- ## Product description

RHF0M084 is a low-cost, ultra-low power consumption, ultra-small size LoRaWAN® module designed by Ruixing Hengfang Network (Shenzhen) Co., Ltd. The module uses ST system-on-chip STM32WLE5JC, internally integrated high-performance LoRa® SX126X IP and ultra-low The power consumption MCU is also equipped with Semitach's proprietary 2.4G long-distance transceiver SX1281. The target application of this module is wireless sensor network and other Internet of Things devices, especially where battery power requires low power consumption and long distance.

Product outline

Application

- LoRaWAN® node
- Home automation applications
- Smart security
- Low-power wireless sensor network
- 2.4GHz remote application

Features

- Low power consumption: as low as 2uA sleep current (WOR mode)
- Small size: 28mm X 23mm X 2.8mm 33 pins SMT
- High performance:

High transmit power: :

- TXOP=22dBm@470MHz
- TXOP=22dBm@868/915MHz
- TXOP=13dBm@2400MHz

High receiving sensitivity:

- 470MHz:-134 dBm sensitivity for SF12 with 125KHz BW
- 868MHz:-132 dBm sensitivity for SF12 with 125KHz BW
- 2400MHz:-130 dBm sensitivity for SF12 with 125KHz BW

- Interface
  - SPI
  - USART
  - I2C
  - ADC
  - GPIO
  - SWD
- Embedded LoRaWAN® protocol, AT command, support global LoRaWAN® frequency plan
  - EU868
  - US915 and US915 Hybrid
  - CN779
  - AU915
  - CN470 and CN470 Prequet
  - AS923
  - KR920
  - IN865

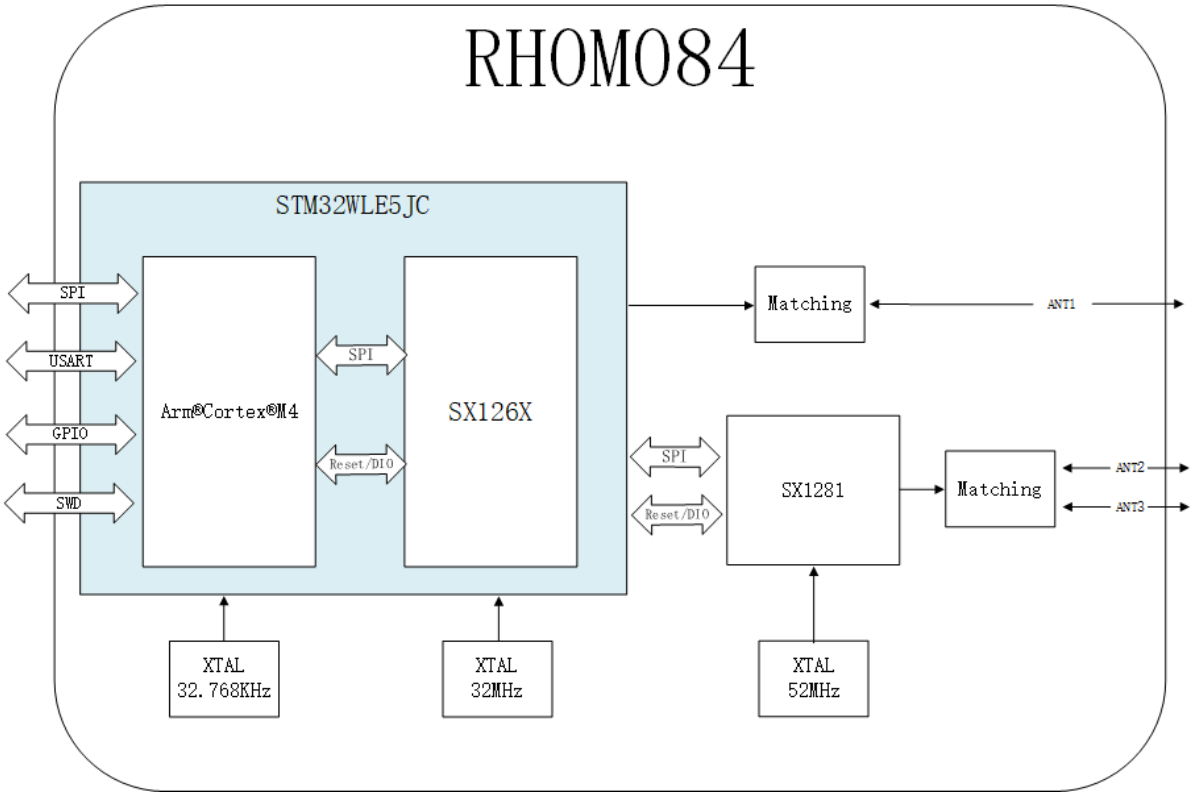
General description

RHF0M084 embeds STM32WLE5JC and SX1281, which is very suitable for the design of various IoT nodes.

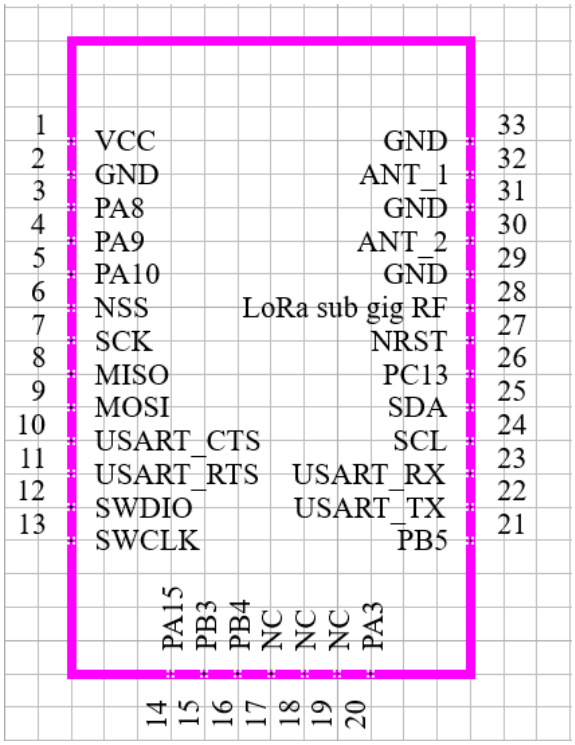
Based on the multi-mode high-performance SX126X and SX1281, the RHF0M084 module supports (G)FSK and LoRa modes. In 470MHz/868MHz/915MHz LoRa mode, 62.5kHz, 125kHz, 250kHz and 500kHz bandwidths can be used. In 2400MHz LoRa mode, 203.125KHz, 406.25KHz, 812.6KHz, 1625KHz can be used.

Based on STM32WLE5JC MCU, the module provides UART and GPIOs for users to choose according to their applications. It is recommended to use the two-wire interface (SWIM) for programming.

Principle block diagram:



Pin definition



Number	Name	Type	Description
1	VCC	-	Supply voltage for the module
2	GND	-	Ground
3	PA8	I/O	MCU GPIO
4	PA9	I/O	MCU GPIO
5	PA10	I/O	MCU GPIO
6	NSS	I/O	NSS of SPI from MCU or GPIO from MCU, PB12
7	SCK	I/O	SCK of SPI from MCU or GPIO from MCU, PB13
8	MISO	I/O	MISO of SPI from MCU or GPIO from MCU, PB14
9	MOSI	I/O	MOSI of SPI from MCU or GPIO from MCU, PB15
10	USART_CTS	I/O	USART1_CTS from MCU or GPIO from MCU, PA11
11	USART_RTS	I/O	USART1_RTS from MCU or GPIO from MCU, PA12
12	SWDIO	I/O	SWDIO of SWIM for program download
13	SWCLK	I/O	SWCLK of SWIM for program download
14	PA15	I/O	MCU GPIO
15	PB3	I/O	MCU GPIO
16	PB4	I/O	MCU GPIO
17	NC	-	-
18	NC	-	-
19	NC	-	-
20	PA3	I/O	MCU GPIO
21	PB5	I/O	MCU GPIO
22	USART_TX	I/O	USART1_TX from MCU or GPIO from MCU, PB6
23	USART_RX	I/O	USART1_RX from MCU or GPIO from MCU, PB7
24	SCL	I/O	SCL of I2C from MCU or GPIO from MCU, PB8
25	SDA	I/O	SDA of I2C from MCU or GPIO from MCU, PB9
26	PC13	I/O	MCU GPIO
27	NRST	I	Reset trigger input for MCU
28	LoRa sub gig RF	-	RF input/output PORT3 (470MHz/868MHz/915MHz)
29	GND	-	Ground
30	ANT_2	-	RF input/output PORT2（2400MHz）

Number	Name	Type	Description
31	GND	-	Ground
32	ANT_1	-	RF input/output PORT1 (2400MHz)
33	GND	-	Ground

Remarks: The 2400MHz antenna port is shipped in batches, and the ANT_1 port is opened by default

Electrical characteristics

- ## Extreme working conditions

Reaching or exceeding the maximum ratings listed in the table below will cause damage to the equipment.

