ALERT	CMD	TYPE	CMD	VAL

The detail payload:

ALERT	(Alert)	
	0x0F	
CMD	(Alert CMD)	
	Bit[7:0]	0x10-temperature 0x11-humidity 0x16-CO2 0x17-VOC 0x91-battery voltage 0x95-battery capacity
TYPE	(Type)	
	Bit[7:0]	0-above threshold 1-below threshold 2-open alert 3-open overtime alert

		4-close alert 5-close overtime alert 6- intrusion alert 7-255-preserve	
CMD	(Alert CMD)		
	Bit[7:0]	0x10-temperature 0x11-humidity 0x16-CO2 0x17-VOC 0x91-battery voltage 0x95-battery capacity	
VAL	(Value)(Corresponds to the Alert CMD.If Alert CMD is Temperature, the Value is the following Temperature)		
	Temperature, little-endian	Bit[15:0]	temperature, unit 0.01℃
	humidity	Bit[7:0]	humidity, unit 0.5%
	CO2, little-endian	Bit[15:0]	CO2, unit 1ppm
	VOC, little-endian	Bit[15:0]	eVOC, unit 1ppb
	Battery voltage, (little-endian)	Bit[15:14]	Power supply type 0-battery supply 1-DC input 2-AC input 3-preserve
		Bit[13:12]	Voltage unit 0-0.01V 1-0.1V 2-1V 3-preserve
		Bit[11:0]	Battery voltage value
	Battery capacity	Bit[7:0]	Defined value, to indicate the battery capacity, 0 means power supply, 0xFF means unknow,battery capacity =(Defined value - 1)/253, unit is 1%

Message example：

0F 91 01 91 18 01 →battery voltage below threshold，voltage 2.8v

0F 95 01 95 10 →battery capacity below threshold，capacity 5.9%

0F 10 00 10 64 19→Alert，Temperature above threshold, temperature value 65℃

5.2.6 Sub-Pack(0x06)

When the current uplink data frame length exceeds the maximum at the current rate of the current frequency plan, the data frame will be sub-packed and uplinked. When this uplink occurs, it is necessary to wait for all sub-packet receptions to be completed before combining for analysis.

LoRaWAN port: 8
Payload length: Variable

Byte	0	1	2	3	4	5	N
Payload	SUBPACK	PACKETNUMBER	DATA	...	...	...	DATA

The detail payload:

SUBPACK	Sub-Pack	
	0x06	
PACKETNUMBER	Packet Number	
	Bit[7:0]	0x00-0xFF,0xFF means finally data pack
DATA	DATA	
...	DATA	
DATA	DATA	

5.2.7 Version Information(0x90)

Version Information is used to get LAP Protocol version, Hardware version and Firmware version.

LoRaWAN port: 8
Payload length: 4 Bytes

Byte	0	1	2	3
Payload	VER	DATA		

The detail payload:

VER	Version	
	0x90	
DATA	Version Information, little-endian	
	Bit[23:21]	LAP Protocol version 0-7
	Bit[20:18]	Hardware major version 0-7
	Bit[17:16]	Hardware minor version 0-3
	Bit[15:12]	Firmware major version 0-15
	Bit[11:8]	Firmware minor version 0-15
	Bit[7:0]	Firmware patch version 0-255

5.2.8 Device Information(0x9F)

Device Information is uesd to get year of manufacture, week of manufacture, device series, device type and device band.

LoRaWAN port: 8
Payload length: 9 Bytes

Byte	0	1	2	3	4	5	6	7	8
Payload	DINFO	YY	WW	PN0	PN1	PN2	PN3	PN4	SUBPN

The detail payload:

DINFO	Device Information	
	0x9F	
YY	Year of manufacture	
	Bit[7:0]	Hex
WW	Week of manufacture	
	Bit[7:0]	Hex
	Device series	
PN0	Bit[7:0]	ASCII
PN1	Bit[7:0]	ASCII
PN2	Bit[7:0]	ASCII
PN3	Bit[7:0]	ASCII
PN4	Bit[7:0]	ASCII
SUBPN	Device SubPN	
	Bit[7:0]	Hex, means device type and band,For details, please refer to **Appendix 2**

5.2.9 ACK Error(0x0D)

When the device receives a downlink command, but the command processing error (parameter error / setting error), this command will be uplinked.

LoRaWAN port: 8
Payload length: 2 Bytes

Byte	0	1
Payload	ACKERR	CMD

The detail payload:

ACKERR	ACK error	
	0x0D	
CMD	Command	
	Bit[7:0]	Hex

5.2.10 ACK OK(0x0E)

When the device receives a downlink command and the command is successfully processed, this command will be uplinked.

