

## DS119180

### RHF0M0E5 模块技术规格书

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V1.5

#### Document information

Info	Content
<b>Keywords</b>	RisingHF, LoRaWAN®, 模块, 超小尺寸, AT 指令
<b>Abstract</b>	本文档是 RHF0M0E5 模块技术规格书

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## 1 介绍

RHF0M0E5 是瑞兴恒方网络(深圳)有限公司设计的低成本, 超低功耗, 超小尺寸的 LoRaWAN<sup>®</sup>模组, 模块采用 ST 系统级芯片 STM32WLE5JC, 内部集成高性能 LoRa<sup>®</sup> SX126X IP 和超低功耗 MCU. 该模块的目标应用是无线传感网络和其他物联网设备, 尤其是有电池供电要求低功耗和远距离的场合。

本规格书主要描述模块的硬件信息、硬件性能和应用信息。

RHF0M0E5 LoRaWAN<sup>®</sup>模块主要适用于远距离, 超低功耗的应用, 比如无线抄表, 传感网络和其他低功耗广域物联网场景。



### 1.1 主要特点

- 超低功耗: 低至 2.1uA 睡眠电流 (WOR 模式)
- 低成本
- 小尺寸: 12mm X 12mm \*2.5mm 28 pins SMT
- 高性能:
  - RHF0M0E5-LF22:
    - ✓ TXOP=10dBm@434MHz
    - ✓ TXOP=22dBm@470MHz
  - RHF0M0E5-HF22:
    - ✓ TXOP=22dBm@868/915MHz
    - ✓ -136.5dBm sensitivity for SF12 with 125KHz BW
    - ✓ 158dB 链路预算, 适合长距离的需要
- 灵活的接口
  - ✓ USART
  - ✓ I2C
  - ✓ SWD
  - ✓ ADC
- 内嵌 LoRaWAN<sup>®</sup>协议, AT 指令, 支持全球 LoRaWAN<sup>®</sup>频率计划
  - ✓ EU868
  - ✓ US915 and US915 Hybrid
  - ✓ CN779
  - ✓ AU915
  - ✓ CN470 and CN470 Prequel
  - ✓ AS923
  - ✓ KR920
  - ✓ IN865

本产品规格书包括 RHF0M0E5 模块性能和功能的详细描述。获取最新的固件，产品更新或勘误表等请与瑞兴恒方联系。

## 2 总体描述

RHF0M0E5 内嵌高性能 MCU STM32WLE5JC，非常适合于各种物联网节点的设计。

RHF0M0E5 模块支持(G)FSK 模式和 LoRa<sup>®</sup>。LoRa<sup>®</sup>模式下可以使用 62.5kHz, 125kHz, 250kHz 和 500kHz 带宽。

基于 STM32WLE5JC 的强大功能和丰富的外设，模块提供 UART, I2C, SPI, ADC 和 GPIOs 供用户根据应用选用。如果需要对内置的 AT 指令固件进行升级，请使用两线接口 (UART) 基于 boot 模式完成烧录；而客户基于模组内部 MCU 自主开发软件，则可以通过 SWD 完成程序擦除和烧录。

RHF0M0E5 目前包含两个子型号，RHF0M0E5-LF22(单核 STM32WLE5JC 集成 SX126X IP)和 RHF0M0E5-HF22(单核 STM32WLE5JC 集成 SX126X IP)，RHF0M0E5-LF22 支持 22dBm@LF band (470MHz)；10dBm@LF band (434MHz)；RHF0M0E5-HF22 支持 22dBm@HF band (868/915MHz)。

