UM02516

RHF4M603 LTE Cat.1 Module Hardware Manual

V0.1

Document information

Info	Content
Keywords	*RisingHF, LTE, Cat.1, GSM, Module, AT command*
Abstract	Describe RHF4M603 LTE Cat.1 Module Hardware Manual

Contents

Image Index

Table Index

Chapter 1. Introduction

This document is the hardware manual of the LTE Cat1 module RHF4M603, which aims to describe the hardware composition and functional characteristics of the module, and also the application interface definition, use instructions, electrical and mechanical properties, etc. Combined with this document and other application documents, users can quickly use this module to design wireless application schemes.

Chapter 2. Module Overview

2.1 Module introduction

RHF4M603 module is a LTE Cat.1 bis + GNSS positioning two-in-one wireless communication module based on ASR1603 platform, which supports multi-band and cost-effective in overseas markets. The module supports data connection communication protocols such as LTE-FDD, EDGE, GPRS and GSM, and supports up to 10Mbps download rate and 5Mbps upload rate. It can provide voice function for customer specific scene application.

The RHF4M603 module is an LCC+LGA packaged patch module with a compact size of only (24 ±0.1) mm * (24 ±0.1) mm * (2.4 ±0.2) mm, can meet almost all M2M application needs.

RHF4M603 can be applied in the following situations：

- ✧ Mobile computing devices
- ✧ Automated industry
- ✧ Remote monitoring
- ✧ Tracking and positioning system
- ✧ Smart metering
- ✧ Wireless advertising, multimedia
- ✧ Security system
- ✧ Wireless POS machine

2.2 Module Characteristics

Table 2-1 Module part number list

Part number	Region	Band	RAM+Flash	GNSS
RHF4M603CX-EU	Europe Australia Asia	LTE: B1/B3/B5/B7/B8/B20/B28 GSM: 850/900/180	8MB+8MB	×
RHF4M603CG-EU				√
RHF4M603SX-EU			16MB+8MB	×
RHF4M603SG-EU				√

RHF4M603EX-EU			16MB+16MB	×
RHF4M603EG-EU				√
RHF4M603CX-LA	Latin America	LTE: B1/B2/B3/B4/B5/B7/B8/B28/B66 GSM: 850/900/1800/1900	8MB+8MB	×
RHF4M603CG-LA				√
RHF4M603SX-LA			16MB+8MB	×
RHF4M603SG-LA				√
RHF4M603EX-LA			16MB+16MB	×
RHF4M603EG-LA				√

Table 2-2 Key features

Features		Description
Physical Property		(24±0.1)mm * (24±0.1)mm * (2.4±0.2)mm
Mount method		LCC+LGA packaging, SMT
Working Voltage		3.3V ~ 4.2V typical 3.7V
Energy Saving Current		Sleep current < 2mA
Interface	USIM	Two groups of USIM cards are supported, and the module supports 3.0V and 1.8V USIM cards
	USB	✧ Comply with USB2.0 specification (only support slave mode), data transfer rate up to 480Mbps ✧ It is used for AT command, data transfer, software debugging and software upgrade ✧ USB driver supports Windows/Linux/Android etc
	UART	Main serial port (4-wire) : ✧ Used for AT commands and data transfers ✧ Support RTS and CTS hardware flow control ✧ The baud rate is up to 3.6Mbps, and the default is 115200bps Auxiliary serial port (2 lines) : ✧ By default, it is connected to GNSS serial port for data through transmission ✧ The default baud rate is 115200bps Debugging serial port (2 lines) : ✧ For debugging information output, print module log ✧ The default baud rate is 115200bps

	I2C	✧ Conform to I2C bus protocol ✧ The high-speed mode supports up to 3.4Mbps
	SPI	✧ Support host mode, up to 52M clock frequency
	Audio interface	✧ Support a set of analog audio input interfaces ✧ Support a set of analog audio output interfaces
	ADC interface	✧ Support 1 channel general ADC ✧ Supports 1 VBAT ADC
	Status Indication	✧ NET_STATUS network operation status indication ✧ STATUS module running status indicator
	BOOT	✧ Forced download interface
	LCD*	✧ Supports a maximum resolution of 240 ×320 ✧ Support SPI single-wire data communication
	Camera*	✧ Supports up to 0.3MP pixels, does not support video mode ✧ Support SPI single-wire or dual-wire data communication
Transmission Power		Class 4 (33dBm±2dB) for GSM850/EGSM900: Class 1 (30dBm±2dB) for DCS1800/PCS1900: Class E2 (26dBm±3dB) for GSM850/EGSM900 8-PSK Class E2 (25dBm±3dB) for DCS1800/PCS1900 8-PSK Class 3 (23dBm±2dB) for LTE bands Note：In the 4-slot transmission mode of the GPRS network, the maximum output power will be reduced by 3dB. This design complies with the GSM specifications outlined in Section 13.16 of 3GPP TS 51.010-1.
LTE Data Service		✧ LTE: DL 10Mbps, UL 5Mbps@20M
GSM Characteristics		EDGE: Support EDGE multi slot level 12 Support GMSK and 8-PSK modulation and coding methods Supports a maximum downlink speed of 236.8Kbps and a maximum uplink speed of 236.8Kbps GPRS: Supports GPRS multi slot level 12 Maximum downlink speed 85.6Kbps, maximum uplink speed 85.6Kbps
SMS		✧ Text and PDU mode ✧ Peer-to-peer messaging

	✧ Short message cell broadcast ✧ Short message storage: Stored in USIM card and ME, default in ME
Wi-Fi Scan	✧ Support Wi-Fi hotspot scanning and Wi-Fi localization
GNSS Characteristics	✧ Supports GPS, GLONASS, BDS, Galileo, QZSS ✧ Horizontal positioning accuracy< 2m@CEP50 ✧ Cold start sensitivity (typical value) -149dBm ✧ Re capture sensitivity (typical value) -159dBm ✧ Tracking sensitivity (typical value) -166dBm
AT Command	✧ Support standard AT instruction set (Hayes 3GPP TS 27.007 和 27.005) ✧ Refer to AT command Specification for detail
Network Protocol	✧ TCP/UDP/PPP/HTTP/NITZ/CMUX/RNDIS/NTP/ HTTPS/PING
Antenna interface	✧ Main & Wi-Fi Scan Antenna Interface ✧ GNSS antenna interface (optional) ✧ 50Ω characteristic impedance
Virtual network card	✧ Support USB virtual network card
Temperature range	✧ Normal operating temperature -30℃ to + 75℃ ✧ Extreme working temperature -40 ℃ to+85 ℃ ✧ Storage temperature -40 ℃ to+90 ℃

NOTE

- ✧ When the temperature ranges from -40 ℃ to -30 ℃ or+75 ℃ to+85 ℃, some RF indicators of the module may slightly exceed the 3GPP standard range. The module can still maintain normal working status, and the RF spectrum and network are basically not affected. When the temperature returns to the normal operating temperature range, all indicators of the module can still meet the requirements of 3GPP specifications.
- ✧ The main antenna and Wi Fi Scan share the antenna interface, and the two functions cannot be used simultaneously. Time division multiplexing is required.
- ✧ * Unless otherwise specified, the (*) marked after defining module interfaces and pins indicates that the feature is currently under development and not supported.

2.3 Module Functions

RHF4M603 module mainly contains the following circuit units:

- ✧ LTE RF processing unit
- ✧ GNSS processing unit
- ✧ Power management unit
- ✧ Module interface unit

RHF4M603 functional block diagram：

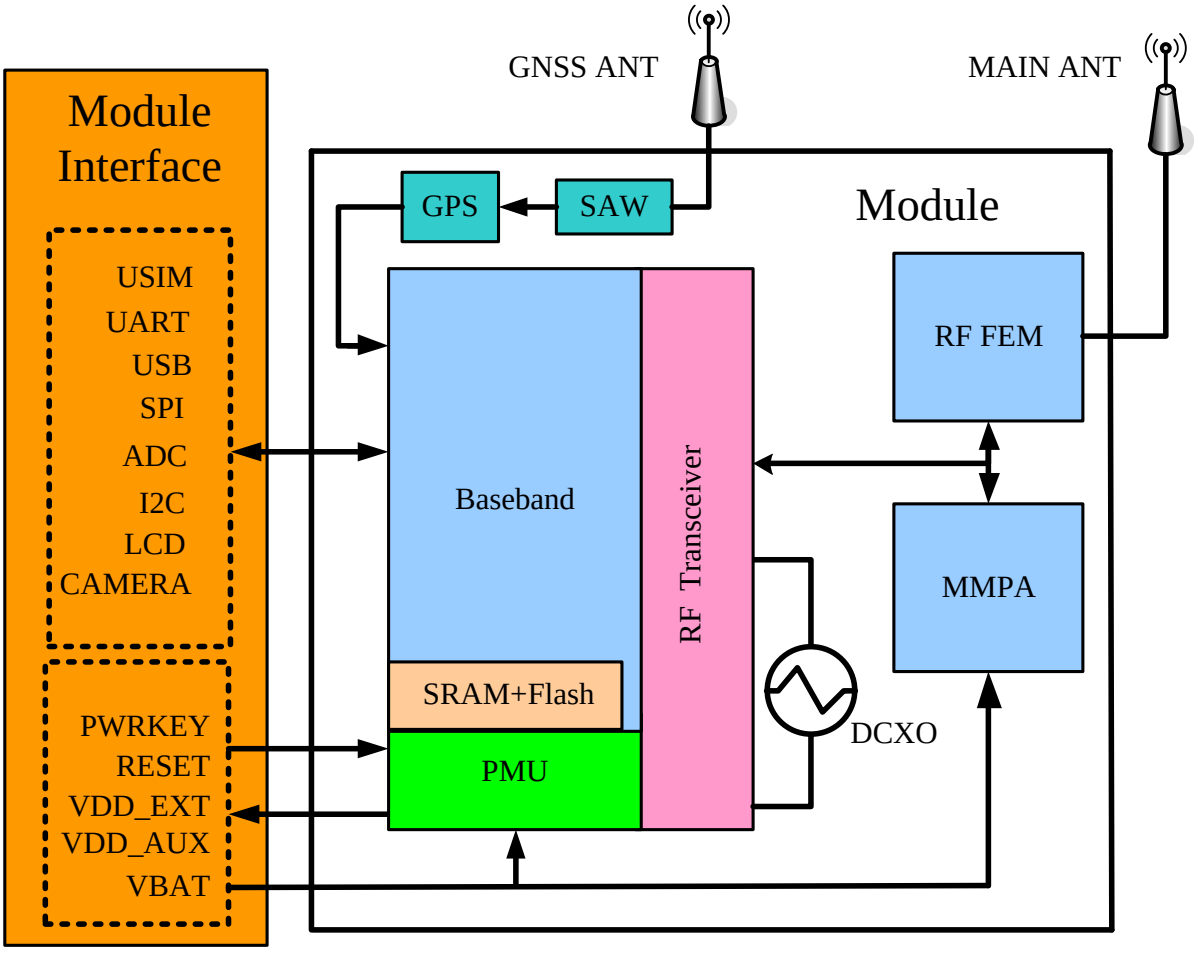


Figure 2-1 RHF4M603 functional block diagram

Chapter 3. Interface Application Description

3.1 Overview of this Chapter

This chapter mainly describes the interface definition and application of the module. It consists of the following parts：

- ✧ Module Pin Distribution Diagram
- ✧ Pin Definition
- ✧ power Interface
- ✧ USB Interface
- ✧ USIM Interface
- ✧ UART Interface
- ✧ ADC Interface
- ✧ Audio Interface
- ✧ LCD*
- ✧ Camera*
- ✧ SPI Interface
- ✧ RF Antenna Interface

3.2 Module Interface

3.2.1 Module Pin Distribution Diagram

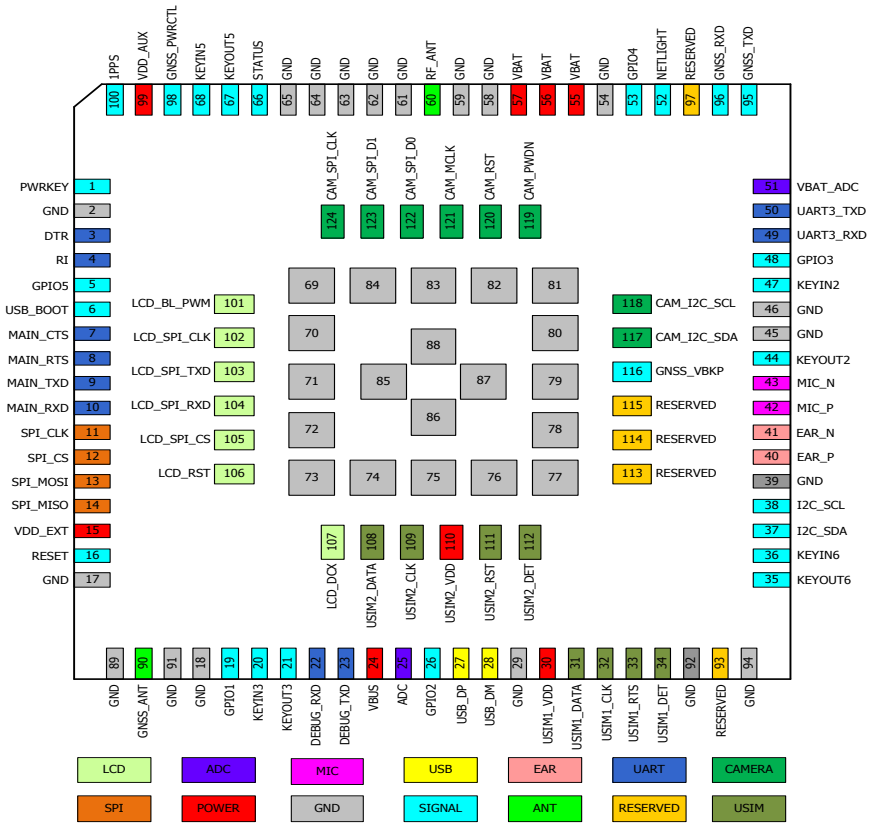


Figure 3-1 RHF4M603 Pin Distribution Diagram（TOP Perspective）

NOTE

- ✧ All RESERVED and unused pins should be suspended.
- ✧ USB_BOOT pin should not be pulled down before the module is successfully powered.
- ✧ The GNSS function of the module is optional:

  When the module GNSS function is not selected, UART3 can be used as an auxiliary serial port function.

  When selecting the GNSS function module, UART3 can be connected to the GNSS UART pin for GNSS transparent transmission.

