Lierda DB6L Series Hardware Design Manual

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Document revision history

Document version	Date of change	proposer	auditor	Changes
Rev0.1	23-08-08	LHL	YB	initial version

Safety Instructions

It is the user's responsibility to follow the relevant regulations of other countries and the specific environmental regulations for the use of wireless communication modules and equipment. By observing the following safety principles, you can ensure your personal safety and help to protect the product and the working environment from potential damage. We are not liable for damages related to the customer's failure to comply with these regulations.

	Safety on the road comes first! When you are driving, do not use hand-held mobile terminal devices unless they have a hands-free function. Please stop the car before making a call!
	Please turn off your mobile devices before boarding the airplane. The wireless function of mobile devices is prohibited on board to prevent interference with the aircraft's communication system. Ignoring this reminder may lead to flight safety or even violate the law.
	When in a hospital or health care setting, note if there are restrictions on the use of mobile devices.RF interference can cause medical equipment to malfunction, so it may be necessary to turn off the mobile device.
	The mobile device does not guarantee a valid connection in all circumstances, for example if the mobile device is out of credit or the SIM is invalid. When you are in an emergency situation, please remember to use the emergency call and make sure that your device is switched on and in an area with sufficient signal strength.
	Your mobile device receives and transmits RF signals when it is switched on, which can cause RF interference when in close proximity to TVs, radios computers or other electronic devices.
	Keep the mobile terminal unit away from flammable gases. Turn off the mobile device when you are near gas stations, oil depots, chemical plants, or explosive workplaces. It is a safety hazard to operate electronic devices in any place where there is a potential explosion hazard.

Applicable modules Options

serial number	Module Model	Supported Frequency Bands	sizes	Module Introduction
1	l-wfmdb6l-g5nn4	2.4 GHz ISM Band	12x12x2.6 mm	

catalogs

1 introductory

DB6L series modules are IEEE 802.11b/g/n/ax@2.4G in wifi6 and BLE5.2 module supporting SDIO 2.0 interface. The modules support standard 20/40MHz bandwidth to ensure backward and network compatibility; they can be widely used in IPC, surveillance PTZ, smart home, security equipment, car recorder and smart access control.

Figure 1.1 Schematic diagram of the module

2 Product Overview

2.1 Key Features

connector	LCC+Stamp Hole
wireless standard	IEEE 802.11b/g/n/ax+BLE5.2
Module Packaging	12 mm × 12 mm × 2.6 mm
operating voltage	3.0V~3.6V, 3.3V typical
operating frequency	2400~2483.5MHZ (2.4GHz ISM Band)
operating temperature	-20 ~ +80°C
Storage temperature	-40 ~ +85°C
communication interface	SDIO 2.0
bandwidths	Supports standard 20/40MHz bandwidth
MAC	IEEE 802.11d/e/i/k/v/w

2.2 Product Advantages

1) Supports IEEE 802.11b/g/n/ax@2.4G

2) Supports BLE 5.2

3) Supports STA, AP, and Wi-Fi Direct modes

4) Supports WEP/WPA/WPA2/WPA3-SAE Personal, MFP bands

5) Supports Wi-Fi/BLE time-sharing multiplexing

6) Supports SDIO 2.0 interface

7) Supports OFDMA

8) Supports Wi-Fi 6 TWT

2.3 application scenario

- IPC, Monitor Head
- Smart home, security equipment
- car recorder
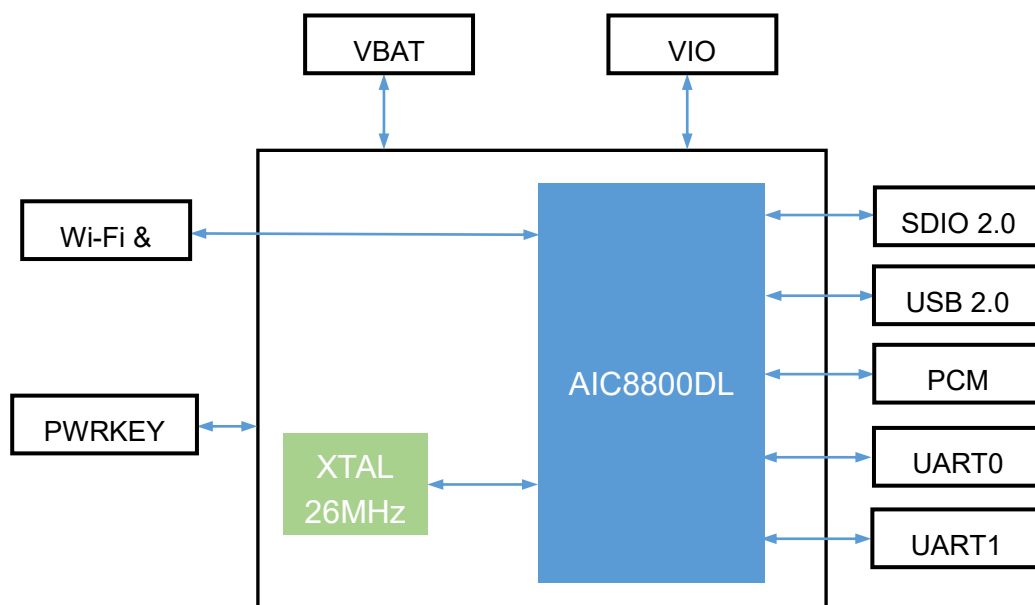- intelligent access control