原理框图：

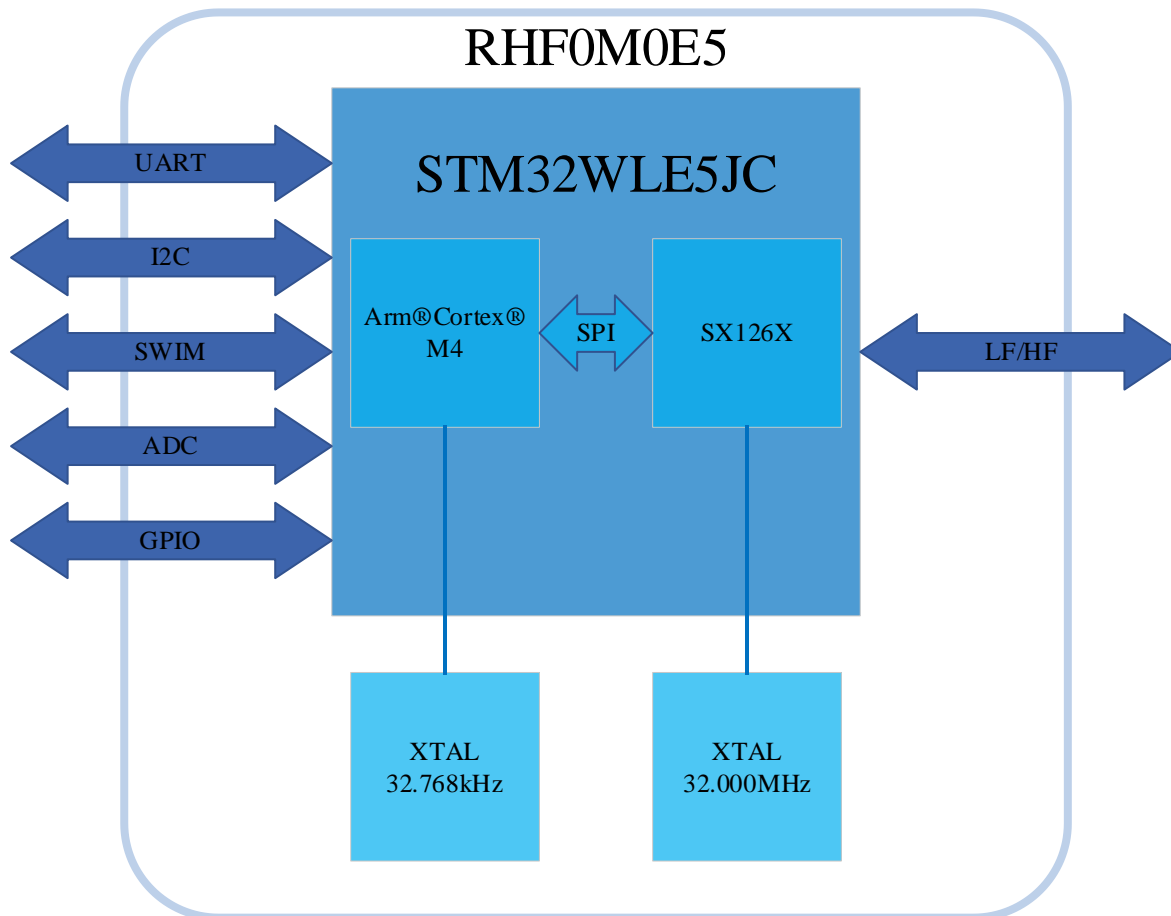


Figure 1 RHF0M0E5 Schematic diagram

## 2.1 管脚定义

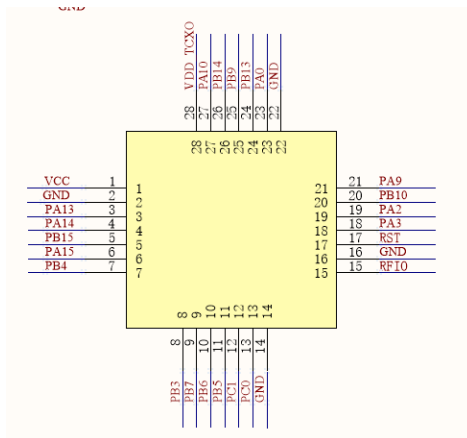


Figure 2 RHF0M0E5 Pin arrangement  
Table 1 RHF0M0E5 pinout

Number	Name	Type	Description
1	VCC	-	Supply voltage for the module
2	GND	-	Ground
3	PA13	I	SWDIO of SWIM for program download
4	PA14	I/O	SWCLK of SWIM for program download
5	PB15	I/O	SCL of I2C2 from MCU
6	PA15	I/O	SDA of I2C2 from MCU
7	PB4	I/O	MCU GPIO
8	PB3	I/O	MCU GPIO
9	PB7	I/O	UART1_RX from MCU
10	PB6	I/O	UART1_TX from MCU
11	PB5	I/O	MCU GPIO
12	PC1	I/O	MCU GPIO ; LPUART1_TX from MCU
13	PC0	I/O	MCU GPIO ; LPUART1_RX from MCU
14	GND	-	Ground
15	RFIO	I/O	RF input/output
16	GND	-	Ground
17	RST	I/O	Reset trigger input for MCU
18	PA3	I/O	MCU GPIO; USART2_RX from MCU
19	PA2	I/O	MCU GPIO; USART2_TX from MCU
20	PB10	I/O	MCU GPIO
21	PA9	I/O	MCU GPIO
22	GND	-	Ground
23	PA0	I/O	MCU GPIO
24	PB13	I/O	SPI2_SCK from MCU; Boot pin(Active low)
25	PB9	I/O	SPI2_NSS from MCU

26	PB14	I/O	SPI2_MISO from MCU
27	PA10	I/O	SPI2_MOSI from MCU
28	PB0	I/O	Unavailable; Suspended treatment

## 3 电气特性

### 3.1 极限工作条件

达到或超过下表列出的额定最大值会导致设备损坏。

Table 2 Absolute Maximum Ratings

Item	Description	min	max	unit
VCCmr	供电电压	-0.3	+3.9	V
Tmr	环境温度	-40	+85	°C
Pmr	射频输入信号	-	+10	dBm

### 3.2 正常工作条件

Table 3 Recommended Operating Conditions

Item	Description	min	max	unit
VCCop	供电电压	+1.8	+3.6	V
Top	环境温度	-40	+85	°C
Pop	射频输入信号	-	+10	dBm

### 3.3 模块规格指标

Table 4 RHF0M0E5 features

ITEMs	Parameter	Specifications	Unit
<b>Structure</b>	Size	12(W) X 12(L) X 2.5(H)	mm
	Package	28 pins, SMT	
<b>Electrical Characteristics</b>	power supply	3.3V type	V
	Sleep current	2.1uA (WDT on);	uA
	Operation current (Transmitter+MCU)	50mA @10dBm in 434MHz type	mA
111mA @22dBm in 470MHz type			
111mA @22dBm in 868MHz type			

	Operation current (Receiver+MCU)	6.7mA @BW125kHz, 434MHz type				mA
		6.7mA @BW125kHz, 470MHz type				
		6.7mA @BW125kHz, 868MHz type				
	Output power	10dBm max @434MHz				dBm
		22dBm max @470MHz				
		22dBm max @868MHz				
	Sensitivity	@SF12, BW125kHz				
Fr(MHz)		min	type	max		
434		-	-134.5	-136		
470		-	-136.5	-137.5		
Harmonics	<-36dBm below 1GHz				dBm	
	<-40dBm above 1GHz				dBm	
Interface	RFIO	RF port				
	UART	3 group of UART, include 2pins				
	I2C	1 group of I2C, include 2 pins				
	ADC	1 ADC Input, include 1pins,12-bit 1Msps				
	NRST	Manual reset pin input				
	SPI	1 group of SPI, include 4 pins				

## 4 典型射频性能测试

### 4.1 RHF0M0E5-LF22 性能测试

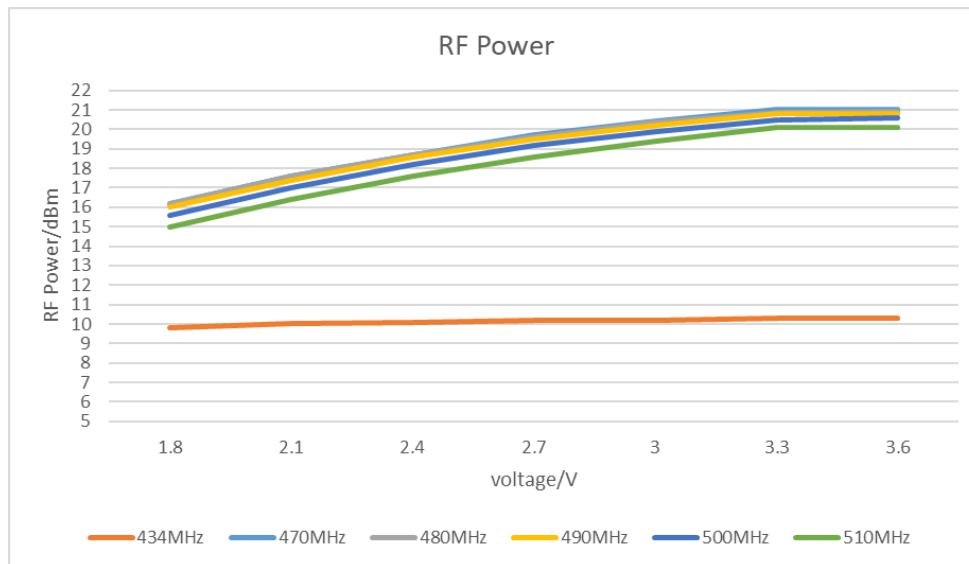


Figure 3 RF Power vs Voltage (434-510MHz)