LoRaWAN port: 8
Payload length: 2 Bytes

Byte	0	1
Payload	ACKOK	CMD

The detail payload:

ACKOK	ACK OK	
	0x0E	
CMD	Command	
	Bit[7:0]	Hex

5.3 Downlink Message

5.3.1 Get device used CMD list(0x01)

LoRaWAN port: 8
Payload length: 1 Byte

Byte	0
Payload	GCMD

Payload detail:

GCMD	(Get Command)
	0x01

5.3.2 Set CFRM correlative command code list(0x03)

LoRaWAN port: 8
Payload length: 2-242 Bytes

Byte	0	1	2	3	4	5	...
Payload	SPAT	CMD	CMD	CMD	CMD	CMD	CMD

Available CMD：

CMD TYPE	MODE	TEMP	HUM	CO2	VOC	VER	PS	RTC
CMD CODE	0x05	0x10	0x11	0x16	0x17	0x90	0x91	0x94
CMD TYPE	BAT	TIME	DELAY	ULPRD	DLSQ	DINFO	SW	
CMD CODE	0x95	0x96	0x9C	0x9D	0x9E	0x9F	0x20	

Payload detail:

SPAT	(Set CMD Pattern)
	0x03

CMD	CMD CODE
CMD	CMD CODE
....	CMD CODE

5.3.3 Get CFRM correlative command code list(0x02)

LoRaWAN port: 8

Payload length: 1 Byte

Byte	0
Payload	GPAT

Payload detail:

GPAT	(Get CMD Pattern)
	0x02

5.3.4 Inquiry(0x04)

LoRaWAN port: 8

Payload length: 2-242 Bytes

Byte	0	1	2	3	4	5	6	7	...
Payload	QUERY	CMD	CMD	CMD	CMD	CMD	CMD	CMD	CMD

Available CMD：

CMD TYPE	MODE	TEMP	HUM	CO2	VOC	VER	PS	RTC
CMD CODE	0x05	0x10	0x11	0x16	0x17	0x90	0x91	0x94
CMD TYPE	BAT	TIME	DELAY	ULPRD	DLSQ	DINFO	SW	
CMD CODE	0x95	0x96	0x9C	0x9D	0x9E	0x9F	0x20	

Payload detail:

QUERY	Query
	0x04
CMD	CMD CODE
CMD	CMD CODE
....	CMD CODE

e.g:0405909F

Means that inquiry Working mode(0x05),Version Information(0x90),Device Information(0x9F)

5.3.5 Set working mode(0x05)

LoRaWAN port: 8

Payload length: 2Bytes

Byte	0	1
Payload	SMODE	MODE

Payload detail:

SMODE	(Set Mode)
	0x05
MODE	(Mode)

Bit[7:4]	preserve
Bit[3:0]	0- Periodic reporting mode 1- threshold Alarm mode 2- intrusion Alarm mode (PIR Motion sensor) 3- Room occupation mode (PIR Motion sensor) 4- Door window open alert mode (Door&Window) 5- Door window close alert mode (Door&Window) 6- Door window open & close monitoring mode (Door&Window) 7-15-preserve

5.3.6 Disable alert(0x0F)

LoRaWAN port: 8

Payload length: 3Bytes

Byte	0	1	2
Payload	SALERT	CMD	INTERVAL

Payload detail:

SALERT	(Set Alert Parameter)	
	0x0F	
CMD	(Alert CMD)	
	Bit[7:0]	0x10-temperature 0x11-humidity 0x16-CO2 0x17-VOC 0x91-battery voltage 0x95-battery capacity
INTERVAL	Bit[7:0]	Disable duration time unit:10min

5.3.7 Set temperature control parameter(0x10)

LoRaWAN port: 8

Payload length: 6 Bytes

Byte	0	1	2	3	4	5
Payload	STEMP	CTRL	DATA			

Payload detail:

