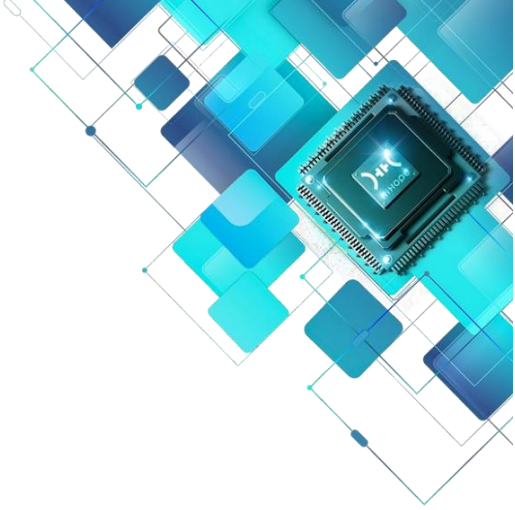


HH-M02 NearLink Module Specifications

Document version: 03

Release date: 2024/12/12

Table of contents

1 Overview

The HH-M02 is a high-performance, low-power, highly integrated Combo module based on the HiSilicon WS63E, featuring 2.4GHz Wi-Fi 6, BLE, and SLE.

Key Features:

- **Wi-Fi**: Full Wi-Fi network functionality supporting standard IEEE802.11 b/g/n/ax protocols and a complete TCP/IP protocol stack.
- **BLE**: Supports BLE versions 4.0/4.1/4.2/5.0/5.1/5.2.
- **SLE**: Supports SLE 1.0.
- **Radar Sensing**: Includes radar sensing capabilities.

The module can be used to add networking functionality to existing devices or build standalone network controllers. It can operate independently or be used as a slave module integrated with other host MCUs.

Peripheral Interfaces:

The module provides a variety of peripheral interfaces, including:

- **SPI, QSPI, UART, I2C, PWM, GPIO, and multiple ADC channels.**
- Built-in **SRAM** and **Flash** memory, enabling independent operation and support for running programs directly from Flash.

Development Support:

- Compatible with **Oniro** and third-party components, allowing developers to create IoT smart terminal devices.

- Applications span across various IoT fields, including:
    - Smart homes
    - Wearable devices
    - Medical monitoring
    - Industrial inspection
    - Power and water utilities
    - Smart agriculture

The HH-M02 module offers a versatile, powerful solution for IoT applications, combining robust performance, low power consumption, and rich functionality.