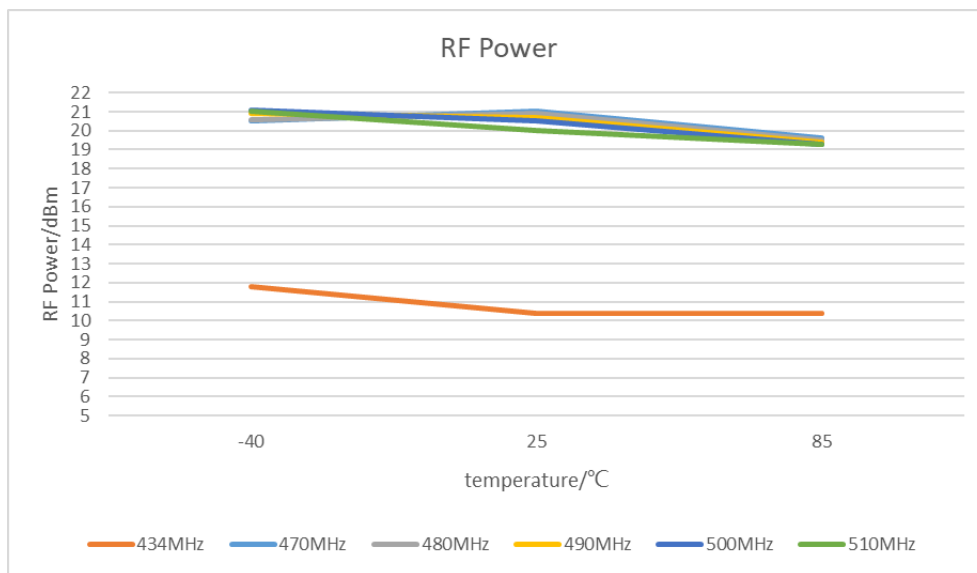


Figure 4 RF Power VS Temperature (434-510MHz)

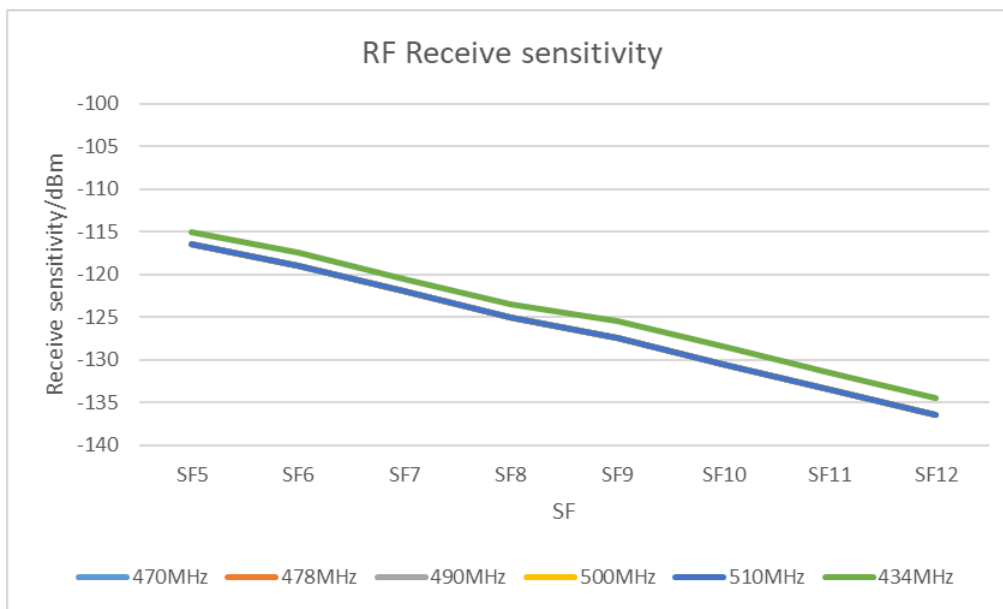


Figure 5 RF Receiver Sensitivity vs Spreading factor (434-510MHz)



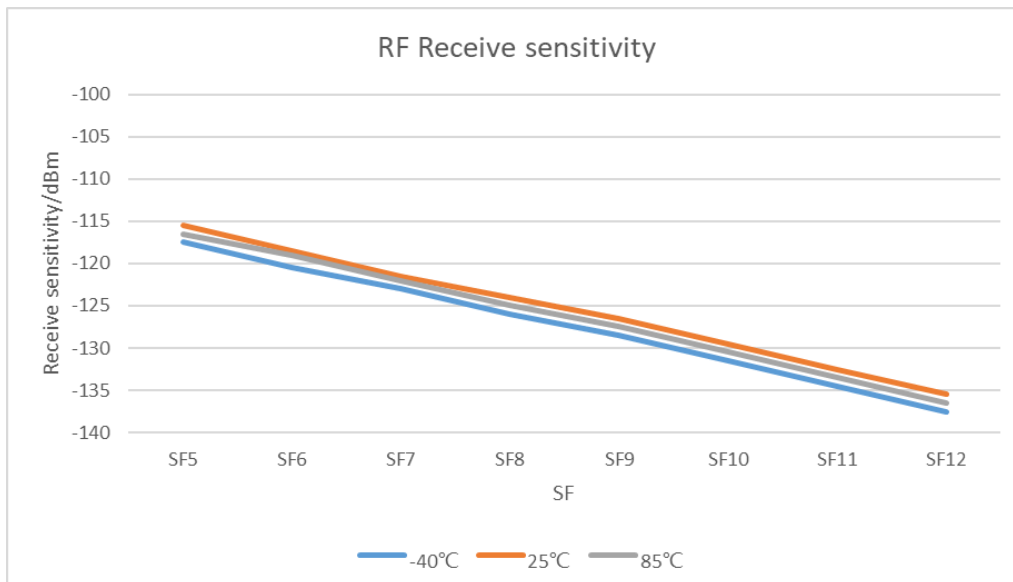


Figure 6 RF Receiver Sensitivity VS Temperature (470MHz)