Item	Description	min	max	unit
VCCmr	Supply voltage	-0.3	+3.9	V
Tmr	Ambient temperature	-55	+115	℃
Pmr	RF input power	-	+10	dBm

- ## Normal working conditions

Item	Description	min	max	unit
VCCop	Supply voltage	+1.8	+3.6	V
Top	Ambient temperature	-40	+85	℃
Pop	RF input power	-	+10	dBm

- ## Specifications

ITEMs	Parameter	Specifications				Unit
Structure	Size	28(L)X 23(W) X 2.8(H)				mm
	Package	33 pins, SMT				
Electrical Characteristics	power supply	3.3V type				V
	Sleep current	2uA (WDT on);				uA
	Operation current (Transmitter+MCU)	105mA @22dBm in 470MHz type				mA
		118mA @22dBm in 868MHz type				
		111mA @22dBm in 915MHz type				
		24mA @13dBm in 2400MHz type				
	Operation current (Receiver+MCU)	6.7mA @BW125kHz, 470MHz type				mA
		6.7mA @BW125kHz, 868MHz type				
		6.7mA @BW125kHz, 915MHz type				
		6.7mA @BW125kHz, 2400MHz type				
	Output power	21dBm max @470MHz				dBm
		20dBm max @868MHz				
		19.5dBm max @915MHz				
		12dBm max @2400MHz				
	Sensitivity	@SF12, BW125kHz				dBm
		Fr(MHz)	min	type	max	
		470	-	-133	-134	
		868	-	-131	-132	
		915	-	-131	-132	
		2400	-	-128	-130	
	Harmonics	<-36dBm below 1GHz				dBm
		<-30dBm above 1GHz				dBm
Interface	RFIO	RF port				
	UART	1 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				

- # RF performance

  - ## RF Power vs Power configuration (470MHz)

Configuration	1	2	3	4	5	6	7	8	9	10	11
Current (mA)	32.9	35.11	36.5	38.84	40.28	42.14	44.41	46.63	49.27	51.86	54.79
Output Power (dBm)	0.263	1.396	2.081	3.327	4.131	5.147	6.243	7.226	8.241	9.159	10.082
Configuration	12	13	14	15	16	17	18	19	20	21	22
Current (mA)	58.16	62.3	66.36	70.49	74.02	76.92	80.07	83.57	87.79	93.01	99.63
Output Power (dBm)	11.04	12.059	12.966	13.833	14.747	15.684	16.748	17.766	18.768	19.78	20.768

  - ## RF Power vs Power configuration (490MHz)

Configuration	1	2	3	4	5	6	7	8	9	10	11
Current (mA)	36.03	38.55	40.11	42.78	44.52	46.84	49.59	52.3	55.46	58.57	62.08
Output Power (dBm)	0.698	1.833	2.539	3.817	4.638	5.654	6.756	7.709	8.726	9.622	10.526
Configuration	12	13	14	15	16	17	18	19	20	21	22
Current (mA)	66.02	70.86	75.49	79.81	83.42	86.59	90.1	93.83	98.12	103.24	109.78
Output Power (dBm)	11.45	12.446	13.314	14.143	15.042	15.951	16.959	17.922	18.886	19.856	20.788

  - ## RF Power vs Power configuration (868MHz)

Configuration	1	2	3	4	5	6	7	8	9	10	11
Current (mA)	48.86	52.07	54.06	57.62	59.95	62.82	66.12	69.24	72.68	76	79.54
Output Power (dBm)	-0.466	0.638	1.291	2.505	3.301	4.274	5.358	6.328	7.314	8.198	9.032
Configuration	12	13	14	15	16	17	18	19	20	21	22
Current (mA)	83.62	88.45	93.08	97.76	102.15	104.86	107.77	110.92	114.43	118.35	124.41
Output Power (dBm)	9.917	10.871	11.683	12.464	13.359	14.464	15.755	16.92	17.993	18.965	20.01

  - ## RF Power vs Power configuration (915MHz)

Configuration	1	2	3	4	5	6	7	8	9	10	11
Current (mA)	48.45	51.52	53.39	56.65	58.76	61.35	64.33	67.09	70.2	73.21	76.4
Output Power (dBm)	-2.304	-1.195	-0.511	0.717	1.533	2.536	3.632	4.602	5.601	6.51	7.369
Configuration	12	13	14	15	16	17	18	19	20	21	22
Current (mA)	80.11	84.54	88.81	93.07	95.91	96.96	98.07	99.69	102.06	105.51	111.03
Output Power (dBm)	8.292	9.258	10.106	10.94	12.049	13.261	14.629	15.893	17.078	18.205	19.452

- **RF Power vs Power configuration（2400MHz）**

Configuration	-2	-1	0	1	2	3	4	5
Current（mA）				10.83	11.36	12.03	12.68	13.5
Output Power（dBm）				0.92	1.868	2.893	3.811	4.837
Configuration	6	7	8	9	10	11	12	13
Current（mA）	14.35	15.28	16.37	17.44	18.57	19.77	21.12	22.93
Output Power（dBm）	5.777	6.709	7.669	8.529	9.375	10.184	11.048	11.801

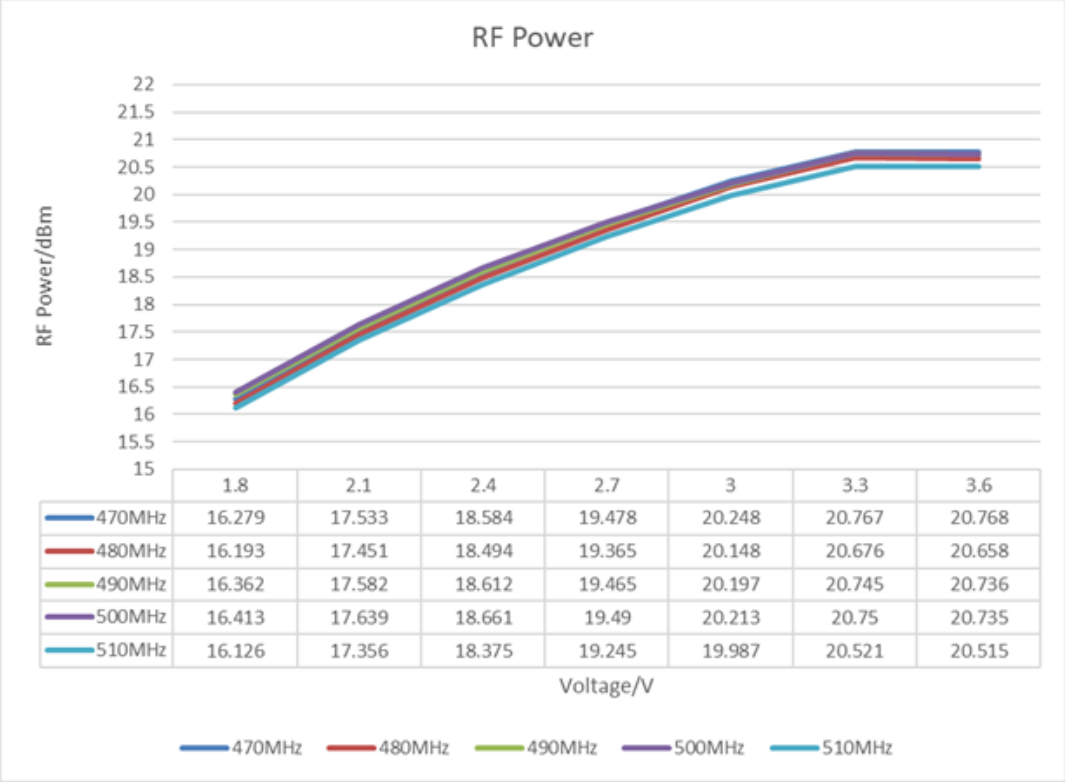
- **RF Power vs Power configuration（2460MHz）**

