

Lierda UB6U Series Hardware Design Manual

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version

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Document revision history

Document version	Date of change	proposer	auditor	Changes
Rev1.0	23-06-25	LHL	YB	initial version

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Safety Instructions

It is the user's responsibility to follow the relevant regulations of other countries regarding wireless communication modules and equipment and the specific environmental regulations for their use. By following these safety principles, you can ensure your personal safety and help protect your products and work environment from potential damage. We are not responsible 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 Module Selection

serial number	Module Model	Supported Frequency Bands	sizes	Module Introduction
1	L-WFMUB6U-G5NI4	2.4 GHz ISM Band	13 x12.2x2.1 mm	

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catalogs

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1 introductory

UB6U series modules are 802.11b/g/n/ax@2.4G in wifi6 module with USB interface, which can be widely used in HD webcam, OTT/IPTV/DVB/Set-top box, Smart TV and so on.

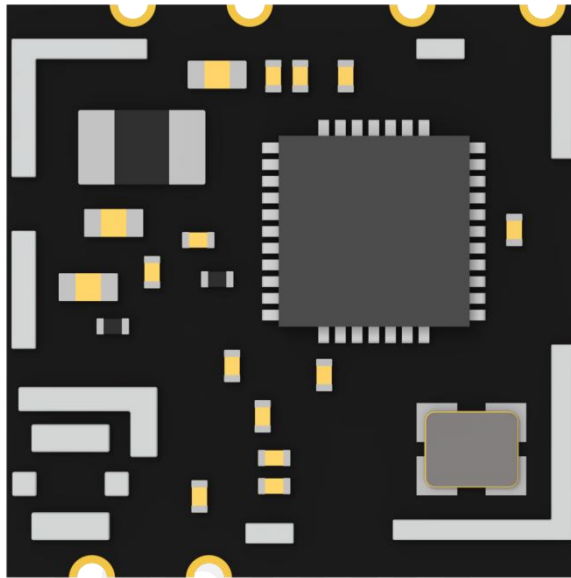


Figure 1.1 Schematic diagram of the module

2 Product Overview

2.1 Key Features

connector	LCC+Stamp Hole
wireless standard	IEEE 802.11b/g/n/ax
Module Packaging	13 mm × 12.2 mm × 2.1 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	USB 2.0
bandwidths	Supports standard 20/40MHz bandwidth
MAC	IEEE802.11d/e/i/k/v/w

2.2 Product Advantages

- 1) Supports IEEE 802.11b/g/n/ax@2.4G
- 2) Supports STA, AP, and Wi-Fi Direct modes
- 3) Supports WEP/WPA/WPA2/WPA3-SAE Personal, MFP bands
- 4) Supports USB 2.0 interface
- 5) Support MU-MIMO, OFDMA
- 6) Supports Wi-Fi 6 TWT

2.3 application scenario

- HD Webcam, Surveillance Head
- OTT/IPTV/DVB/Set-top Boxes
- Smart Home, Smart Home Appliances