2.4 functional block diagram

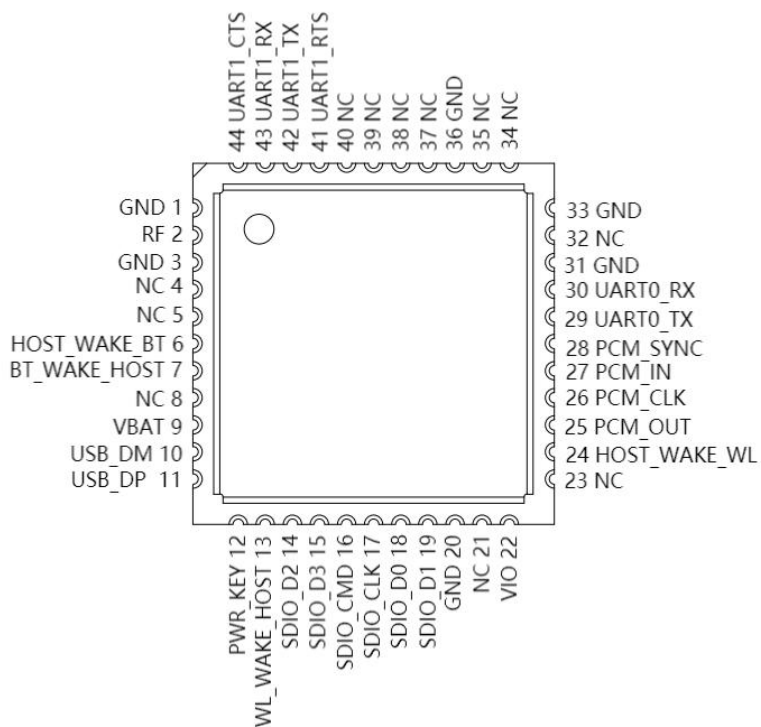Figure 2.1 Functional Block Diagram

2.5 Pinouts

Figure 2.2 Pinouts

2.6 Pin Description Table

pin	Pin Definitions	I/O Type	input voltage	Functional Description
1	GND	G	-	grounding
2	RF	ANT	-	2.4G Wi-Fi&B T Antennas
3	GND	G	-	grounding
4	NC	NC	-	NC Pin, Overhang Handling
5	NC	NC	-	NC Pin, Overhang Handling
6	HOST_WAKE_BT	I	VIO	Wake-up pin, master wake-up BT function
7	BT_WAKE_HOST	o	VIO	Wake-up pin, BT wake-up master function
8	NC	NC	-	NC Pin, Overhang Handling
9	VBAT	P	3.3V	power supply
10	USB_DM	I/O	-	USB DATA -
11	USB_DP	I/O	-	USB DATA +
12	PWR_KEY	I	VIO	Enable pin, high level enable, low level shutdown
13	WL_WAKE_HOST	o	VIO	Wake-up pin, Wi-Fi wake-up master function
14	SDIO_D2	I/O	VIO	SDIO data cable 2
15	SDIO_D3	I/O	VIO	SDIO data cable 3
16	SDIO_CMD	I/O	VIO	SDIO Command/Response
17	SDIO_CLK	I	VIO	SDIO Clock Signal
18	SDIO_D0	I/O	VIO	SDIO data line 0
19	SDIO_D1	I/O	VIO	SDIO data cable 1
20	GND	G	-	grounding
21	NC	NC	-	NC Pin, Overhang Handling
22	VIO	P	VIO	IO Power, all IO level select pins, supports 1.8V and 3.3V
23	NC	NC	-	NC Pin, Overhang Handling
24	HOST_WAKE_WL	I	VIO	Wake-up pin, master wake-up Wi-Fi function
25	PCM_OUT	O	VIO	PCM data signal output
26	PCM_CLK	o	VIO	PCM clock signal
27	PCM_IN	I	VIO	PCM data signal input
28	PCM_SYN	o	VIO	PCM synchronization signal

29	UART0_TX	o	VIO	UART0 serial transmit pin
30	UART0_RX	I	VIO	UART0 serial receive pin
31	GND	G	-	grounding
32	NC	NC	-	NC Pin, Overhang Handling
33	GND	G	-	grounding
34	NC	NC	-	NC Pin, Overhang Handling
35	NC	NC	-	NC Pin, Overhang Handling
36	GND	G	-	grounding
37	NC	NC	-	NC Pin, Overhang Handling
38	NC	NC	-	NC Pin, Overhang Handling
39	NC	NC	-	NC Pin, Overhang Handling
40	NC	NC	-	NC Pin, Overhang Handling
41	UART1_RTS	o	VIO	UART1 serial port RTS pin
42	UART1_TX	o	VIO	UART1 serial transmit pin
43	UART1_RX	I	VIO	UART1 serial receive pin
44	UART1_CTS	I	VIO	UART1 serial port CTS pin