Configuration	-2	-1	0	1	2	3	4	5
Current（mA）				10.66	11.14	11.75	12.35	13.1
Output Power（dBm）				0.657	1.613	2.643	3.538	4.582
Configuration	6	7	8	9	10	11	12	13
Current（mA）	13.88	14.73	15.72	16.68	17.71	18.8	20.04	21.91
Output Power（dBm）	5.515	6.428	7.422	8.283	9.135	9.991	10.847	11.638

- **RF Power vs Power configuration（2500MHz）**

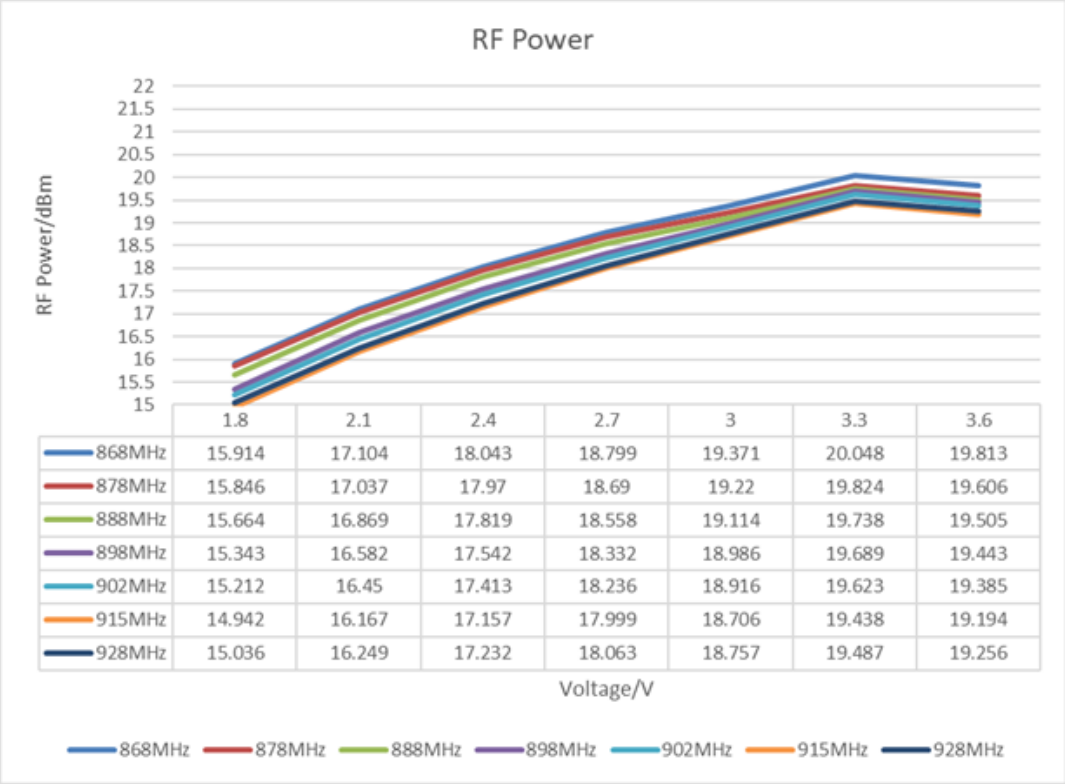
Configuration	-2	-1	0	1	2	3	4	5
Current（mA）				10.96	11.48	12.13	12.76	13.56
Output Power（dBm）				0.946	1.896	2.925	3.85	4.876
Configuration	6	7	8	9	10	11	12	13
Current（mA）	14.4	15.3	16.35	17.38	18.44	19.6	20.92	22.83
Output Power（dBm）	5.828	6.748	7.754	8.606	9.487	10.332	11.195	11.973

- **RF Power vs Voltage（470~510MHz）**



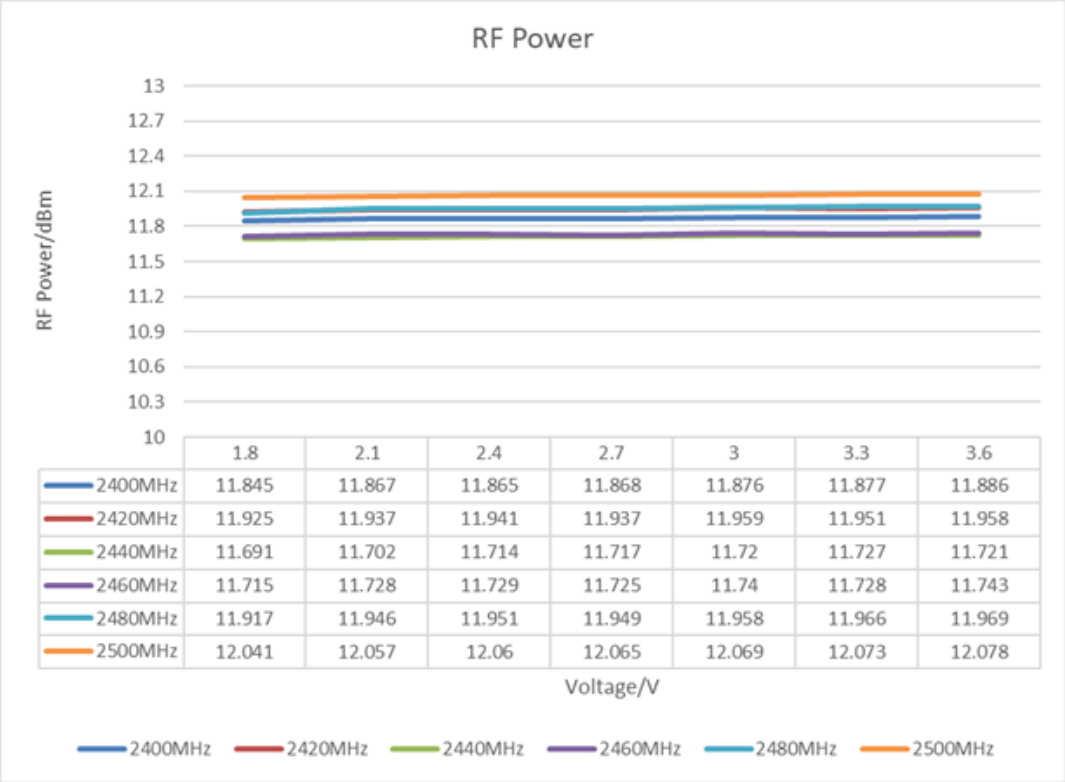
	1.8	2.1	2.4	2.7	3	3.3	3.6
470MHz	16.279	17.533	18.584	19.478	20.248	20.767	20.768
480MHz	16.193	17.451	18.494	19.365	20.148	20.676	20.658
490MHz	16.362	17.582	18.612	19.465	20.197	20.745	20.736
500MHz	16.413	17.639	18.661	19.49	20.213	20.75	20.735
510MHz	16.126	17.356	18.375	19.245	19.987	20.521	20.515

- **RF Power vs Voltage（868~915MHz）**



	1.8	2.1	2.4	2.7	3	3.3	3.6
868MHz	15.914	17.104	18.043	18.799	19.371	20.048	19.813
878MHz	15.846	17.037	17.97	18.69	19.22	19.824	19.606
888MHz	15.664	16.869	17.819	18.558	19.114	19.738	19.505
898MHz	15.343	16.582	17.542	18.332	18.986	19.689	19.443
902MHz	15.212	16.45	17.413	18.236	18.916	19.623	19.385
915MHz	14.942	16.167	17.157	17.999	18.706	19.438	19.194
928MHz	15.036	16.249	17.232	18.063	18.757	19.487	19.256