2.4 functional block diagram

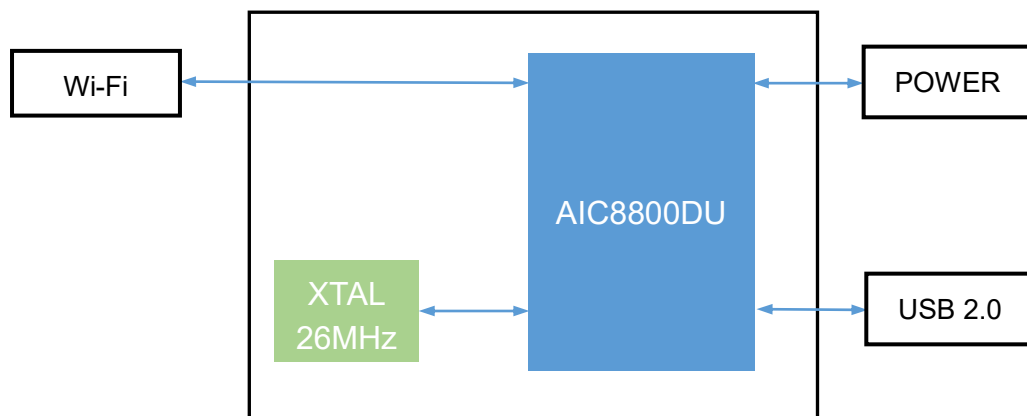


Figure 2.1 Functional Block Diagram

2.5 Pinouts

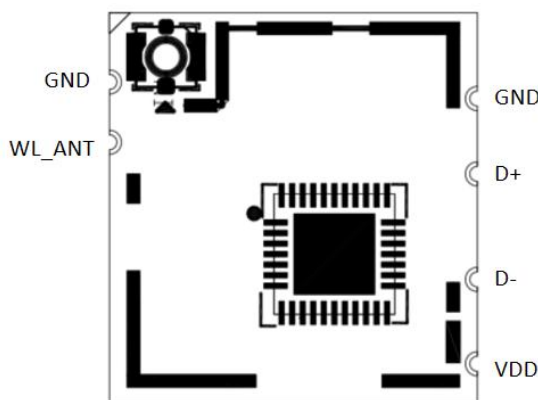


Figure 2.2 Pinouts

2.6 Pin Description Table

pin number	Pin Definitions	I/O Type	Functional Description
1	GND	G	grounding
2	WL_ANT	RF	2.4G Wi-Fi Antennas
3	VDD	P	Power supply (DC 3.3V, TYP)
4	D-	I/O	USB DATA -
5	D+	I/O	USB DATA +
6	GND	G	grounding

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

3 Working Characteristics

3.1 Power Supply Design

3.1.1 Power connector

The VDD 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
3	VDD	Module Power Supply	3.0	3.3	3.6

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.

3.1.2 Power Supply Design

A 22uF with 0.1uF decoupling capacitor is recommended for the UB6U 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. The VDD pin is directly connected to the module internal chip VDD33_PA pin, 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 meet 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 the 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:

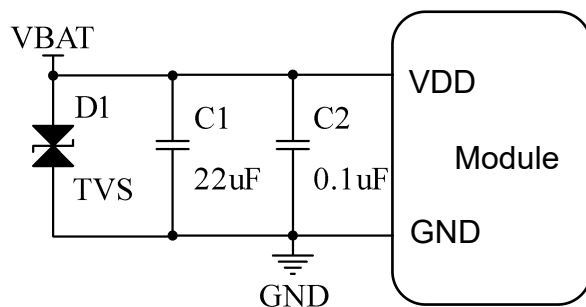


Figure 3.1 Power Supply Recommended Design

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

3.1.3 Power-Up Timing

UB6U module power supply VDD pin power up to the chip in the module to reach a stable state, the length of time 208ms, module power-up time sequence is shown in the following figure:

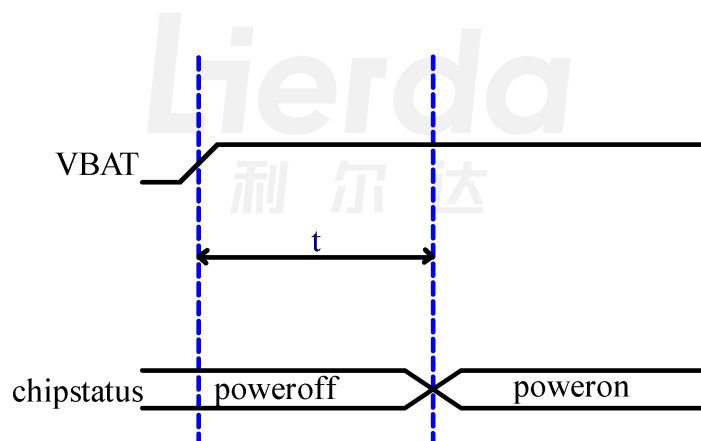


Figure 3.2 UB6U module power-up timing sequence

t: chip status stabilized $\geq$ VDD power-up +208ms

The module reaches a steady state after 208ms of power-up, so it is required to operate the module after $\geq$ 208ms of power-up.

