Hi-12FL Specifications

Version V1.0

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Document development/revision/revocation resume

Vision	Data	Revised content	Edition	Approve
V1.0	2021.08.30	First Edition	Peihong Su	Ning Guan

Contents

1. Product Overview

Hi-12FL is a Wi-Fi module developed by Ai-Thinker. It can be widely used in intelligent terminal products related to the IoT, such as smart homes, smart security, and smart cities.

Hi-12FL is equipped with Hi3861LV100 core processor chip. The chip is a highly integrated 2.4GHz low-power SoC WiFi chip that integrates IEEE 802.11b/g/n baseband and RF circuits. The RF circuit includes power amplifier PA, low noise amplifier LNA, RF balun, antenna switch and power supply Management and other modules. It supports 20MHz standard bandwidth and 5MHz/10MHz narrow bandwidth, and provides a maximum physical layer rate of 72.2Mbit/s. The WiFi baseband of the chip supports Orthogonal Frequency Division Multiplexing (OFDM) technology, and is backward compatible with Direct Sequence Spread Spectrum (DSSS) and Complementary Code Keying (CCK) technology, and supports various data in IEEE 802.11 b/g/n protocols rate.

The Hi3861LV100 chip of the Hi-12FL module also integrates a high-performance 32-bit microprocessor,a hardware security engine, and a wealth of peripheral interfaces. The peripheral interfaces include SPI、UART、I2C、PWM、GPIO and multiple ADC, It also supports high-speed SDIO2.0 SlaveSlave interface, the highest clock can reach 50MHz; The chip has built-in SRAM and Flash, which can run independently, and supports running programs on Flash.

The Hi-12FL module supports Huawei LiteOS and third-party components, and provides an open and easy-to-use development and debugging environment.

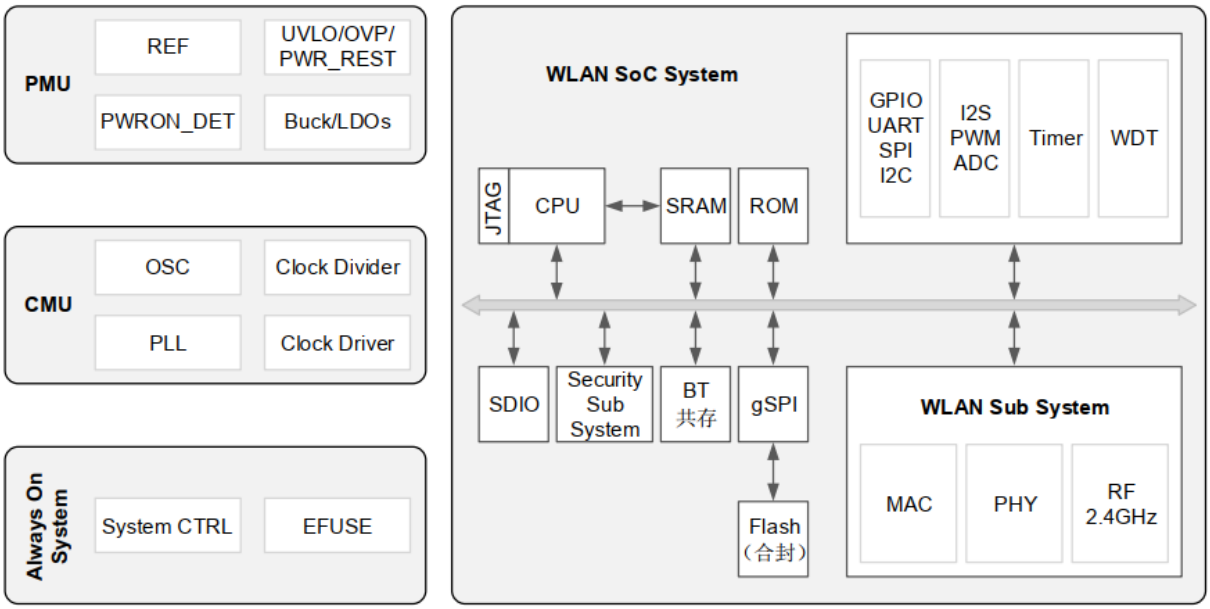


Figure 1 Main chip architecture diagram

1.1. Features

- 1×1 2.4GHz Frequency band（ch1～ch11）
- Support all data rates of IEEE802.11b/g/n single antenna
- Support maximum rate：72.2Mbps@HT20 MCS7
- Support STBC
- Support Short-GI
- Support STA and AP form， as an AP, it supports up to 6 STAs to access.
- Support WFA WPA/WPA2 personal, WPS2.0
- High-performance 32bit microprocessor, with a maximum operating frequency of 160MHz.
- Embedded SRAM 352KB, ROM 288KB, embedded 2MB Flash
- Integrated EFUSE internally, supports secure storage, secure boot, and hardware ID
- Support 256 node Mesh networking
- Support AT command, can get started quickly
- Huawei LiteOS, an open operating system, provides an open, efficient and safe system development and operating environment
- Adopts SMD-22 package
- Support UART/SPI/I2C/GPIO/ADC/PWM/I2S/SDIO interface