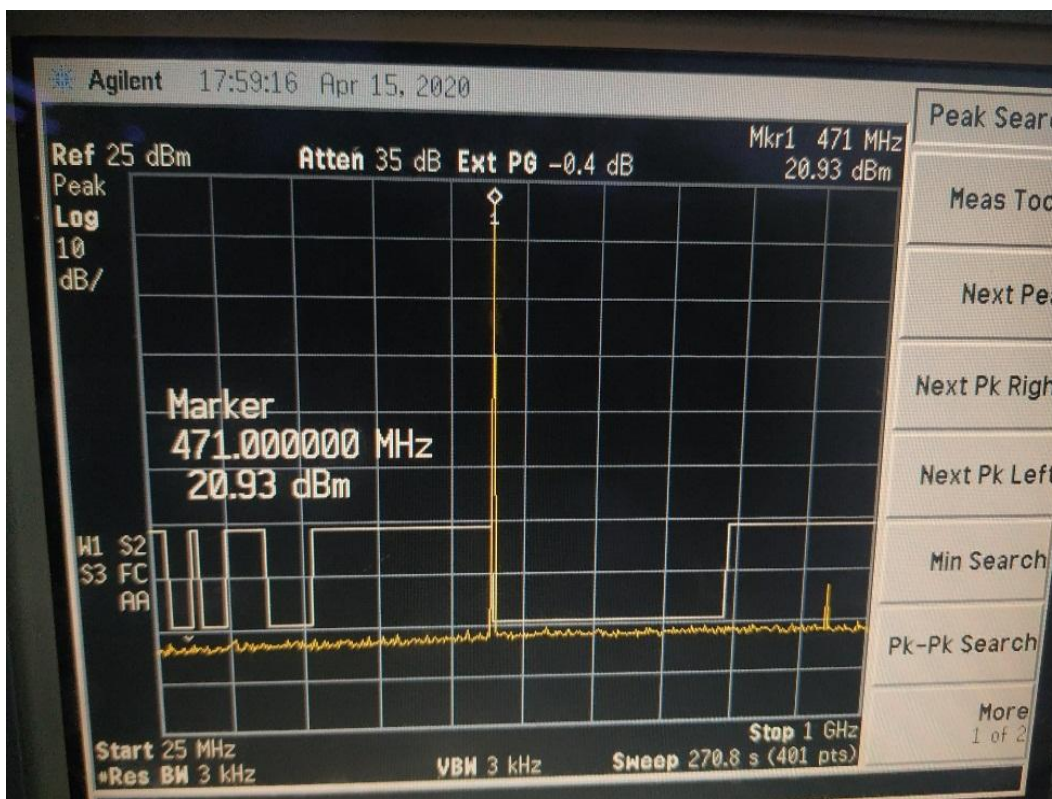


Figure 7 Harmonic(25MHz~1GHz)@Frf=470MHz, TXOP=22dBm

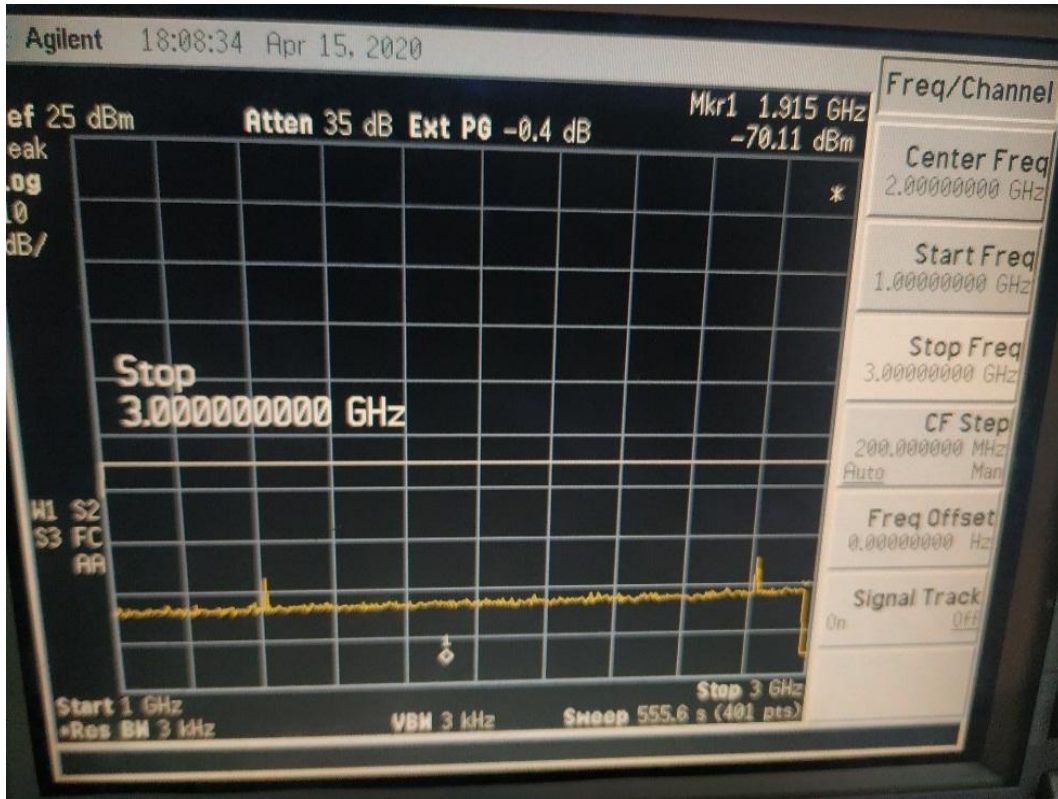


Figure 8 Harmonic(1GHz~3GHz)@Frq=470MHz, TXOP=22dBm

## 4.2 RHF0M0E5-HF22 性能测试

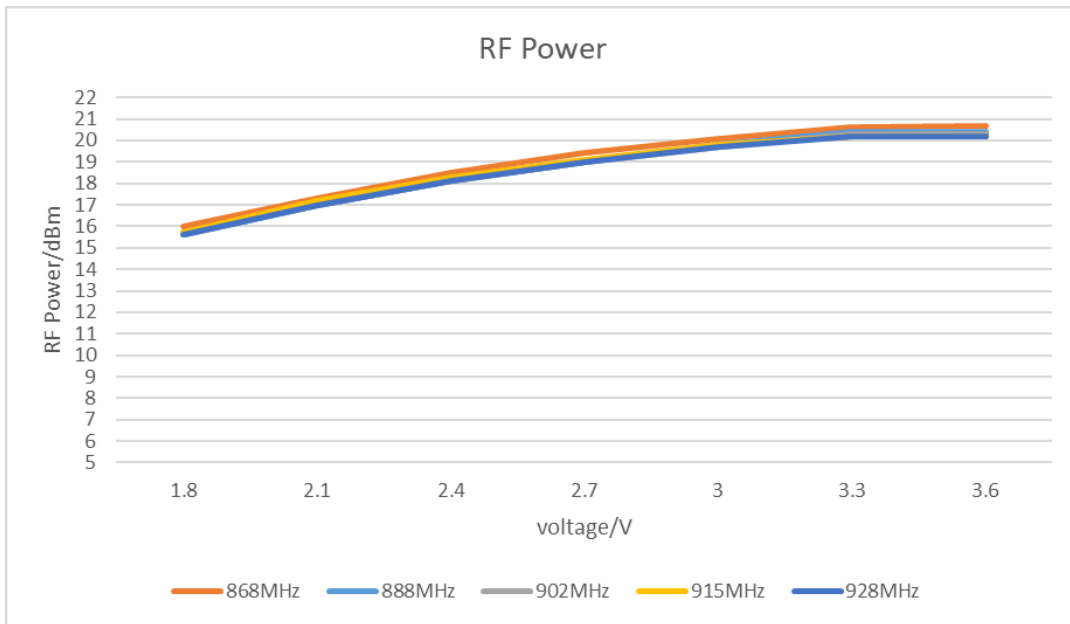


Figure 9 RF Power vs Voltage (868-928MHz)