- **RF Power vs Voltage（2400~2500MHz）**

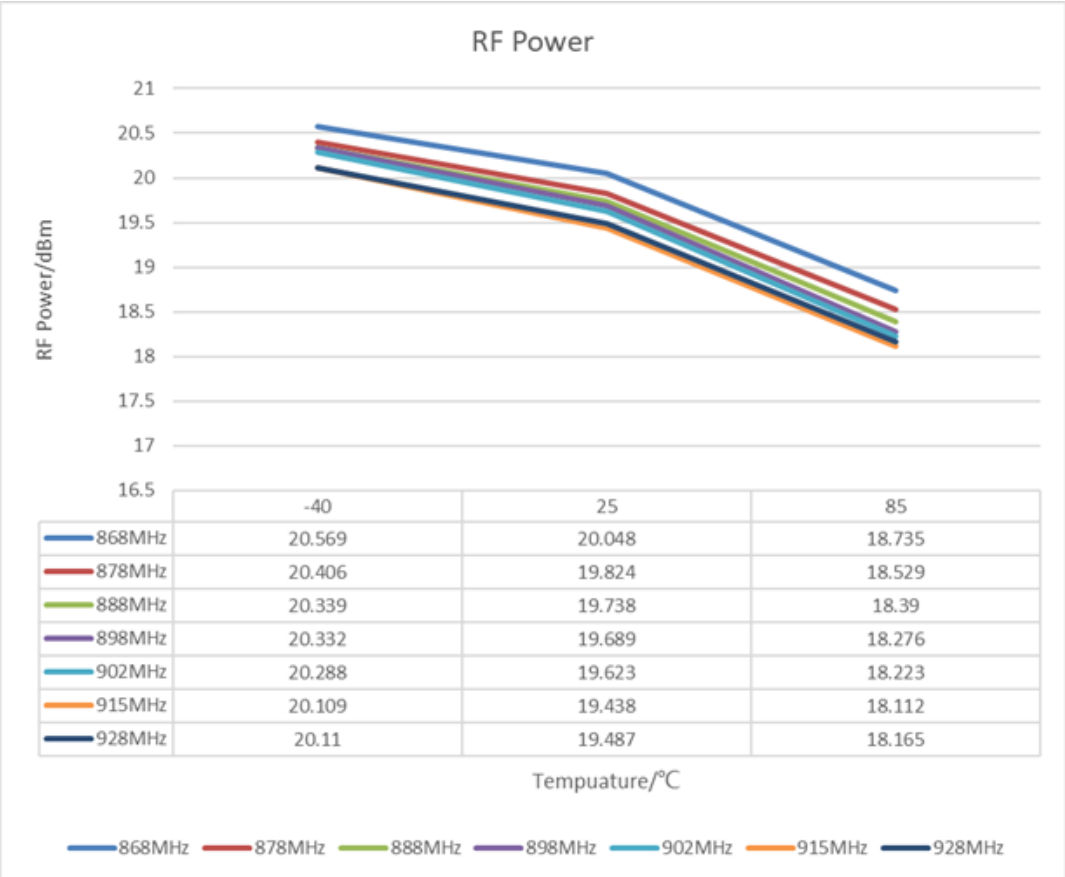


	1.8	2.1	2.4	2.7	3	3.3	3.6
2400MHz	11.845	11.867	11.865	11.868	11.876	11.877	11.886
2420MHz	11.925	11.937	11.941	11.937	11.959	11.951	11.958
2440MHz	11.691	11.702	11.714	11.717	11.72	11.727	11.721
2460MHz	11.715	11.728	11.729	11.725	11.74	11.728	11.743
2480MHz	11.917	11.946	11.951	11.949	11.958	11.966	11.969
2500MHz	12.041	12.057	12.06	12.065	12.069	12.073	12.078

- **RF Power VS Temperature（470~510MHz）**

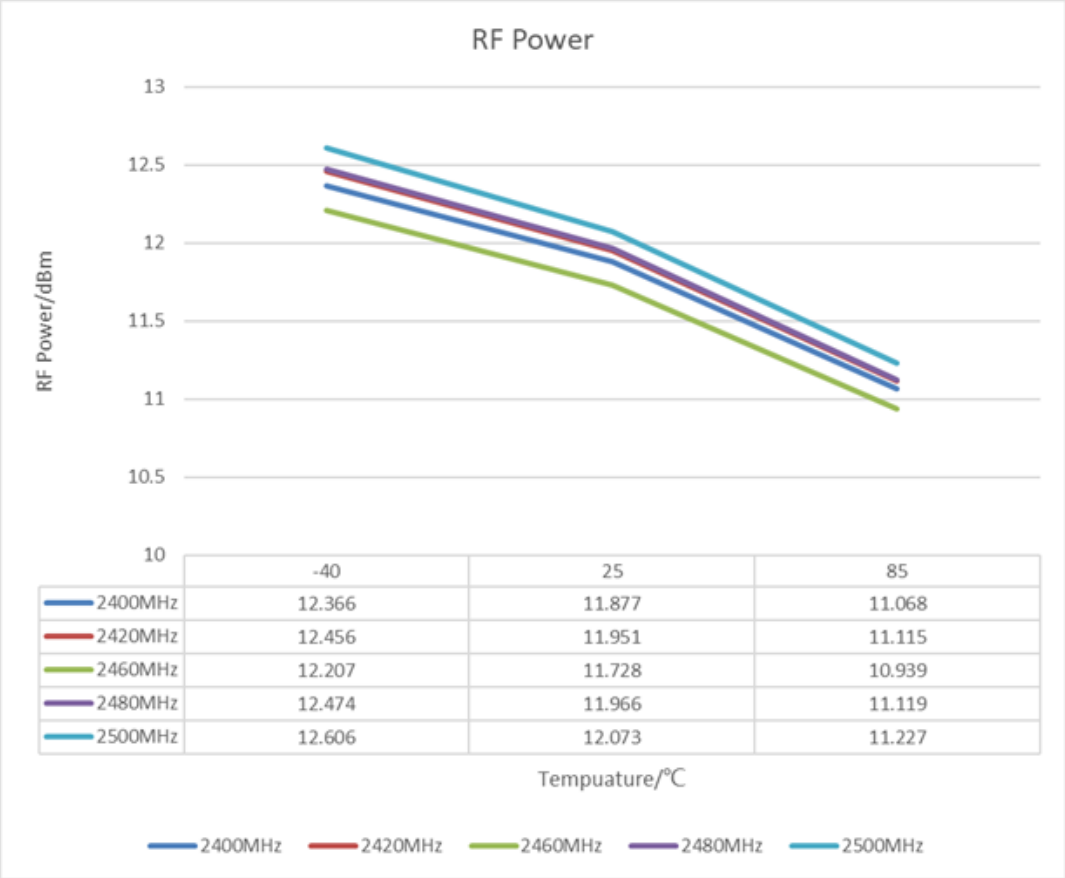
	-40	25	85
470MHz	21.174	20.767	19.809
480MHz	21.076	20.676	19.669
490MHz	21.167	20.745	19.584
500MHz	21.203	20.75	19.497
510MHz	20.996	20.521	19.308

- **RF Power VS Temperature（868~915MHz）**



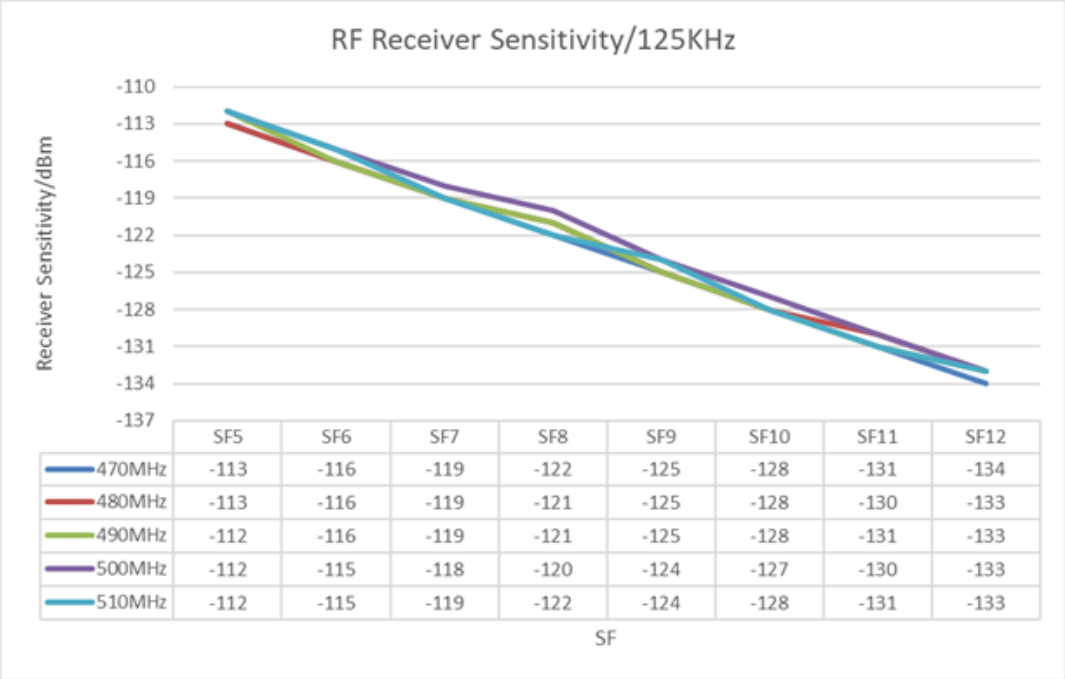
	-40	25	85
868MHz	20.569	20.048	18.735
878MHz	20.406	19.824	18.529
888MHz	20.339	19.738	18.39
898MHz	20.332	19.689	18.276
902MHz	20.288	19.623	18.223
915MHz	20.109	19.438	18.112
928MHz	20.11	19.487	18.165