2.Main parameters

Table 1 main parameter descriptions

Model Name	Hi-12FL
Package	SMD-22
Size	24.0*16.0*3.2(±0.2)mm
Antenna	On-Board PCB
Frequency Range	2400 ~ 2483.5MHz
Operating Temperature	-40 □ ~ 85 □
Store Temperature	-40 □ ~ 125 □ , < 90%RH
Power supply range	Voltage 3.0V ~ 3.6V，Electrical current >500mA
Support Interface	UART/SPI/I2C/GPIO/ADC/PWM /I2S/SDIO
UART Rate	Default 115200
WiFi	802.11b/g/n
Security	WFA WPA/WPA2 personal、WPS2.0

2.1. Electrical parameters

Hi-12FL module is electrostatic sensitive devices and special precautions need to be taken when handling

Figure 2 ESD anti-static diagram

2.2. Electrical characteristics

Table 2 Main parameter description

Parameters		Conditions	Min	Typical values	Max	Unit
Supply voltage		VCC	3.0	3.3	3.6	V
I/O	Interface voltage	VDDIO1/ VDDIO2	3.125	3.3	3.6	V
	V_{IH}	-	2.4	-	3.63	V
	V_{IL}	-	-0.3	-	0.8	V
	V_{OH}	-	2.4	-	-	V
	V_{OL}	-	-	-	0.4	V

2.3. WIFI Electrical characteristics

Table 3 Description of main parameters

Description	Typical values	Unit
Operating frequency	2412 - 2462	MHz
Output power		
11n mode HT20，PA output power	12.5±2	dBm
11g mode，PA output power	12±2	dBm
11b mode，PA output power	11±2	dBm
Receiving sensitivity		
11b, 1 Mbps	≤-96	dBm
11b, 11 Mbps	≤-89	dBm
6 Mbps (1/2 BPSK)	≤-92	dBm
54 Mbps (3/4 64-QAM)	≤-74	dBm
HT20 (MCS7)	≤-72	dBm

2.4. Power consumption

- The following power consumption data is measured based on a 3.3V power supply and an ambient temperature of 25°C.
- All measurements were completed at the antenna interface without SAW filters
- All emission data are based on 50% duty cycle, measured in continuous emission mode.

Table 4 Description of main parameters

Mode	Mix	Typical values	Max	Unit
Tx 802.11b, CCK 11Mbps, POUT=+17dBm	-	TBD	-	mA
Tx 802.11g, OFDM 54Mbps, POUT =+15dBm	-	TBD	-	mA

Tx 802.11n, MCS7, POUT =+14dBm	-	TBD	-	mA
Rx 802.11b,1024 bit	-	TBD	-	mA
Rx 802.11g,1024 bit	-	TBD	-	mA
Rx 802.11n,1024 bit	-	TBD	-	mA
Ultra Deep Sleep	-	TBD	-	μA
DTIM1	-	TBD	-	μA
DTIM3	-	TBD	-	μA
DTIM10	-	TBD	-	μA