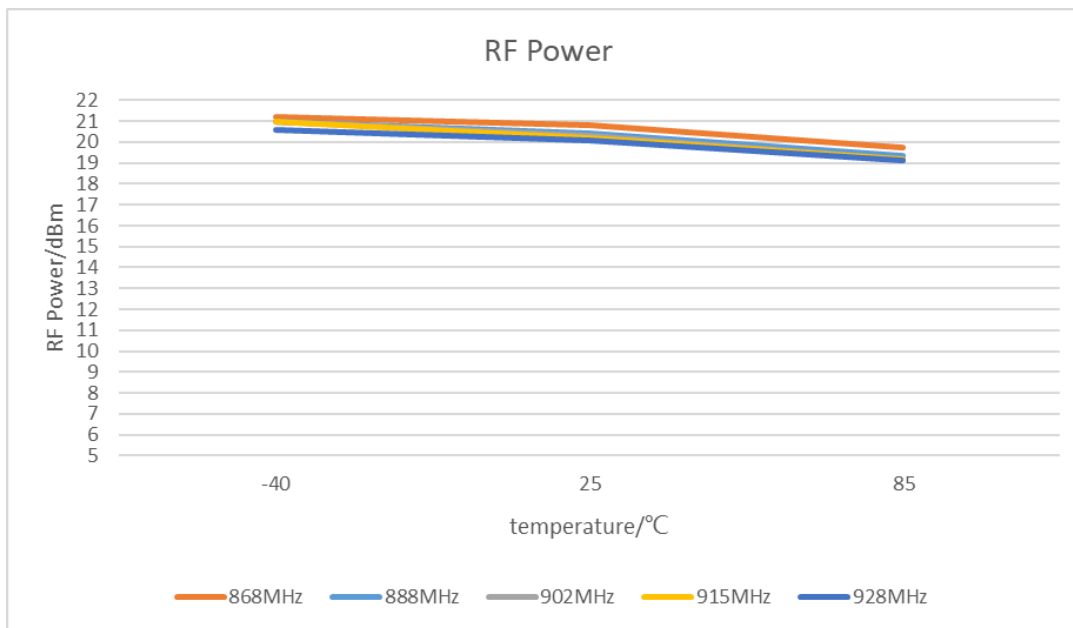


Figure 10 RF Power VS Temperature (868~928MHz)

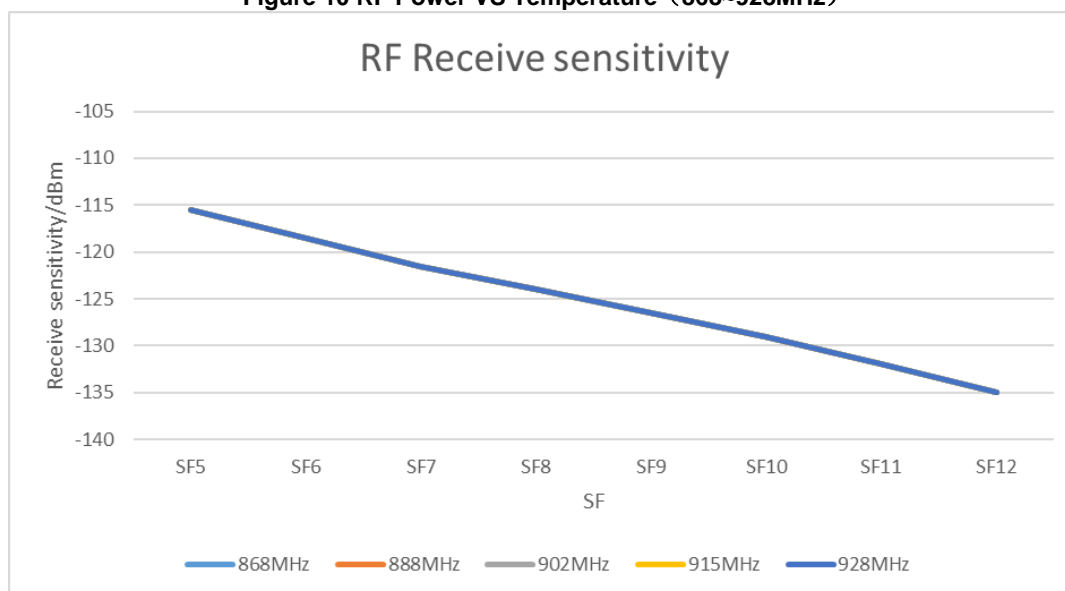


Figure 11 RF Receiver Sensitivity vs Spreading factor (868~928MHz)