"P":POWER "I":INPUT "O":OUTPUT "G". GND

3 Working Characteristics

3.1 Power Supply Design

3.1.1 Power connector

The VBAT pin is used to connect to an external power supply and the interface is described in the following table:

Table 3-1 Power Supply Pin Definitions

pin number	Pin Definitions	descriptive	Minimum V	Typical Value V	Maximum value V
9	VBAT	Module Power Supply	3.0	3.3	3.6
22	VIO	IO Level Selection	-	1.8/3.3	-

The power supply range of the module is 3.0~3.6V, to ensure that the voltage is not lower than 3.0V during operation, and the power supply current requirement is not lower

than 500mA.

VIO is used to select the IO pin level, and the IO level is determined by the external power supply voltage, supporting 1.8V/3.3V IO level.

3.1.2 Power Supply Design

A 22uF with 0.1uF decoupling capacitor is recommended for the DB6L module power supply pin. The capacitors should be as close as possible to the VDD power supply pin. The power supply voltage range is 3.0~3.6V, when using 3.3V power supply, we need to make sure that the power supply voltage is not lower than 3.0V. VDD pin is directly connected to the VDD33_PA pin of the internal chip in the module, which is used to supply power to the Wi-Fi PA module circuitry, and when the maximum power is emitted, the VDD33_PA needs to satisfy the power supply capacity of 300mA peak current, and at the same time, the power supply ripple is recommended to be within 10mV to avoid ripple. The power supply ripple is recommended to be within 10mV to avoid excessive ripple causing RF performance degradation. The power supply recommended circuit is as follows:
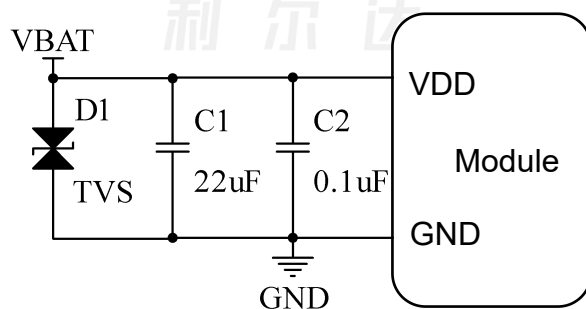

Figure 3.1 Power Supply Recommended Design

Note: D1 TVS static protection is used and it is recommended to place a TVS tube for static protection.

3.1.3 Power-Up Timing

DB6L module power supply VBAT pin power-up to the chip in the module to reach a

stable state, the length of time at least 208ms, the module power-up time sequence is shown in the following figure:
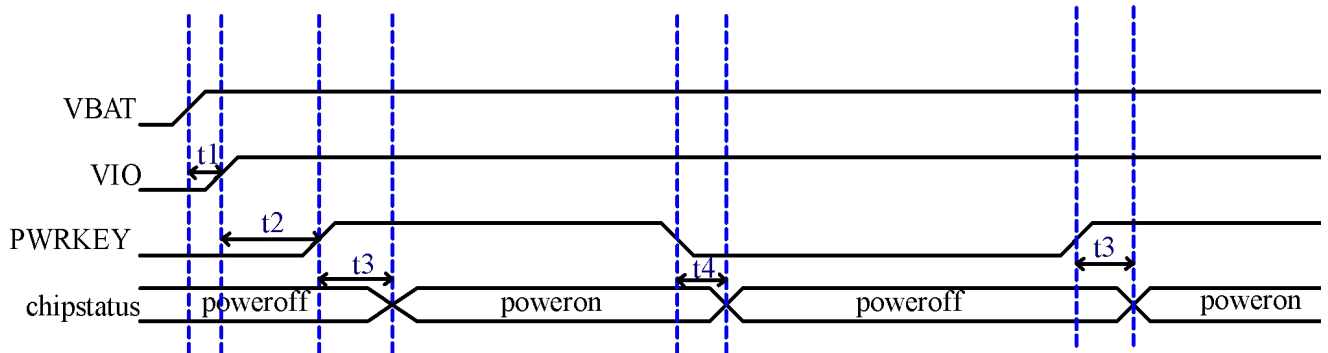

Figure 3.2 DB6L Module Power-Up Timing

t1:VIO power-up ≥ VBAT power-up

t2:PWRKEY power-up ≥ VIO power-up + 200ms

t3: Chip power-up initialization ≥ PWRKEY+8ms

t4: PWRKEY pull down to chip shutdown ≥ 6ms

4 application interface

4.1 SDIO interface

SDIO interface, WIFI data is transmitted between the SDIO interface and the master control.