3.Appearance dimensions

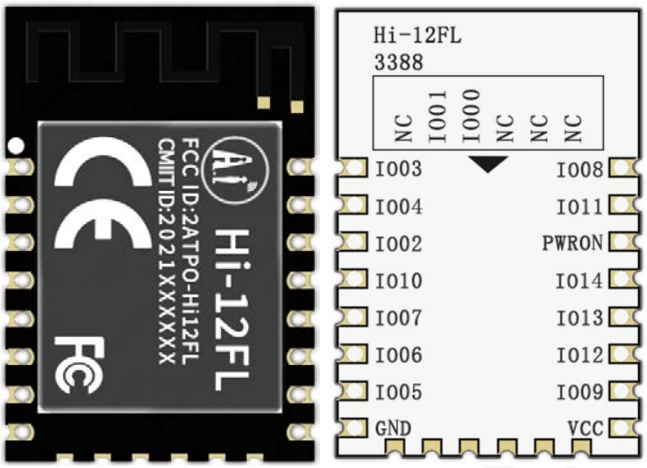


Figure 3 The appearance of the module(For reference only

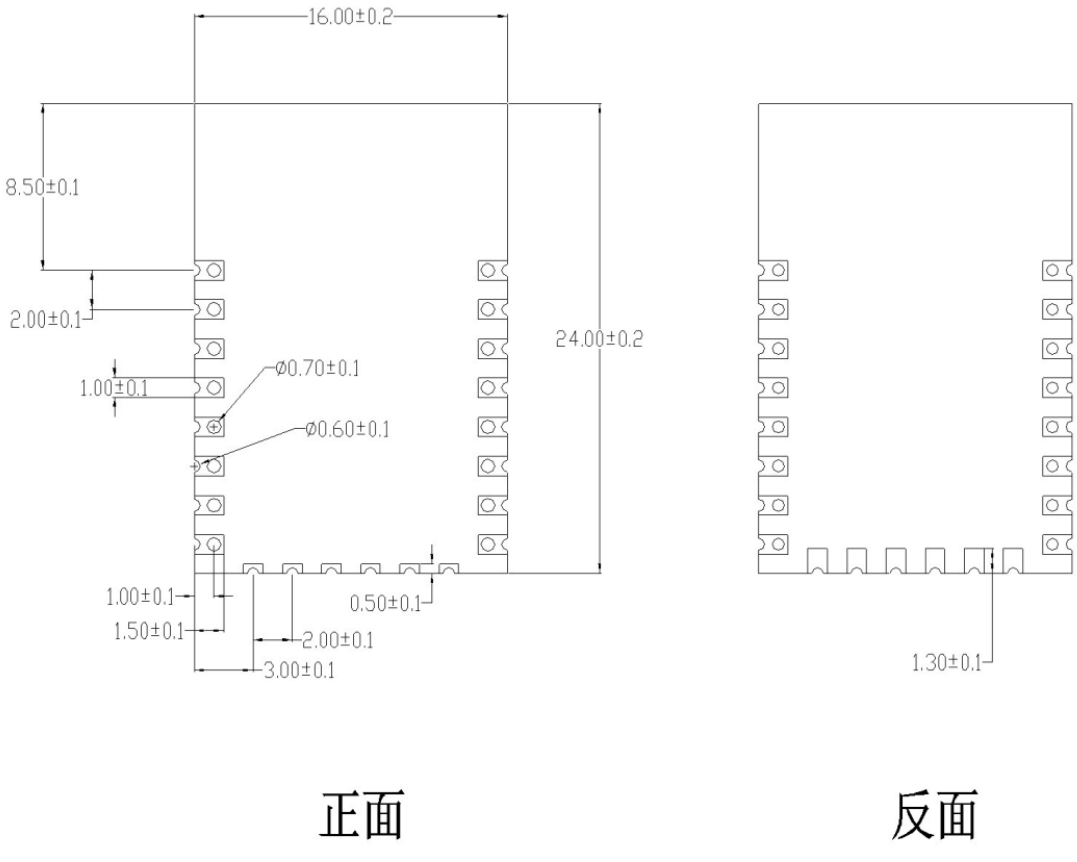


Figure 4 Module size diagram

4.Pin definition

Figure 5 Schematic diagram of the pin

Hi-12FL series modules have 22 interfaces. As shown in the pin diagram, the pin function definition table is the interface definition.

able 5 Hi-07FL Pin function definition

No.	Name	Function
1	IO08	GPIO_08,UART1_RTS,SPI0_TXD,PWM1_OUT,I2S0_WS,WLAN_ACTIVE,JTAG_ENABLE
2	IO11	GPIO_11，UART2_TXD，SPI0_RXD，SDIO_CMD，ADC5，PWM2_OUT，I2S0_RX，HW_ID6
3	PWRON	Chip PMU power-on enable pin, pulled up inside the module 0: Power off 1: Power on
4	IO14	GPIO_14，UART0_LOG_RXD，UART2_CTS，SDIO_D1，PWM5_OUT，I2C0_SCL，HW_ID2
5	IO13	GPIO_13，UART0_LOG_TXD，UART2_RTS，SDIO_D0，ADC6，PWM4_OUT，I2S0_WS，I2C0_SDA
6	IO12	GPIO_12，UART2_RXD，SPI0_CS1，SDIO_CLK，ADC0，PWM3_OUT，I2S0_CLK，HW_ID7
7	IO09	GPIO_09，UART2_RTS，SPI0_TXD，SDIO_D2，ADC4，PWM0_OUT，I2S0_MCK，I2C0_SCL
8	VCC	Power supply, recommended 3.3V, > 500mA
9	NC	NC
10	NC	NC
11	NC	NC
12	IO00	Internally connected with 32K crystal
13	IO01	Internally connected with 32K crystal
14	NC	
15	GND	Grounded
16	IO05	GPIO_05，UART1_RXD，SPI0_CS1，ADC2，PWM2_OUT，

		I2S0_MCK，BT_STATUS，HW_ID4
17	IO06	GPIO_06，UART1_TXD，SPI0_CLK，PWM3_OUT，I2S0_TX，COEX_SWITCH，JTAG_MODE
18	IO07	GPIO_07，UART1_CTS，SPI0_RXD，ADC3，PWM0_OUT，I2S0_CLK，BT_ACTIVE，HW_ID5
19	IO10	GPIO_10，UART2_CTS，SPI0_CLK，SDIO_D3，PWM1_OUT，I2S0_TX，I2C0_SDA
20	IO02	GPIO_02，UART1_RTS，SPI1_TXD，PWM2_OUT，JTAG_TRSTN，REFCLK_FREQ_STATUS
21	IO04	GPIO_04，UART0_LOG_RXD，ADC1，PWM1_OUT，I2C1_SCL，JTAG_TMS，HW_ID3
22	IO03	GPIO_03，UART0_LOG_TXD，UART1_CTS，SPI1_CS1，PWM5_OUT，I2C1_SDA，JTAG_TDI

Note: IO00 and IO01 are internally connected to 32K crystals and cannot be used, please leave them open.