3.2.2 Pin Definition

RHF4M603 module has a total of 124 pins, of which 80 are LCC pins and the remaining 44 are LGA pins. The pin definition is shown in the following table:

Table 3-1Pin Definitions

Pin number	Pin Name	Pin number	Pin Name
1	PWRKEY	2	GND
3	DTR	4	RI
5	GPIO5	6	USB_BOOT
7	MAIN_CTS	8	MAIN_RTS
9	MAIN_TXD	10	MAIN_RXD
11	SPI_CLK	12	SPI_CS
13	SPI_MOSI	14	SPI_MISO
15	VDD_EXT	16	RESET
17	GND	18	GND
19	GPIO1	20	KEYIN3
21	KEYOUT3	22	DBG_RXD
23	DBG_TXD	24	VBUS
25	ADC	26	GPIO2
27	USB_DP	28	USB_DM
29	GND	30	USIM1_VDD
31	USIM1_DATA	32	USIM1_CLK
33	USIM1_RST	34	USIM1_DET
35	KEYOUT6	36	KEYIN6
37	I2C_SDA	38	I2C_SCL
39	GND	40	EAR_P
41	EAR_N	42	MIC_P
43	MIC_N	44	KEYOUT2
45	GND	46	GND
47	KEYIN2	48	GPIO3
49	UART3_RXD	50	UART3_TXD

51	VBAT_ADC	52	NETLIGHT
53	GPIO4	54	GND
55	VBAT	56	VBAT
57	VBAT	58	GND
59	GND	60	RF_ANT
61	GND	62	GND
63	GND	64	GND
65	GND	66	STATUS
67	KEYOUT5	68	KEYIN5
69	GND	70	GND
71	GND	72	GND
73	GND	74	GND
75	GND	76	GND
77	GND	78	GND
79	GND	80	GND
81	GND	82	GND
83	GND	84	GND
85	GND	86	GND
87	GND	88	GND
89	GND	90	GNSS_ANT
91	GND	92	GND
93	RESERVED	94	GND
95	GNSS_TXD	96	GNSS_RXD
97	RESERVED	98	GNSS_PWRCTL
99	VDD_AUX	100	1PPS
101	LCD_BL_PWM*	102	LCD_SPI_CLK*
103	LCD_SPI_TXD*	104	LCD_SPI_RXD*
105	LCD_SPI_CS*	106	LCD_RST*
107	LCD_DCX*	108	USIM2_DATA
109	USIM2_CLK	110	USIM2_VDD
111	USIM2_RST	112	USIM2_DET
113	RESERVED	114	RESERVED

115	RESERVED	116	GNSS_VBKP
117	CAM_I2C_SDA*	118	CAM_I2C_SCL*
119	CAM_PWDN*	120	CAM_RST*
121	CAM_MCLK*	122	CAM_SPI_D0*
123	CAM_SPI_D1*	124	CAM_SPI_CLK*

Table 3-2 IO Parameter Definitions

Symbolic Mark	Description
IO	Two-Way Input and Output
PI	Power Input
PO	Power Output
AI	Analog Input
AO	Analog Output
AIO	Analog input/output
DI	Digital Input
DO	Digital Output
OD	Open Drain

Table 3-3 Pin Description

Power Supply				
Pin number	**Pin Definition**	**IO**	**Function Description**	**Remarks**
15	VDD_EXT	PO	1.8V voltage output	It can provide pull-up for external GPIOs (Imax<50mA)
24	VBUS	AI	USB insertion detection	The range is 3 to 5.25V
99	VDD_AUX	PO	Adjustable voltage output power supply. The default voltage output is 3V	It can provide power for GNSS active antennas or peripheral devices such as LCD, with a maximum current of

				50mA
30	USIM1_VDD	PO	USIM1 power supply	The module automatically recognizes 1.8V or 3.0V SIM cards
110	USIM2_VDD	PO	USIM2 power supply	
55,56,57	VBAT	PI	Module main power supply	The power supply needs to have a current-carrying capacity of at least 2A
2,17-18,29,39,45-46,54,58-59,61-65,69-89,91-92,94			GND	
Module on/off and Reset				
Pin Number	**Pin Definition**	**IO**	**Function Description**	**Remarks**
1	PWRKEY	DI	Power on/off pin	Default low level is valid
16	RESET	DI	Reset pin, internally pull up to VDD_EXT	Active low
Status Indication				
Pin Number	**Pin Definition**	**IO**	**Function Description**	**Remarks**
52	NETLIGHT	DO	Module network status indication	1.8V level. If not in use, it remains suspended
66	STATUS	DO	Module operation status indication	1.8V level. If not in use, it remains suspended
Debug the Serial Port				
Pin Number	**Pin Definition**	**IO**	**Function Description**	**Remarks**
22	DBG_RXD	DI	Debug the serial port data reception	1.8V level. If not in use, it remains suspended
23	DBG_TXD	DO	Debug the serial port data transmission	
Auxiliary Serial Port				

Pin Number	Pin Definition	IO	Function Description	Remarks
49	UART3_RXD	DI	UART3 data reception	1.8V level. If not in use, it remains suspended
50	UART3_TXD	DO	UART3 data transmission	
Main Serial Port				
Pin Number	**Pin Definition**	**IO**	**Function Description**	**Remarks**
3	DTR	DI	Used for the host wake-up module	1.8V level. If not in use, it remains suspended
4	RI	DO	Used for module wake-up of the host	1.8V level. If not in use, it remains suspended
7	MAIN_CTS	DO	DTE Clear Send	CTS connected to the main control
8	MAIN_RTS	DI	DTE request is sent	Connect to the main control RTS
9	MAIN_TXD	DO	Main serial port data transmission	1.8V level. If not in use, it remains suspended
10	MAIN_RXD	DI	Main serial port data reception	
SPI Interface				
Pin Number	**Pin Definition**	**IO**	**Function Description**	**Remarks**
11	SPI_CLK	DO	SPI clock output	1.8V level. If not in use, it remains suspended
12	SPI_CS	DO	SPI chip selection signal	
13	SPI_MOSI	DO	SPI data output	
14	SPI_MISO	DI	SPI data input	
USB Interface				
Pin Number	**Pin Definition**	**IO**	**Function Description**	**Remarks**
24	USB_VBUS	AI	USB insertion detection	3V~5.25V
27	USB_DP	AIO	USB bus differential	90 Ω differential

			positive signal	impedance
28	USB_DM	AIO	USB bus differential negative signal	90Ω differential impedance
I2C Interface				
Pin Number	**Pin Definition**	**IO**	**Function Description**	**Remarks**
37	I2C_SDA	IO	I2C bus data	1.8V level An external pull-up resistor is required
38	I2C_SCL	DO	I2C bus clock	
Analog Audio				
Pin Number	**Pin Definition**	**IO**	**Function Description**	**Remarks**
40	EAR_P	AO	Audio receiver output (+)	If not in use, it will be suspended
41	EAR_N	AO	Audio receiver output (-)	
42	MIC_P	AI	Audio microphone input (+)	
43	MIC_N	AI	Audio microphone input (-)	
USIM Interface				
Pin Number	**Pin Definition**	**IO**	**Function Description**	**Remarks**
30	USIM1_VDD	PO	Power supply for USIM card 1	Pull up the internal 4.7K resistor to USIM1-VDD
31	USIM1_DATA	DIO	USIM card 1 data	
32	USIM1_CLK	DO	USIM card 1 clock	
33	USIM1_RST	DO	USIM card 1 reset	
34	USIM1_DET	DI	USIM card 1 hot plug detection	USIM1 hot plug detection
108	USIM2_DATA	DIO	USIM card 2 data	Pull up the internal 4.7K resistor to USIM2-VDD
110	USIM2_VDD	PO	USIM card 2 power supply	
109	USIM2_CLK	DO	USIM card 2 clock	
111	USIM2_RST	DO	USIM card 2 reset	

112	USIM2_DET	DI	USIM card 2 hot-swappable test	USIM2 hot-swappable test
USB_BOOT Interface				
Pin Number	**Pin Definition**	**IO**	**Function Description**	**Remarks**
6	USB_BOOT	DI	Forced download and startup	Low level is effective. Do not pull down before the module is powered on
ADC Interface				
Pin Number	**Pin Definition**	**IO**	**Function Description**	**Remarks**
25	ADC	AI	12-bit universal analog-to-digital conversion	Input range: 0-1.8V
51	VBAT_ADC	AI	12-bit VBAT analog-to-digital conversion	The input range is 0 to VBAT
General-Purpose GPIO				
Pin Number	**Pin Definition**	**IO**	**Function Description**	**Remarks**
5	GPIO5	DIO	Universal input/output port	PU, 1.8V. If not in use, leave it suspended
19	GPIO1	DIO	Universal input/output port	
26	GPIO2	DIO	Universal input/output port	PU, 1.8V. If not in use, leave it suspended
48	GPIO3	DIO	Universal input/output port	
53	GPIO4	DIO	Universal input/output port	PU, 1.8V. If not in use, leave it suspended
LCD Interface				
Pin Number	**Pin Definition**	**IO**	**Function Description**	**Remarks**
101	LCD_BL_PW	DO	LCD backlight PWM	1.8V voltage range

	M*		regulation	has functions to be developed and remains suspended
102	LCD_SPI_CLK*	DO	SPI clock signal	
103	LCD_SPI_TXD*	DIO	SPI data output	
104	LCD_SPI_RXD*	DI	SPI data input	
105	LCD_SPI_CS*	DO	SPI chip selection signal	
106	LCD_RST*	DO	LCD reset signal	
107	LCD_DCX*	DO	LCD register selection	
Camera Interface				
Pin Number	**Pin Definition**	**IO**	**Function Description**	**Remarks**
117	CAM_I2C_SDA*	OD	CAM I2C serial data	1.8V voltage range has functions to be developed and remains suspended
118	CAM_I2C_SCL*	OD	CAM I2C serial clock	
119	CAM_PWDN*	DO	CAM PWDN control	
120	CAM_RST*	DO	CAM reset signal	
121	CAM_MCLK*	DO	CAM Master clock	
122	CAM_SPI_D0*	DIO	CAM SPI data bit D0	
123	CAM_SPI_D1*	DIO	CAM SPI data bit D1	
124	CAM_SPI_CLK*	DO	CAM SPI clock	
Matrix key Interface				
Pin Number	**Pin Definition**	**IO**	**Function Description**	**Remarks**
20	KEYIN3	DI	Matrix key input 3	1.8V voltage range remains suspended if
21	KEYOUT3	DO	Matrix key output 3	

35	KEYOUT6	DO	Matrix key output 6	not in use
36	KEYIN6	DI	Matrix key input 6	
44	KEYOUT2	DO	Matrix key output 2	
47	KEYIN2	DI	Matrix key input 2	
67	KEYOUT5	DO	Matrix key output 5	
68	KEYIN5	DI	Matrix key input 5	
Radio Frequency Interface				
Pin Number	**Pin Definition**	**IO**	**Function Description**	**Remarks**
60	RF_ANT	AIO	The main antenna and WI-FI Scan share the antenna, with time-division multiplexing	50Ω characteristic impedance
90	GNSS_ANT	AI	GNSS antenna	50Ω characteristic impedance
Other Interfaces				
Pin Number	**Pin Definition**	**IO**	**Function Description**	**Remarks**
93、97、113、114、115			RESERVED	Stay Suspended

NOTE

✧ The IO pin level of this module is 1.8V (except for USIM1 and USIM2, the pins of USIM1 and USIM2 support 1.8V and 3.0V respectively)

3.3 Power Interface

The power interface of RHF4M603 module includes four parts:

- ✧ VBAT is the main power supply for module operation
- ✧ The USIM1-VDD and USIM2-VDD modules provide power output specifically for SIM1 and SIM2 cards, supporting two voltage levels of 1.8V and 3.0V.
- ✧ The VDD_EXT pin outputs a 1.8V power supply for the internal digital circuits of the module. It can also be used in external small current circuits (Imax=50mA). When supplying power to the external circuit, it is recommended to connect a decoupling capacitor of 2.2uF to 4.7uF in parallel. When the module is powered on, VDD_EXT is turned on by default and cannot be turned off. Keep it suspended when not in use.
- ✧ The VDD_AUX pin is an adjustable voltage output power supply. The default voltage output is 3V, and it can provide a maximum current capacity of 50mA, which can supply power to GNSS active antennas or peripheral devices such as LCDS.

3.3.1 Power Supply Design

RHF4M603 power interface definition：

Table 3-4 power interface definition

pin number	Name	I/O	Description	Minimum value	Typical voltage	Maximum value
15	VDD_EXT	PO	1.8V voltage output		1.8V	
30	USIM1_VDD	PO	SIM card 1 power supply	0V	1.8V/2.85V	1.98/3.3V
110	USIM2_VDD	PO	SIM card 2 power supply	0V	1.8V/2.85V	1.98/3.3V
99	VDD_AUX	PO	3.0V voltage output		3.0V	
55、56、57	VBAT	PI	Module main power supply	3.3V	3.7V	4.2V

The RHF4M603 module adopts a single power supply mode and provides three VBAT pins for connecting to external power supply.

When the module is registered for GSM standard data communication or call, the instantaneous high-power transmission will form a current peak, with the maximum current peak reaching 2A, which will cause a significant instantaneous voltage drop on the power supply, resulting in low voltage or insufficient supply current. The module may shut down or restart. Therefore, to reduce the power fluctuation during the operation of the module, a voltage stabilizing capacitor with a low ESR value should be used. The VBAT traces should be as short and wide as possible to reduce the equivalent impedance of the traces. In addition, to ensure the stability of the power supply, it is recommended to add a TVS diode with VRWM=4.7V, low clamping voltage and peak pulse current IPP at the front end of the power supply.

Please ensure the power supply has sufficient load capacity from VBAT, and a 220uF/6.3V tantalum capacitor can be connected in parallel near the power input. Additionally, 1uF, 0.1uF capacitors (to eliminate clock and digital signal interference) and 10pF, 33pF ceramic capacitors (to eliminate low-frequency RF interference) can be connected in parallel.。

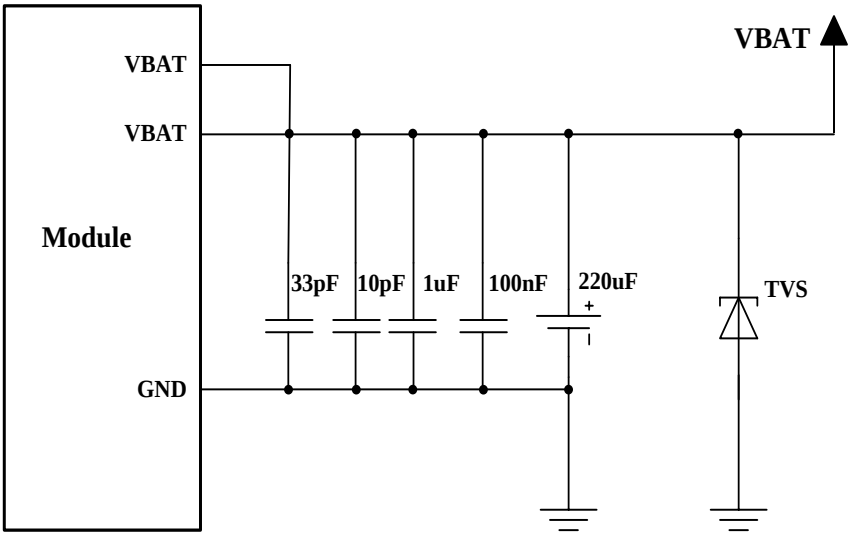


Figure 3-2 Design of Power Supply

Table 3-5 Power Supply Design Description

Recommendation value	Application Instructions	Remarks
220uF	Voltage stabilizing capacitor	Low ESR value capacitors are adopted to reduce power supply fluctuations

WS4.5D3HV	Low-capacitance TVS diode	Avoid power surges or ESD damage to the chip
1uF，100nF	Filter capacitor	Filter out the interference of digital signal noise
33pF，10pF	Filter capacitor	Filter out the radio frequency interference in the low and medium frequency bands

3.3.2 Power Supply Reference Circuit

Power supply design is crucial to the performance of the module. For modules that support the GSM standard, the selected external power supply should be able to provide a current capacity of at least 2A. The external power supply can be designed using a switching DC power supply or a linear LDO power supply, and then a PMOS transistor is used to control the power supply input so that the power can be completely cut off.

If the voltage value of the external power supply is not significantly higher than the voltage value required by the module, it is recommended to use LDO power supply. For specific details, please refer to the following circuit design:

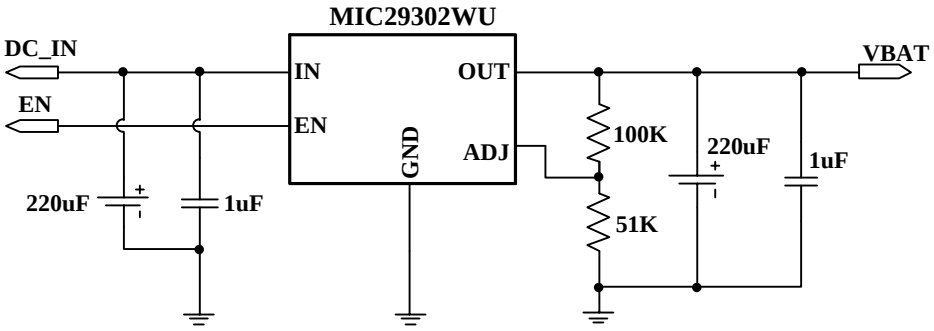


Figure 3-3 LDO linear power supply reference circuit

If the voltage value of the external power supply is significantly different from the voltage value required by the module, it is recommended to use a DC-DC switching power converter for power supply. For specific details, please refer to the following circuit design:

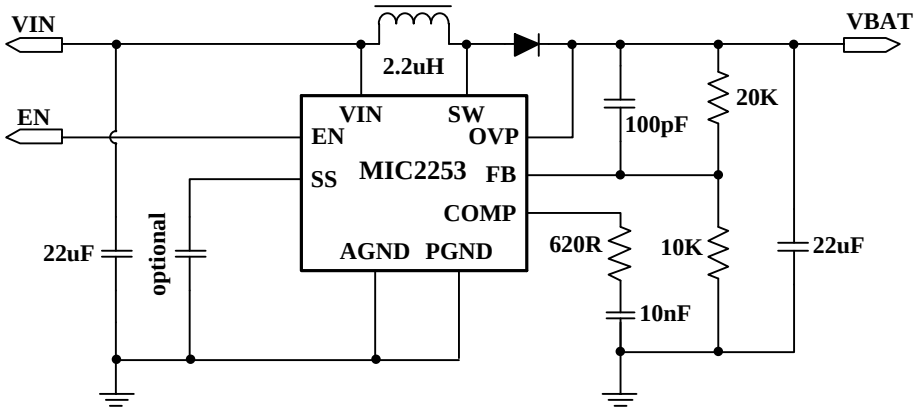


Figure 3-4 Reference circuit of DC-DC Power converter

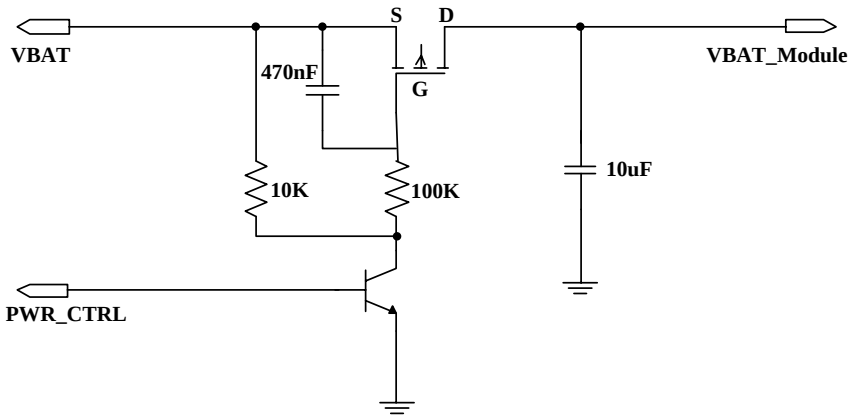


Figure 3-5 Reference circuit for power control by PMOS transistor

NOTE

- ✧ To prevent damage to the module caused by surges and overvoltage, it is recommended to connect a TVS diode with VRWM=4.5V and Ppp=1260W in parallel at the VBAT pin of the module.
- ✧ The minimum operating voltage of the module is 3.3V. When GSM transmits data or makes calls at its maximum transmission power, it will generate an instantaneous peak current of up to 2A. At the maximum transmission power of LTE, there will be approximately 600mA of continuous current. Therefore, the power supply must be able to provide sufficient load capacity; otherwise, a significant ripple voltage drop will occur on the power supply voltage, causing the module to restart or operate abnormally.
- ✧ Due to the large current consumption of the module power supply, it is recommended that the power supply PCB traces be as short and wide as possible to minimize the equivalent impedance of the VBAT traces.
- ✧ If a switching power supply is used to power the module, the power devices and power

traces of the switching power supply should be as far away from the antenna part as possible to prevent electromagnetic interference (EMI).