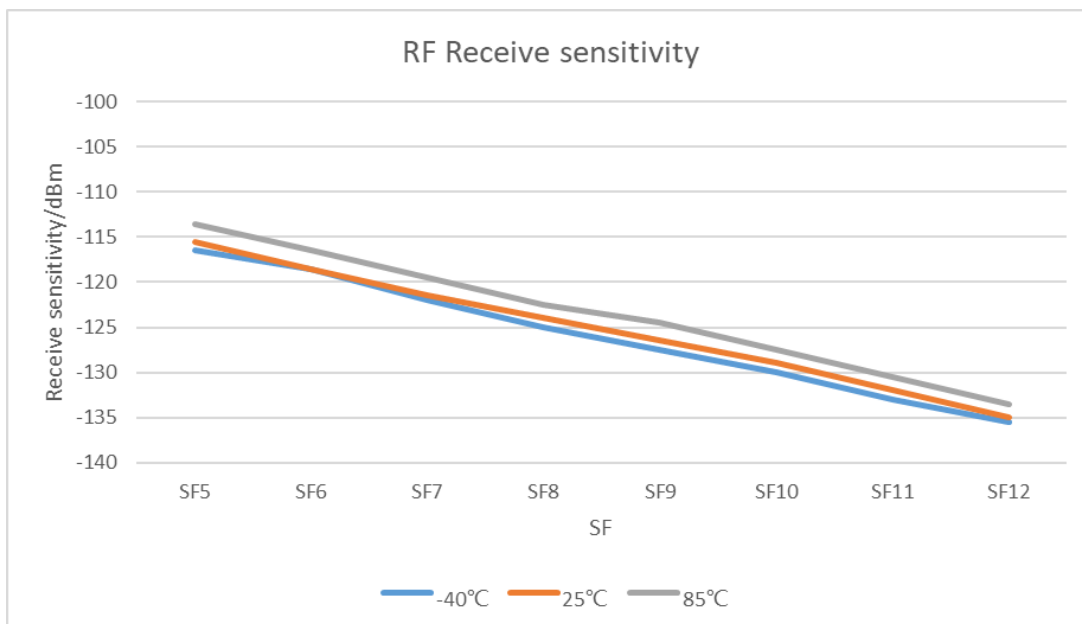


Figure 12 RF Receiver Sensitivity VS Temperature (868MHz)

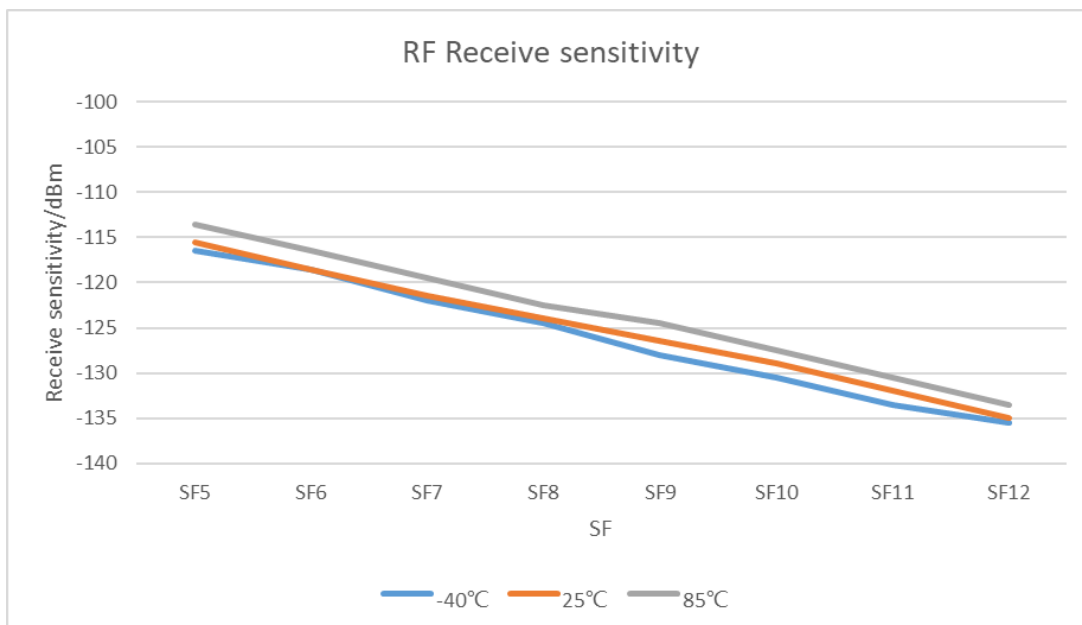


Figure 13 RF Receiver Sensitivity VS Temperature (915MHz)