Table 6 Module start mode description

System start up mode			
Pin	Default state	Low level	High level
IO2/REFCLK_FREQ_STATUS	Pull down	40MHz（Default）	24MHz
IO6/JTAG_MODE	Pull down	Normal function mode（Default）	DFT Test mode
IO8/JTAG_ENABLE	Pull down	Ordinary IO（Default）	JTAG enable

Note: IO2/IO6/IO8 are hardware configuration words, which cannot be in high level state when power on, otherwise the module cannot enter normal working state

5. Schematic diagrams

5.1. 5.1. Schematic diagrams of module

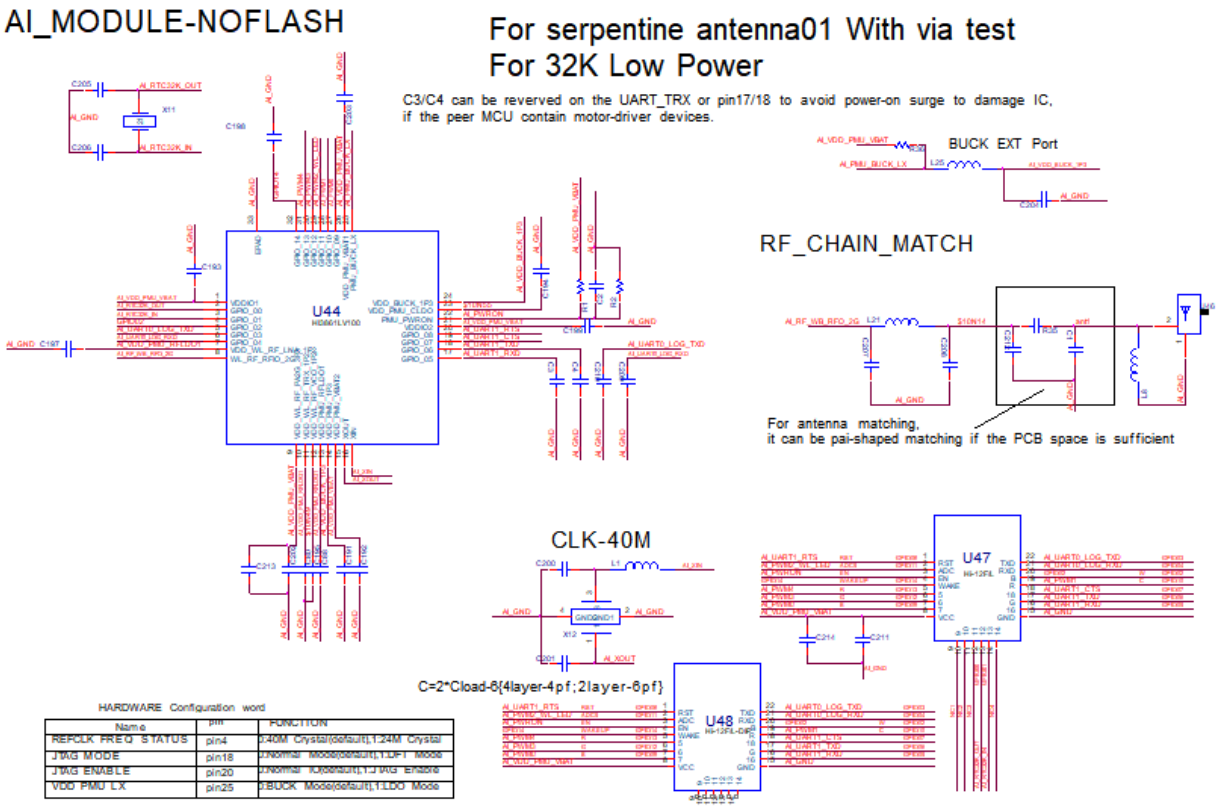


Figure 6 Module schematic diagram

5.2. 5.2. Application circuit diagram

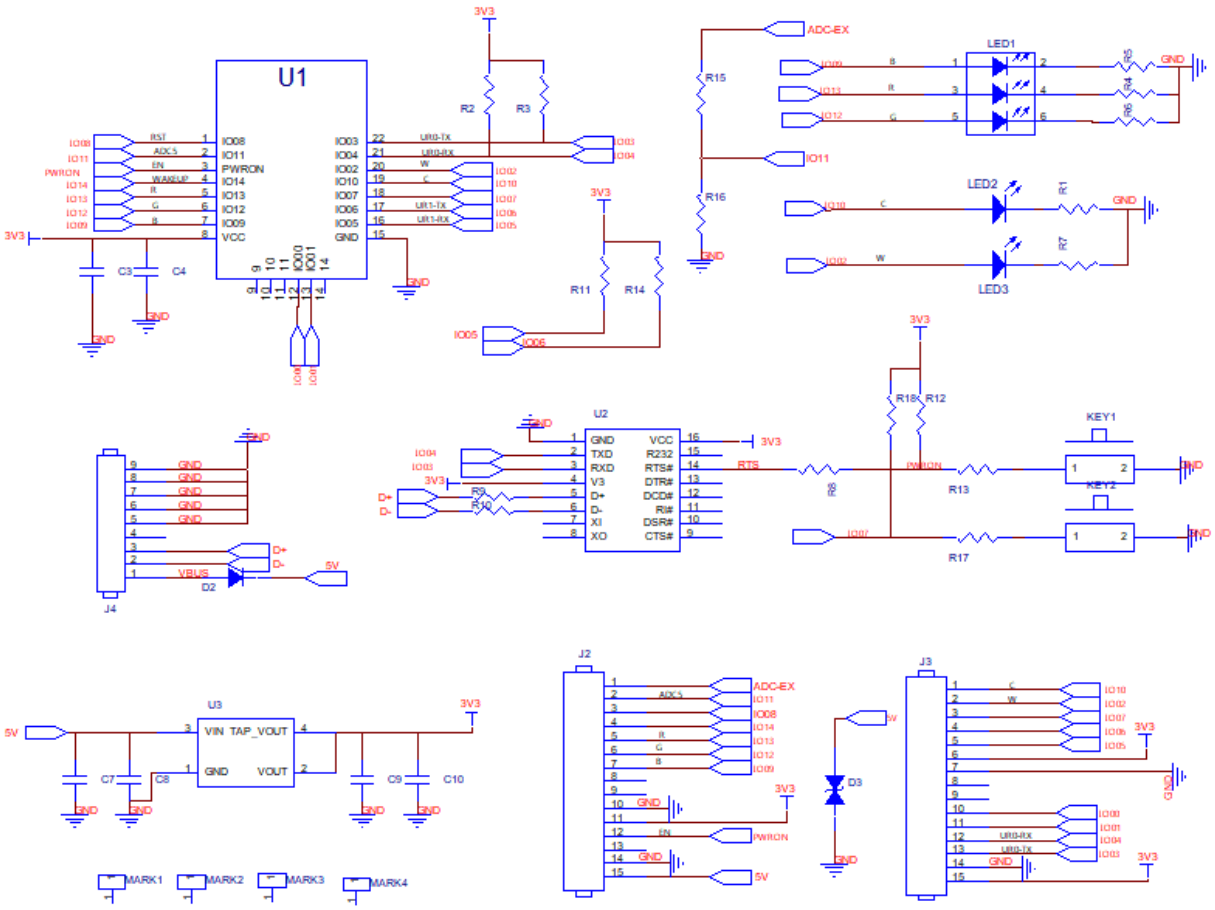


Figure 7 Application circuit diagram

Note: IO2/IO6/IO8 are hardware configuration words and cannot be in a high level state after power-on, otherwise the module cannot enter normal working state.

6.Design guidance

6.1. Antenna layout requirements

（1）The installation position on the motherboard, the following two ways are recommended:
Solution 1: Put the module on the edge of the main board, and the antenna area extends out of the edge of the main board.
Solution 2: Put the module on the edge of the motherboard, and hollow out an area at the antenna position on the edge of the motherboard
（2）In order to meet the performance of the on-board antenna, it is forbidden to place metal