4.2 USB port

4.2.1 USB Port Description

DB6L module supports USB2.0 interface, which is used for communication data transfer and firmware upgrade, and the interface is described as follows:

Table 4-1 USB Interface Pin Definitions

pin number	Pin Definitions	descriptive	note
4	D-	USB Differential Data (-)	Differential impedance needs to be controlled at design time
5	D+	USB Differential Data (+)	

4.2.2 USB Circuit Reference Design

USB signals are differential high-speed signals, the design needs to pay attention to control the differential impedance and equal length, the reference design is as follows:
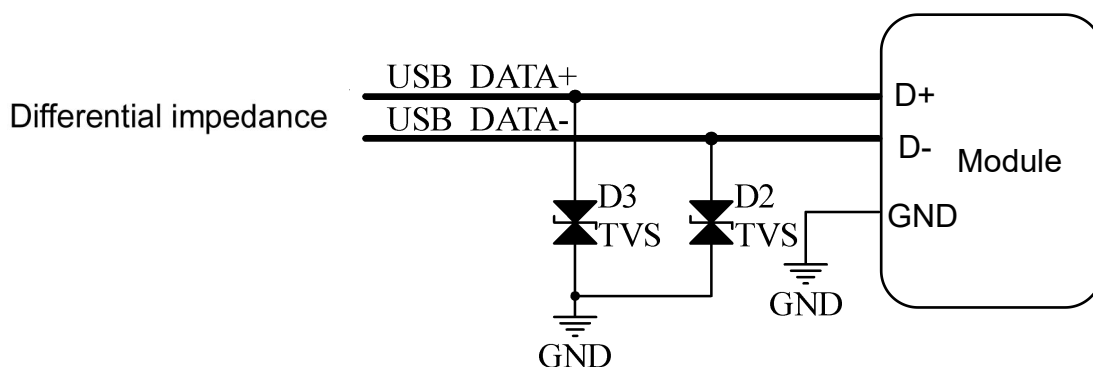

Figure 4.1 USB Reference Design

D2 and D3 are TVS tubes, which are used to prevent the interference generated by the

USB interface during hot-swapping and thus causing the internal circuit to work abnormally. When connected to the external USB connector, it is necessary to add TVS tubes and place them close to the USB interface. It is recommended that the junction capacitance of less than 0.6pF protection device.

USB Differential Cable Alignment Notes:

● Differential impedance is controlled at 90Ohm ±15%;

● Common mode impedance is controlled at 30Ohm±30% and equal length is guaranteed;

● Cable Skew is less than 100ps and Cable Delay is less than 26ns;

● Ground wrapping is required around the alignment, away from areas such as crystals, crystals, magnetic devices or devices, and RF signals.

4.3 PCM interface

Voice data transmission via PCM interface

4.4 UART interface

The UART interface includes UART0 and UART1, where the UART0 serial port is used for firmware burning and debugging; the UART1 serial port is used for BT data transfer with the master control and supports flow control.

4.5 PWRKEY Enable Interface

PWRKEY enable pin, PWRKEY pin has 200K pull-down resistor and 47K pull-up resistor. PWRKEY pin has 200K pull-down resistor and 47K pull-up resistor.

4.6 VIO Pin Level Selection Interface

VIO is used to select the IO pin level, which is determined by the external supply voltage.

Supports 1.8V/3.3V IO levels with a maximum drive current of 10mA per GPIO.

Table 4-2 VIO Voltage Thresholds

VIO	level state	GPIO Threshold
1.8V	0->1	1.18V
1.8V	1->0	0.59V
3.3V	0->1	2.62V
3.3V	1->0	0.44V

5 RF Characterization

5.1 Antenna Interface

Table 5-1 Antenna Interface Definitions

pin number	Pin Definitions	I/O Type	descriptive	note
2	RF	ANT	2.4G Wi-Fi & BT Antenna Interface	50Ω Characteristic Impedance

5.2 Wi-Fi Performance

Table 5-2 Wi-Fi Performance Parameters

performances	descriptive	
wireless standard	IEEE 802.11b/g/n/ax(@2.4GHz),Wi-Fi compliant	
operating frequency	2.400GHz ~ 2.4835GHz (2.4GHz ISM Band)	
signal path	2.4GHz: Ch1 ~ Ch13	
modulation method	802.11b	DQPSK,DBPSK,CCK
	802.11g/n: OFDM	64-QAM,16-QAM,QPSK,BPSK
	802.11ax: OFDMA	1024-QAM,256-QAM,64-QAM, 16-QAM,QPSK,BPSK
firing power	802.11b/1Mbps	20dBm ± 2dB@EVM ≤ -10.5dB
	802.11b/11Mbps	20dBm ± 2dB@EVM ≤ -15.5dB
	802.11g/6Mbps	20dBm ± 2dB@EVM ≤ -5dB
	802.11g/54Mbps	16dBm ± 2dB@EVM ≤ -25dB
	802.11n/MCS0 (20/40M)	20dBm ± 2dB@EVM ≤ -5dB
	802.11n/MCS7 (20/40M)	16dBm ± 2dB@EVM ≤ -27dB
	802.11ax/MCS0 (20/40M)	20dBm ± 2dB@EVM ≤ -5dB
	802.11ax/MCS9 (20/40M)	16dBm ± 2dB@EVM ≤ -32dB
	802.11ax/MCS11 (20/40M)	15dBm ± 2dB@EVM ≤ -35dB
frequency tolerance	±20ppm	