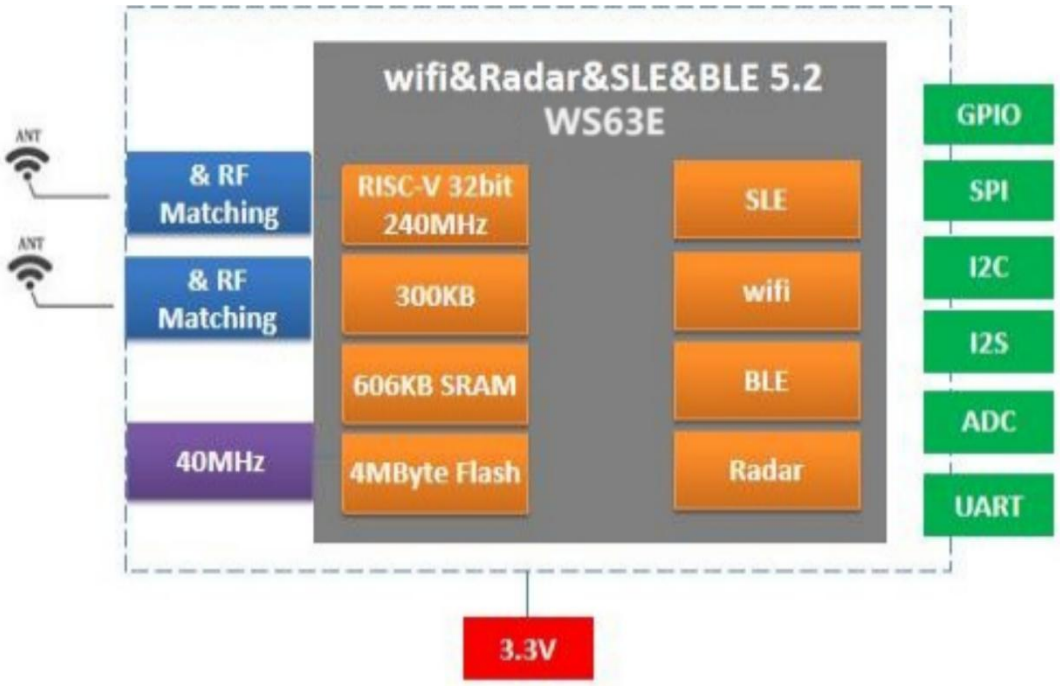


Figure 1-1 HH-M02 module structure

1.1 Main features

Table 1-1 Main features of HH-M02 module

Main features	describe
Stable and reliable communication capabilities	● Supports reliable communication algorithms such as TPC, automatic rate, and weak interference immunity in complex environments
Flexible networking capabilities	● Support BLE Mesh networking ● Supports three networking methods: Wi-Fi, BLE or SLE
Complete network support	● Support IPv4/IPv6 network functions ● Support DHCPv4/DHCPv6 Client/Server ● Support DNS Client function ● Support mDNS function ● Support CoAP/MQTT/HTTP/JSON basic components
Powerful security engine	● Hardware implementation of AES128/256 encryption and decryption algorithm ● Hardware implementation of HASH-SHA256 and HMAC_SHA256 algorithms ● Hardware implementation of RSA and ECC signature verification algorithms ● Hardware implements true random number generation, meeting FIPS140-2 random testing standards ● Hardware supports TLS/DTLS acceleration ● Hardware supports national secret algorithms SM2, SM3, SM4 ● Internally integrated EFUSE, supporting secure storage, secure boot, and hardware ID ● Internally integrated MPU features support memory isolation features

Open operating system	● Open operating system Oniro provides an open, efficient and secure system development and operating environment ● Rich low power consumption, small memory, high stability, high real-time mechanism ● Flexible protocol support and expansion capabilities ● Secondary development interface ● Multi-level development interface: operating system adaptation interface and system diagnostic interface, link layer interface, network layer interface

Main technical parameters

Table 1-2 Main technical parameters of HH-M02 module

Category	Feature	Parameter
Wi-Fi	Frequency	2.4G (2412M~2484M)
	Transmit power	802.11b: +23 dBm
		802.11g: +19 dBm
		802.11n: +18 dBm
	Receive sensitivity	802.11b: -90 dBm (11Mbps)
		802.11g: -78 dBm (54Mbps)
		802.11n: -76 dBm (MCS7)
	EVM	-20dB @802.11b,11Mbps @23dBm
		-25dB @802.11g,54Mbps @19dBm
		-28dB @802.11n,HT40,MCS7 @18dBm
BE	Power output range	-27~20dBm
SLE	Power output range	14~20dBm
hardware	CPU	32-bit RISC-V 240MHz CPU
	peripherals	UART/SPI/I2C/I2S/ADC/GPIO/PWM (multiplex)
	Working voltage	3.0V ~ 3.6V
	working temperature	-40°C ~ 85°C
	ambient temperature	-40°C ~ 105°C
	size	12mm x 12mm x 3mm
Software	Wi-Fi mode	STA, Soft-AP and sniffer modes
	security mechanism	WPS / WEP / WPA / WPA2 / WPA3
	Encryption type	UART Download
	software development	SDK
	network protocol	IPv4, TCP/UDP/HTTP/FTP/MQTT

1.2 Main features and specifications

Table 1-3 Main features of HH-M02 module

Module	Specification description
CPU subsystem	● High-performance 32bit microprocessor, maximum operating frequency 240MHz ● Embedded SRAM 606KB, ROM 300KB ● Embedded 4MB Flash
Peripheral interface	● 1 SPI interface, 1 QSPI interface, 2 I2C interfaces, 1 I2S interface, 3 UART interfaces, 19 GPIO interfaces, 6 ADC inputs, 8 PWM (Note: the above interfaces are implemented through multiplexing) ● External crystal clock frequency 24MHz, 40MHz
Wi-Fi	● 1×1 2.4GHz frequency band (ch1 ~ ch14) ● PHY supports IEEE 802.11b/g/n/ax MAC supports IEEE 802.11d/e/i/k/v/w ● Support 802.11n 20MHz/40MHz bandwidth, support 802.11ax 20MHz bandwidth ● Supported maximum rate: 150Mbps@HT40 MCS7, 114.7Mbps@HE20 MCS9 ● Built-in PA and LNA, integrated TX/RX Switch, Balun, etc. ● Supports STA and AP forms. When used as an AP, it supports up to 6 STAs. ● Support A-MPDU, A-MSDU ● Support Block-ACK ● Support QoS to meet different business service quality requirements ● Support WPA/WPA2/WPA3 personal, WPS2.0 ● Supports RF self-calibration scheme ● Supports STBC and LDPC ● Support radar sensing function
Bluetooth	● Bluetooth Low Energy (BLE)