STEMP	(Set TEMP Control Parameter)	
	0x10	
CTRL	Bit[7:4]	preserve
	Bit[3:0]	0-Disable alert 1-enable alert and set upper limit threshold 2-enable alert and set lower limit threshold 3-enable alert and set both upper/lower limit

	threshold 4-6-preserve 7-calibration		
	Calibration value	Bit[15:0]	Calibration value (temperature), unit 0.01℃
		Bit[31:16]	blank
	enable alert and set upper limit threshold	Bit[15:0]	upper limit threshold, unit 0.01℃
		Bit[31:16]	blank
DATA	enable alert and set lower limit threshold	Bit[15:0]	blank
		Bit[31:16]	lower limit threshold, unit 0.01℃
	enable alert and set both upper/lower limit threshold	Bit[15:0]	upper limit threshold, unit 0.01℃
		Bit[31:16]	lower limit threshold, unit 0.01℃
	Disable alert	Bit[31:0]	blank

5.3.8 Set humidity control parameter(0x11)

LoRaWAN port: 8
Payload length: 6 Bytes

Byte	0	1	2	3	4	5
Payload	SHUM	CTRL	DATA			

The detail payload:

SHUM	(Set Humidity Control Parameter)		
	0x11		
CTRL	Bit[7:4]	preserve	
	Bit[3:0]	0-Disable alert 1-enable alert and set upper limit threshold 2-enable alert and set lower limit threshold 3-enable alert and set both upper/lower limit threshold 4-6-preserve 7-calibration	
DATA	Calibration value	Bit[7:0]	Calibration value (humidity)
		Bit[31:8]	blank
	enable alert and set upper limit threshold	Bit[7:0]	upper limit threshold, unit 0.5%
		Bit[31:8]	blank
	enable alert and set lower limit threshold	Bit[7:0]	blank
		Bit[15:8]	lower limit threshold, unit 0.5%
		Bit[31:16]	blank
	enable alert and set both upper/lower limit threshold	Bit[7:0]	upper limit threshold, unit 0.5%
		Bit[15:8]	lower limit threshold, unit 0.5%
		Bit[31:16]	blank
	Disable alert	Bit[31:0]	blank

5.3.9 Set CO2 control parameter(0x16)

LoRaWAN port: 8

Payload length: 6 Bytes

Byte	0	1	2	3	4	5
Payload	SCO2	CTRL	DATA			

Payload detail:

SCO2	(Set CO2 Control Parameter)			
	0x16			
CTRL	Bit[7:4]		Preserve	
	Bit[3:0]		0-Disable alert 1-enable alert and set upper limit threshold 2-enable alert and set lower limit threshold 3-enable alert and set both upper/lower limit threshold 4-6-preserve 7-calibration	
DATA	Calibration value		Bit[15:0]	Value CO2, unit 1ppm
			Bit[31:16]	blank
	enable alert and set upper limit threshold		Bit[15:0]	CO2 upper limit threshold, unit 1ppm
			Bit[31:16]	blank
	enable alert and set lower limit threshold		Bit[15:0]	CO2 lower limit threshold, unit 1ppm
			Bit[31:16]	blank
	enable alert and set both upper/lower limit threshold		Bit[15:0]	CO2 upper limit threshold, unit 1ppm
			Bit[31:16]	CO2 lower limit threshold, unit 1ppm
	Disable alert		Bit[31:0]	blank

5.3.10 Set VOC control parameter(0x17)

LoRaWAN port: 8

Payload length: 6 Bytes

Byte	0	1	2	3	4	5
Payload	SVOC	CTRL	DATA			

The detail payload:

SVOC	(Set VOC Control Parameter)

	0x17			
CTRL	Bit[7:4]	Preserve		
	Bit[3:0]	0-Disable alert 1-enable alert and set upper limit threshold 2-enable alert and set lower limit threshold 3-enable alert and set both upper/lower limit threshold 4-6-preserve 7-calibration		
DATA	Calibration value	Bit[15:0]	Value , unit 1ppb	
		Bit[31:16]	blank	
	enable alert and set upper limit threshold	Bit[15:0]	upper limit threshold, unit 1ppb	
		Bit[31:16]	blank	
	enable alert and set lower limit threshold	Bit[15:0]	lower limit threshold, unit 1ppb	
		Bit[31:16]	blank	
	enable alert and set both upper/lower limit threshold	Bit[15:0]	upper limit threshold, unit 1ppb	
		Bit[31:16]	lower limit threshold, unit 1ppb	
	Disable alert	Bit[31:0]	blank	

5.3.11 Set voltage control parameter(0x91)

LoRaWAN port: 8

Payload length: 4Bytes

Byte	0	1	2	3
Payload	SPS	CTRL	DATA	

Payload detail:

SPS	(Set Power Supply Control Parameter)		
	0x91		
CTRL	Bit[7:0]	0-calibration 1-enable alert and set lower limit threshold 2-Disable alert 3-255-preserve	
DATA	Calibration value	Bit[15:0]	Calibration value（unit 0.01V)
	set alert lower threshold	Bit[15:14]	Power supply type 0-battery supply 1-DC input 2-AC input