Receive Sensitivity (11b,20MHz) @8% PER	1Mbps	TBD
	11Mbps	TBD
Receive Sensitivity (11g, 20MHz) @10% PER	6Mbps	TBD
	54Mbps	TBD
Receive Sensitivity (11n,20MHz) @10% PER	MCS=0	TBD
	MCS=7	TBD
Receive Sensitivity (11n,40MHz) @10% PER	MCS=0	TBD
	MCS=7	TBD
Receive Sensitivity (11ax,20MHz) @10% PER	MCS=0	TBD
	MCS=9	TBD
Receive Sensitivity (11ax,40MHz) @10% PER	MCS=0	TBD
	MCS=9	TBD

5.3 BT Performance

The DB6L module supports BLE mode.

5.4 LE mode

Table 5-3 BT Performance Parameters

performances	descriptive
Bluetooth standard	BLE5.2
operating frequency	2.402GHz ~ 2.480GHz
signal path	LE: Ch0 ~ Ch39
modulation method	GFSK
firing power	6±2dBm

Sensitivity @ PER=30.8% for LE(1Mbps)	TBD
Sensitivity @ PER=30.8% for LE(2Mbps)	TBD
sensitivity, @ PER=30.8% for LE Coded (S=2)	TBD
sensitivity, @ PER=30.8% for LE Coded (S=8)	TBD
Maximum Input Level	0dBm

5.5 reference design

When DB6L module is used, the π-matching circuit needs to be reserved between the RF antenna interface of the module and the antenna interface of the baseboard, and the recommended antenna matching circuit and initial parameters are shown in the following figure:
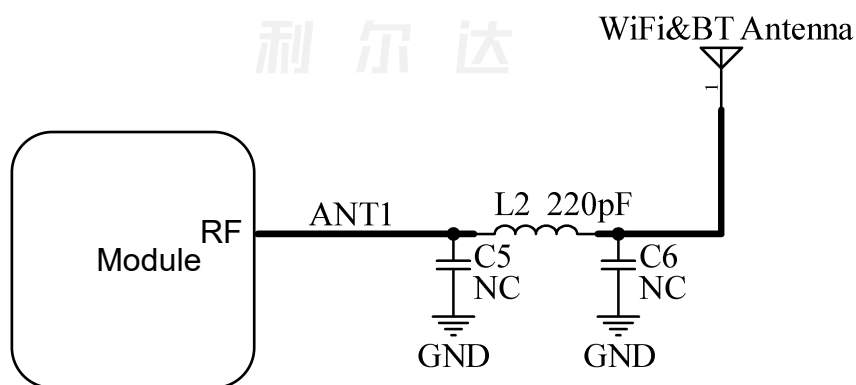
Figure 5.1 Antenna reference design circuit

L2 default use 220pF capacitor or 0R resistor, C5, C6 default, do match reserved, its final value according to the actual debugging results to determine.

Antenna interface to the bottom of the board antenna alignment to ensure that the impedance control of 50Ω, the alignment should be as short as possible, do not hit the hole, do not go to the sharp line. RF alignment around more GND holes. As shown in Figure 5.2 below:
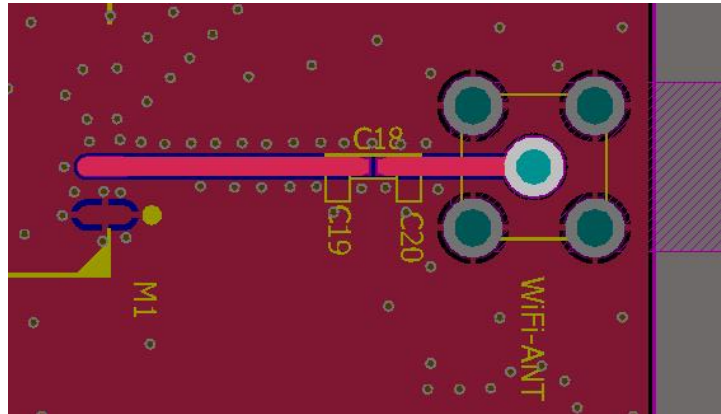
Figure 5.2 Impedance lines of the base plate

The relationship between plate thickness and line width and line spacing can be referenced:

Recommended values for FR4 double-sided boards (H=board thickness, W=wire width, D=spacing between alignment and copper placement)

- h=1.0mm, w=0.8mm, d=0.2mm
- H=1.0mm, W=1.0mm, D=0.254mm (recommended)
- H=1.2mm, W=1.0mm, D=0.2mm (recommended)
- H=1.6mm, W=1.0mm, D=0.2mm (recommended)

For π-matching circuits, to avoid introducing additional parasitic parameters that affect debugging difficulty, the recommended placement is shown in the figure below:

Figure 5.3 Matching circuit LC placement method

6 Electrical performance and reliability

6.1 Power supply ratings
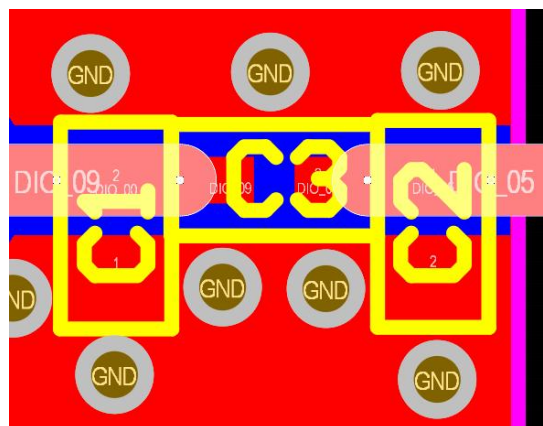
parameters	descriptive	minimum value	typical value	maximum values	unit (of measure)
V_{DD}	Power Supply	3.0	3.3	3.6	V

6.2 power wastage

descriptive	test condition	maximum values	
		@TX(mA)	@RX(mA)
Wi-Fi data transmission	802.11b,11Mbps@20dBm, 80% duty cycle	247	31
	802.11g, 54Mbps@16dBm, 50% duty cycle	130	32
	802.11n,HT20,MCS7@16dBm with 50% duty cycle	127	31
	802.11n, HT40, MCS7@16dBm, 40% duty cycle	98	32
	802.11ax,HE20,MCS11@15dBm, 50% duty cycle	104	32
	802.11ax,HE40,MCS11@15dBm, 40% duty cycle	92	32
BT data transmission	BLE @1M default power	49	62
	BLE @2M default power	41	64
	BLE @S=8 default power	111	65
	BLE @S=2 default power	81	66
shutdown state		TBD	
operational state		TBD	

6.3 Digital Logic Level Characterization

para	descriptive	minimum	typical	maximu	unit

meters		value	value	m values	(of measure)
V_{IL}	CMOS Low Level Input Voltage	0	/	0.3*VDD	V
V_{IH}	CMOS High Level Input Voltage	0.7*VDD	/	VDD	V
V_{TH}	CMOS Threshold Voltage	/	0.5*VDD	/	V

6.4 electrostatic protection

parameters	descriptive	minimum value	typical value	maximum values	unit (of measure)
V_{ESD}	VDD PIN ESD	/	TBD	/	KV
	ANT PIN ESD	/	TBD	/	KV

6.5 Operating and storage temperature
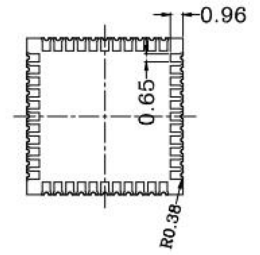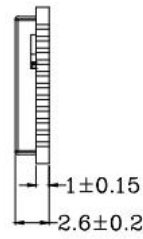
parameters	descriptive	minimum value	typical value	maximum values	unit (of measure)
T_A	operating temperature	-20	/	+80	℃
TStorage	Storage temperature	-40	/	+85	℃

7 Mechanical dimensions
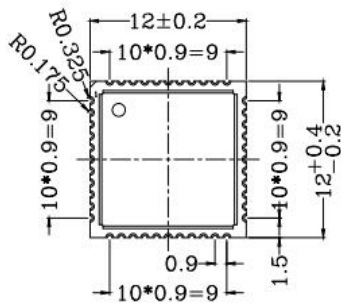
TOP Layer

BOTTOM Layer

Figure 7.1 Module external dimensions

8 Production and Packaging Information

8.1 Production Welding

8.1.1 Production Guidelines

It is recommended that the stamp port encapsulated module be mounted using SMT machine and the mounting should be completed within 24 hours after unpacking, otherwise it should be re-vacuum-packed to avoid moisture leading to poor mounting.

If the package contains a humidity indication card, it is recommended to judge whether the module needs to be baked according to the humidity card indication, and the conditions during baking are as follows:

Baking temperature: 125℃±5℃;

The alarm temperature is set to 130°C;

After cooling <36℃ under natural conditions, it is ready for SMT placement;

If the unpacking time is more than 3 months, you need to pay special attention to whether the product is affected by moisture, because the PCB immersion gold process, more than 3 months may lead to pad oxidation, the patch may lead to false soldering, leakage soldering and other problems.

In order to ensure that the reflow soldering pass rate, the first patch is recommended to take 10% of the products for visual inspection, AOI testing to ensure that the furnace temperature control, device adsorption method, placement of the rationality of the way;

Operators at each station must wear electrostatic gloves during the entire production process;

8.1.2 Module location requirements at the base plate

It is recommended that the base plate module location of the green oil thickness of less than 0.02mm, to avoid excessive thickness, padding module can not effectively contact

with the solder paste affects the welding quality. Also need to consider the interface board module location within 2mm around the layout of other devices, in order to protect the maintenance of the module.

8.1.3 Stencil opening design

The thickness of the stencil on the base plate is selected in principle according to the type of packaging of the device on the board to be selected, need to focus on the following requirements:

Module pad locations can be locally thickened to 0.15~0.20mm to avoid void soldering.