	● Support BLE 4.0/4.1/4.2/5.0/5.1/5.2 ● Supports 125Kbps, 500Kbps, 1Mbps, 2Mbps rates ● Support multicast ● Support Class 1 ● Support high power 20dBm ● Support BLE Mesh, support BLE gateway
NearLink	● Sparklink Low Energy (SLE) ● Support SLE 1.0 ● Support SLE 1MHz/2MHz/4MHz, maximum air interface rate 12Mbps ● Supports Polar channel coding ● Support SLE gateway

2 Interface definition

(1) The HH-M02 module interface definition is as shown in the figure below:

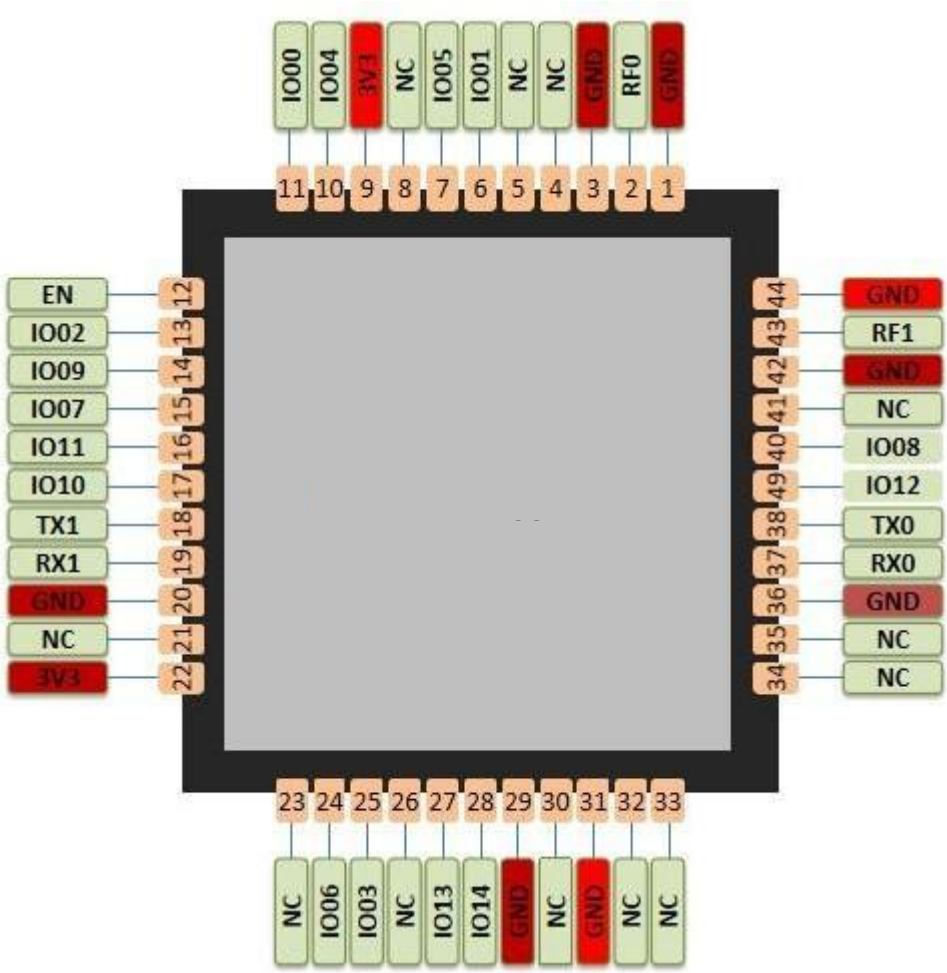


Figure 2-1 HH-M02 interface definition

(2) The modules working mode selection and each pin definition are as shown in the following table:

Table 2-1 Working mode

model
3V3/power supply 3.3V
EN/high level
TX0 RX0/ UART Download

.