4 application interface

4.1 USB interface

The UB6U 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 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:

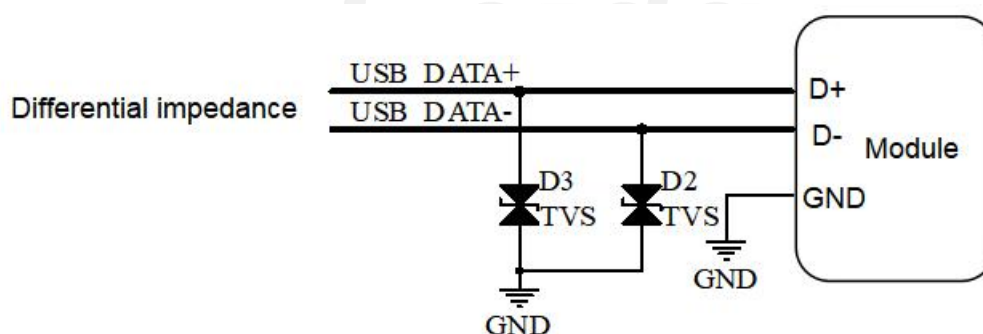


Figure 4.1 USB Reference Design

D2 and D3 are TVS tubes, which are used to prevent the interference generated by the USB interface during hot plugging and unplugging, 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 $\pm 15\%$;

- Common mode impedance is controlled at $30\Omega \pm 30\%$ and equal length is guaranteed;
- Cable Skew is less than 100ps and Cable Delay is less than 26ns;
- Ground-covering is required around the alignment, away from areas such as crystals, crystals, magnetic devices or devices, RF signals, etc.



5 RF Characterization

5.1 Wi-Fi Interface

Table 5-1 Wi-Fi Antenna Interface Definitions

pin number	Pin Definitions	I/O Type	descriptive	note
2	WL_ANT	RF	2.4G Wi-Fi 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	PER@-99dBm,typical
	11Mbps	PER@-90.5dBm,typical
Receive Sensitivity (11g, 20MHz) @10% PER	6Mbps	PER@-94.5dBm,typical
	54Mbps	PER@-77.5dBm,typical
Receive Sensitivity (11n,20MHz) @10% PER	MCS=0	PER@-94dBm,typical
	MCS=7	PER@-75.5dBm,typical
Receive Sensitivity (11n,40MHz) @10% PER	MCS=0	PER@-91.5dBm,typical
	MCS=7	PER@-72.5dBm,typical
Receive Sensitivity (11ax,20MHz) @10% PER	MCS=0	PER@-93.5dBm,typical
	MCS=9	PER@-68.5dBm,typical
Receive Sensitivity (11ax,40MHz) @10% PER	MCS=0	PER@-90dBm,typical
	MCS=9	PER@-65.5dBm,typical

5.3 reference design

When the UB6U module is used, a π -matching circuit needs to be reserved between the WL_ANT antenna connector of the module and the antenna connector of the baseboard, and the recommended antenna matching circuit and initial parameters are shown in the following figure:

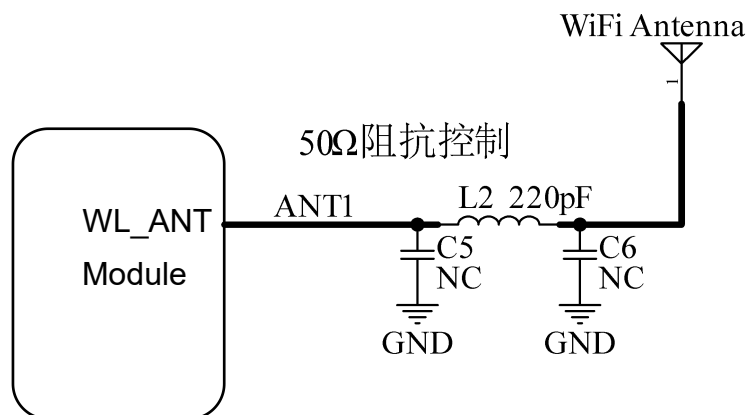


Figure 5.1 Wi-Fi antenna reference design circuitry

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:

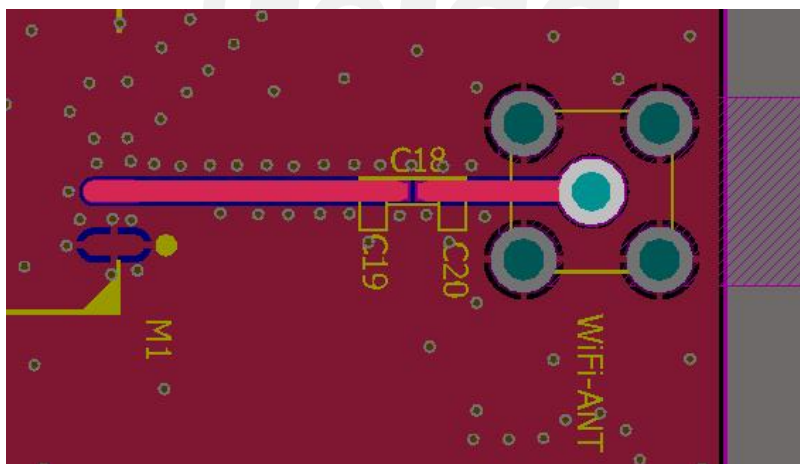


Figure 5.2 Impedance lines of the base plate

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:

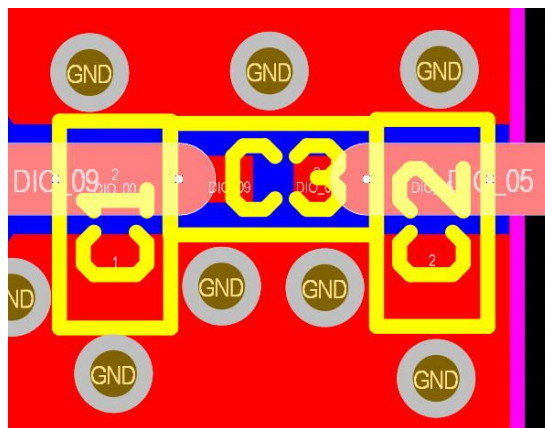


Figure 5.3 Matching circuit LC placement method

6 Electrical performance and reliability

6.1 Power supply ratings

parameters	descriptive	minimum value	typical value	maximum values	unit (of measure)
V _{DD}	Supply Voltage	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, 60% duty cycle	209	32
	802.11g, 54Mbps@16dBm, 50% duty cycle	127	32
	802.11n, HT40, MCS7@16dBm, 20% duty cycle	74	33
	802.11ax, HE40, MCS11@15dBm with 20% duty cycle	90	32

6.3 Digital Logic Level Characterization

parameters	descriptive	minimum value	typical value	maximum values	unit (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&ANT PIN ESD performance	/	1	/	KV

6.5 Operating and storage temperature

parameter	descriptive	minimum	typical	maximum	unit
-----------	-------------	---------	---------	---------	------

ers		m value	value	m values	(of mea sure)
T _A	operating temperature	-20	/	+80	°C
T _{Storage}	Storage temperature	-40	/	+85	°C

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7 reference design

7.1 reference schematic

The UB6U series module interface consists of three parts: power supply, USB interface and RF antenna port. The specific detailed design content of each part is detailed in sections 3, 4 and 5.