8.1.4 Production Precautions

- During the production process, each operator must wear electrostatic gloves;
- Baking should not exceed the specified baking time;
- It is strictly prohibited to add explosive, flammable and corrosive substances during baking;
- During baking, modules should be placed in high temperature trays to maintain air circulation between modules;
- The door of the baking box needs to be closed during baking to ensure that the baking box is closed and to prevent the temperature from leaking out;
- Try not to open the door when the oven is running, if you have to open it, try to shorten the time you can open the door;
- After baking, wait until the module cools down naturally to below 36℃ before taking it out with electrostatic gloves to avoid burns;
- When operating, do not allow the bottom surface of the module to get wet or dirty;

8.1.5 Reflow soldering instruction

Note: This work instruction is suitable for lead-free work only and is for reference only.

作业指导书 / Standard Operation Procedure (SOP)

生产工段 Station	SMT	工序名 Station	回流焊
文件编号 Doc No.	MSOP-FL-RX1060N-G01	程序名 Program	003-RR-T-S606-S3
版本 Rev	A0		

批准　审核　作成　作成日

曲线图 (Curve): Temp — 240℃, 217℃; Ramp-up; Soaking Zone 150~180℃ 60~120 SEC; Reflow Zone:45~90SEC; Peak Temp; Time

温区参数 (Zone parameters)

Zone	1	2	3	4	5	6	7	8	9	10
Top	150	150	180	180	180	195	210	240	250	240
Bottom	150	150	180	180	180	195	210	240	250	240
Conveyor speed	900 mm/min									

曲线参数 (Curve parameters)

规格	峰值温度	浸温	熔锡温度	上升斜率	回焊斜率	降温斜率
Temp Range	240±5	150~180	217	25~150	183	
Time,		60~120S	45~90S	1~3 ℃/s	1~3 ℃/s	≤4℃/s

工具/设备 (Tools/Equipment)

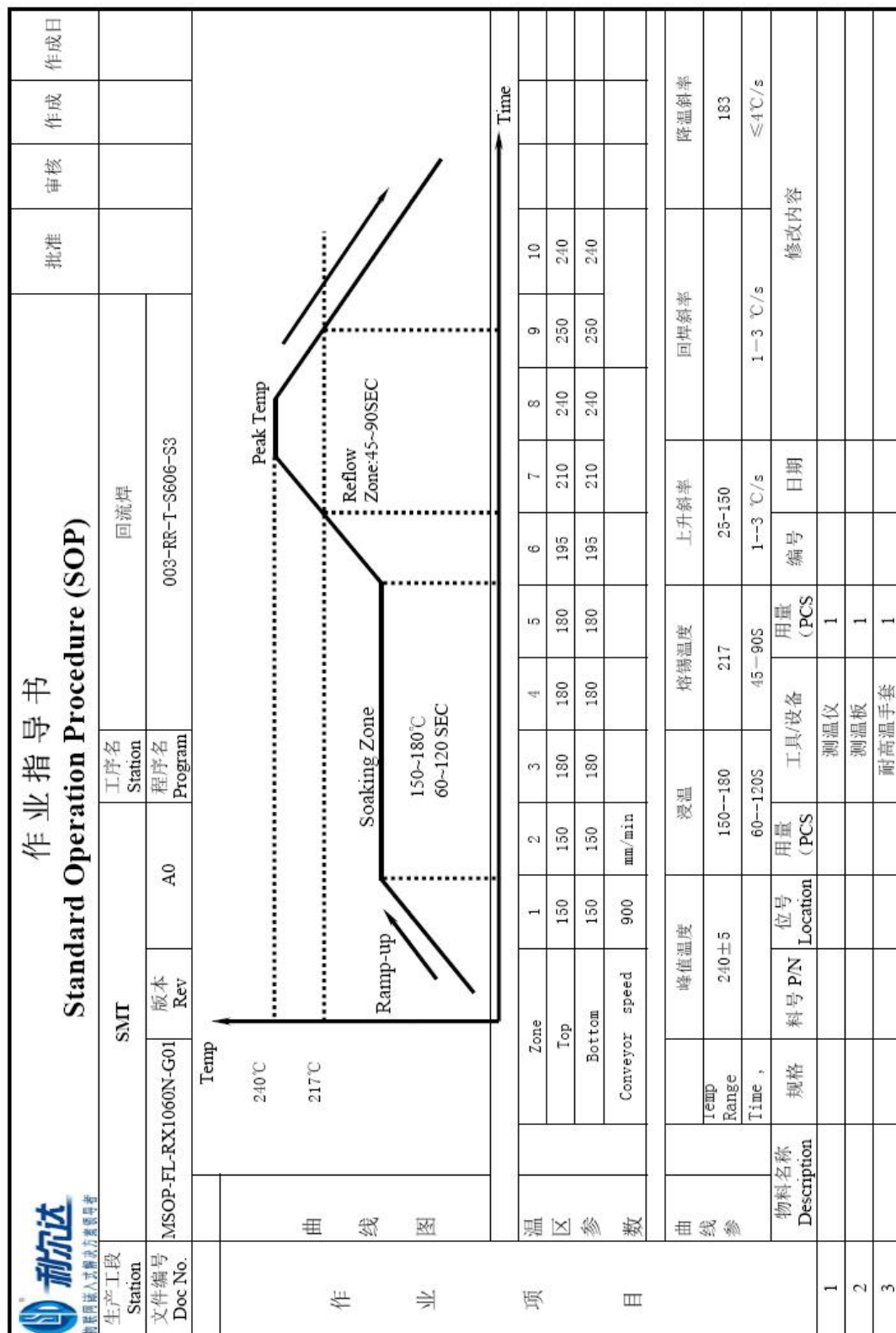| 物料名称 Description	料号 P/N	位号 Location	用量 (PCS)
测温仪			1
测温板			1
耐高温手套			1