3.3.3 VDD_EXT Voltage Output

After RHF4M603 module is powered on, it will output a 1.8V power supply through the PIN15 VDD_EXT pin for use by the internal digital circuits. It can also be used in external small current circuits. When supplying power to external circuits, it is recommended to connect a decoupling capacitor of 2.2uF to 4.7uF in parallel. Keep it suspended when not in use.

NOTE

- ✧ After module is powered on, VDD_EXT is turned on by default and can't be turned off.
- ✧ Peripheral devices can determine whether the module is powered on by reading the voltage of VDD_EXT.
- ✧ The output current of the VDD_EXT pin is relatively small, with Imax=50mA. This power supply is more suitable for logic level circuits.

3.4 Reset Control

The PIN16 pin of the module is the reset pin. When the application end detects an abnormality in the module or the software is unresponsive, the module can be reset. Pull this pin down for at least 300ms to complete the reset. The RESET signal is relatively sensitive to interference. A capacitor no larger than 10nF can be reserved near the signal for signal filtering, and the wiring should be kept away from the RF interference signal.

Table 3-6 Definition of Reset Pins

Pin	Signal Name	I/O Attribute	High Level Value	Description
16	RESET	DI	1.8V	Low Level Effective

Table 3-7 Reset Methods

Reset Mode	Reset Mode
AT Command Reset	AT+CFUN=1,1
Hardware Reset	The module can be RESET by pulling down the reset pin at

	least 300ms and releasing it

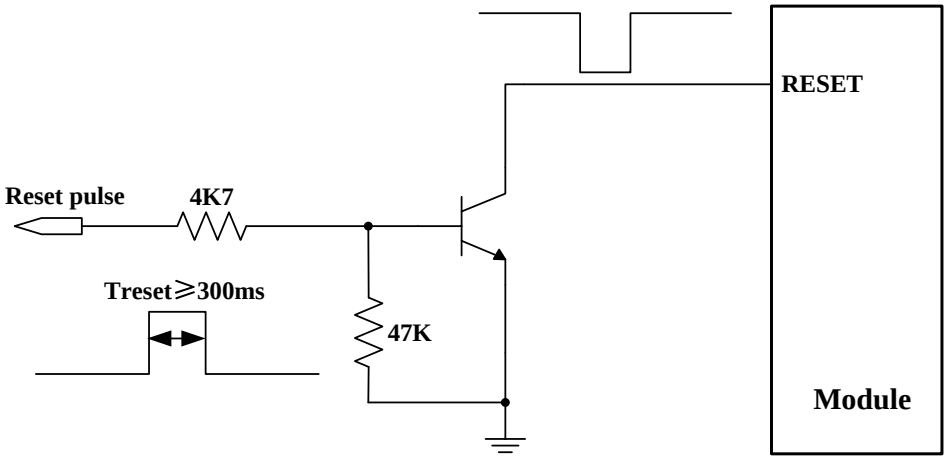


Figure 3-6 Reset reference circuit

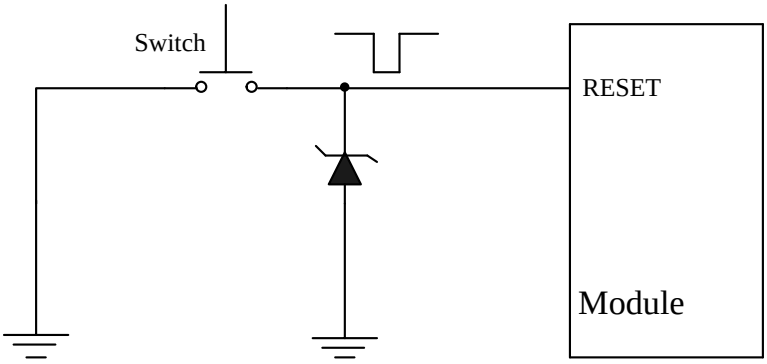


Figure 3-7 Reference circuit for key reset

Table 3-8 RESET Pin Parameters

Symbol	Description	Minimum value	Typical value	Maximum value	Unit
Treset	Low-level pulse width	300		-	ms
VIH	RESET inputs a high-level voltage		1.8	2.1	V
VIL	RESET input low-level voltage	-0.3	0	0.8	V

The RESET time sequence is as follows:

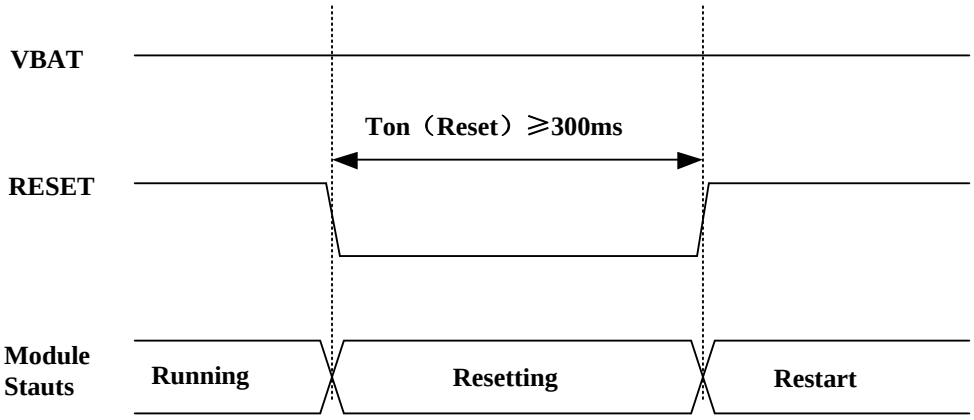


Figure 3-8 reset timing diagram

NOTE

- ✧ The RESET signal is relatively sensitive to interference. The wiring should be as far away from the radio frequency interference signal as possible and ground wrapped. A capacitor no larger than 10nF can be placed near the signal pin to filter out interference.
- ✧ The RHF4M603 module supports AT command reset. The AT command is AT+CFUN=1, and 1 can restart the module. Detailed instructions can be referred to the RHF4M603 AT instruction set manual.

3.5 Module Start-up

The PIN1 pin of the RHF4M603 module is the power-on pin. It can be powered on by pulling down the PWRKEY of the module PIN1 pin for at least 500ms. Users can determine whether the module is powered on by querying the high and low levels of the VDD_EXT pin。

Table 3-9 Definitions of Power on/Off Pins

Pin	Signal name	I/O Attribute	High-Level Value	Description
1	PWRKEY	DI	VBAT	active low voltage

The startup sequence is as follows:

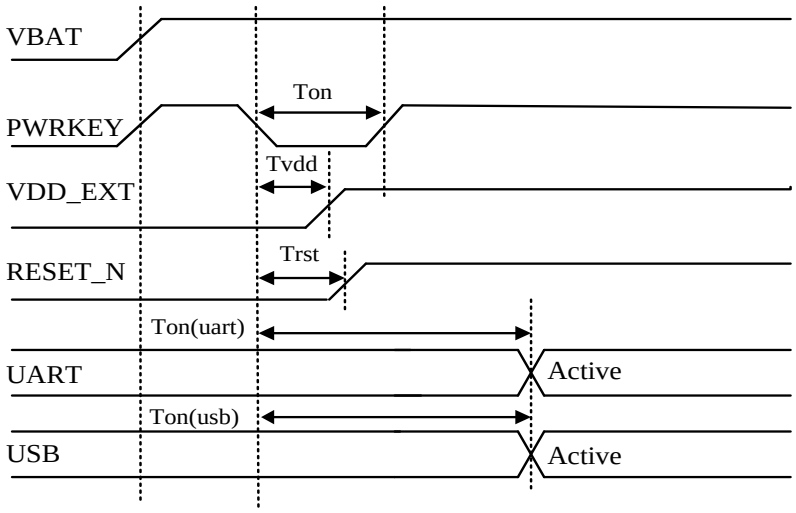


Figure 3-9 Startup timing diagram

Table 3-10 Startup Timing Parameters

Symbol	Description	Minimum value	Typical value	Maximum value	Unit
Ton	The module boots at a low level width	500	-	-	ms
Tvdd	VDD_EXT outputs the waiting time	-	10	-	ms
Trst	Module reset time	300	-	-	ms
Ton(usb)	Startup time (determined by usb status)		10	-	s
Ton(uart)	Startup time (judged by the status of uart)		4	-	s

It is recommended to use an open–collector output drive circuit to control the PWRKEY. After raising the base level for 500ms, it can be released, at which point the module is powered on。

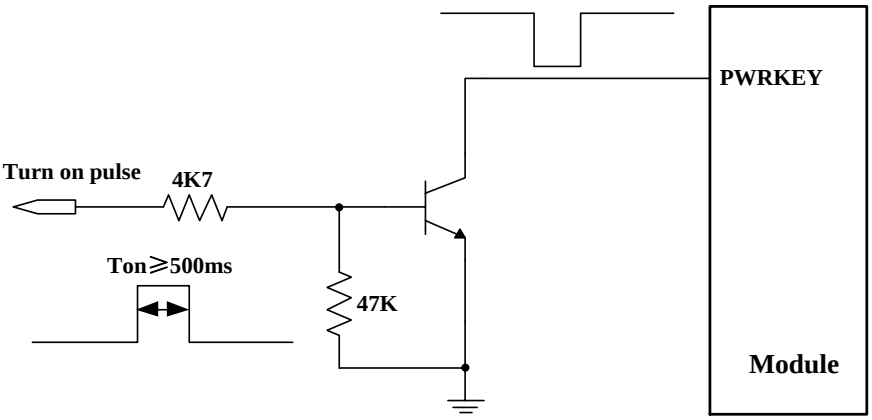


Figure 3-10 Open-collector output drive circuit to control the PWRKEY

The second way to power on is by pressing the button. Press the button for at least 500ms and then release it. At this point, the module is powered on.

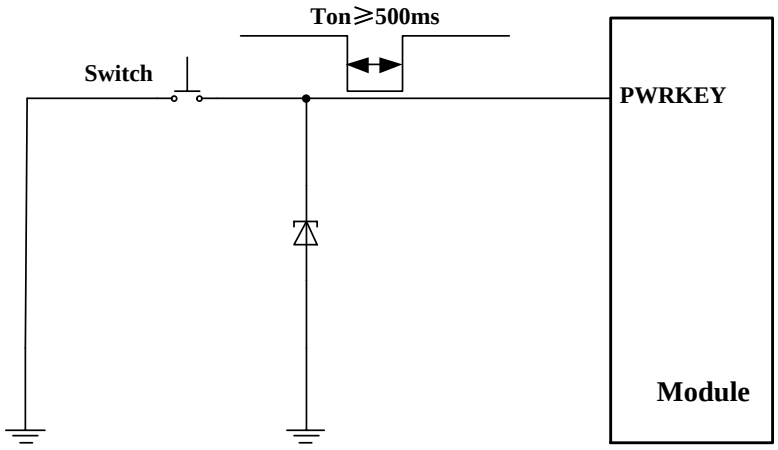


Figure 3-11 Reference circuit for button press startup

NOTE

- ✧ The module VBAT is usually stable after power-on for at least 30ms by the PWRKEY power-on action.
- ✧ If the user does not need the shutdown function, the PWRKEY can be directly pulled down to GND. It is recommended to connect a 4.7K resistor in series between GND and the PWRKEY.
- ✧ Make sure there are no large capacitors on the PWRKEY pins and their signal lines。

3.6 Module Shutdown

RHF4M603 supports the following three shutdown methods.

Table 3-11 Module Shutdown Methods

Shutdown Mode	Shutdown Conditions	Description
Low-voltage shutdown	The power supply voltage is too low or there is an abnormal power failure	The module did not go through the normal shutdown process
Hardware shutdown	Pull down the PWRKEY pin for more than 3 seconds	Perform the normal shutdown process
AT command shutdown	AT Command	Software shutdown

When the module is working normally, it cannot be shut down by cutting off the power supply, as this may damage the Flash data of the module. It is recommended to execute the shutdown process through the power on/off pin or the AT command.

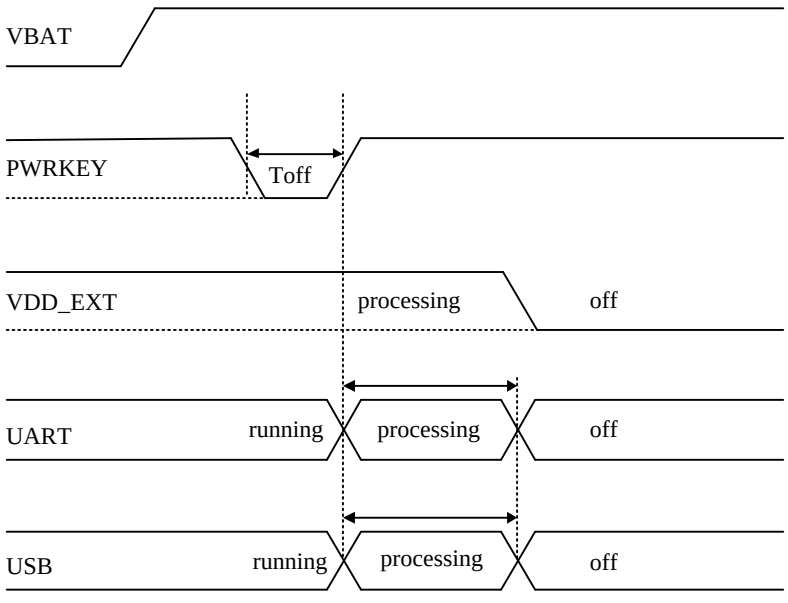


Figure 3-12 Shutdown sequence diagram

Table 3-12 Shutdown Timing Parameters

Symbol	Description	Minimum value	Typical value	Maximum value	Unit

Toff	Module shutdown low level width	3	-	-	s
Tpdp	Module system shutdown time	-	5	-	s

NOTE

- ✧ The module does not support the hardware shutdown function by default. If you need this function, you can contact your local FAE for support。
- ✧ When the module is working normally, do not shut it down by cutting off the power supply, otherwise the Flash data of the module may be damaged. It is recommended to execute the shutdown process through the PWRKEY and AT command (please refer to the RHF4M603 AT Command Specification).
- ✧ When executing the AT command to shut down, please ensure that the PWRKEY remains at a high level after the shutdown command is executed. Otherwise, after the module is shut down, it will automatically restart.

3.7 Firmware Download

The RHF4M603 supports the forced download function. Before starting up the module, pull the USB_BOOT pin to GND. Then the module will enter the download mode when starting up. At this time, the software of the module can be upgraded through the USB interface.

Table 3-13 Pin Definitions of USB_BOOT Interface

Pin Number	Pin Definition	I/O attribute	Function Description
6	USB_BOOT	DI	In the 1.8V voltage range, it is recommended to reserve test points. When the forced download function is not used, it is prohibited to pull down this pin before startup.