- **RF Power VS Temperature（2400~2500MHz）**



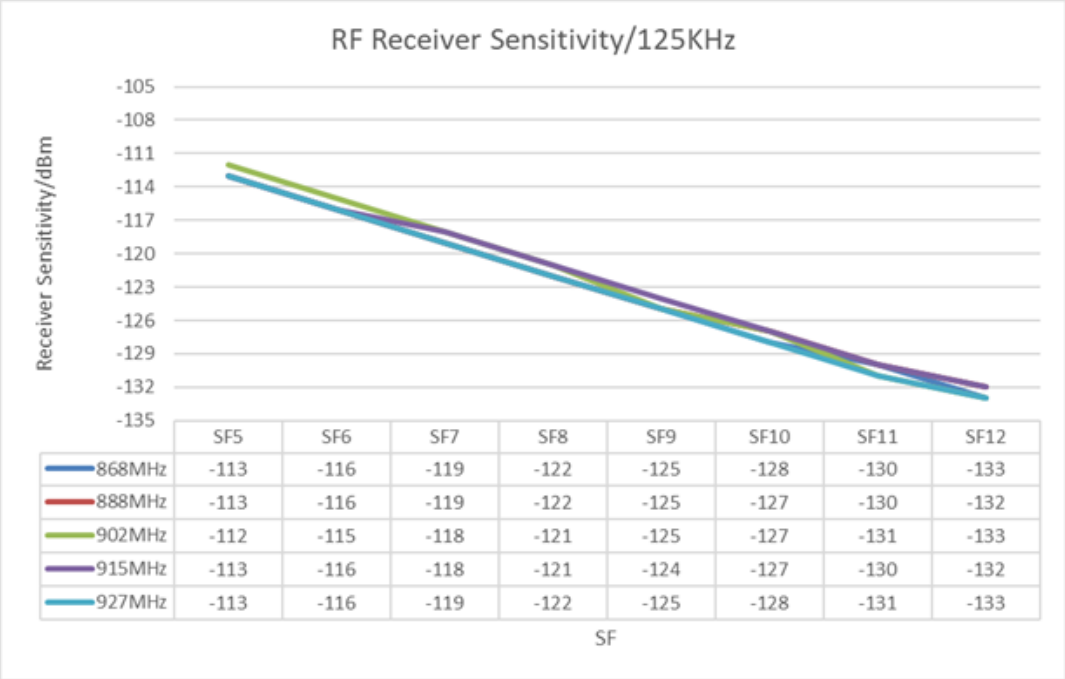
	-40	25	85
2400MHz	12.366	11.877	11.068
2420MHz	12.456	11.951	11.115
2460MHz	12.207	11.728	10.939
2480MHz	12.474	11.966	11.119
2500MHz	12.606	12.073	11.227

- **RF Receiver Sensitivity vs Spreading factor（470~510MHz）**



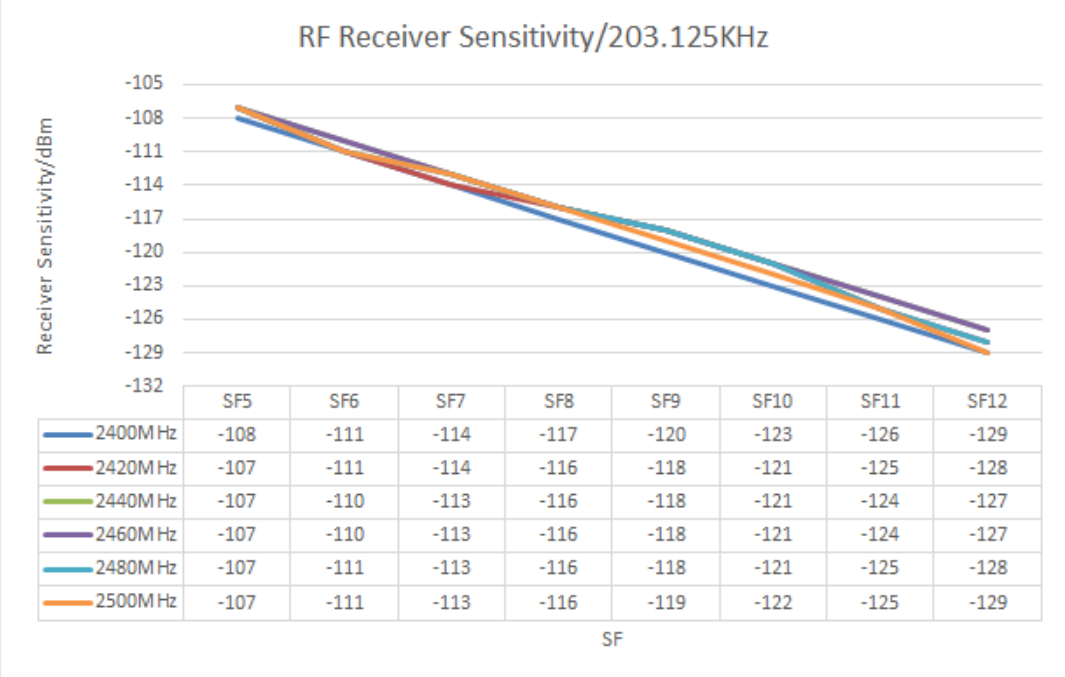
	SF5	SF6	SF7	SF8	SF9	SF10	SF11	SF12
470MHz	-113	-116	-119	-122	-125	-128	-131	-134
480MHz	-113	-116	-119	-121	-125	-128	-130	-133
490MHz	-112	-116	-119	-121	-125	-128	-131	-133
500MHz	-112	-115	-118	-120	-124	-127	-130	-133
510MHz	-112	-115	-119	-122	-124	-128	-131	-133

- **RF Receiver Sensitivity vs Spreading factor（868~915MHz）**



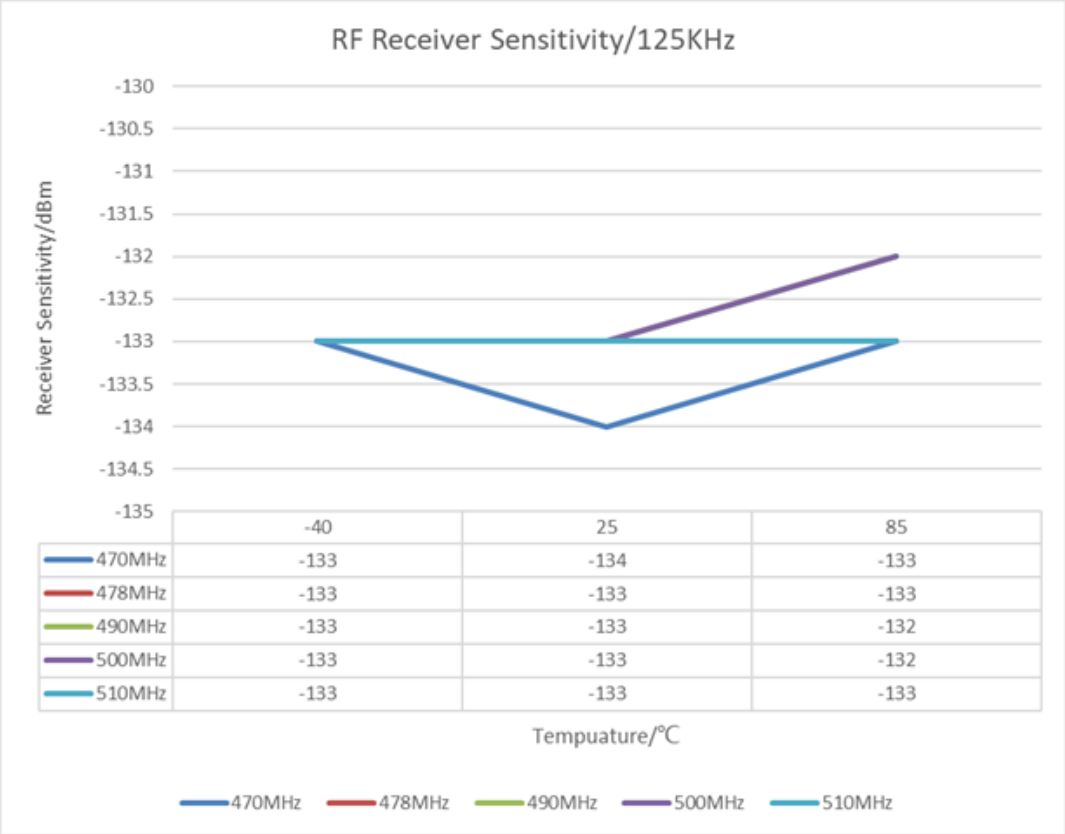
	SF5	SF6	SF7	SF8	SF9	SF10	SF11	SF12
868MHz	-113	-116	-119	-122	-125	-128	-130	-133
888MHz	-113	-116	-119	-122	-125	-127	-130	-132
902MHz	-112	-115	-118	-121	-125	-127	-131	-133
915MHz	-113	-116	-118	-121	-124	-127	-130	-132
927MHz	-113	-116	-119	-122	-125	-128	-131	-133