编号　日期　修改内容

Figure 8.1 Reflow Soldering Operating Instructions

FCC MODULAR APPROVAL INFORMATION EXAMPLES for Manual

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.

(2) This device must accept any interference received, including interference that may cause undesired operation.

CAUTION: Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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.

FCC Radiation Exposure Statement:

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

OEM INTEGRATION INSTRUCTIONS:

This device is intended only for OEM integrators under the following conditions:

The module must be installed in the host equipment such that 20 cm is maintained between the antenna and users, and the transmitter module may not be co-located with any other transmitter or antenna. The module shall be only used with the internal on-board antenna that has been originally tested and certified with this module. External antennas are not supported. As long as these 3 conditions above are met, further transmitter test will not be required.

However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.). The end-product may need Verification testing, Declaration of Conformity testing, a Permissive Class II Change or new Certification. Please involve a FCC certification specialist in order to determine what will be exactly applicable for the end-product.

Validity of using the module certification:

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization for this module in combination with the host equipment is no longer considered valid and the FCC ID of the module cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization. In such cases, please involve a FCC certification specialist in order to determine if a Permissive Class II Change or new Certification is required.

Upgrade Firmware:

The software provided for firmware upgrade will not be capable to affect any RF parameters as certified for the FCC for this module, in order to prevent compliance issues.

End product labeling:

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: "Contains FCC ID: 2AOFDL-WFMDB6L".

Information that must be placed in the end user manual:

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module. The end user manual shall include all required regulatory information/warning as show in this manual.

FCC MODULAR APPROVAL INFORMATION EXAMPLES for Manual

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.

    (2) This device must accept any interference received, including interference that may cause undesired operation.

CAUTION: Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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.

WARNING

Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.

"CAUTION : Exposure to Radio Frequency Radiation.
Antenna shall be mounted in such a manner to minimize the potential for human contact during normal operation. The antenna should not be contacted during operation to avoid the possibility of exceeding the FCC radio frequency exposure limit.

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). part 15E(15.407)

2.3 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 EUT has a Dipole Antenna, and the antenna use a permanently attached antenna which is not replaceable.

2.4 Limited module procedures

If a modular transmitter is approved as a "limited module," then the module manufacturer is responsible 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 not a limited module.

2.5 Trace antenna designs

For a modular transmitter with trace antenna designs, see the guidance in Question 11 of KDB Publication 996369 D02 FAQ – Modules for Micro-Strip Antennas and traces. The integration information shall include for the TCB review the integration instructions for the following aspects:

layout of trace design, parts list (BOM), antenna, connectors, and isolation requirements.

a) Information that includes permitted variances (e.g., trace boundary limits, thickness, length, width, shape(s), dielectric constant, and impedance as applicable for each type of antenna);

b) Each design shall be considered a different type (e.g., antenna length in multiple(s) of frequency,

the wavelength, and antenna shape (traces in phase) can affect antenna gain and must be considered);

c) The parameters shall be provided in a manner permitting host manufacturers to design the printed circuit (PC) board layout;

d) Appropriate parts by manufacturer and specifications;

e) Test procedures for design verification; and

f) Production test procedures for ensuring compliance.

The module grantee shall provide a notice that any deviation(s) from the defined parameters of the antenna trace, as described by the instructions, require that the host product manufacturer must notify the module grantee that they wish to change the antenna trace design. In this case, a Class II permissive change application is required to be filed by the grantee, or the host manufacturer can take responsibility through the change in FCC ID (new application) procedure followed by a Class II permissive change application.

Explanation: Yes, The module with trace antenna designs, and This manual has been shown the layout

of trace design, antenna, connectors, and isolation requirements.

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: This module complies with FCC RF radiation exposure limits set forth for an uncontrolled environment, This equipment should be installed and operated with a minimum distance of 20 centimeters between the radiator and your body." This module is designed to comply with the FCC

statement, FCC ID is: 2AOFDL-WFMDB6L.

2.7 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 EUT has a Dipole Antenna, and the antenna use a permanently attached antenna which is unique.

2.8 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: 2AOFDL-WFMDB6L"

2.9 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: Top band can increase the utility of our modular transmitters by providing instructions that simulates or characterizes a connection by enabling a transmitter.

2.10 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.