Table 2-2 Pin definition

serial number	name	type	Function description
1	GND	P	land
2	RF0	-	WIFI/BLE/SLE
3	GND	P	land
4	NC	-	Not connected
5	NC	-	Not connected
6	IO01	I/O	GPIO01,PWM1, SPI1_IO0, JTAG_MODE
7	IO05	I/O	GPIO05, SSI_DATA, SPI1_IO2, UART2_CTS, PWM5,DFT_ JTAG_TCK
8	NC	-	Not connected
9	3V3	P	Recommended 3.3V/500mA
10	IO04	I/O	GPIO4,SSI CLK,PWM4,SPI1_IO1,DFT_JTAG_TMS，JTAG_ENABLE
11	IO00	I/O	GPIO00, PWM0,SPI1_CSN,JTAG_TDI
12	IN	-	high level
13	IO02	I/O	GPIO02,PWM2,SPI_IO3
14	IO09	I/O	GPIO09,PWM1,SPI0_OUT,I2S_ DO,JTAG_TDO,ADC2
15	IO07	I/O	GPIO07,PWM7,UART2_RXD,SPI0_SCK,I2S_ MCLK,ADC0
16	IO11	I/O	GPIO11,PWM3,SPI0_IN,I2S_LRCLK,ADC4
17	IO10	I/O	GPIO10,PWM2,SPI0_CS0_N,I2S_SCLK,ADC3
18	TX1	I/O	UART1_TXD,GPIO15,I2C1_SDA
19	RX1	I/O	UART1_RXD,GPIO16,I2C1_SCL
20	GND	P	land
21	NC	-	Not connected
22	3V3	P	Recommended 3.3V/500mA
23	NC	-	Not connected
24	IO06	I/O	GPIO06,PWM6,UART2_RTS,SPI1_SCK,DFT_JTAG_TDI,SPI0_OUT
25	IO03	I/O	GPIO03,PWM3,SPI1_IO1
26	NC	-	Not connected
27	IO13	I/O	GPIO13,UART_CTS,DFT_JTAG_TDO,JTAG_TMS
28	IO14	I/O	GPIO14,DFT_JTAG_TRSTN,UART1_RTS
29	GND	P	land
30	NC	-	Not connected
31	GND	P	land
32	NC	-	Not connected
33	NC	-	Not connected

34	NC	-	Not connected
35	NC	-	Not connected
36	GND	P	land
37	RX0	I/O	UART0_RXD,GPIO18,I2C0_SCL
38	TX0	I/O	UART0_TXD,GPIO17,I2C0_SDA
39	IO12	I/O	GPIO12,PWM4,I2S_DI,ADC5
40	IO08	I/O	GPIO08,PWM0,UART2_TXD,SPI0_CS1_N,ADC1
41	NC	-	Not connected
42	GND	P	land
43	RF1	-	Radar perception
44	GND	P	land

3 Appearance and dimensions

（1） HH-M02 dimensions are as follows:

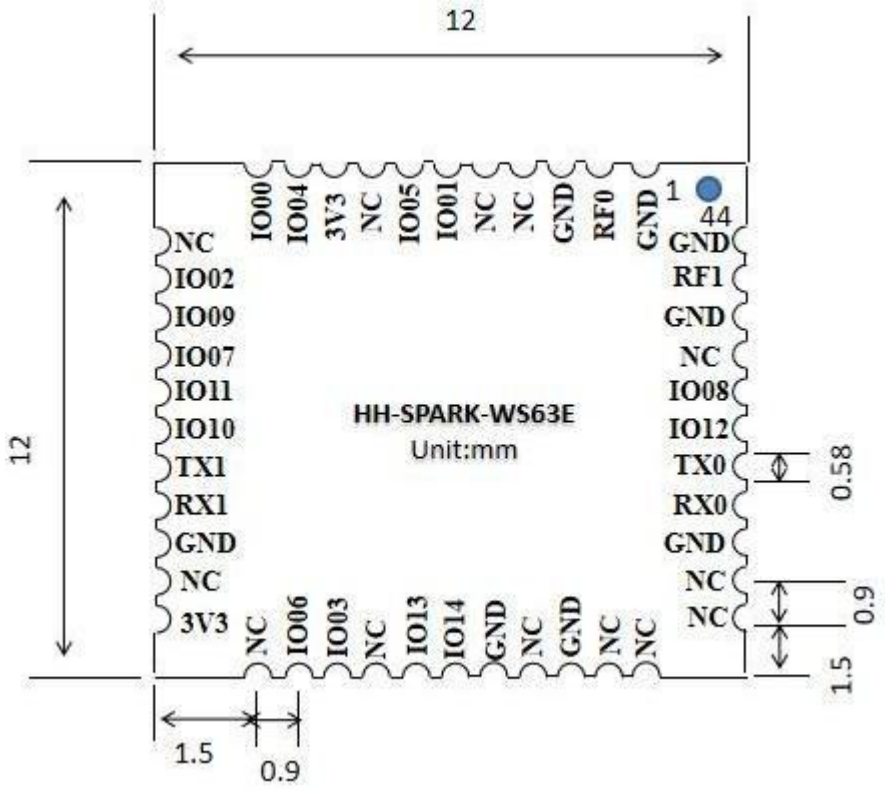


Figure 3-1 HH-M02 appearance (top view)

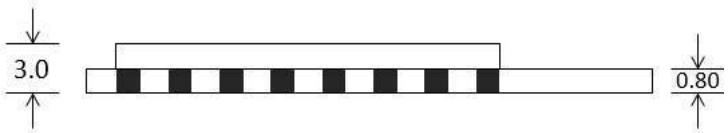


Figure 3-2 HH-M02 appearance (side view)