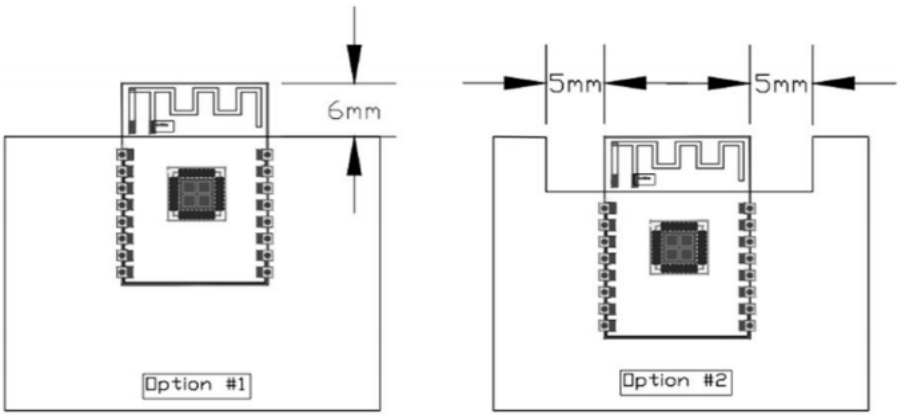


Figure 8 Schematic diagram of antenna layout

6.2. Power Supply

（1）Recommended 3.3V voltage, peak current above 500mA
（2）It is recommended to use LDO power supply; if using DC-DC, it is recommended that the ripple be controlled within 30mV.
（3）It is recommended to reserve the position of the dynamic response capacitor for the DC-DC power supply circuit, which can optimize the output ripple when the load changes greatly.
（4）3.3V power interface recommends adding ESD devices

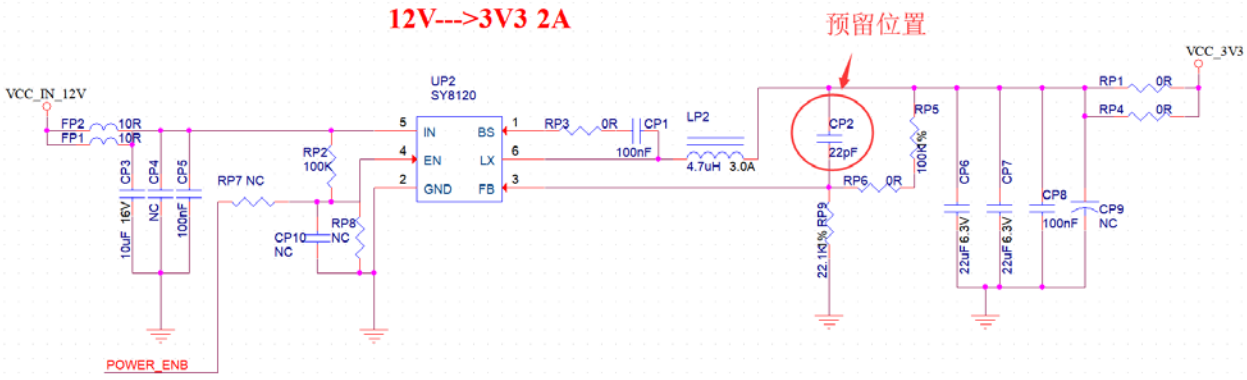


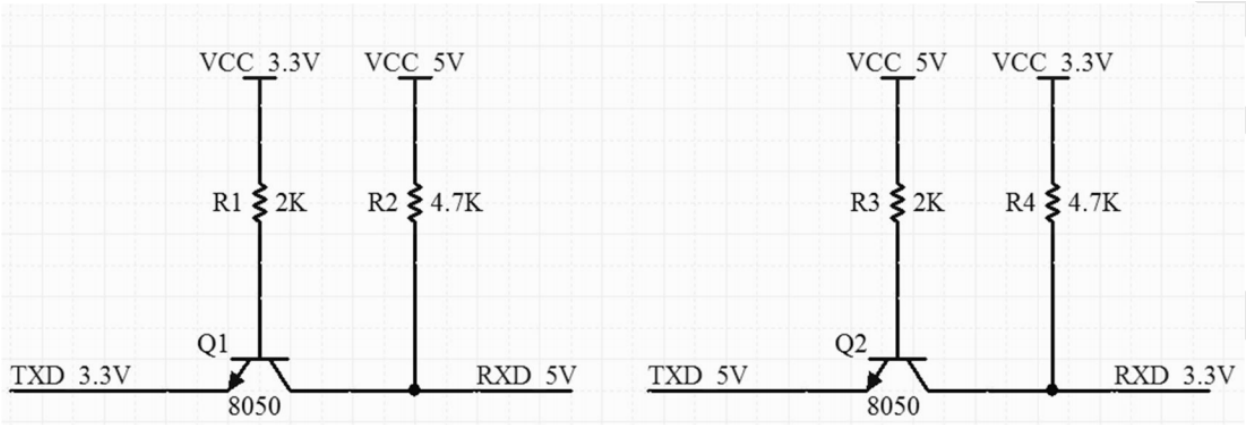
Figure 9 DC-DC step-down circuit diagram

6.3. GPIO

(1)There are some GPIO ports on the periphery of the module. If you need to use it, it is recommended to connect a 10-100 ohm resistor in series with the IO port. This can suppress overshoot and make the levels on both sides more stable. Helps both EMI and ESD
(2)For the pull-up and pull-down of special IO ports, please refer to the instructions in the specification. This will affect the startup configuration of the module.