- **RF Receiver Sensitivity vs Spreading factor（2400~2500MHz）**

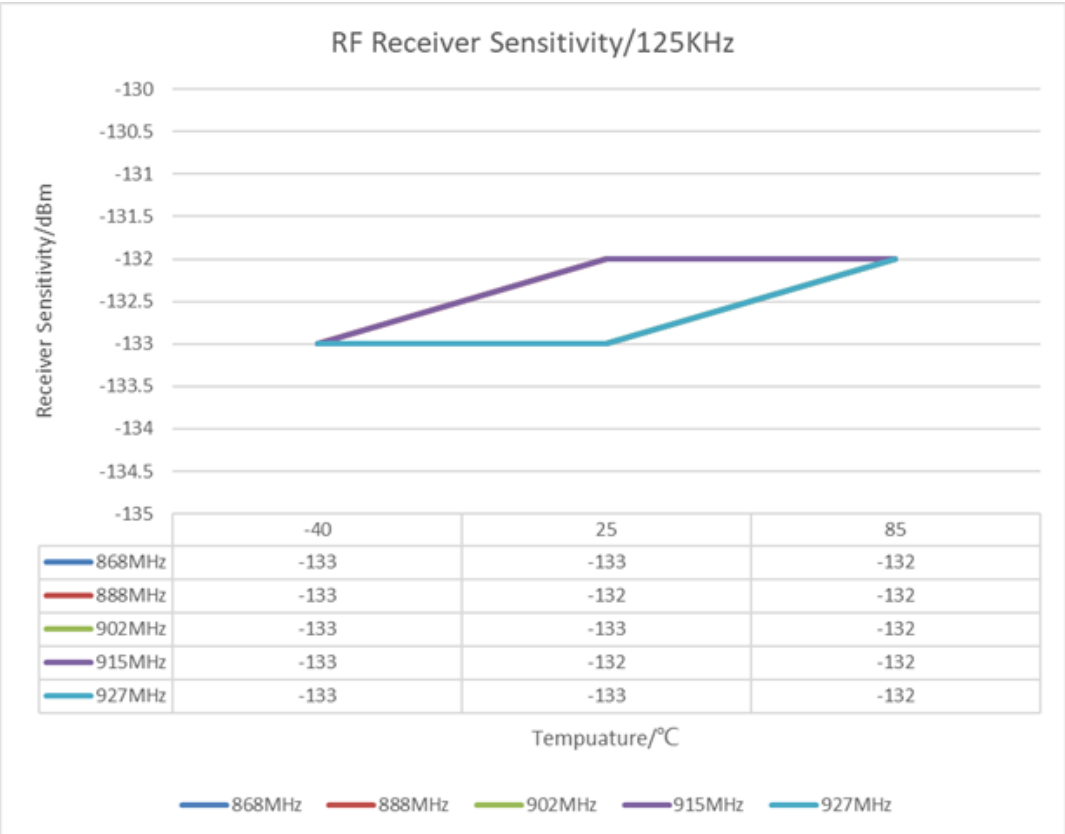


	SF5	SF6	SF7	SF8	SF9	SF10	SF11	SF12
2400MHz	-108	-111	-114	-117	-120	-123	-126	-129
2420MHz	-107	-111	-114	-116	-118	-121	-125	-128
2440MHz	-107	-110	-113	-116	-118	-121	-124	-127
2460MHz	-107	-110	-113	-116	-118	-121	-124	-127
2480MHz	-107	-111	-113	-116	-118	-121	-125	-128
2500MHz	-107	-111	-113	-116	-119	-122	-125	-129

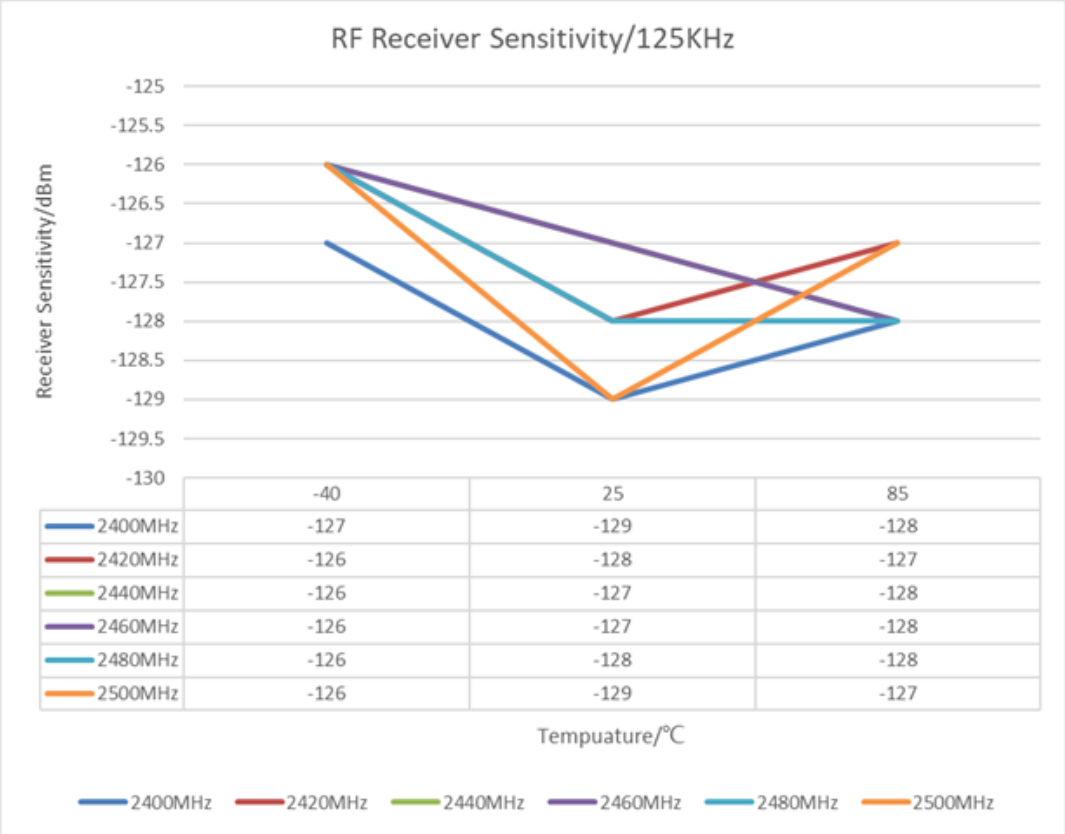
- **RF Receiver Sensitivity/SF12 VS Temperature（470~510MHz）**