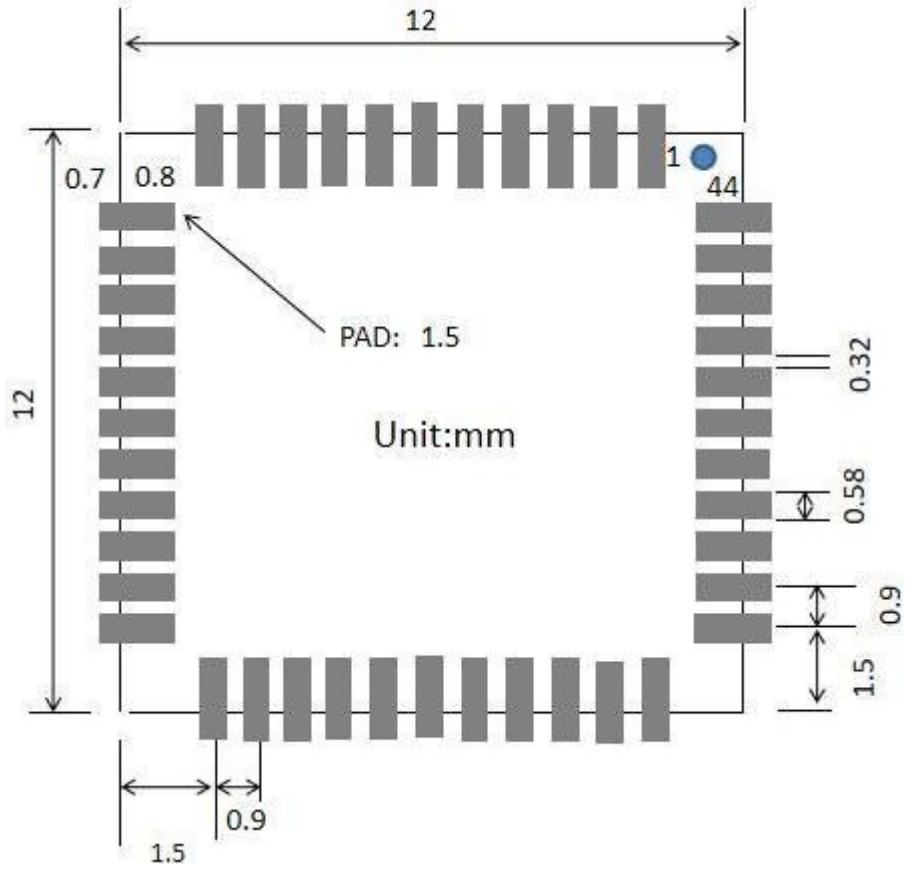


Figure 3-3 HH-M02 PCB package (top view)

4 Electrical Characteristics

Table 4.1

Electrical

Characteristics

Parameter		Condition	Minimum value	Typical value	Maximum value	Unit
Storage temperature range		-	-40	room temperature	150	℃
Maximum welding temperature		IPC/JEDEC J-STD-020	-	-	260	℃
Working voltage		-	3.0	3.3	3.6	V
I/O	WILL	-	-0.3	-	0.25*VDD	V
	HIV	-	0.75*VDD	-	VDD+0.3	
	VOL	-	-	-	0.1*VDD	
	VOH	-	0.8*VDD	-	-	
Amount of electrostatic discharge (human body model)		TAMB=25℃	-	-	2	KV
Amount of electrostatic discharge (machine model)		TAMB=25℃	-	-	0.5	KV

5 power consumption

Table 5-1 Power

consumption

Parameter	Smallest	Typical	Maximum	Unit
RX 11b /g/n, HT20	-	-	82	mA
RX 11n, HT40		-	84	mA

TX 11b, 1Mbps @23dBm		-	350	mA
TX 11g, 54Mbps @19dBm	-	-	295	mA
TX 11n, HT20, MCS7, @18dBm	-	-	290	mA
TX 11n, HT40, MCS7, @18dBm	-	-	290	mA
Modem-sleep, CPU is powered	-	1.5	-	mA
Power consumption when turned off (DVDD, AVDD33 and AVDD18 are all in office)	-	500	-	uA
Power consumption when shutting down (DVDD power-off, AVDD33 and AVDD18 is in place)	-	4.3	0	uA

HH-M02 The peak current may exceed 400mA, the recommended power supply is 500mA.

6 Wi-Fi RF parameters

The data in the table below are measured at room temperature and a voltage of 3.3V.