(3)The IO port of the module is 3.3V. If the main control and the IO level of the module do not match, a level conversion circuit needs to be added.
(4)If the IO port is directly connected to a peripheral interface, or a terminal such as a header, it is recommended to reserve an ESD device near the terminal of the IO trace

Figure 10 Level conversion circuit



7.Reflow soldering

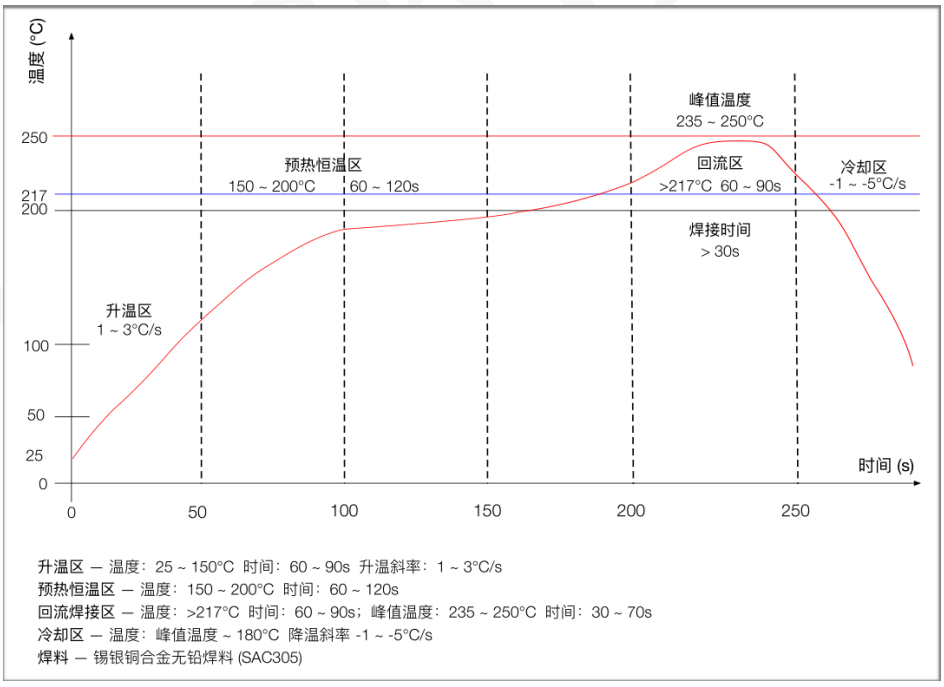


Figure 11 Reflow soldering

8.Packaging information

As shown in the figure below, Hi-12FL is packed with tape

Figure 12 Schematic diagram of packaging

9.Product related model

Table 7 Table of related models

Model	Chip	Package	Size	Antenna
Hi-12F	Hi3861V100	SMD-22	24.0*16.0*3.2(±0.2)mm	On-board
Hi-12FL	Hi3861LV100	SMD-22	24.0*16.0*3.2(±0.2)mm	On-board
Hi-07S	Hi3861V100	SMD-22	17.0*16.0*3.2(±0.2)mm	IPEX
Hi-07SL	Hi3861LV100	SMD-22	17.0*16.0*3.2(±0.2)mm	IPEX
Product related information：https://docs.ai-thinker.com				

10.Contact us

Official website：https://www.ai-thinker.com

Development DOCS ：https://docs.ai-thinker.com

Official Forum：http://bbs.ai-thinker.com

Sample purchase：https://ai-thinker.en.alibaba.com/

Business cooperation：overseas@aithinker.com

Technical support：support@aithinker.com

Company Address：Room 403,408-410, Block C, Huafeng Smart Innovation Port, Gushu 2nd Road, Xixiang, Baoan District, Shenzhen.

Tel ： 0755-29162996

FCC WARNING

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

This device complies with Part 15 of the FCC Rules.

Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This device and its antenna(s) must not be co-located or operating in conjunction with any other antenna or transmitter.

15.105 Information to the user.

(b) For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

—Reorient or relocate the receiving antenna.

—Increase the separation between the equipment and receiver.

—Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

—Consult the dealer or an experienced radio/TV technician for help.

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20 cm between the radiator and your body.

Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment.

This transmitter must not be co-located or operating in conjunction with any other

antenna or transmitter.
The availability of some specific channels and/or operational frequency bands are country dependent and are firmware programmed at the factory to match the intended destination.
The firmware setting is not accessible by the end user.
The final end product must be labelled in a visible area with the following:
“Contains Transmitter Module “2ATPO-HI12FL”

Requirement per KDB996369 D03

2.2 List of applicable FCC rules

List the FCC rules that are applicable to the modular transmitter. These are the rules that specifically establish the bands of operation, the power, spurious emissions, and operating fundamental frequencies. DO NOT list compliance to unintentional-radiator rules (Part 15 Subpart B) since that is not a condition of a module grant that is extended to a host manufacturer. See also Section 2.10 below concerning the need to notify host manufacturers that further testing is required.3

Explanation: This module meets the requirements of FCC part 15C (15.247).it Specifically identified AC Power Line Conducted Emission, Radiated Spurious emissions, Band edge and RF Conducted Spurious Emissions, Conducted Peak Output Power, Bandwidth, Power Spectral Density, Antenna Requirement.