- **RF Receiver Sensitivity/SF12 VS Temperature（868~915MHz)**

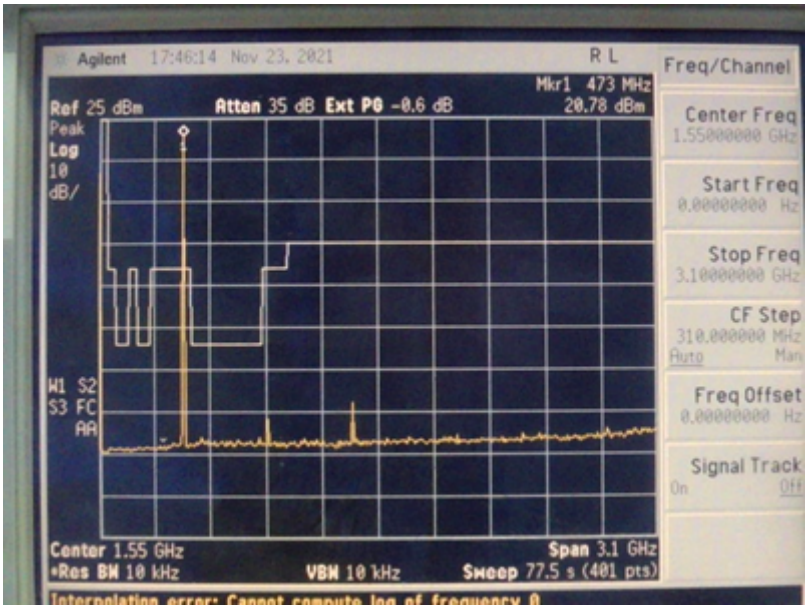


- **RF Receiver Sensitivity/SF12 VS Temperature（2400~2500MHz)**

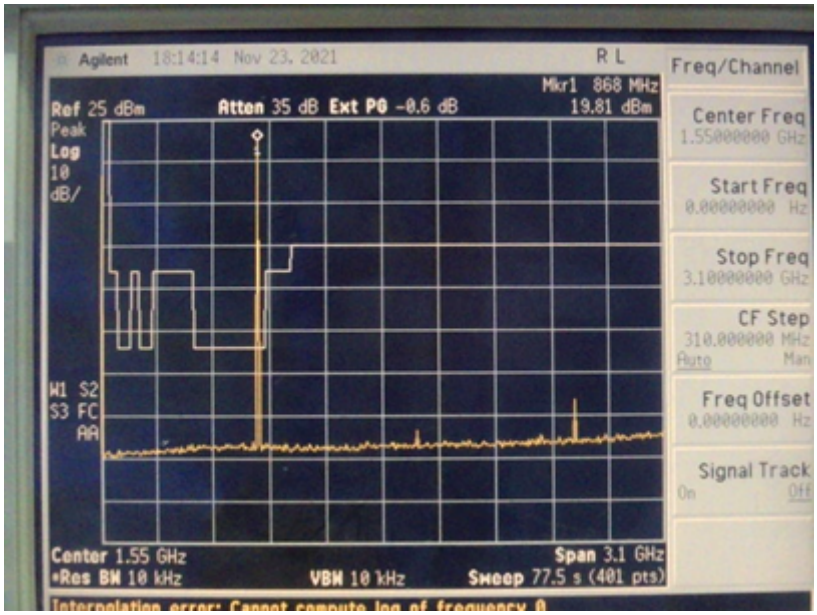


	-40	25	85
2400MHz	-127	-129	-128
2420MHz	-126	-128	-127
2440MHz	-126	-127	-128
2460MHz	-126	-127	-128
2480MHz	-126	-128	-128
2500MHz	-126	-129	-127

- **Harmonic(25MHz~3GHz)@Frf=470MHz, TXOP=22dBm**



- **Harmonic(25MHz~3GHz)@Frf=868MHz, TXOP=22dBm**

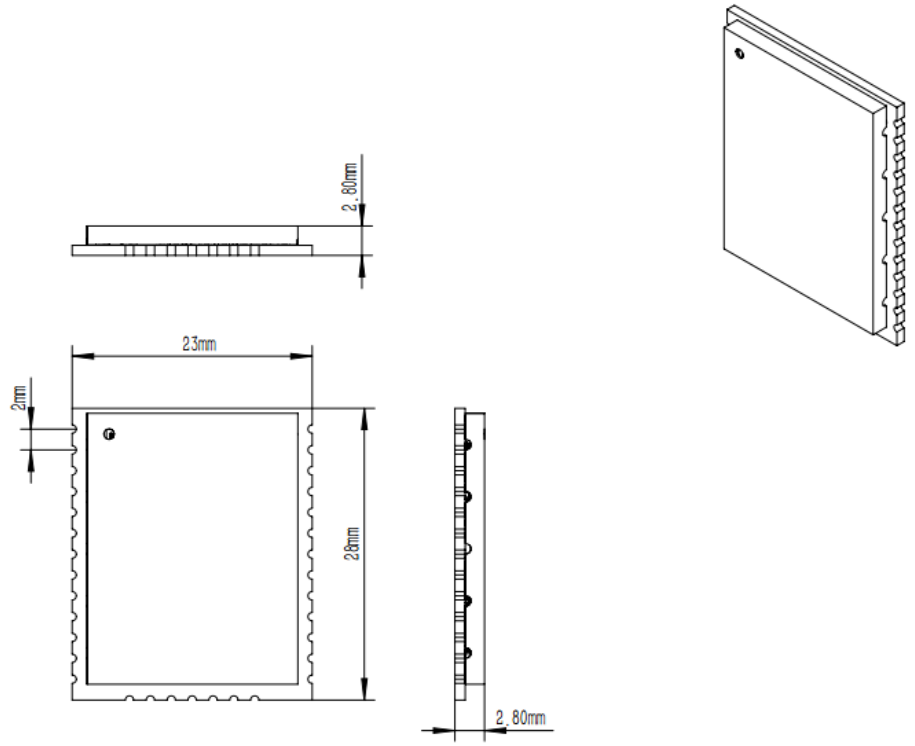


- **Harmonic(25MHz~3GHz)@Frf=2400MHz, TXOP=22dBm**

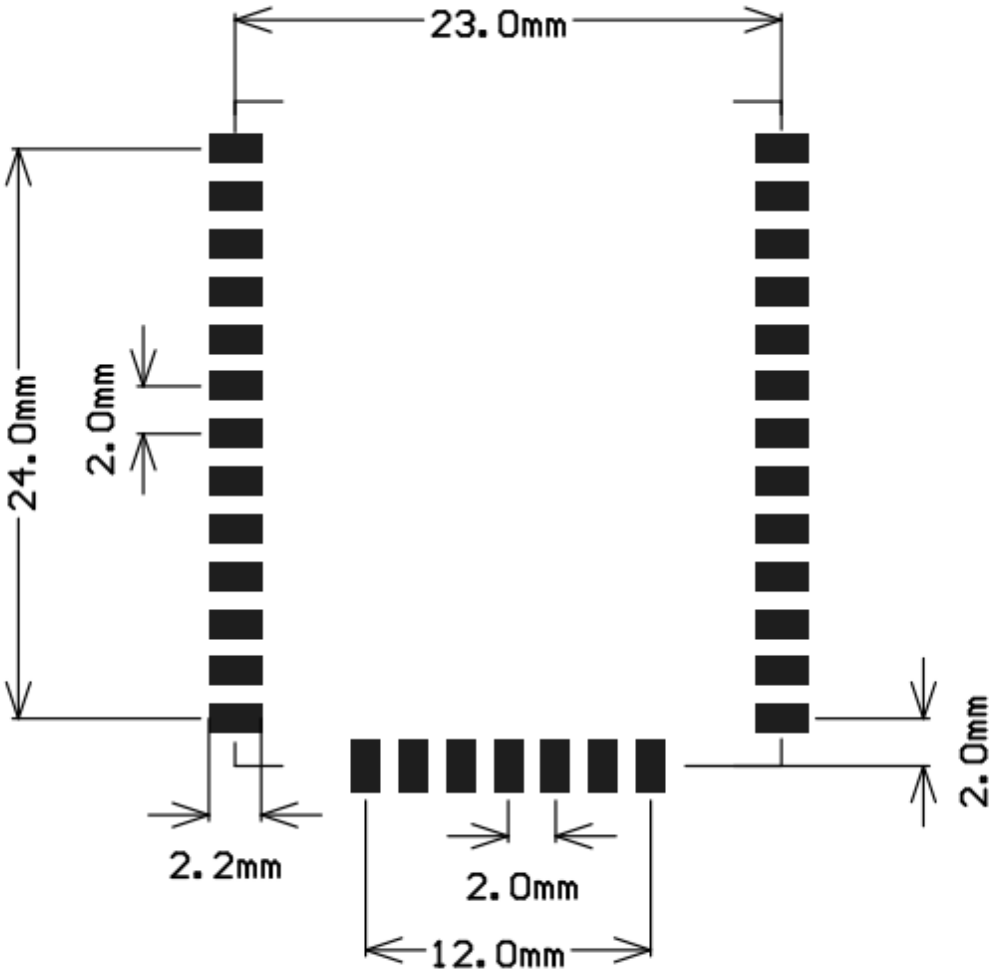
Application information

Package information

RHF0M084 has a 33pin chip package:



The following figure shows the recommended Layout package size:

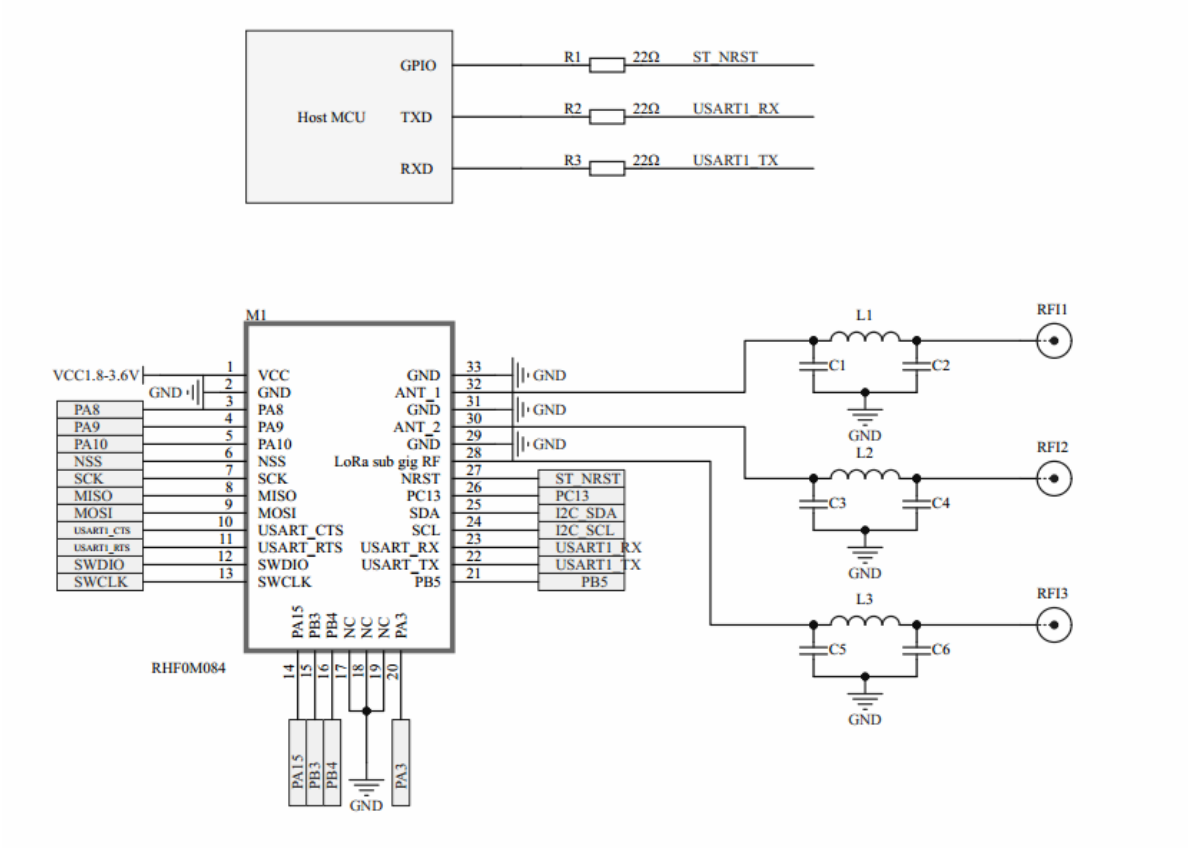


Module external interface

Except for a few necessary GPIO ports and a set of SPI ports that are used for the control of the internal radio frequency transceiver, other GPIOs of the MCU have been led out, including UART (used for AT commands) and so on. For those users who wish to develop software or expand peripherals on the on-chip MCU of the module, these rich GPIO interfaces can meet the needs of most applications.

Reference design based on RHF0M084 module

RHF0M084 embeds the global LoRaWAN® protocol and AT command set. This will make the LoRaWAN® node design based on this module very easy. The following is a typical reference design for using RHF0M084 to quickly start LoRaWAN® applications. Just connect UART and NRST to the host MCU and send AT commands.



LoRaWAN® application information

- ## LoRaWAN® application

The topology of the LoRaWAN® network is a star network, and the gateway acts as a relay between
nodes and network servers. The gateway is connected to the network server through a standard IP link,
and the node device uses LoRa® or FSK to communicate with one or more gateways. Communication
is bidirectional, although it is mainly upstream communication from the node to the network server.
The communication between the node and the gateway uses different frequencies and rates. The choice of rate is a compromise between power consumption and distance, and different rates do not
interfere with each other. According to different spreading factors and bandwidths, the rate of

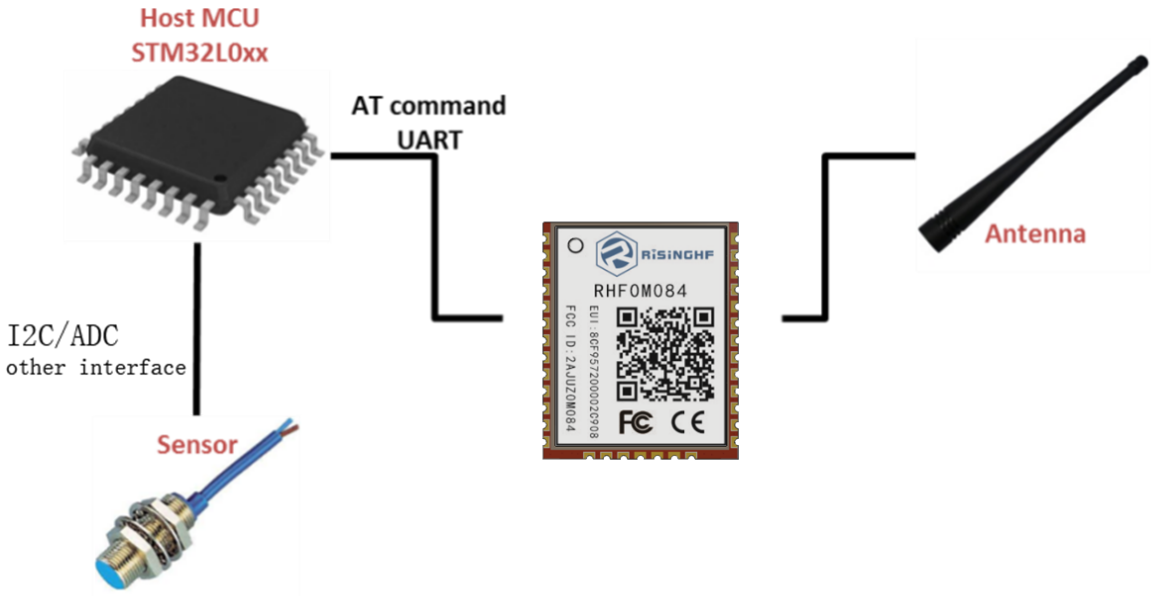
LoRa®
can be from 300bps to 50Kbps. In order to maximize battery life and network capacity, the network
server manages the node's rate and output power through rate adaptation (ADR).
The node device may transmit on a random channel at any time and at any rate, as long as the following conditions are met:

1. The channel currently used by the node is pseudo-random. This makes the system more resistant to interference \
2. The maximum transmission time (dwell time of the channel) and duty cycle of each node depends on the frequency band used and local regulations

The current of RHF0M084 module is only 2uA in sleep mode, this module is very suitable for various applications of LoRaWAN®.

- ## Design of LoRaWAN® wireless sensor based on RHF0M084

RHF0M084 is an AT command set that encapsulates the global LoRaWAN® standard protocol. Customers only need a very simple MCU as the master control, and can control RHF0M084 through the serial port, thus easily implementing the LoRaWAN® protocol. This helps customers quickly introduce sensor products to the LoRaWAN® market.



Ordering Information

Part Number	MCU	TX Power (dBm)	AT Modem
RHF0M084	**ROM 256KB / RAM 60KB**	**22@LF (470MHz)/22dBm@(868/915MHz)/13dBm@2400MHz**	Yes

Contact salescn@risinghf.com for more ordering information.