Table 6-1 Wi-Fi TX characteristics

Parameter	Smallest	Typical	Maximum	Unit
input frequency	2412	-	2484	MHz
802.11b @11Mbps	-	23	-	dBm
802.11g @54Mbps	-	19	-	dBm
802.11n,HT20,MCS7	-	18	-	dBm
EVM @11b,11Mbps@23dBm	-	-20	-	dBm
EVM @11g,54Mbps@19dBm	-	-25	-	dBm
EVM @11n,HT20,MCS7@18dBm	-	-28	-	dBm

Table 6-2 Wi-Fi RX sensitivity

Parameter	Smallest	Typical	Maximum	Unit
802.11b,1Mbps	-	-99	-	dBm
802.11b,11Mbps	-	-90	-	dBm
802.11g,6Mbps	-	-96	-	dBm
802.11g,54Mbps	-	-78	-	dBm
802.11n,HT20,MCS0	-	-96	-	dBm
802.11n,HT20,MCS3	-	-87	-	dBm
802.11n,HT20,MCS7	-	-76	-	dBm

Table 6-3 Wi-Fi RX features

Parameter	Smalle	Typical	Maximun	Unit
ACI suppression interference signal ratio @11b,1Mbps	-	42	-	dB
ACI suppression interference signal ratio @11b,11Mbps	-	35	-	dB
ACI suppression interference signal ratio @11g,6Mbps	-	40	-	dB
ACI suppression interference signal ratio @11g,54Mbps	-	16	-	dB
ACI suppression interference signal ratio @11n,HT20,MCS0	-	39	-	dB
ACI suppression interference signal ratio @11n, HT20, MCS7	-	14	-	dB

7 BLE/SLE RX TX performance

Table 7-1 BLE/SLE performance

Mode	DR	Unit	NF (db)	-	Remark
BECAME 1M	-97.7	dBm	4.7	30% PER	-
BECAME 2M	-94.7	dBm	4.7	30% PER	-
WAS 125K	-105.7	dBm	4.7	30% PER	-
SLE 1M GFSK	-96.7	dBm	4.7	10% PER	modulation index=0.5
SLE 2M GFSK	-93.7	dBm	4.7	10% PER	modulation index=0.5
SLE 4M GFSK	-90.7	dBm	4.7	10% PER	modulation index=0.5
SLE 1M QPSK	-99.7	dBm	4.7	10% PER	code rate=3/4
SLE 1M 8PSK	-94.7	dBm	4.7	10% PER	code rate=3/4
SLE 2M QPSK	-96.7	dBm	4.7	10% PER	code rate=3/4
SLE 2M 8PSK	-91.7	dBm	4.7	10% PER	code rate=3/4
SLE 4M QPSK	-93.7	dBm	4.7	10% PER	code rate=3/4

Table 7-2 BLE/SLE power

Mode	Power	Unit
BE	(Maximum) 20	dBm
SLE GFSK	(Maximum) 20	dBm
SLE QPSK	(Max 4M BW) 14	dBm
SLE 8FSK	(Max 4M BW) 14	dBm

8 Recommended temperature curve

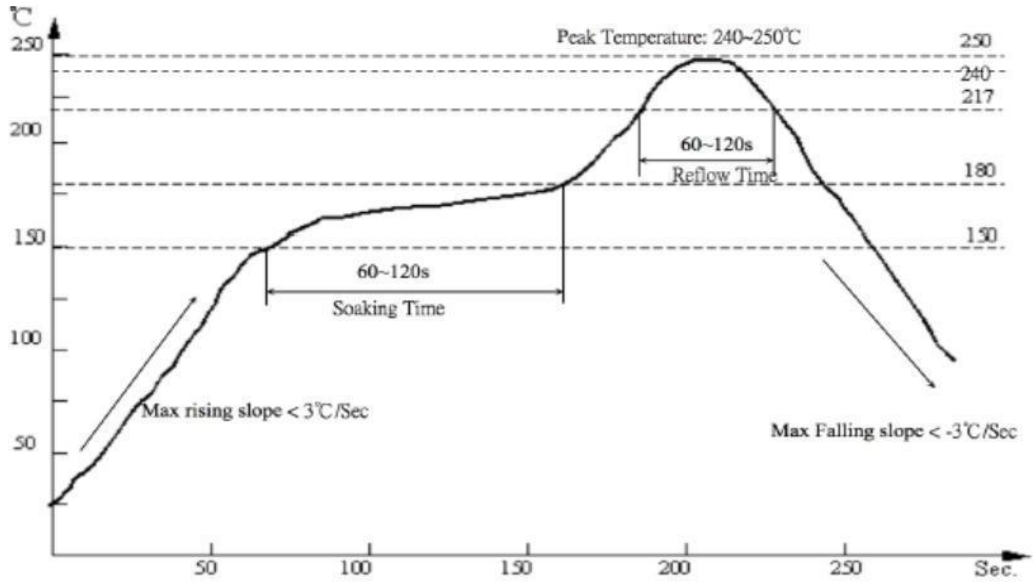


Figure 8-1 Recommended temperature curve

9 Minimal system module

This module works at 3.3V voltage:

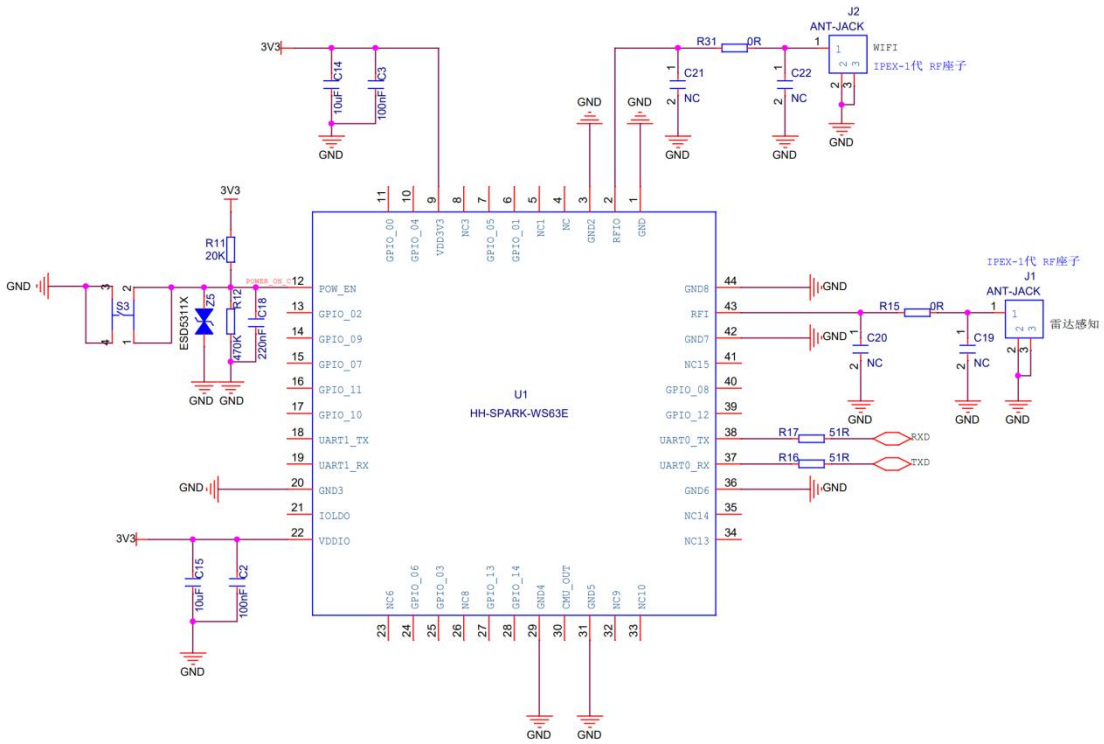


Figure 9-1 Minimal system

Note:

（1） The module power supply voltage is DC 3.3V;

（2） The maximum output current of module IO is 27mA;

（3） Module EN enable pin high level;

（4） The RXD of the Wi-Fi module is connected to the TXD of the external MCU, and the TXD of the Wi-Fi module is connected to the RXD of the external MCU;

10 Recommended PCB Design

For PCB, the characteristic impedance of all RF traces should be controlled at 50Ω. The impedance of an RF trace is typically determined by the trace width (W), the dielectric constant of the material, the height from the reference ground to the signal layer (H), and the spacing between the RF trace and ground (S). Microstrip or coplanar waveguides are commonly used in RF layouts to control characteristic impedance. Below are reference designs for microstrip or coplanar waveguides with different PCB structures.