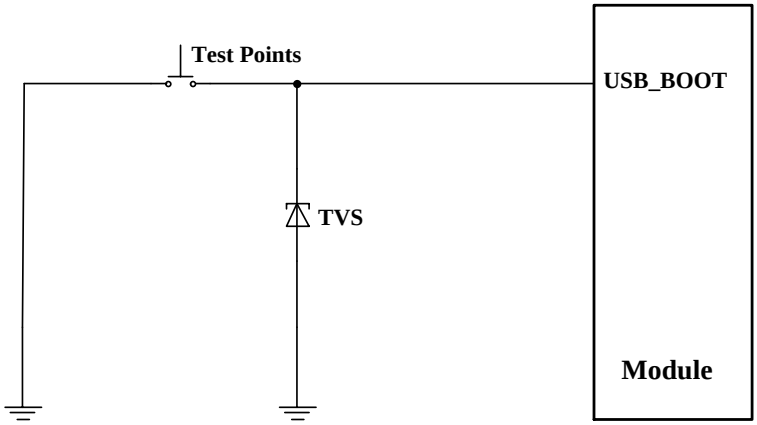


Figure 3-13 USB_BOOT reference design drawing

3.8 USB Interface

The RHF4M603 module supports one USB2.0 interface, supports device mode, but does not support USB charging function. The USB cable must comply with the USB2.0 protocol specification. The USB interface is defined as follows:

Table 3-14 USB Interface Pin Definitions

Pin Number	Signal Name	I/O Attribute	Description
24	VBUS	AI	USB insertion detection
27	USB_DP	AIO	USB differential signal +
28	USB_DM	AIO	USB differential signal -

The module, as a USB slave device, supports USB sleep and wake-up mechanisms. The reference circuit for the USB interface application is as follows:

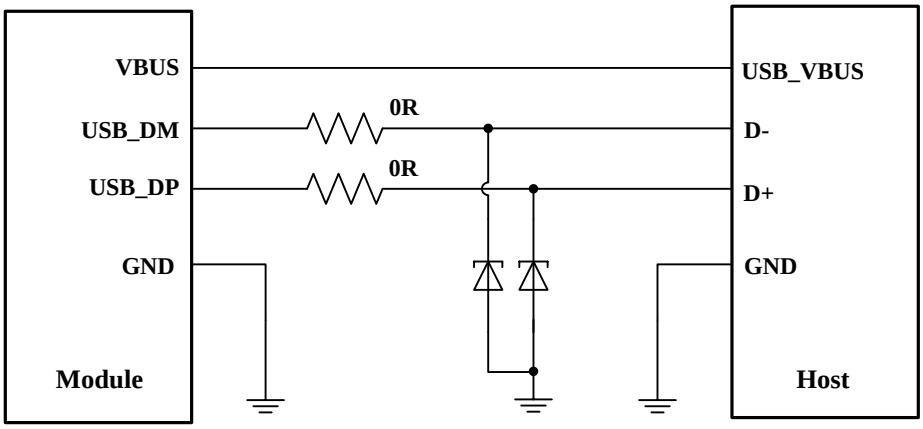


Figure 3-14 USB connection design circuit diagram

NOTE

- ✧ The USB interface supports high-speed (480Mbps) and full-speed (12Mbps) modes, so the design must strictly follow the requirements of the USB2.0 protocol.
- ✧ To enhance the anti-static performance of the USB interface, it is recommended to add ESD protection devices to the data cable. The equivalent capacitance value of the protection device should be less than 1pF, and the TVS diode should be placed close to the USB socket.
- ✧ It is recommended to string 0R resistors in series on each USB differential line, and place the resistors close to the peripheral devices.
- ✧ LAYOUT needs to strictly abide by the following rules:

1）The differential impedance controlled by USB_DP and USB_DM signal lines is 90Ω.

2）The USB_DP and USB_DM signal lines should be of equal length, parallel, and avoid right-angle and sharp-angle routing.

3）The USB_DP and USB_DM signal lines are laid in the signal layer closest to the ground layer. They are laid in the upper and lower layers and protected by ground shielding on both sides.

The USB interface can support the following functions:

- ✧ Software download and upgrade
- ✧ Data communication
- ✧ AT Command

3.9 UART Interface

The RHF4M603 module provides three sets of UART interfaces. Among them, one group is the main serial port, one group is the debugging serial port, and one group is the two-wire auxiliary serial port. All serial port levels are 1.8V.

3.9.1 Main Serial Port

Main serial port: This serial port can implement AT interaction instructions and interact with peripheral device data, etc.

The baud rate of the main serial port of the module can be set to 9600,19200,38400,57600,115200,230400,460800,921600 bps, etc. The default is 115200bps.

The main serial port interface is defined as follows:

Table 3-15 Definition of Main Serial Port Signal

Pin number	Signal name	I/O	Description	Remarks
3	DTR	DI	Used for the host wake-up module	The 1.8V voltage range remains suspended if not in use
4	RI	DO	Used for the module to wake up the host	
7	MAIN_CTS	DO	Clear the send	The CTS connected to the DTE
8	MAIN_RTS	DI	Request to send	The RTS connected to the DTE
9	MAIN_TXD	DO	Module data transmission	The 1.8V voltage range remains suspended if not in use
10	MAIN_RXD	DI	Module data reception	

When users want to use a 4-wire serial port, they can refer to the following connection methods:

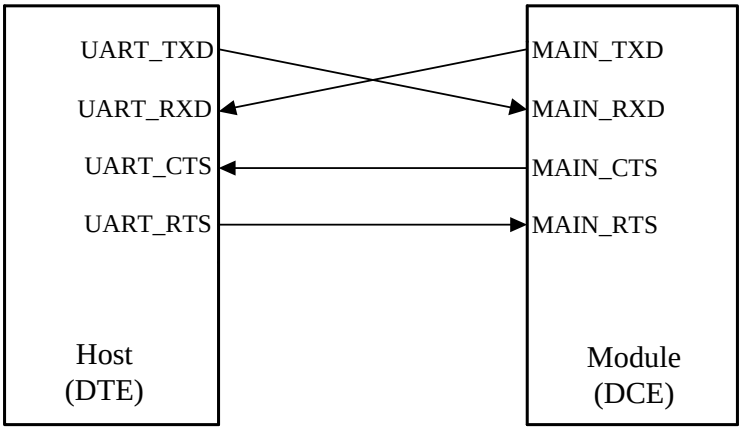


Figure 3-15 Four-wire serial port design drawing

When a two-wire serial port is needed, the following serial port design can be referred to:

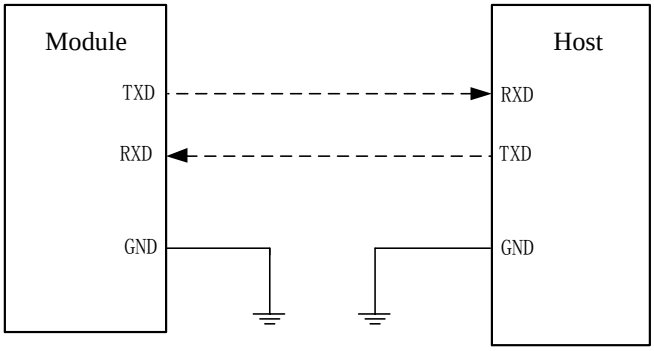


Figure 3-16 Design drawing of the two-wire serial port

The serial port of the module is at TTL 1.8V level. If the serial port needs to be connected to an MCU at 3.3V level, an external level conversion chip needs to be added to achieve level matching. The connection method of the chip can be referred to the following circuit:

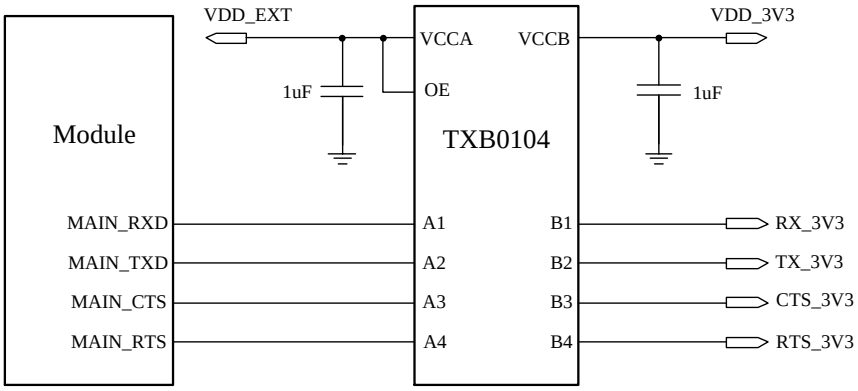


Figure 3-17 Level conversion chip circuit

NOTE

✧ It is necessary to pay attention to the input and output directions of the CTS and RTS pins of the serial port hardware flow control.

3.9.2 Debug the Serial Port

The RHF4M603 module provides a 2-wire Debug serial port for use as a debugging module. The debugging serial port supports a baud rate of 115200bps, which is used for Linux control and log printing. Test points can be reserved. Please keep them suspended when not in use.

Table 3-16 Definitions of Debug Serial Port Pins

Pin number	Signal name	I/O	Description	Remarks

22	DBG_RXD	DI	module receives data	The 1.8V voltage range remains suspended if not in use
23	DBG_TXD	DO	module sends data	

3.9.3 UART3

Pins 49 and 50 of the module are auxiliary serial ports, which are multiplexed with the GNSS serial port function by default. When the GNSS function is not selected, the UART3 serial port can be used directly. The auxiliary serial port is defined as follows:

Table 3-17 Definition of Auxiliary Serial Port Interface

Pin number	Signal Name	I/O	Description	Remarks
49	UART3_ RXD	DI	Auxiliary serial port data reception	The 1.8V voltage range remains suspended if not in use
50	UART3_ TXD	DO	Assist in serial port data transmission	

3.10 Hibernation Wake-up

The RHF4M603 module supports the sleep wake-up function. Through sleep, the power consumption of the module can be reduced. The way to wake up from hibernation can be achieved through different interface communication methods. For details, please refer to the following content.

3.10.1 Serial Port Sleep Wake-up Control

The RHF4M603 module is connected to the host via a serial port. The module can be put into sleep mode or awakened in the following ways:

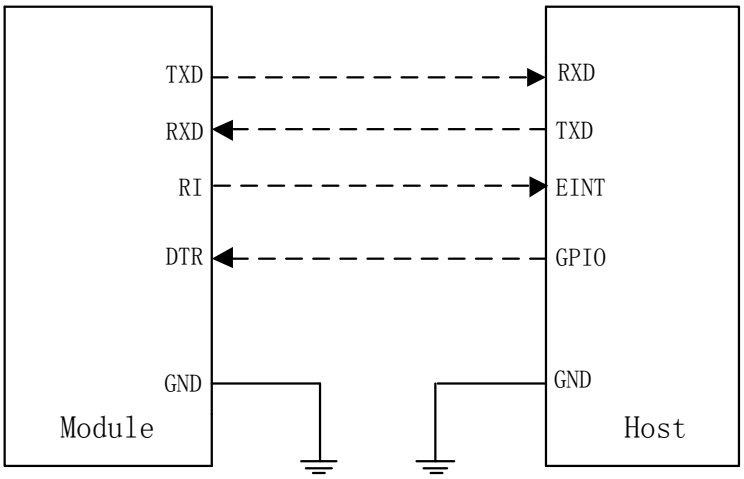


Figure 3-18 Hardware connection diagram for the sleep wake-up of the UART interface

Simultaneously satisfy the following two conditions:

1. The DTR remains at a high level or is suspended.

2. Execute the AT command: AT+CSCLK=1. The module then enters the sleep mode.

The module is awakened by pulling down the DTR of the module through the host. When the module has URC to report, the module can wake up the host through RI.

3.10.2 USB Sleep Wake-up Control

If the host supports USB suspension/interruption and remote wake-up functions, the module can enter sleep mode when the following three conditions are met simultaneously:

- ✧ AT+CSCLK=1 enables the sleep function of the module.
- ✧ The DTR pins of the module remain pulled high or suspended.
- ✧ The USB bus of the host connected to the USB interface enters the suspended state.

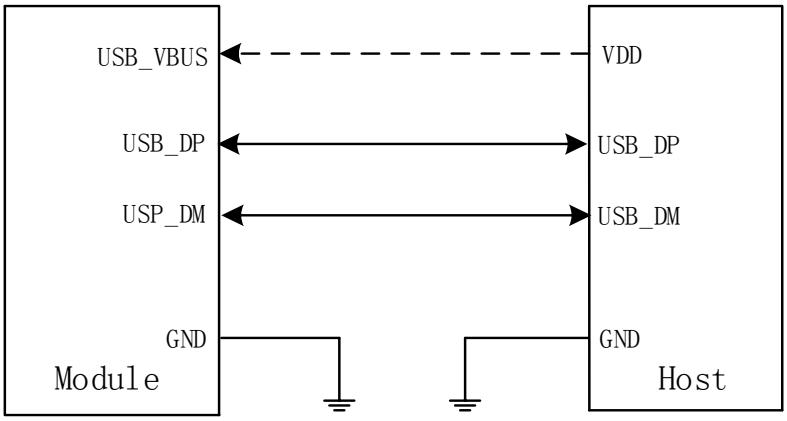


Figure 3-19 USB Remote Wake-up/Sleep Application

If the host supports USB suspension/interruption but does not outperform the remote wake-up function, the host needs to be awakened by the RI signal. If the following three conditions are met simultaneously, the module can enter the sleep mode:

- ✧ AT+CSCLK=1 enables the sleep function of the module.
- ✧ The DTR pins of the module remain pulled high or suspended.
- ✧ The USB bus of the host connected to the USB interface enters the suspended state.

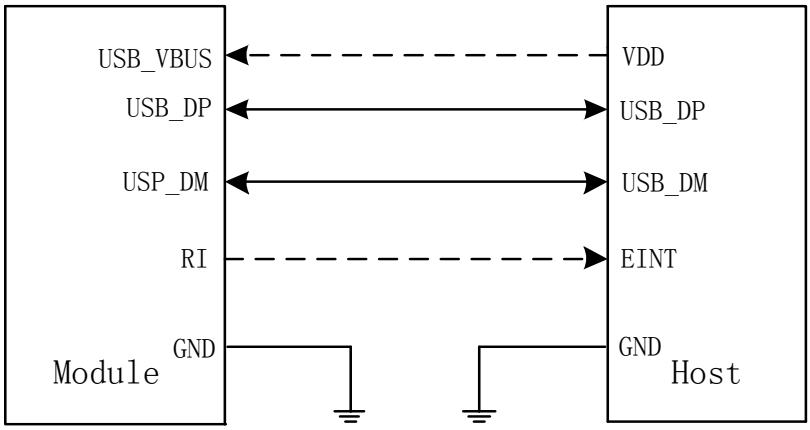


Figure 3-20 Wake-up/sleep application with RI function

NOTE

- ✧ Sending data to the module via USB will wake up the module.
- ✧ When the module has an URC report, it will send a remote wake-up signal via the USB bus to wake up the host.

If the host does not support the USB suspension function, the USB_VBUS can be disconnected through the external GPIO to put the module into sleep mode.

- ✧ Enable the sleep function of the module with AT+CSCLK=1.
- ✧ The DTR pins of the module remain pulled high or suspended.
- ✧ Disconnect the power supply of USB_VBUS.

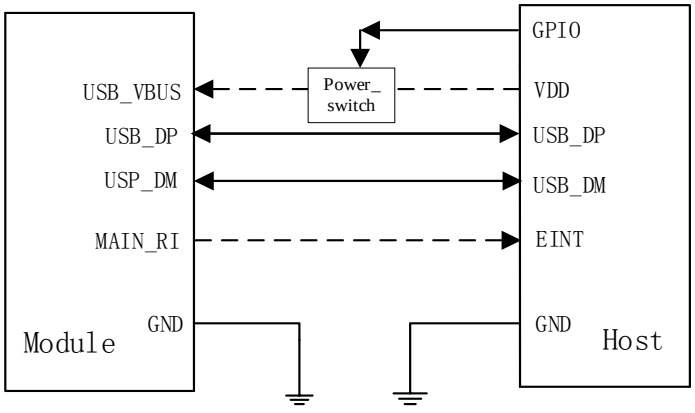


Figure 3-21 Wake-up/sleep applications that do not support the USB suspension function

NOTE

✧ Restoring the power supply of USB_VBUS can wake up the module.

✧ Please pay attention to the level matching of the dashed line connection signals between the module and the host in each of the above figures.

3.11 USIM Interface

The RHF4M603 module provides two USIM card interfaces compatible with the ISO 7816-3 standard. The power supply of the USIM card is provided by the internal power manager of the module. The module supports USIM cards with voltages of 1.8V and 3.0V.