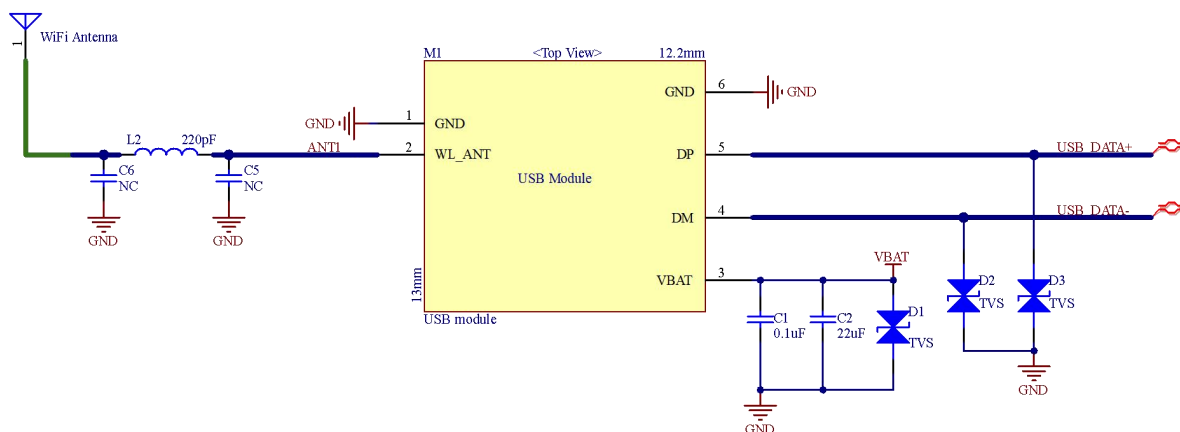


Figure 7.1 Reference Design Schematic

7.2 Baseboard Layout Considerations

UB6U module BOTTOM layer no high-speed signal or sensitive signal alignment, but it is recommended that the bottom TOP layer design alignment to avoid the module, so as not to bring unexpected factors of influence.

Module BOTTOM layer of the test point of the soldering disk and version of the information open window exposed copper, need to do to avoid processing, the corresponding position of the bottom plate, can not be placed over the hole or exposed copper, to prevent short-circuit. Module Bottom layer of the window description is shown in the figure below:

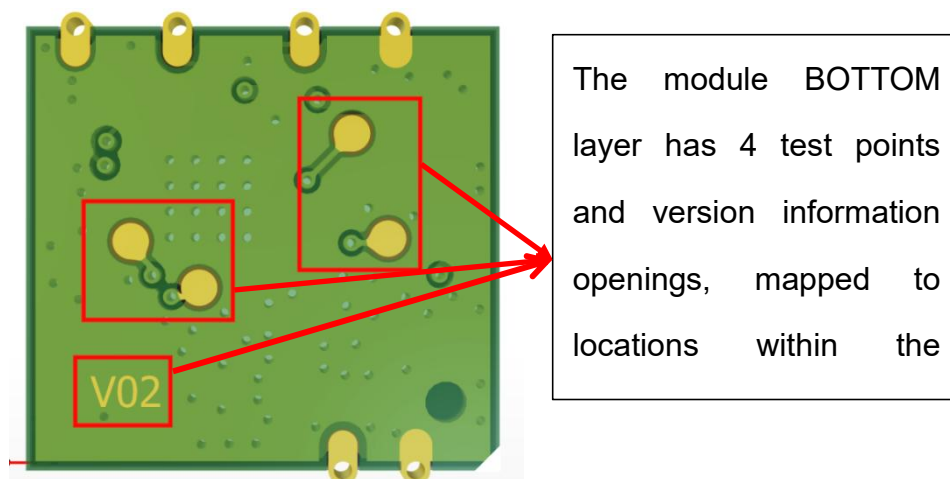


Figure 7.2 UB6U module bottom window location

7.3 Precautions for placing components around the module

Module package outermost Mechanical 1 layer for 0402 and the following devices need to control the safety distance, if the base plate has 0402 and the following packages of components, need to be placed outside the peripheral Mechanical 1 layer, to avoid product placement interference phenomenon, resulting in product anomalies.