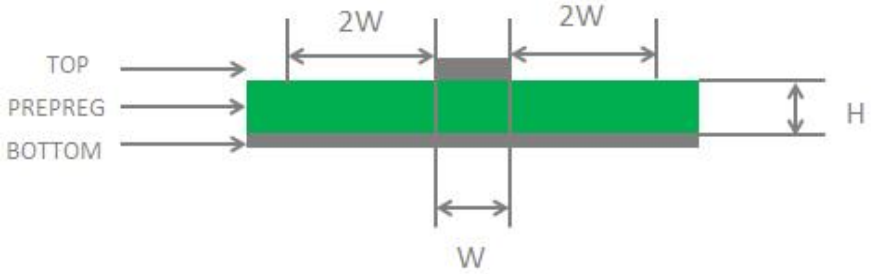


Figure 10-1 Microstrip design of 2-layer PCB

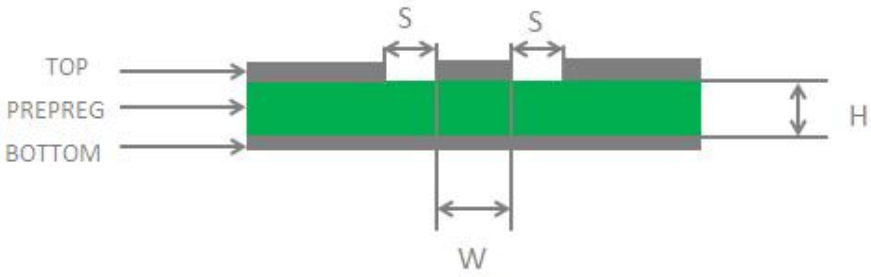
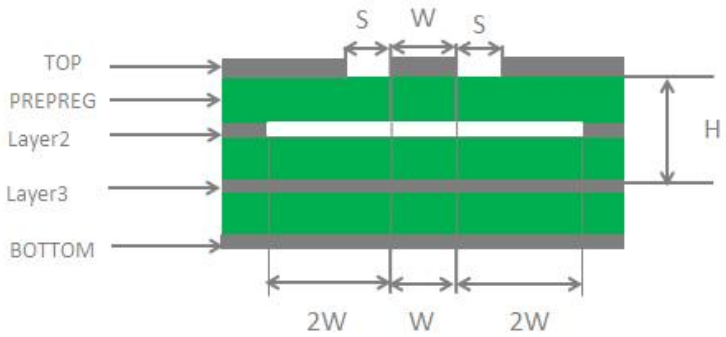


Figure 10-2 Coplanar waveguide design on double-layer PCB



.

Figure 10-3 Coplanar waveguide design on 4-layer PCB (layer 3 serves as reference ground)

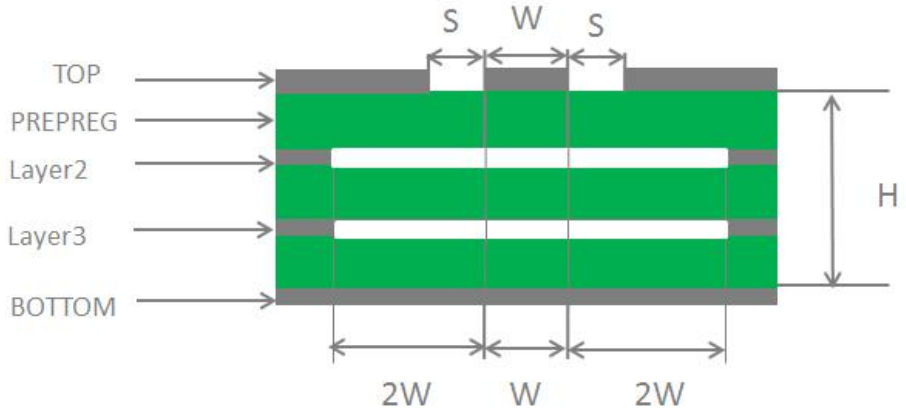


Figure 10-4 Coplanar waveguide design on 4-layer PCB (layer 4 serves as reference ground)

To ensure RF performance and reliability, follow the following principles in RF layout design:

- Use impedance simulation tools to accurately control the characteristic impedance of the RF trace to 50Ω.
- The GND pin adjacent to the RF pin should not be designed as a thermal relief pad but should be fully grounded.
- The distance between the RF pins and the RF connector should be as short as possible, and all right-angle traces should be replaced with curved traces.
- There should be clearance underneath the signal pins of the antenna connector or solder joint.
- The reference ground of the RF trace should be intact. Also, adding some ground vias around the RF traces and ground reference can help improve RF

performance. The distance between ground vias and RF traces should be no less than twice the width of the RF signal trace (2×W).

11 Peripheral routing suggestions

Wi-Fi modules integrate high-speed GPIO and peripheral interfaces, which can generate significant switching noise. If some applications have higher requirements for power consumption and EMI characteristics, it is recommended to connect a 10~100 ohm resistor in series with the digital I/O line. This suppresses overshoot and smoothes the signal when switching the power supply on and off, while also providing some protection against electrostatic discharge (ESD).

12 Packaging instructions

The product is packed in tape form.

The dimensions of a single packaging box are: 340 x 360 x 60mm, each packaging box contains 1000 modules.

The outer box size is: 355 x 375 x 325mm, which can hold 5 boxes.

Figure 12-1 Module packaging