Table 3-18 Definition of SIM Card Signal

Pin number	Signal Name	I/O Attribute	Description
30	USIM1_VDD	PO	Power supply for USIM card 1
31	USIM1_DATA	DIO	USIM card 1 data
32	USIM1_CLK	DO	USIM card 1 clock
33	USIM1_RST	DO	Reset USIM Card 1
34	USIM1_DET	DI	USIM card 1 hot plug detection
108	USIM2_DATA	DIO	USIM card 2 data
109	USIM2_CLK	DO	USIM card 2 clock
110	USIM2_VDD	PO	Power supply for USIM card 2
111	USIM2_RST	DO	Reset USIM Card 2
112	USIM2_DET	DI	USIM card 2 hot plug detection

3.11.1 Reference Circuit of USIM Card

The RHF4M603 module does not come with a USIM card slot. When users use it, they need to design a USIM card slot on their own interface board.

The reference circuit of the USIM card interface is as follows:

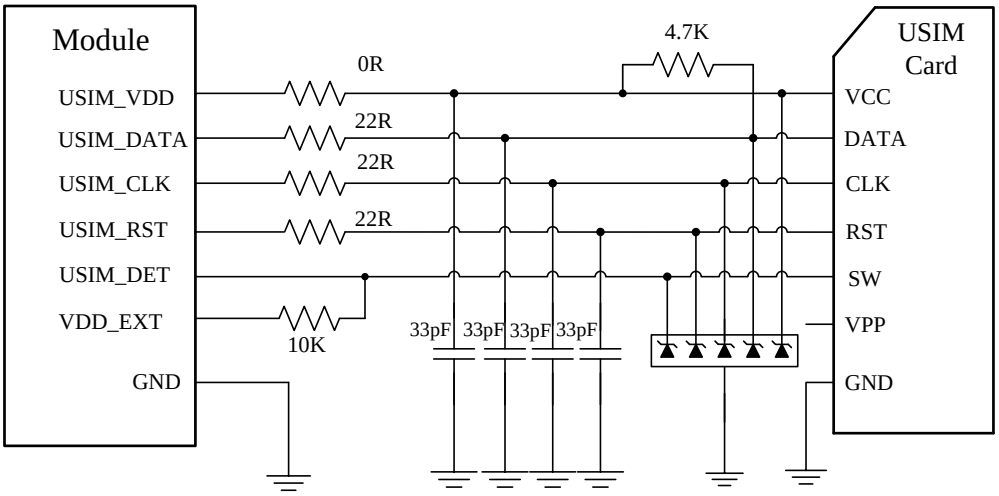


Figure 3-22 USIM design circuit diagram

NOTE

The circuit design of the USIM card needs to meet the EMC standards and ESD requirements. At the same time, the anti-interference ability needs to be improved to ensure that the USIM card can work stably. The following points need to be strictly adhered to during the design:

- ✧ The peripheral circuit devices of the USIM interface should be placed close to the card slot, and the USIM card slot should be arranged close to the module.
- ✧ The USIM card circuit is prone to RF interference, which may cause the card to fail to recognize or drop. Therefore, the card slot should be placed as far away as possible from the RF radiation of the antenna, and the card routing should be kept as far away as possible from RF, power and high-speed signal lines.
- ✧ To prevent instantaneous voltage overload for the USIM interface, it is recommended to connect a 22R resistor in series on each signal line path.
- ✧ The ground of the USIM card slot and the ground of the module should maintain good connectivity.
- ✧ For USIM card slots, it is advisable to choose those with metal casings as much as possible to enhance their anti-interference capability.

3.11.2 USID_DET Hot Plug Reference Design

The RHF4M603 module supports hot swapping of USIM cards. The USIM1-DET and USIM2-DET pins are used as input detection pins to determine whether the USIM card is inserted or not. The USIM1-DET pin module has been pulled up internally. The hot plug function can be turned on or off through AT+HOSCFG, and this function is turned off by

default. (For details, please refer to the RHF4M603 AT instruction set)

3.12 Status Indication

The RHF4M603 module provides two GPIO pins to indicate the module status. The status indicator is mainly used to drive the status indicator light (it is necessary to control the on and off of the transistor to power on and off the LED light to achieve the on and off of the LED, and it is not recommended to directly drive the LED light). The following table defines the pin functions and the levels in different states respectively.

Table 3-19 Definition of Status Indicator Pins

Pin	Signal Name	I/O	Description	Remarks
52	NETLIGHT	DO	Module network status indication	1.8V voltage range does not need to remain suspended
66	STATUS	DO	Module operation status indication	

Table 3-20 Module Operating Status Indication

Pin Name	Operating status indication	Pin Level	Remarks
STATUS	Power on status	high Level	1.8V voltage range does not need to remain suspended
	other	Low Level	

Table 3-21 Module Network Status Indication

Pin Name	Operating status indication	Pin Level State
NETLIGHT	During the phone call	high level
	Data transmission status	Flash (125ms high/125ms low)
	Standby state	Slow flashing (1800ms high/200ms low)
	Web search status	Slow flashing (200ms high/1800ms low)

The reference design drawing of the module network status indicator light is as follows:

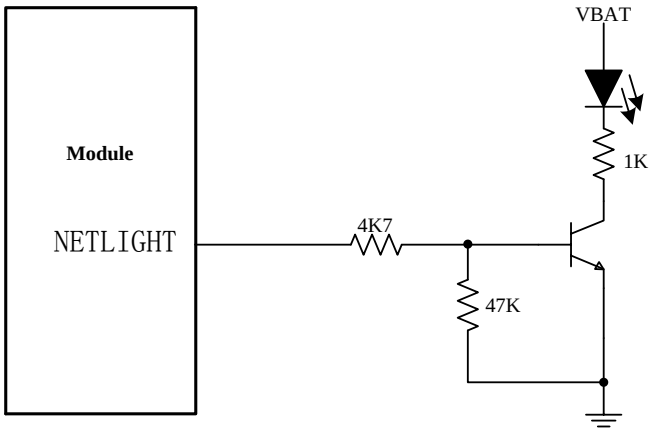


Figure 3-23 Circuit diagram of network status indicator light

NOTE

✧ The brightness of the network indicator light can be adjusted by regulating the current-limiting resistor.

3.13 I2C Bus

The RHF4M603 module provides a set of I2C protocol interfaces, with a clock rate of 400KHz and an operating level of 1.8V.

Table 3-22 Definition of I2C Pins

Pin	Signal Name	I/O	Description	Remarks
37	I2C_SDA	OD	I2C bus data	It needs to be pulled up at 1.8V externally and does not need to remain suspended
38	I2C_SCL	OD	I2C bus clock	

The connection method of the I2C reference circuit is as follows:

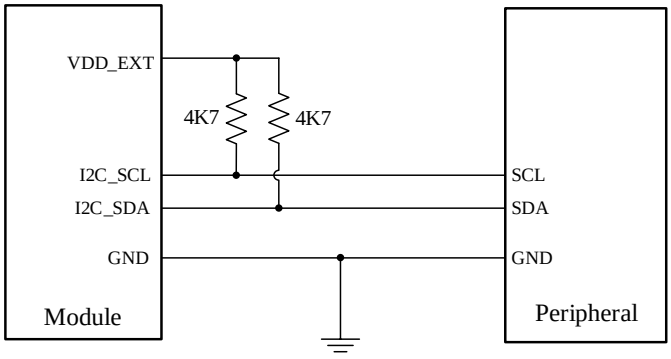


Figure 3-24 Reference circuit diagram of I2C interface

3.14 Analog Audio Interface

The RHF4M603 module provides one analog audio input channel and one analog audio output channel. The pin definitions are as follows:

Table 3-23 Definitions of Analog Audio Output and Input Pins

Pin	Signal Name	I/O	Description	
40	EAR_P	AO	Receiver differential output channel (+)	No need to keep it suspended
41	EAR_N	AO	Receiver differential output channel (-)	
42	MIC_P	AI	Microphone input channel (+)	
43	MIC_N	AI	Microphone input channel (-)	

NOTE

- ✧ The EAR-P and EAR-N signals are differential outputs, typically used for earpiece.
- ✧ The MIC_P and MIC_N signals are differential inputs and are usually used for electret microphone inputs.
- ✧ For the modules that support the GSM standard, it is recommended to adopt electret microphones with built-in RF filters and dual capacitors (10pF and 33pF) to filter out RF interference from the source of interference and minimize the coupled TDD noise to the greatest extent.
- ✧ To minimize signal interference as much as possible, the antenna should be kept away from audio devices and audio traces.

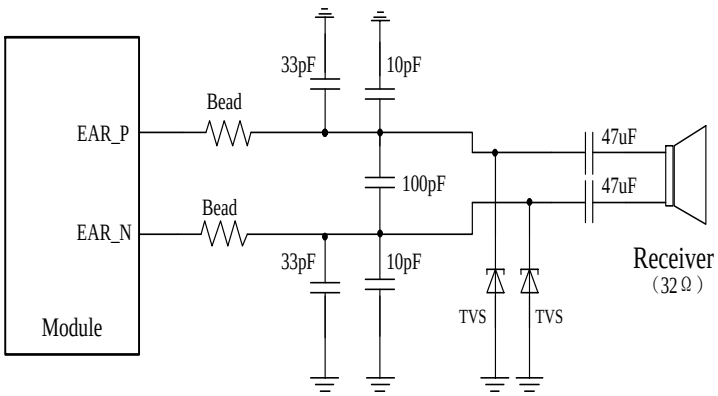


Figure 3-25 Receiver output reference circuit

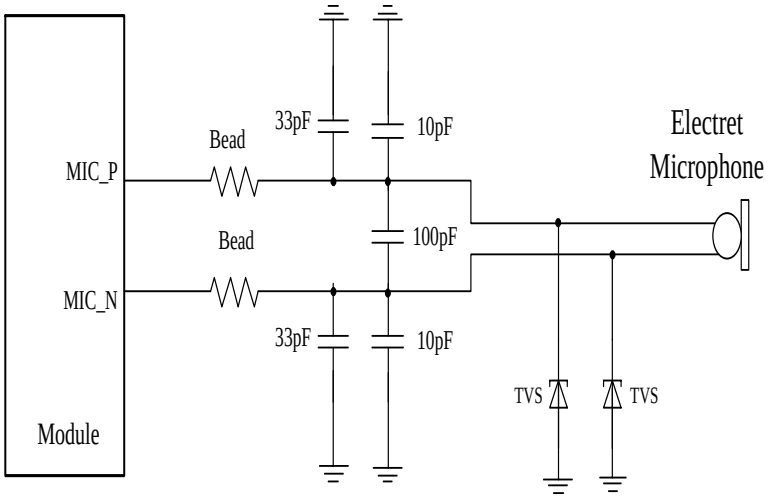


Figure 3-26 Microphone input reference circuit

3.15 ADC Interface

The RHF4M603 module provides two universal analog-to-digital converter interfaces. To improve the accuracy of ADC voltage measurement, it is recommended to cover the ground when routing the ADC.

Table 3-24 ADC Pin Definitions

Pin Number	Signal Name	Description	Level Value (V)			Remarks
			Minimum value	Typical value	Maximum value	
25	ADC	Universal analog-to-digital converter interface	0	-	1.8V	ADC resolution is 12bits
51	VBAT_ADC		0	-	VBAT	

NOTE

- ✧ The input voltage of each ADC pin should not exceed its corresponding voltage threshold.
- ✧ The input voltage range of the VBAT_ADC pin is 0 to VBAT. By default, it is used to read the battery voltage. When designing the hardware, 680K(1% accuracy) and 470K(1% accuracy) resistors must be used for voltage division on the periphery of the VBAT_ADC.

✧ When the module VBAT is not powered, the ADC interface cannot be directly connected to any input voltage.

3.16 LCD Interface

Some models of RHF4M603 module can support LCD display modules with a maximum resolution of 320 * 240. Supports standard SPI4 wire single data transmission.

The LCD interface of the module does not have a dedicated TE signal. If necessary, you can choose to use GPIO simulation by yourself.

Table 3-25 Definitions of LCD interface Pins

Pin Number	Signal Name	I/O	Description	Remarks
101	LCD_BL_PWM*	DO	LCD backlight PWM regulation	1.8V voltage domain, function to be developed, keep suspended
102	LCD_SPI_CLK*	DO	LCD SPI clock	
103	LCD_SPI_TXD*	DIO	LCD SPI data (bidirectional)	
104	LCD_SPI_RXD*	DO	LCD SPI data	
105	LCD_SPI_CS*	DO	LCD SPI chip selection	
106	LCD_RST*	DO	LCD reset	
107	LCD_DCX*	DO	Selection of LCD SPI registers	

3.17 Camera Interface

The camera interface of some models of RHF4M603 module supports up to 300K pixel sensors and supports SPI single or dual data cable transmission.

Table 3-26 Pin Definitions of the Camera Interface

Pin Number	Signal Name	I/O	Description	Remarks
117	CAM_I2C_SDA*	OD	CAM dedicated I2C data	External 4.7K resistor needs to be pulled up
118	CAM_I2C_SCL*	OD	CAM dedicated I2C clock	

119	CAM_PWDN*	DO	CAM Control Signal	1.8V voltage domain, function to be developed, keep suspended
120	CAM_RST*	DO	CAM reset signal	
121	CAM_MCLK*	DO	CAM Master clock	
122	CAM_SPI_D0*	DIO	CAM SPI data bit D0	
123	CAM_SPI_D1*	DIO	CAM SPI data bit D1	
124	CAM_SPI_CLK*	DO	CAM SPI clock	

3.18 Matrix keyboard Interface

RHF4M603 module provides a set of 4×4 keyboard interfaces.

Table 3-27 Definitions of Keyboard Interface Pins

Matrix key Interface				
Pin Number	**Pin Name**	**IO**	**Function Description**	**Remarks**
20	KEYIN3	DI	Matrix key input 3	1.8V voltage range remains suspended if not in use
21	KEYOUT3	DO	Matrix key output 3	
35	KEYOUT6	DO	Matrix key output 6	
36	KEYIN6	DI	Matrix key input 6	
44	KEYOUT2	DO	Matrix key output 2	
47	KEYIN2	DI	Matrix key input 2	
67	KEYOUT5	DO	Matrix key output 5	
68	KEYIN5	DI	Matrix key input 5	

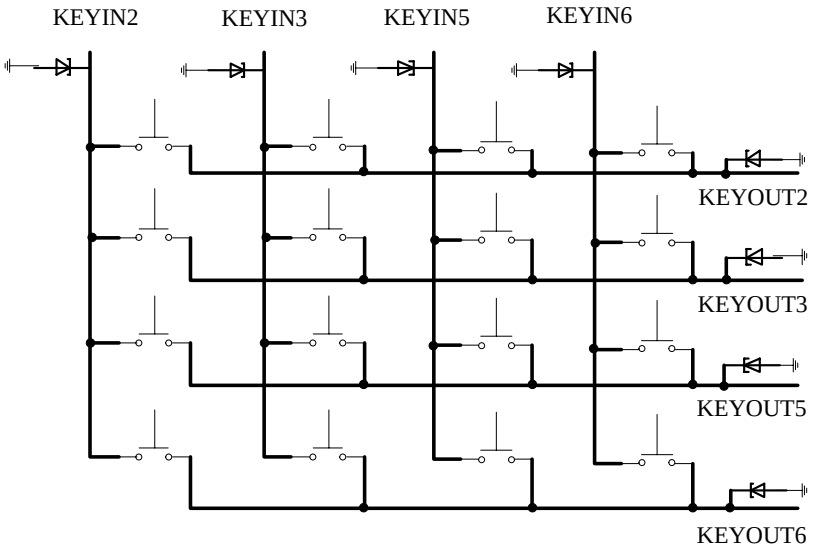


Figure 3-27 Matrix keyboard reference circuit

3.19 GPIO Interface

The RHF4M603 module provides 5 GPIO interfaces.

Table 3-28 GPIO Pin Definitions

Pin number	Name of the pipe pin	IO	Function Description	Remarks
5	GPIO5	DIO	Universal input/output port	PU,1.8V. If not in use, leave it suspended
19	GPIO1	DIO	Universal input/output port	
26	GPIO2	DIO	Universal input/output port	PD,1.8V. If not in use, it is left floating
48	GPIO3	DIO	Universal input/output port	
53	GPIO4	DIO	Universal input/output port	PU,1.8V. If not in use, leave it suspended

3.20 SPI Interface

The RHF4M603 module provides a set of hardware SPI interfaces, with a 1.8V voltage range. It only supports host mode and has a maximum clock frequency of 52MHz.