	3-preserve	
	Bit[13:12]	Voltage unit 0-0.01V 1-0.1V 2-1V 3-preserve
	Bit[11:0]	Voltage value threshold
Disable alert	Bit[15:0]	Null/blank

5.3.12 Set battery capacity control parameter(0x95)

LoRaWAN port: 8

Payload length: 3Bytes

Byte	0	1	2
Payload	SBAT	CTRL	DATA

Payload detail:

SBAT	(Set Battery Control Parameter)		
	0x95		
CTRL	Bit[7:0]	0-calibration 1-set alert lower threshold 2-Disable alert 3-255-preserve	
DATA	Calibration value	Bit[7:0]	Calibration value（unit 1%）
	set alert lower threshold	Bit[7:0]	Capacity alert lower threshold: Set defined value to transfer to actual value, use formula ((x/100)*253)+1) example：set 50% will be ((50/100)*253)+1)
	Disable alert	Bit[7:0]	Null/blank

5.3.13 Set uplink Periodic reporting time(0x9D)

LoRaWAN port: 8

Payload length: 3Bytes

Byte	0	1	2
Payload	SULPRD	PERIOD	

Payload detail:

SULPRD	(Set Uplink Period)
	0x9D
PERIOD	(Period)

Bit[15:0]	Uplink Period, algorithm: <= 28800: unit 1s (DATA * 1)s <= (28800 + 36735 = 65535): unit 5s ((DATA - 28800) * 5)s

5.3.14 Factory default(0xA0)

LoRaWAN port: 8

Payload length: 1Bytes

Byte	0
Payload	FDEFAULT

Payload detail:

FDEFAULT	(Factory Default)
	0xA0

Because this command will restore the parameters to the default values, you need to go through a handshake to ensure that the information between the server and the device is synchronized.

Transmission direction	Payload
server->device	Donwlink factory default cmd
	0xA0
device->server	Uplink ACK OK
	0x0E 0xA0
server->device	Downlink ACK OK
	0xA0

When the device receives the Downlink ACK OK from the server, it starts to restore the factory settings.

5.3.15 Downlink binding and un-binding message

LoRaWAN port: 8

Payload length: 2Bytes

Byte	0	1
Payload	USIGNAL	SIGNAL

Payload detail:

USIGNAL	Downlink binding and un-binding	
	0xA1	
SIGNAL	(value)	
	Bit[7:0]	0-preserved 1-unbind process (Not applicable in downlink) 2-unbound status 3-bound status 4-255-preserve

6 Annex

6.1 ANNEX 1 RHF1S020 LED indication description

Table 6- 1 LED indication description

Mode	status	Red LED	Blue LED
Normal Application Mode	Device Power ON	Red LED will be on for 1 second	--
	OTAA Join success	--	Blue LED keep on for 3 seconds
	Heartbeat indication every 1 minute, Device is normal	--	Blue LED flicker one time every Heartbeat period
	Heartbeat indication every 1 minute, Network drop/off-line	Red LED will be on for 1 second every Heartbeat period	--
	Heartbeat indication every 1 minute, Sensor fault	Red LED flicker twice every Heartbeat period	--
	Heartbeat indication every 1 minute, Device low voltage	Red LED flicker one time every Heartbeat period	--
	Hall sensor triggered for <5s	Red LED flicker slowly (remove magnet, LED will be off)	--
	5s< Hall sensor triggered for <10s	Red LED flicker fast (remove magnet, device will switch to Field installation mode)	--
	10s< Hall sensor triggered for <15s	Red LED will keep on (remove magnet, device will switch to OTA firmware upgrade)	--
	15s< Hall sensor triggered for <20s	Both Red LED and Blue LED will keep on (remove magnet, device will jump to unbind process and uplink unbind message)	
	20s< Hall sensor triggered for	Hall trigger timeout, LED will be off, invalid action	--
unbound	Uplink unbound status every 20seconds, maximal 9 repeated uplinks	Red LED flicker --> 3s interval --> blue LED flicker -->3s interval, Repeated	
Field installation mode	Processing: (1)Get sensor data (2)Communication with LoRaWan network server (keep current data rate)	Red LED and Blue LED flicker alternately	
	Device not join network	Red LED and Blue LED flicker alternately, then Exit after 2 seconds	
	Sensor fault	Red LED and Blue LED flicker alternately,2 seconds → Red LED flicker twice → Exit Field installation mode	