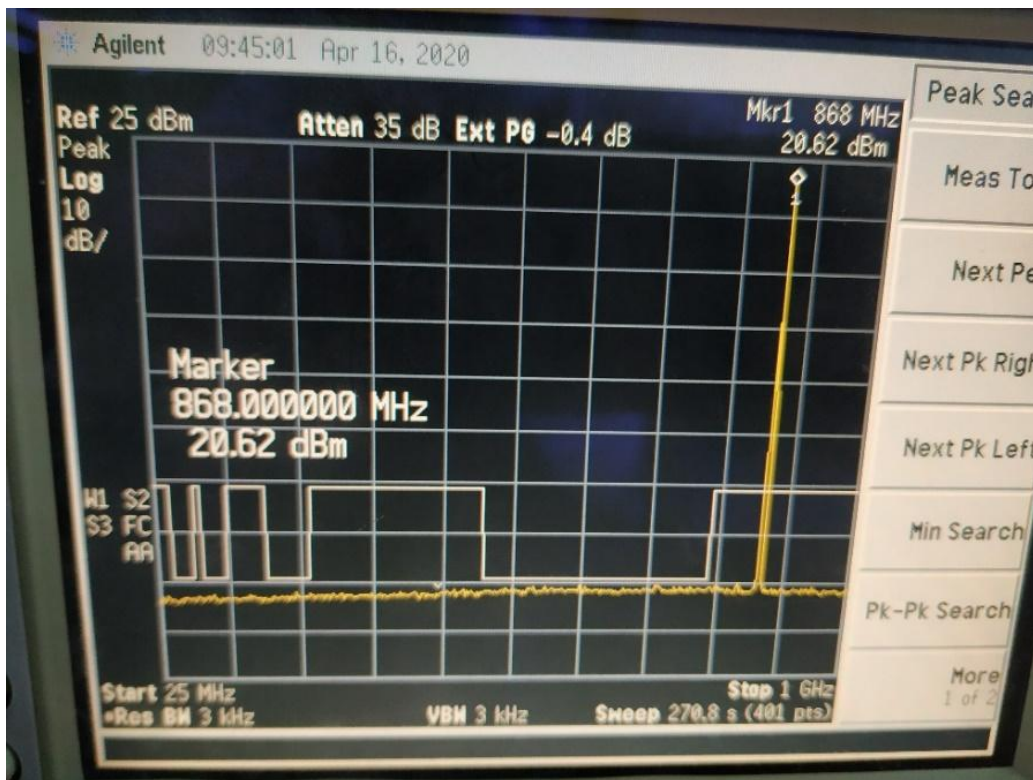


Figure 14 Harmonic(25MHz~1GHz)@Frf=868MHz, TXOP=22dBm

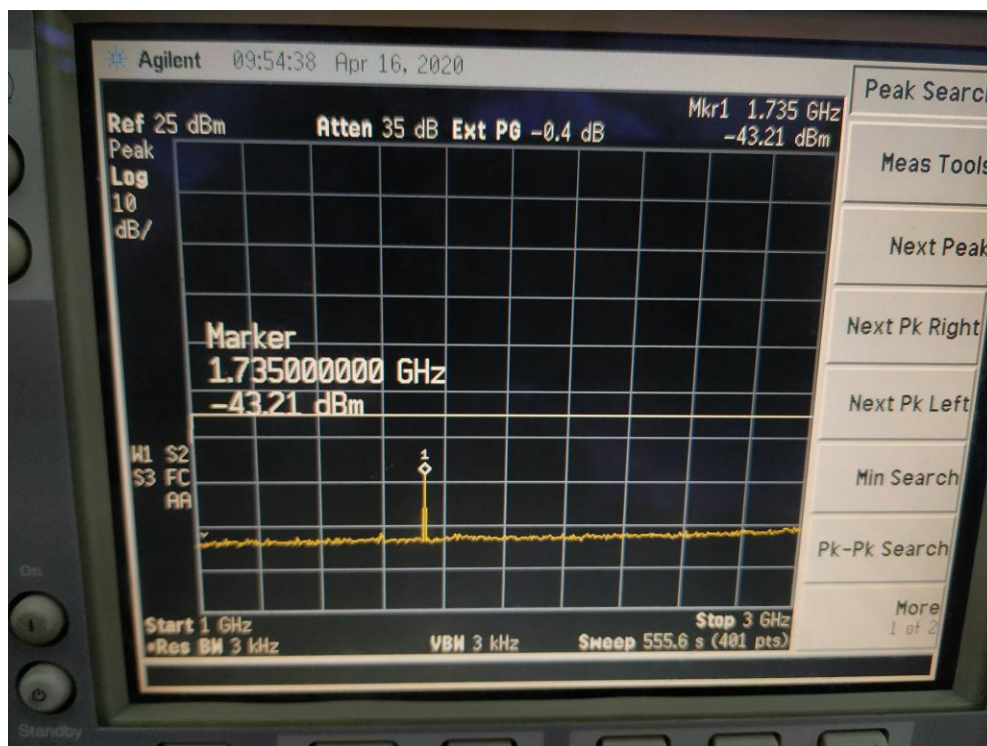


Figure 15 Harmonic(1GHz~3GHz)@Frf=868MHz, TXOP=22dBm

## 5 应用信息

### 5.1 封装信息

除特别说明尺寸外，以下标注尺寸公差为±0.1mm，单位为 mm。

RHF0M0E5 具有 28pin 的贴片封装：

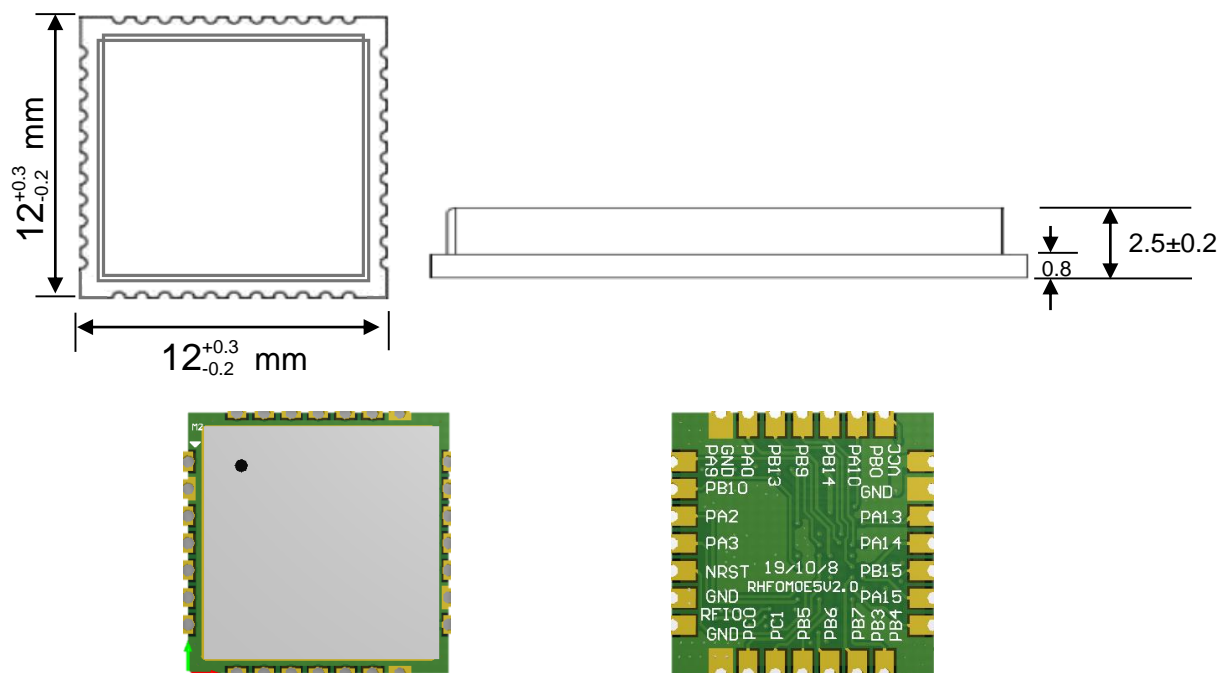


Figure 16 RHF0M0E5 Module appearance

下图给出了建议的 Layout 封装尺寸图：

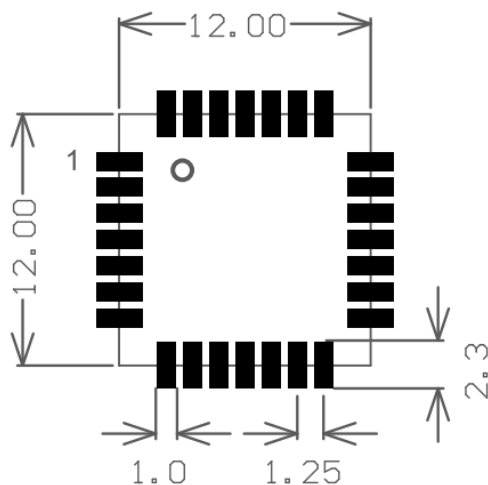


Figure 17 PCB footprint

## 5.2 模块对外接口

除了几个必要的 GPIO 口和一组 SPI 口被用于内部射频收发机的控制外，MCU 的其他 GPIO 都已引出，包括 UART(用于 AT 指令)，I2C，ADC 等。对于那些希望在模组的片上 MCU 进行软件开发或拓展外设的用户来说，这些丰富的 GPIO 接口能满足绝大多数应用的需求。

## 5.3 基于 RHF0M0E5 模块的参考设计

RHF0M0E5 内嵌全球的 LoRaWAN®协议和 AT 指令集。这将使得基于该模块的 LoRaWAN®节点设计变得非常容易， 以下是使用 RHF0M0E5 快速启动 LoRaWAN®应用程序的典型参考设计。只需将 UART 和 NRST 连接到主机 MCU 并发送 AT 命令即可。