Table 3-29 SPI Pin Definitions

Pin number	Name of the pipe pin	IO	Function Description	Remarks
11	SPI_CLK	DO	SPI clock output	1.8V voltage range remains suspended if not in use
12	SPI_CS	DO	SPI chip selection signal	
13	SPI_MOSI	DO	SPI data output	
14	SPI_MISO	DI	SPI data input	

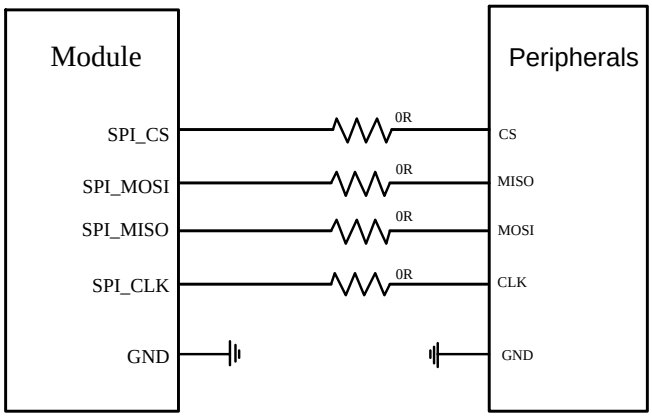


Figure 3-28 SPI reference Circuit (module as the main device)

3.21 GNSS Functional Interface

Some models of RHF4M603 module include a complete embedded GNSS solution.

Table 3-30 GNSS Pin Definitions

Pin Number	Signal Name	I/O	Description	Remarks
90	GNSS_ANT	AI	GNSS Antenna Interface	50Ω characteristic impedance
95	GNSS_TXD	DO	module is embedded with a GNSS serial port for transmission	1.8V Voltage Domain Scheme 1: 1K resistor series module UART3-RXD (PIN49) Solution 2: Connect a 1K resistor in series with the MCU UART_RXD
96	GNSS_R	DI	module is embedded with	1.8V voltage range

	XD		GNSS serial port reception	Solution 1: Connect a 1K resistor in series with the module UART3_TXD (PIN50) Solution 2: Connect a 1K resistor in series with the MCU UART_TXD
100	1PPS	DO	GNSS pulse clock synchronization signal	Second pulse signal, used for precise timekeeping
116	GNSS_VBKP	PI	GNSS backup power input	Power supply range: 1.4V-3.6V

The RHF4M603 module supports two schemes for UART transparent transmission: independent GNSS and non-independent GNSS.

Non-independent GNSS solution:

The GNSS function is fully integrated by modules. A non-independent GNSS that is powered by the module itself to the GNSS chip and UART transmission.

The reference design is as follows:

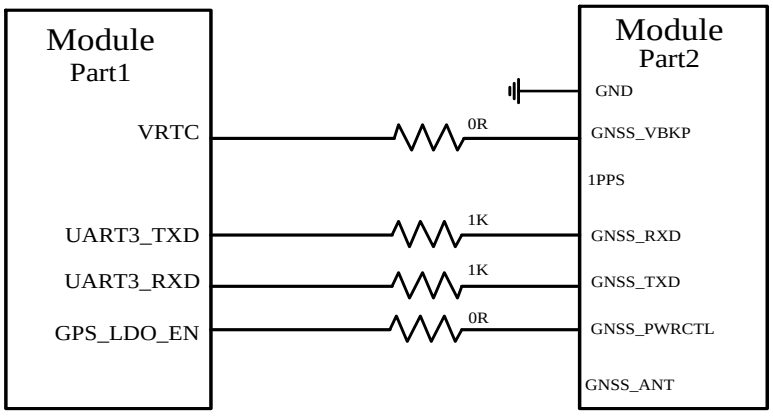


Figure 3-29 Non-independent GNSS scheme

Independent GNSS solution:

The GNSS function is fully powered by the external supply of the module and transmitted through the MCU UART to the independent GNSS chip. This wiring method is used in scenarios where GNSS operates independently when the module is not powered on.

The reference design is as follows:

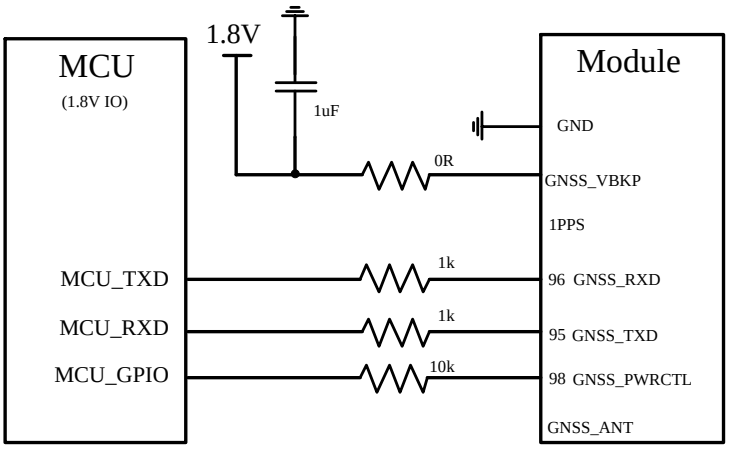


Figure 3-30 Independent GNSS Scheme

3.22 Radio Frequency Interface

The RHF4M603 module provides two antenna interfaces and one main antenna interface, which is responsible for the reception and transmission of the module's RF signals. One GNSS antenna interface, responsible for receiving satellite signals. The characteristic impedances of both antenna interfaces are 50Ω.

Table 3-31 Antenna Interface Pin Definitions

Pin Number	Signal Name	I/O Attribute	Description	Remarks
60	RF_ANT	AIO	Main antenna interface	50 Ω characteristic impedance
90	GNSS_ANT	AI	GNSS antenna interface	50 Ω characteristic impedance

NOTE

- ✧ The module supports the Wi-Fi Scan function. Due to the shared RF_ANT antenna interface, the two functions cannot be used simultaneously and time-division multiplexing is required. Wi-Fi Scan only receives but does not transmit.
- ✧ In scenarios such as static electricity and lightning strikes, positions for TVS diode devices need to be reserved on the base plate.

3.22.1 Antenna Matching Circuit

The 60th pin of the RHF4M603 is the main antenna interface. To facilitate antenna debugging, a π -shaped matching circuit needs to be added to the mainboard, with a 50Ω impedance wire.

Pin 90 of the RHF4M603 is the GNSS antenna interface. To facilitate antenna debugging, a π -shaped matching circuit needs to be added to the mainboard, with a 50Ω impedance wire.

The circuit is as shown in the following figure:

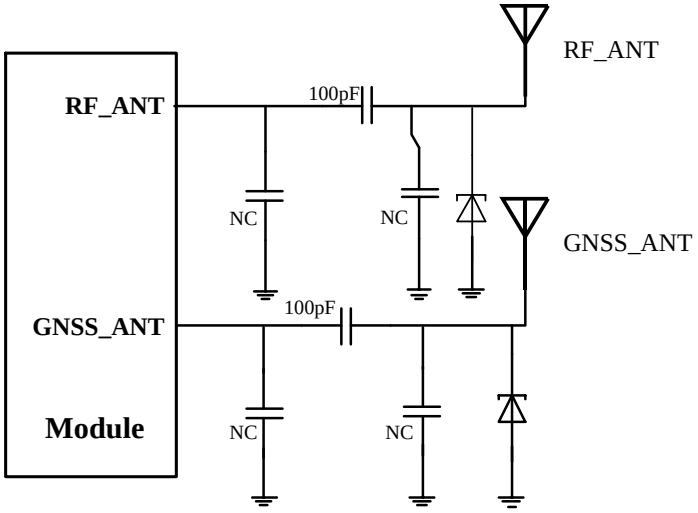


Figure 3-31 Reference diagram of the radio frequency antenna

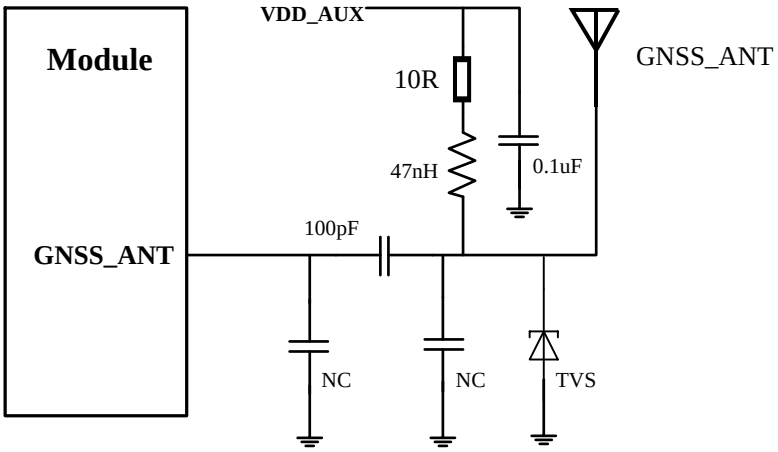


Figure 3-32 GNSS active antenna reference diagram

NOTE

- ✧ The matching circuit should be placed as close as possible to the antenna.
- ✧ To reduce coexistence issues and avoid interference with the receiving sensitivity, it is recommended that the isolation between antennas be above 20dB.
- ✧ The antenna is a sensitive device that is easily affected by the external surrounding environment. Therefore, it needs to be kept away from interference signals such as digital clock lines and DC power supplies. It is recommended to use a complete ground layer as the reference site.
- ✧ The trace between the RF port of the module and the antenna should be as short as possible, and the board manufacturer needs to perform 50Ω impedance control on the RF trace.

3.22.2 RF Wiring Reference

The antenna of the RHF4M603 module is led out by pad method. Microstrip lines or other types of RF traces must be used from the antenna pad to the antenna feed point. The characteristic impedance of the signal line should be controlled at 50 Ω.

The impedance of a radio frequency (RF) signal line is determined by the dielectric constant of the material, the width of the trace (W), the ground clearance (S), and the height of the reference ground plane (H). Therefore, for RF traces, impedance simulation tools need to be used to calculate the impedance value of RF traces.

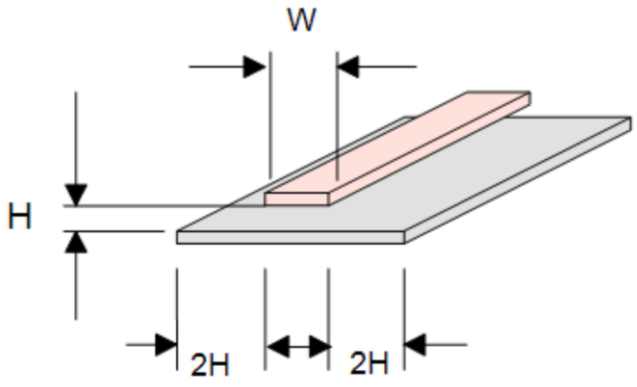


Figure 3-33 The complete structure of the microstrip lines

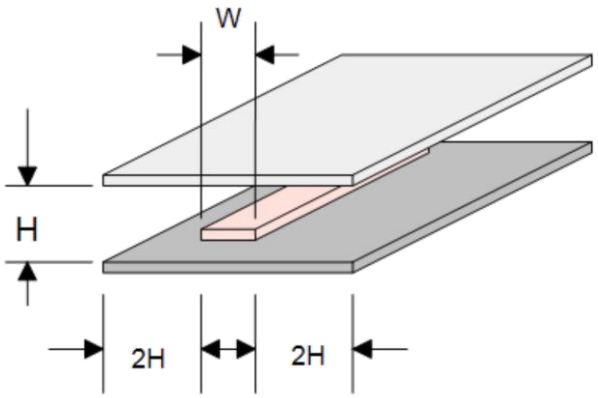


Figure 3-34 The complete structure of the ribbon

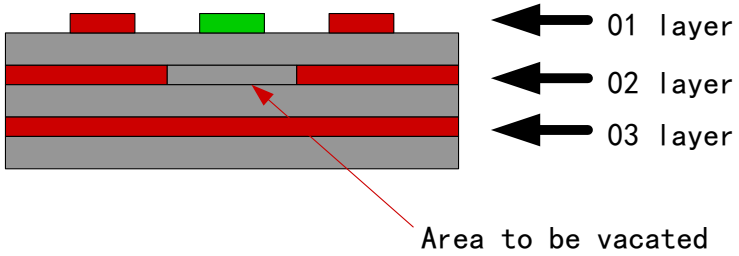


Figure 3-35 shows the structure of the third-layer PCB microstrip transmission line at the reference site

Chapter 4 Overall technical indicators

4.1 Overview of This Chapter

The overall technical specifications of the RHF4M603 module RF include the following parts:

- ✧ Operating frequency
- ✧ Radio-frequency conduction measurement
- ✧ Conducted receiving sensitivity and transmitted power
- ✧ Antenna requirement
- ✧ Module power characteristics

4.2 Operating Frequency

Table 4-1 GSM Frequency Table

Band	Receive	Launch
GSM850	869MHz - 894MHz	824MHz - 849MHz
EGSM900	925MHz - 960MHz	880MHz - 910MHz
DCS1800	1805MHz - 1880MHz	1710MHz - 1785MHz
PCS1900	1930MHz - 1990MHz	1850MHz - 1910MHz

Table 4-2 LTE Frequency Table

Band	Up frequency	Downlink Frequency	Duplex Mode
LTE B1	1920MHz - 1980MHz	2110MHz - 2170MHz	FDD
LTE B2	1850MHz - 1910MHz	1930MHz - 1990MHz	FDD
LTE B3	1710MHz - 1785MHz	1805MHz - 1880MHz	FDD
LTE B4	1710MHz - 1755MHz	2110MHz - 2155MHz	FDD
LTE B5	824MHz - 849MHz	869MHz - 894MHz	FDD
LTE B7	2500MHz - 2570MHz	2620MHz - 2690MHz	FDD
LTE B8	880MHz - 915MHz	925MHz - 960MHz	FDD
LTE B20	832MHz - 862MHz	791MHz - 821MHz	FDD
LTE B28	703MHz - 748MHz	758MHz - 803MHz	FDD
LTE B66	1710MHz - 1780MHz	2110MHz - 2200MHz	FDD

Table 4-3 GNSS Radio Frequency Table

System	Signal	Frequency	Unit
GPS	L1C/A	1575.42 ±1.023 (L1)	MHz
GLONASS	L1	1597.5~1605.8 (L1)	
Galileo	E1B/C	1575.42 ±2.046 (E1)	
BDS	B1I	1561.098 ±2.046 (B1I)	

4.3 Radio Frequency Conduction Measurement

4.3.1 Test Environment

Table 4-4 Test Instruments

Testing Instrument	Power Supply	Murata Coaxial RF Cable
R&S CMW500	Agilent 66319	MXHP32HP1000

4.3.2 Test Standard

The RHF4M603 module passed the test standards of 3GPP TS 51.010-1, 3GPP TS 34.121-1, and 3GPP TS 36.521-1. Each module is strictly tested in the factory to ensure reliable quality.

4.4 Conduction Receiving Sensitivity and Transmission Power

The test indicators for the LTE and GSM receiving sensitivity and transmission power of the RHF4M603 module are as follows:

Table 4-5 GSM Radio Frequency Sensitivity Index

Directory	Sensitivity (Typical)	Sensitivity (Maximum)
GSM850	< - 110	-109.5
EGSM900	< - 110	-109.5
DCS1800	< - 108.5	-108
PCS1900	< - 109.5	-109

Table 4-6 LTE RF Sensitivity Indicators

Directory (Sensitivity)	Requirements of	small	Typical	largest

	the 3GPP agreement	est		
LTE B1(FDD QPSK PASS >95%)	< - 96.3(10MHz)		-99.2	-98.7
LTE B2(FDD QPSK PASS >95%)	< - 92.3(10MHz)		-99.2	-98.7
LTE B3(FDD QPSK PASS >95%)	< - 93.3(10MHz)		-98.7	-98.2
LTE B4(FDD QPSK PASS >95%)	< - 94.3(10MHz)		-98.7	-98.2
LTE B5(FDD QPSK PASS >95%)	< - 94.3(10MHz)		-99.7	-99.7
LTE B7(FDD QPSK PASS >95%)	< - 93.3(10MHz)		-97.7	-97.2
LTE B8(FDD QPSK PASS >95%)	< - 93.3(10MHz)		-100.2	-99.7
LTE B20(FDD QPSK PASS >95%)	< - 93.3(10MHz)		-100.2	-99.7
LTE B28(FDD QPSK PASS >95%)	< - 94.3(10MHz)		-100.2	-99.7
LTE B66(FDD QPSK PASS >95%)	< - 93.5(10MHz)		-98.7	-98.2

Table 4-7 LTE Radio Frequency Transmission Power Index

Directory	3GPP protocol requirement (dBm)	Minimum	typical	maximum
LTE B1	21 to 25	21	23	24
LTE B2	21 to 25	21	23	24
LTE B3	21 to 25	21	23	24
LTE B4	21 to 25	21	23	24
LTE B5	21 to 25	21	23	24
LTE B7	21 to 25	21	23	24
LTE B8	21 to 25	21	23	24
LTE B20	21 to 25	21	23	24
LTE B28	21 to 25	21	23	24
LTE B66	21 to 25	21	23	24

Table 4-8 GSM Radio Frequency Transmission Power Index

Directory	Maximum power (3GPP)	Maximum power (Typical)	Minimum power (3GPP)
GSM850(GMSK)	33dBm ±2dB	32.3dBm	5dBm ±5dB
EGSM900(GMSK)	33dBm ±2dB	32.2dBm	5dBm ±5dB

DCS1800(GMSK)	30dBm ±2dB	29.2dBm	0dBm ±5dB
PCS1900(GMSK)	30dBm ±2dB	29.3dBm	0dBm ±5dB
EGSM900,GSM850（8PSK）*	26dBm±3dB	26.77dBm	5dBm ±5dB
DCS1800, PCS1900（8PSK）*	25dBm±3dB	25.25dBm	0dBm ±5dB

***Note:** In the 4-slot transmission mode of the GPRS network, the maximum output power will be reduced by 3dB. This design complies with the GSM specifications outlined in Section 13.16 of 3GPP TS 51.010-1.