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Mode	status	Red LED	Blue LED
	Get the signal strengthen results:	NA	NA
	Signal strong	--	Blue LED on for 10s
	Signal good	Both Red LED and Blue LED on 10s	
	Signal weak	Red LED on 10s	--
OTA firmware upgrade	OTA synchronization with Station	--	Blue LED flicker fast
	OTA firmware upgrade processing :	--	Blue LED flicker slowly
	OTA firmware upgrade success	--	Blue LED keep on for 3s
	OTA firmware upgrade Fail	Red LED keep on for 3s → jump to step OTA synchronization with Station to retry →timeout 10s→ jump to " Bootloader Sleep mode "	--
	timeout 10s	Exit OTA firmware upgrade	
Bootloader Sleep mode	Power saving Sleep	--	--
	Activate Bootloader (any time hall sensor triggered)	--	Blue LED flicker fast

6.2 ANNEX 2 RHF1S020 Device SubPN List

Table 6- 2 RHF1S020 Device SubPN List

SUBPN（Decimal）	Device Type	Device Band
1	PMS	CN470
2	PMS	CN470ALID
3	PMS	CN470PREQUEL
4	PMS	EU868
5	PMS	EU433
6	PMS	US915
7	PMS	US915HYBRID
8	PMS	AU915
9	PMS	AS923
10	PMS	KR920
11	PMS	STE920
12	PMS	IN865
13	PMS	Reserve
14	PMS	Reserve

SUBPN（Decimal）	Device Type	Device Band
15	PMS	Reserve
16	HHS	CN470
17	HHS	CN470ALID
18	HHS	CN470PREQUEL
19	HHS	EU868
20	HHS	EU433
21	HHS	US915
22	HHS	US915HYBRID
23	HHS	AU915
24	HHS	AS923
25	HHS	KR920
26	HHS	STE920
27	HHS	IN865
28	HHS	Reserve
29	HHS	Reserve
30	HHS	Reserve
31	DWS	CN470
32	DWS	CN470ALID
33	DWS	CN470PREQUEL
34	DWS	EU868
35	DWS	EU433
36	DWS	US915
37	DWS	US915HYBRID
38	DWS	AU915
39	DWS	AS923
40	DWS	KR920
41	DWS	STE920
42	DWS	IN865
43	DWS	Reserve
44	DWS	Reserve
45	DWS	Reserve

6.3 Annex 3 RHF1S020DWS default parameter list

Table 6-3 RHF1S020HHS default parameter list

Application Mode	parameter	Default value
Default Application mode	Application mode	Mode 0（Periodic reporting mode）

Application Mode	parameter	Default value
Mode 0（Periodic reporting mode）	Voltage threshold	2.8V
	Battery capacity threshold	7%
	command code list of compressed data frame message	mode (0X05), temperature(0X10), humidity(0X11), CO2(0X16), VOC(0X17), battery capacity(0X95)
	LoRaWAN uplink period (heartbeat)	1 hour
	Voltage / battery capacity Threshold check period	1 hour
	Network Online inspection	24 hour
Mode 1（threshold Alarm mode）	Voltage threshold	2.8V
	Battery capacity threshold	7%
	Temperature alert threshold	Upper 32℃；lower 10℃
	Humidity alert threshold	Upper 65%RH； lower 35%RH
	CO2 alert threshold	Upper 1500ppm
	VOC alert threshold	Upper 550ppb
	LoRaWAN uplink period (heartbeat)	3 hours
	Sensor（temperature，humidity，CO2，VOC）Threshold check period	3 hours, equal to LoRaWAN uplink period (heartbeat)
	Voltage / battery capacity Threshold check period	1 hour
	Network Online inspection	24 hour

Revision

V1.5 2020-03-24

      +Modify DevParams(0x07) description

      +Modify Alert(0x0F) description

      +Modify Alert(0x0F) field KIND to CMD

      +Add Message Agreement

      +Add CMD code at the title

      +Add Sub-Pack(0x06) description

      +Add ACKERR(0x0D),ACKOK(0x0E) description

      +Add Version Information(0x90), Device Inforamtion(0x9F) description

      +Add Annex 2 RHF1S020 Device SubPN List

      +Add Magnet Sencing Area Instruction

V1.2 2019-09-05

      + modify battery capacity formula

V1.0 2019-04-27

      + Add installation and Safety attention

      + Add uplink and downlink message

V1.0 2019-03-28

      + Creation

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