此外，模块的 Pin24 接地会使模块强制进入 Boot 升级模式。

注意：28 引脚 PB0 必须悬空处理，不允许上拉或接地。

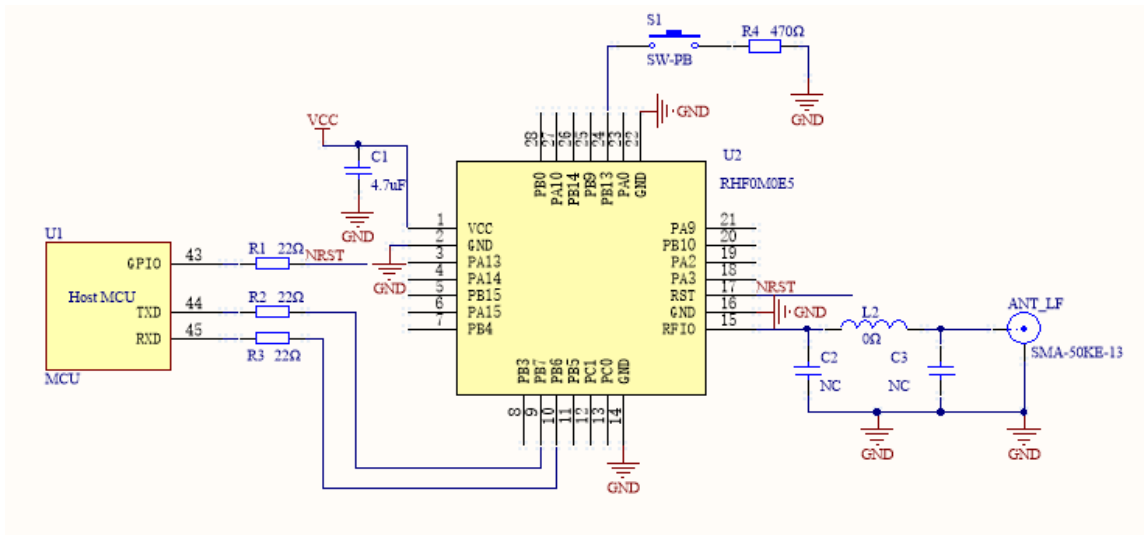


Figure 18 Reference design based on RHF0M0E5

# 6 LoRaWAN®应用信息

## 6.1 LoRaWAN®应用

LoRaWAN®网络的拓扑结构是星形网络，网关作为节点和网络服务器之间的中继。网关通过标准的 IP 链路连接到网络服务器，而节点设备使用 LoRa®或者 FSK 与一个或者多个网关通信。通信是双向的，尽管主要是从节点到网络服务器的上行通信。

节点和网关之间的通信使用不同的频率和速率，速率的选择是功耗和距离的折中，不同的速率之间互不干扰。根据不同的扩频因子和带宽，LoRa®的速率可以从 300bps 到 50Kbps。为了使电池寿命和网络容量最大化，网络服务器通过速率自适应(ADR)管理节点的速率和输出功率。

节点设备可能在任何时间，以任何速率，在随机的一个信道上发射，只要符合以下条件：

- 1) 节点当前使用的信道是伪随机的。这使得系统抗干扰的能力更强
- 2) 节点每次的最大传输时间(信道的驻留时间)和占空比取决于所用的频段和当地的规范

RHF0M0E5 模块集成了 ST 超低功耗 IC STM32WLE5JC. 在睡眠模式下电流仅 2.1uA, 该模块非常适合于 LoRaWAN®的各种应用。.

## 6.2 基于 RHF0M0E5 设计 LoRaWAN®无线传感器

RHF0M0E5 是封装了全球 LoRaWAN®标准协议的 AT 指令集。客户只需要一颗很简单的 MCU 作为主控，便可通过串口来控制 RHF0M0E5，从而轻松实现 LoRaWAN®协议。这有助于帮助客户快速地将传感器产品推向 LoRaWAN®市场。

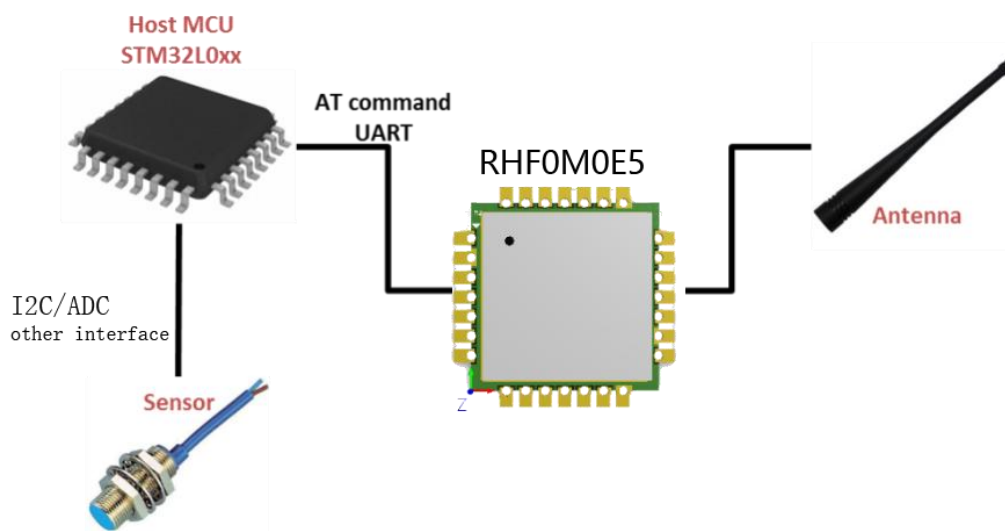


Figure 19 Design of LoRaWAN® wireless sensor based on RHF0M0E5 module



## 7 订购信息

技术支持: support@risinghf.com

中国销售: salescn@risnghf.com

海外销售: salesww@risinghf.com

Table 5 Ordering Information

Part Number	MCU	TX Power (dBm)	AT Modem
RHF0M0E5-LF22	ROM 256KB / RAM 64KB	10@LF(434MHz) 22@LF (470MHz)	Yes
RHF0M0E5-HF22	ROM 256KB / RAM 64KB	22@HF (868/915MHz)	Yes

## 8 Revision

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### V1.5 2023-2-2

- + 更新模块尺寸公差

### V1.4 2020-09-25

- + 更新 STM32WL5JC 描述
- + 更新原理框图

### V1.3 2020-05-06

- + 增加 RHF0M0E5-HF22 性能参数
- + 更新 RHF0M0E5-LF22 性能参数

### V1.2 2020-03-03

- + 增加 STM32WLE5JC 描述
- + 增加 Boot 升级描述

### V1.1 2019-12-18

- + 初稿

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