4.5 GNSS Receiver

The RHF4M603 module contains a complete GNSS solution. Supports joint positioning of multiple systems including GPS, GLONASS, BDS and Galileo. The GNSS function can be turned off or on through the AT command. For details, please refer to the RHF4M603 AT command set.

Table 4-9 GNSS Performance Parameters

Test Items	Description		Indicator
Positioning accuracy	CEP-50, Open area		≤2m
Speed accuracy	--		0.1m/s
Update frequency	--		1Hz ~10Hz
CNR	Signal strength (dBm)		-130dBm
	CNR(dBc/Hz)		CN0 L1 42;G1 41;B1L 41;E1 42
Sensitivity (Typical value)	Cold start sensitivity (dBm)		-149dBm@GNSS
	Tracking sensitivity (dBm）		-166dBm@GNSS
	Recapture sensitivity (dBm)		-159dBm@GNSS
Positioning time	Cold start	TTFF(s)	＜27s (@-130dBm)
		Positioning accuracy (m)	＜2m
	Hot start	TTFF(s)	＜2s (@-130dBm)

		Positioning accuracy (m)	＜2m
	Recaptur e	TTFF(s)	＜3s (@-130dBm)
		Positioning accuracy (m)	＜2m

4.6 Antenna Requirements

Design Requirements for RHF4M603 module Antenna:

✧ Antenna efficiency

Antenna efficiency is the ratio of the input power of the antenna to its emissivity. Due to antenna callback loss, material loss and coupling loss, the radiated power is always lower than the input power, but there are certain index requirements.

✧ S11 or VSWR

S11 indicates the matching degree of the 50-ohm impedance of the antenna, which to some extent affects the antenna efficiency. This indicator can be measured by the VSWR testing method.

✧ Polarization

Polarization is the direction of rotation of the electric field of the antenna in the direction of maximum radiation.

✧ Radiation pattern

The radiation pattern refers to the intensity of the electromagnetic field of the antenna in all directions of the far field, omnidirectional antenna radiation. The half-wave oscillator antenna is the most suitable terminal antenna.

✧ Gain and Directionality

The directionality of an antenna refers to the electromagnetic field intensity of electromagnetic waves in all directions. Gain is the combination of antenna efficiency and antenna directionality.

✧ Interference

Other interference in the PCB panel can also affect the antenna performance of the module. In order to ensure the high performance of the module, the interference must be controlled. Suggestions: such as the LCDC cpem FPC, the audio circuit, the power component should be as far away as possible from the antenna, and do the corresponding isolation and shielding, or the path to do the filtering processing.

The specific requirements for antenna indicators are shown in the following table:

Table 4-10 Antenna Index Requirements

Design requirements for RHF4M603 module main antenna	
Frequency range	Use the most suitable antenna to adapt to the relevant frequency band
Bandwidth (GSM)	GSM850: 70M EGSM900: 80M DCS1800: 170M PCS1900: 140M
Bandwidth (LTE	LTE band1: 250M LTE band2: 140M LTE band3: 170M LTE band4: 445M LTE band5: 70M LTE band7: 190M LTE band8: 80M LTE band20: 71M LTE band28: 100M LTE band66: 470M
Impedance	50Ω
Input power	>23dBm
standing-wave ratio	<2.5:1
Gain	≤2.5dbi
Efficiency	>40%
Insertion line loss	<0.6 dB: Low Band (< 1 GHz) < 1.5 dB: Mid Band (1~2.3 GHz) < 2.0 dB: High Band (> 2.3 GHz)

4.7 Power Consumption Characteristics

Table 4-11 Dormant Idle Power Consumption

Mode	Test Conditions	Current value (Avg)	Unit
Leakage of electricity when shutting down	Module shutdown	< 9.0	uA
Hibernation mode	Minimum function Mode (USB disconnected)	0.86	mA
	Flight mode (USB disconnected)	0.9	mA
	LTE-FDD @ DRX =0.32S(USB disconnected)	1.75	mA
	LTE-FDD @ DRX =0.64S(USB disconnected)	1.36	mA
	LTE-FDD @ DRX =1.28S(USB disconnected)	1.19	mA
	LTE-FDD @ DRX =2.56S(USB disconnected)	1.09	mA
	GSM @BS_PA_MFRMS =2 (USB disconnected)	1.84	mA
	GSM @ BS_PA_MFRMS=5 (USB disconnected)	1.46	mA
	GSM @ BS_PA_MFRMS=9 (USB disconnected)	1.34	mA
Idle Mode	LTE @ DRX=0.64S (USB disconnected)	9.85	mA
	GSM @ MFRMS = 2(USB disconnected)	10.24	mA
	LTE @ DRX=0.64S(USB connection)	24.21	mA
	GSM @ MFRMS = 2(USB connection)	24.64	mA

Table 4-12 LTE Data Transmission Power Consumption (GNSS Function Disabled)

Band	Channel	Power dBm	Current power consumption mA
LTE-FDD B1 @10Mhz,FRB	18050	22.28	515
	18300	22.2	531
	18550	21.73	526
LTE-FDD B2 @10Mhz,FRB	18650	22.28	470
	18900	22.07	478
	19150	22.36	508
LTE-FDD B3 @10Mhz,FRB	19250	22.3	500
	19575	22.2	476
	19900	22.6	515
LTE-FDD B4 @10Mhz,FRB	20000	22.18	522
	20175	22.31	458
	20350	22.14	476
LTE-FDD B5 @10Mhz,FRB	20450	22	497
	20525	22	475
	20600	22	485
LTE-FDD B7 @10Mhz,FRB	20800	22.4	584
	21100	22.3	574
	21400	22.18	565
LTE-FDD B8 @10Mhz,FRB	21500	22.35	527
	21625	22.3	516
	21750	22.27	525
LTE-FDD B20 @10Mhz,FRB	24200	22.45	500
	24300	22.29	513
	24400	22.17	497
LTE-FDD B28 @10Mhz,FRB	27260	22.25	472
	27435	22.01	458
	27610	21.77	478
LTE-FDD B66 @10Mhz,FRB	132022	22.35	535
	132322	22.24	479

	132622	22.7	515

Table 4-13 GSM Call Power Consumption (GNSS Function Disabled)

BAND	Power rating & power	Current power consumption (mA)
GSM850	32.3dBm@PCL=5	225
EGSM900	31.8dBm@PCL=5	236
DCS1800	28.89dBm@PCL=0	175
PCS1900	29.13dBm@PCL=0	160

Table 4-14 GPRS Data Transmission Power Consumption (GNSS Function Off)

BAND	Power level & Configuration	Current power consumption (mA)
GSM850	PCL=5@1DL/4UL	515
EGSM900	PCL=5@1DL/4UL	537
DCS1800	PCL=0@1DL/4UL	388
PCS1900	PCL=0@1DL/4UL	349

Table 4-15 EDGE Data Transmission Power Consumption (GNSS Function Disabled)

BAND	Power level & Configuration	Current power consumption (mA)
GSM850	PCL=8@1DL/4UL	325
EGSM900	PCL=8@1DL/4UL	334
DCS1800	PCL=2@1DL/4UL	288
PCS1900	PCL=2@1DL/4UL	284

Chapter 5 Interface Electrical Characteristics

5.1 Overview of This Chapter

- ✧ Working storage temperature
- ✧ Module IO level
- ✧ Supply Voltage
- ✧ Electrostatic Characteristic
- ✧ Reliability Index

5.2 Working Storage Temperature

Table 5-1 Working Storage Temperature of RHF4M603 Module

Parameters	Minimum Value	Maximum Value
Normal operating temperature	-30℃	75℃
Extreme working temperature	-40℃	85℃
Storage temperature	-40℃	90℃

5.3 Module IO Level

The IO levels of the RHF4M603 module are as follows:

Table 5-2 Electrical Characteristics of RHF4M603 Module

Parameters	Parameter Description	Minimum Value	Maximum Value
VIH	Input a logical high-level voltage	0.65* VDD_EXT	VDD_EXT+0.3V
VIL	Input a logical low-level voltage	-	0.35*VDD_EXT
VOH	Output a logical high-level voltage	VDD_EXT-0.45V	VDD_EXT
VOL	Output a logical low-level voltage	0	0.45V

5.4 Power Supply Characteristics

The power supply requirements for the RHF4M603 module are as follows:

Table 5-3 Working Voltage of RHF4M603 Module

Parameters	Description	Minimum Value	Typical value	Maximum value
VBAT	Module power supply	3.4V	3.7V	4.2V
	VBAT peak current	0		2A
	RMS average supply current			700mA
	Voltage drop during GSM burst transmission (GSM850/900 PCL=5 transmission)			380mV
USB_VBUS	USB insertion detection	3.0V	5.0V	5.25V

NOTE

✧ The power-on time of any interface of the module must not be earlier than the power-on time of the module; otherwise, it may cause abnormality or damage to the module.

5.5 Electrostatic Characteristics

The internal design of the RHF4M603 module has taken into account and implemented corresponding ESD protection. However, ESD problems may also occur during the production assembly and experimental testing of the module. Therefore, application developers need to consider the ESD protection of the final product.

When customers design, in addition to referring to the recommended circuits in the document interface design, the following points also need to be noted:

✧ The PCB layout of protective devices should follow a "V" shaped line as much as possible and avoid a "T" shaped line.

✧ The ground plane around the module should be kept intact and not divided.

✧ During the production, assembly and laboratory testing of the module, attention should be paid to the ESD control of the surrounding environment and the operators.

Table 5-4 ESD Characteristics of RHF4M603

Test port	Contact discharge	Air discharge	Unit
VBAT power supply	±4	±8	KV
Antenna interface	±4	±8	KV
Other interfaces	±0.5	±1	KV

5.6 Reliability Index

Table 5-5 Reliability Test of RHF4M603

Test items	Test Conditions	Reference standard	Test results
Low temperature work	Temperature: －40℃ Working mode: normal work Test duration: 24h	IEC60068-2-1	Appearance check: Normal Function check: Normal
High temperature work	Temperature: 85℃ Working mode: normal work Test duration: 24h	JESD22-A108-C	Appearance check: Normal Function check: Normal
Temperature cycle	High temperature: 85℃ Low temperature: －40℃ Working mode: normal work Test duration: 30 Cycles;1h+1h/cycle	JESD22-A105-B	Appearance check: Normal Function check: Normal
Alternating hot and humid	High temperature: 55℃ Low temperature: 25℃ Humidity: 95% ± 3% Working mode: normal work Test duration: 6 Cycles;12h+12h/cycle	JESD22-A101-B	Visual inspection: normal Function check: normal RF indicator check: normal
Temperature shock	High temperature: 85℃ Low temperature: －40℃ Temperature change time: <30s	JESD22-A106-B	Appearance check: Normal Function check: Normal

	Working mode: no packaging, no Power on, do not boot Test duration: 100 Cycles;15min+15min/cycle		
Drop test	Height 0.8m, 6 sides each time, dropped to the horizontal marble platform Working mode: no packaging, no Power on, do not boot	IEC60068-2-32	Visual inspection: normal Function check: normal RF indicator check: normal
Low temperature storage	Temperature: －40℃ Working mode: no packaging, no power, no boot Test duration: 24 h	JESD22-A119-C	Appearance check: Normal Function check: Normal
High temperature storage	Temperature: 85℃ Working mode: no packaging, no power, no boot Test duration: 24h	JESD22-A103-C	Appearance check: Normal Function check: Normal

Chapter 6 Structure and Mechanical Specification

6.1 Overview of This Chapter

- ✧ Appearance
- ✧ Module Mechanical Dimensions

6.2 Appearance

The RHF4M603 module is a single-sided layout PCBA. The appearance diagram is as follows:

Figure 6-1 Appearance drawing of RHF4M603

6.3 Mechanical Dimension

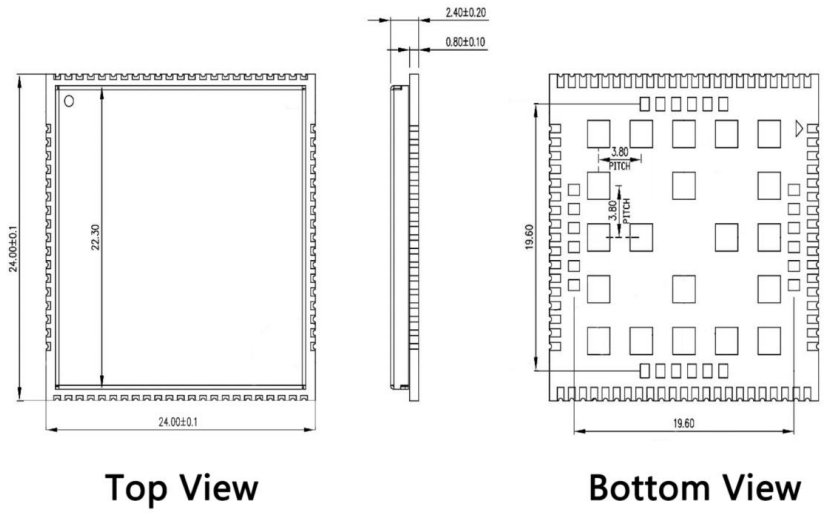


Figure 6-2 Module Front and Bottom Views (Unit: Millimeters)

Module recommended packaging:

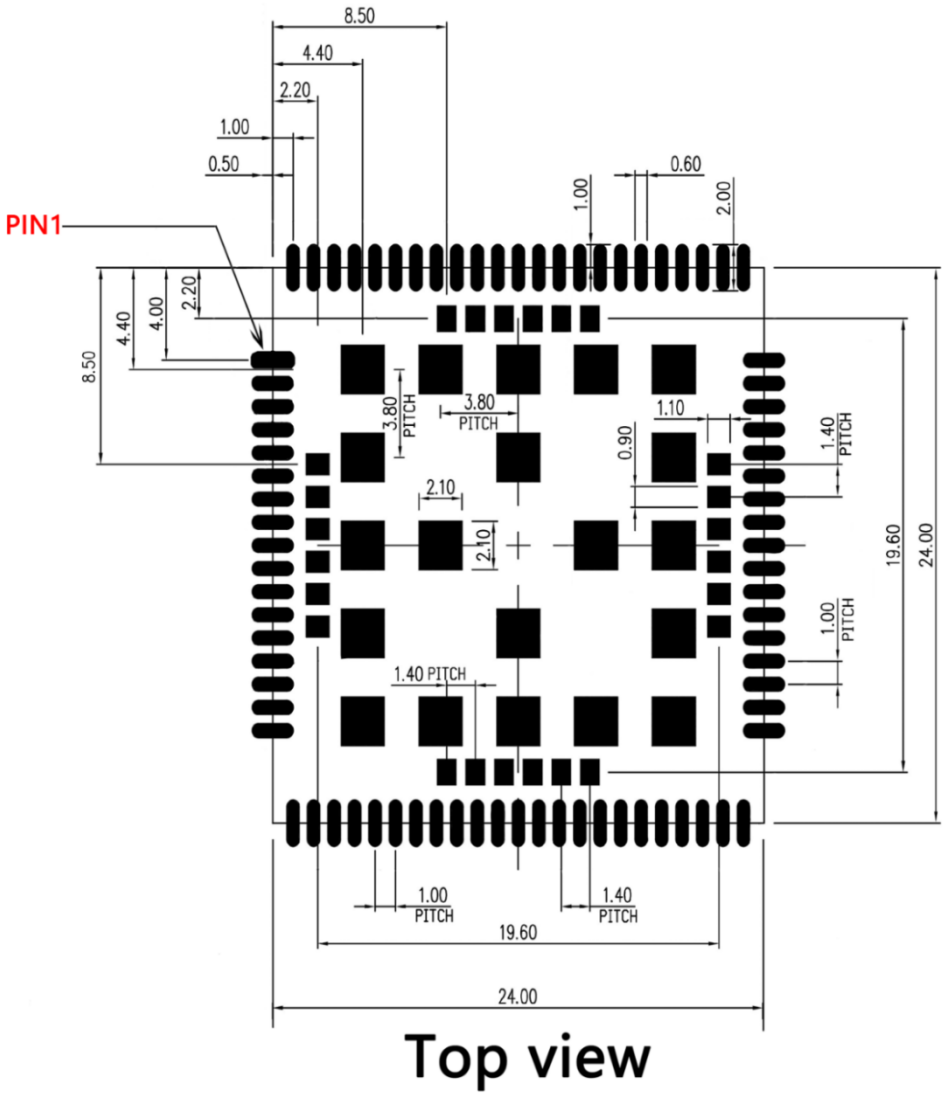


Figure 6-3 Module Recommended Packaging (Unit: Millimeters)

Chapter 7 Packaging and Production

7.1 Overview of This Chapter

- ✧ Module packaging and storage
- ✧ Production welding

7.2 Module Packaging and Storage

The RHF4M603 module is packed in braided tape, with 1,000 PCS per reel, and each reel is shipped in the form of vacuum-sealed bags.