Summarize the specific operational use conditions

Describe use conditions that are applicable to the modular transmitter, including for example any limits on antennas, etc. For example, if point-to-point antennas are used that require reduction in power or compensation for cable loss, then this information must be in the instructions. If the use condition limitations extend to professional users, then instructions must state that this information also extends to the host manufacturer's instruction manual. In addition, certain information may also be needed, such as peak gain per frequency band and minimum gain, specifically for master devices in 5 GHz DFS bands.

Explanation: The product antenna uses an irreplaceable antenna with a gain of 1dBi

Limited module procedures

If a modular transmitter is approved as a "limited module," then the module manufacturer isresponsible for approving the host environment that the limited module is used with. The manufacturer of a limited module must describe, both in the filing and in the installation instructions, the alternative means that the limited module manufacturer uses to verify that the host meets the necessary requirements to satisfy the module limiting conditions.

A limited module manufacturer has the flexibility to define its alternative method to address the conditions that limit the initial approval, such as: shielding, minimum signaling amplitude, buffered modulation/data inputs, or power supply regulation. The alternative method could include that the limited

module manufacturer reviews detailed test data or host designs prior to giving the host manufacturer approval.
This limited module procedure is also applicable for RF exposure evaluation when it is necessary to demonstrate compliance in a specific host. The module manufacturer must state how control of the product into which the modular transmitter will be installed will be maintained such that full compliance of the product is always ensured. For additional hosts other than the specific host originally granted with a limited
module, a Class II permissive change is required on the module grant to register the additional host as a specific host also approved with the module.
Explanation: The module is a single module.

2.6 RF exposure considerations

It is essential for module grantees to clearly and explicitly state the RF exposure conditions that permit a host product manufacturer to use the module. Two types of instructions are required for RF exposure information: (1) to the host product manufacturer, to define the application conditions (mobile, portable – xx cm from a person's body); and (2) additional text needed for the host product manufacturer to provide to end users in their end-product manuals. If RF exposure statements and use conditions are not provided, then the host product manufacturer is required to take responsibility of the module through a change in FCC ID (new application).

Explanation: The module complies with FCC radiofrequency radiation exposure limits for uncontrolled environments. The device is installed and operated with a distance of more than 20 cm between the radiator and your body." This module follows FCC statement design, FCC ID :2ATPO-HI12FL

Antennas

A list of antennas included in the application for certification must be provided in the instructions. For modular transmitters approved as limited modules, all applicable professional installer instructions must be included as part of the information to the host product manufacturer. The antenna list shall also identify the antenna types (monopole, PIFA, dipole, etc. (note that for example an "omni-directional antenna" is not considered to be a specific "antenna type")).
For situations where the host product manufacturer is responsible for an external connector, for example with an RF pin and antenna trace design, the integration instructions shall inform the installer that unique antenna connector must be used on the Part 15 authorized transmitters used in the host product.

The module manufacturers shall provide a list of acceptable unique connectors.

Explanation: The product antenna uses an irreplaceable antenna with a gain of 1dBi

2.7 Label and compliance information

Grantees are responsible for the continued compliance of their modules to the FCC rules. This
includes advising host product manufacturers that they need to provide a physical or e-label stating “Contains FCC ID” with their finished product. See Guidelines for Labeling and User Information for RF Devices – KDB Publication 784748.

Explanation: The host system using this module, should have label in a visible area indicated the following texts: "Contains FCC ID: 2ATPO-HI12FL.

2.8 Information on test modes and additional testing requirements5

Additional guidance for testing host products is given in KDB Publication 996369 D04 Module Integration Guide. Test modes should take into consideration different operational conditions for a stand-alone modular transmitter in a host, as well as for multiple simultaneously transmitting modules or other transmitters in a host product.

The grantee should provide information on how to configure test modes for host product evaluation for different operational conditions for a stand-alone modular transmitter in a host, versus with multiple, simultaneously transmitting modules or other transmitters in a host.

Grantees can increase the utility of their modular transmitters by providing special means, modes, or instructions that simulates or characterizes a connection by enabling a transmitter. This can greatly simplify a host manufacturer’s determination that a module as installed in a host complies with FCC requirements.

Explanation: Shenzhen Ai-Thinker Technology Co., Ltd. can increase the utility of our modular transmitters by providing instructions that simulates or characterizes a connection by enabling a transmitter.

2.9 Additional testing, Part 15 Subpart B disclaimer

The grantee should include a statement that the modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. If the grantee markets their product

as being Part 15
Subpart B compliant (when it also contains unintentional-radiator digital circuity), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

Explanation: The module without unintentional-radiator digital circuity, so the module does not require an evaluation by FCC Part 15 Subpart B. The host shoule be evaluated by the FCC Subpart B.