The storage of the RHF4M603 module needs to follow the following conditions:

- ✧ The module has a moisture sensitivity rating of level 3.
- ✧ When the ambient temperature is less than 40 degrees Celsius and the air humidity is less than 90%, the module can be stored in a vacuum sealed bag for 12 months.
- ✧ When the vacuum seal bag is opened, if the ambient temperature of the module is below 30 degrees Celsius and the air humidity is less than 60%, the factory can finish the patch within 72 hours, and the module can be reflow welding or other high temperature processes.
- ✧ If the module is in other conditions, it needs to be baked before mounting.
- ✧ If the module needs to be baked, remove the module packaging and bake for 8 hours at 125 degrees Celsius (allowing fluctuations of 5 degrees Celsius up and down)

7.3 Production Welding

The RHF4M603 module is packaged with taping, and the SMT line body needs to be equipped with a 32mm carrier.

- ✧ To ensure the quality of the module paste, the recommended thickness of the steel mesh corresponding to the pad part of the RHF4M603 module is 0.18mm.
- ✧ The recommended temperature for reflow soldering is 238-248 ° C and cannot exceed 248 ° C.
- ✧ When the PCB is double-sided laid out, the LCC module layout must be processed on the second side. Avoid module component dropping, weld opening and poor internal welding of the module when the module is flipped and reflow due to the module's gravity.

The recommended furnace temperature curve graph is shown as follows:

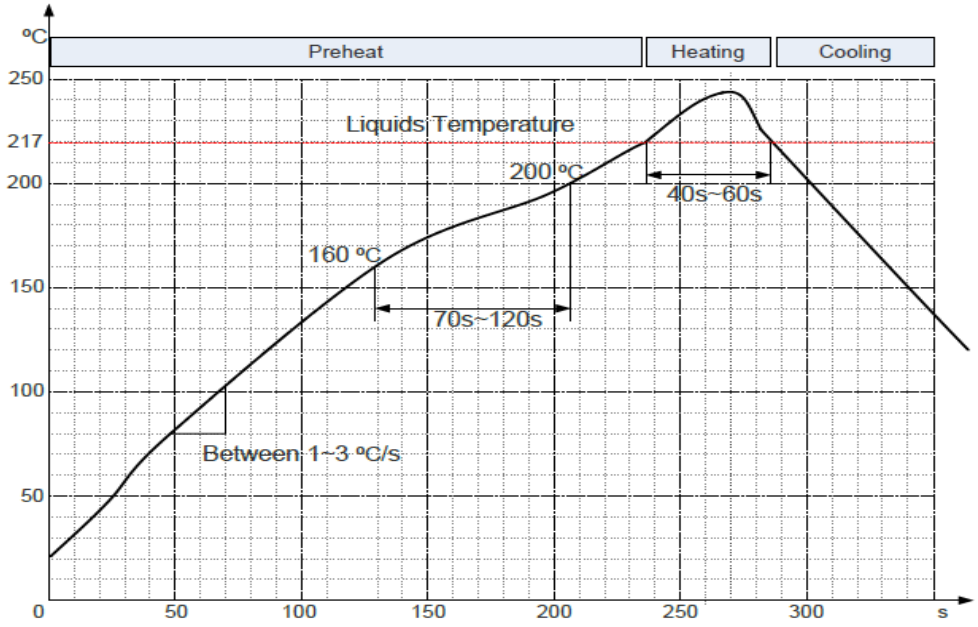


Figure 7-1 reflow soldering temperature curve graph

Table 7-1 Reflux Process Parameters Table

Temperature Range	Time	key Parameter
Preheating zone (40℃ ~ 165℃)		Heating rate: 1℃/s ~ 3℃/s
Uniform temperature zone (160℃ ~ 210℃)	(t1～t2)：70s～120s	
Reflux zone (>217℃)	(t3～t4)：40s～60s	Peak temperature: 238℃ ~ 248℃
Cooling zone	Cooling rate: 2℃/s≤Slope≤5℃/s	

Chapter 8 Appendix

8.1 Overview of This Chapter

- ✧ Abbreviation
- ✧ Encoding Mode
- ✧ Use safety and precautions

8.2 Abbreviation

Table 8-1 Abbreviations of Terms

Abbreviation	Full Name
3GPP	Third Generation Partnership Project
AP	Access Point
AMR	Adaptive Multi-rate
BER	Bit Error Rate
CCC	China Compulsory Certification
CDMA	Code Division Multiple Access
CE	European Conformity
CSD	Circuit Switched Data
CTS	Clear to Send
DC	Direct Current
DTR	Data Terminal Ready
DL	Down Link
DTE	Data Terminal Equipment
EU	European Union
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
HSDPA	High-Speed Downlink Packet Access
HSPA	Enhanced High Speed PacketAccess
HSUPA	High Speed Up-link Packet Access
IMEI	International Mobile Equipment Identity
LED	Light-Emitting Diode

LTE	Long Term Evolution
NC	Not Connected
PCB	Printed Circuit Board
PCM	Pulse Code Modulation
PDU	Protocol Data Unit
PMU	Power Management Unit
PPP	Point-to-point protocol
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RoHS	Restriction of the Use of CertainHazardous Substances
SMS	Short Message Service
TIS	Total Isotropic Sensitivity
TVS	Transient Voltage Suppressor
TX	Transmitting Direction
UART	Universal AsynchronousReceiver-Transmitter
UMTS	Universal Mobile Telecommunications System
USIM	Universal Subscriber Identity Module
USSD	Unstructured Supplementary Service Data
VSWR	Voltage Standing Wave Ratio
WCDMA	Wideband Code Division MultipleAccess
WWAN	Wireless Wide Area Network

8.3 Encoding Mode

Table 8-2 Time Slot Allocation Table for Different Levels of GPRS/EDGE

Slot class	DL slot number	UL slot number	Active slot number
1	1	1	2
2	2	1	3
3	2	2	3
4	3	1	4
5	2	2	4
6	3	2	4

7	3	3	4
8	4	1	5
9	3	2	5
10	4	2	5
11	4	3	5
12	4	4	5

Table 8-3 Maximum Rate of GPRS

GPRS coding scheme	Max data rata（4 slots）	Modulation type
CS 1 = 9.05 kb/s / time slot	36.2 kb/s	GMSK
CS 2 = 13.4 kb/s / time slot	53.6 kb/s	GMSK
CS 3 = 15.6 kb/s / time slot	62.4 kb/s	GMSK
CS 4 = 21.4 kb/s / time slot	85.6 kb/s	GMSK

Table 8-4 Maximum Rate of EDGE

GPRS coding scheme	Max data rata（4 slots）	Modulation type
MCS 1 = 8.8 kb/s/ time slot	35.2 kb/s	GMSK
MCS 2 = 11.2 kb/s/ time slot	44.8 kb/s	GMSK
MCS 3 = 14.8 kb/s/ time slot	59.2 kb/s	GMSK
MCS 4 = 17.6 kb/s/ time slot	70.4 kb/s	GMSK
MCS 5 = 22.4 kb/s/ time slot	89.6 kb/s	8PSK
MCS 6 = 29.6 kb/s/ time slot	118.4 kb/s	8PSK
MCS 7 = 44.8 kb/s/ time slot	179.2 kb/s	8PSK
MCS 8 = 54.4 kb/s/ time slot	217.6 kb/s	8PSK
MCS 9 = 59.2 kb/s/ time slot	236.8 kb/s	8PSK

Table 8-5 Maximum Rate of LTE-FDD DL

LTE-FDD device category	Max data rate(peak)	Modulation type
Category 1	10Mbps	QPSK/16QAM/64QAM
Category 2	50Mbps	QPSK/16QAM/64QAM
Category 3	100Mbps	QPSK/16QAM/64QAM
Category 4	150Mbps	QPSK/16QAM/64QAM

Table 8-6 Maximum UL Rate of LTE-FDD

LTE-FDD device category	Max data rate(peak)	Modulation type
Category 1	5Mbps	QPSK/16QAM
Category 2	25Mbps	QPSK/16QAM
Category 3	50Mbps	QPSK/16QAM
Category 4	50Mbps	QPSK/16QAM

8.4 Safety and Precautions for Use

In order to use the wireless device safely, please inform the user about the safety information:

- ✧ Interference: When the use of wireless devices is prohibited or the use of the device causes interference and security of the electronic device, turn off the wireless device. Because the terminal will send and receive RF signals when it is powered on. It can interfere with TV, radio, computer or other electrical equipment.
- ✧ Medical equipment: In medical and health care facilities where the use of wireless devices is prohibited by express text, please follow the regulations of the site and turn off the device. Some wireless devices may interfere with the medical device, causing the medical device to malfunction or cause errors. If interference occurs, turn off the wireless device and consult a physician.
- ✧ Flammable and explosive areas: In flammable and explosive areas, please turn off your wireless device and follow the relevant label instructions to avoid an explosion or fire. Such as: gas stations, fuel zones, chemical products areas and chemical transportation and storage facilities, areas with explosion hazard signs, areas with "turn off radio equipment" signs.
- ✧ Traffic Safety: Please comply with local laws or regulations in your country or region regarding the use of wireless devices when driving a vehicle.
- ✧ Aviation Safety: When flying, please follow the airline's regulations and regulations regarding the use of wireless equipment. Before taking off, turn off the wireless device to prevent wireless signals from interfering with aircraft control signals.
- ✧ Environmental Protection: Please comply with local laws regarding the handling of equipment packaging materials, equipment or accessories, and support recycling operations.
- ✧ Emergency call: This device uses wireless signals for propagation. Therefore, the network cannot be connected in all cases, so in the emergency, the wireless device cannot be used as the only contact method.

Chapter 9 Ordering information

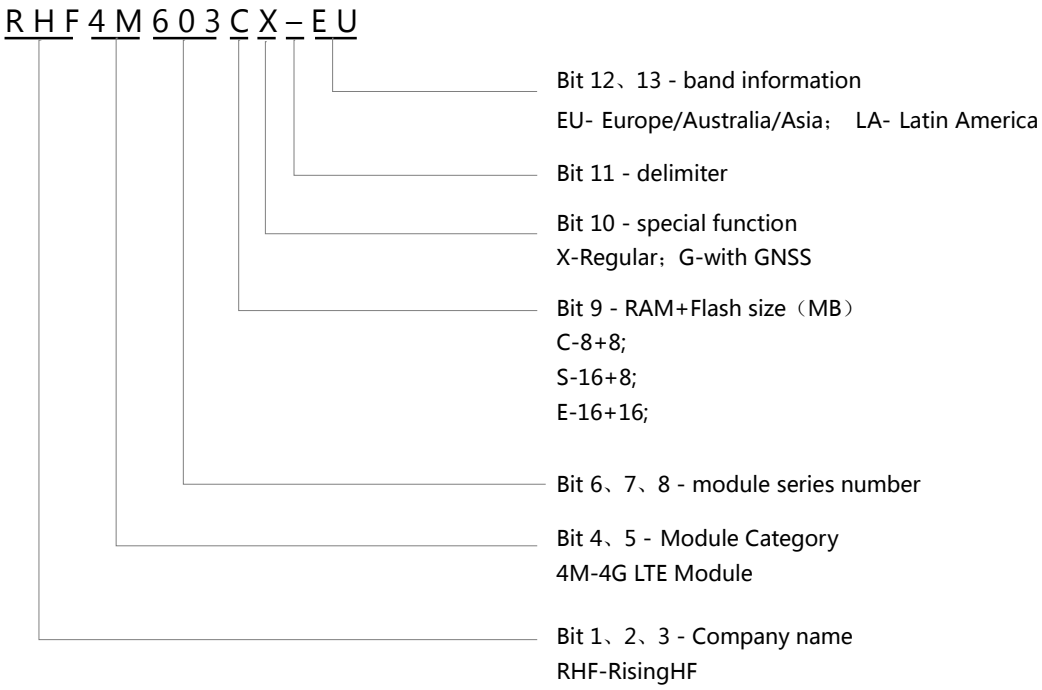
Technical support: Support@RisingHF.com

Sales:

China: Salescn@RisngHF.com

Overseas: Saleswww@RisingHF.com

9.1 Part numbering scheme



9.2 Ordering information

Model number	District	Band	RAM+Flash	GNSS
RHF4M603CX-EU	Europe/Australia/Asia	LTE: B1/B3/B5/B7/B8/B20/B28 GSM: 850/900/180	8MB+8MB	×
RHF4M603CG-EU				√
RHF4M603SX-EU			16MB+8MB	×
RHF4M603SG-EU				√
RHF4M603EX-EU			16MB+16MB	×
RHF4M603EG-EU				√
RHF4M603CX-LA	Latin America	LTE: B1/B2/B3/B4/B5/B7/B8/B28/B66	8MB+8MB	×
RHF4M603CG-LA				√

RHF4M603SX-LA		GSM: 850/900/1800/1900	16MB+8MB	×
RHF4M603SG-LA				√
RHF4M603EX-LA			16MB+16MB	×
RHF4M603EG-LA				√

Revision

V0.1 2025-09-02

+ Create

Please Read Carefully:

Information in this document is provided solely in connection with RisingHF products. RisingHF reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All RisingHF products are sold pursuant to RisingHF's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the RisingHF products and services described herein, and RisingHF assumes no liability whatsoever relating to the choice, selection or use of the RisingHF products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by RisingHF for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

UNLESS OTHERWISE SET FORTH IN RISINGHF'S TERMS AND CONDITIONS OF SALE RisingHF DISCLAIMS ANY EXPRESS OR IMPLIEDWARRANTY WITH RESPECT TO THE USE AND/OR SALE OF RisingHF PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIEDWARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWSOF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

RISINGHF PRODUCTS ARE NOT DESIGNED OR AUTHORIZED FOR USE IN: (A) SAFETY CRITICAL APPLICATIONS SUCH AS LIFE SUPPORTING, ACTIVE IMPLANTED DEVICES OR SYSTEMS WITH PRODUCT FUNCTIONAL SAFETY REQUIREMENTS; (B) AERONAUTIC APPLICATIONS; (C) AUTOMOTIVE APPLICATIONS OR ENVIRONMENTS, AND/OR (D) AEROSPACE APPLICATIONS OR ENVIRONMENTS. WHERE RISINGHF PRODUCTS ARE NOT DESIGNED FOR SUCH USE, THE PURCHASER SHALL USE PRODUCTS AT PURCHASER'S SOLE RISK, EVEN IF RISINGHF HAS BEEN INFORMED IN WRITING OF SUCH USAGE, UNLESS A PRODUCT IS EXPRESSLY DESIGNATED BY RISINGHF AS BEING INTENDED FOR "AUTOMOTIVE, AUTOMOTIVE SAFETY OR MEDICAL" INDUSTRY DOMAINS ACCORDING TO RISINGHF PRODUCT DESIGN SPECIFICATIONS. PRODUCTS FORMALLY ESCC, QML OR JAN QUALIFIED ARE DEEMED SUITABLE FOR USE IN AEROSPACE BY THE CORRESPONDING GOVERNMENTAL AGENCY.

Resale of RisingHF products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by RisingHF for the RisingHF product or service described herein and shall not create or extend in any manner whatsoever, any liability of RisingHF.

RisingHF and the RisingHF logo are trademarks or registered trademarks of RisingHF in various countries.
Information in this document supersedes and replaces all information previously supplied.
The RisingHF logo is a registered trademark of RisingHF. All other names are the property of their respective owners.

http://www.risinghf.com