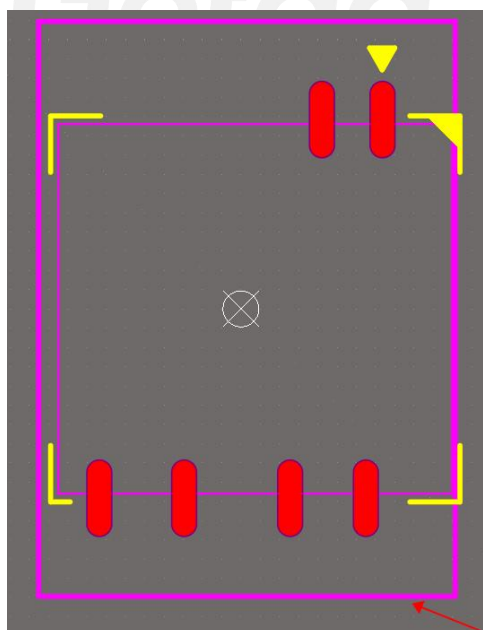


Figure 7.3 Recommended Package for UB6U Modules

8 Mechanical dimensions

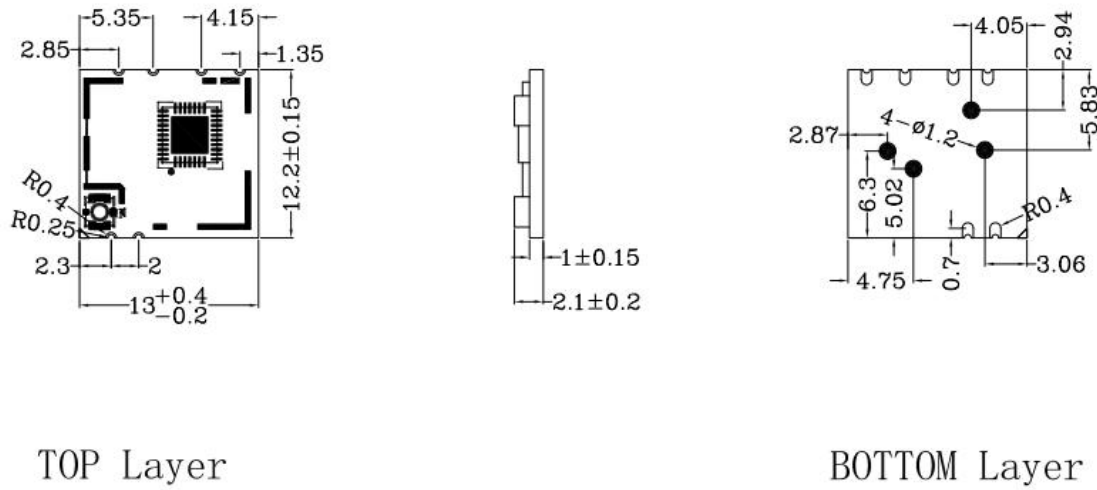


Fig. 8.1 Module external dimensions

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9 Production and Packaging Information

9.1 Production Welding

9.1.1 Production Guidelines

It is recommended that the stamp port encapsulation module be mounted using SMT machine and the mounting should be completed within 24 hours after unpacking, otherwise the vacuum package should be re-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 indication of the humidity card, and the conditions during baking are as follows:

Baking temperature: $125^{\circ}\text{C}\pm 5^{\circ}\text{C}$;

The alarm temperature is set to 130°C ;

After cooling $<36^{\circ}\text{C}$ 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 immersed gold process, more than 3 months may lead to oxidation of the pads, the patch may lead to false soldering, leakage of 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.

9.1.2 Module location requirements on the base plate

It is recommended that the base plate module position of the green oil thickness of less than 0.02mm, to avoid excessive thickness, padding module can not be effective contact with the solder paste to affect the welding quality. Another need to consider the interface

board module location around the 2mm or less can not layout other devices to protect the maintenance of the module.

9.1.3 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.

9.1.4 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;

9.1.5 Reflow soldering instruction

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

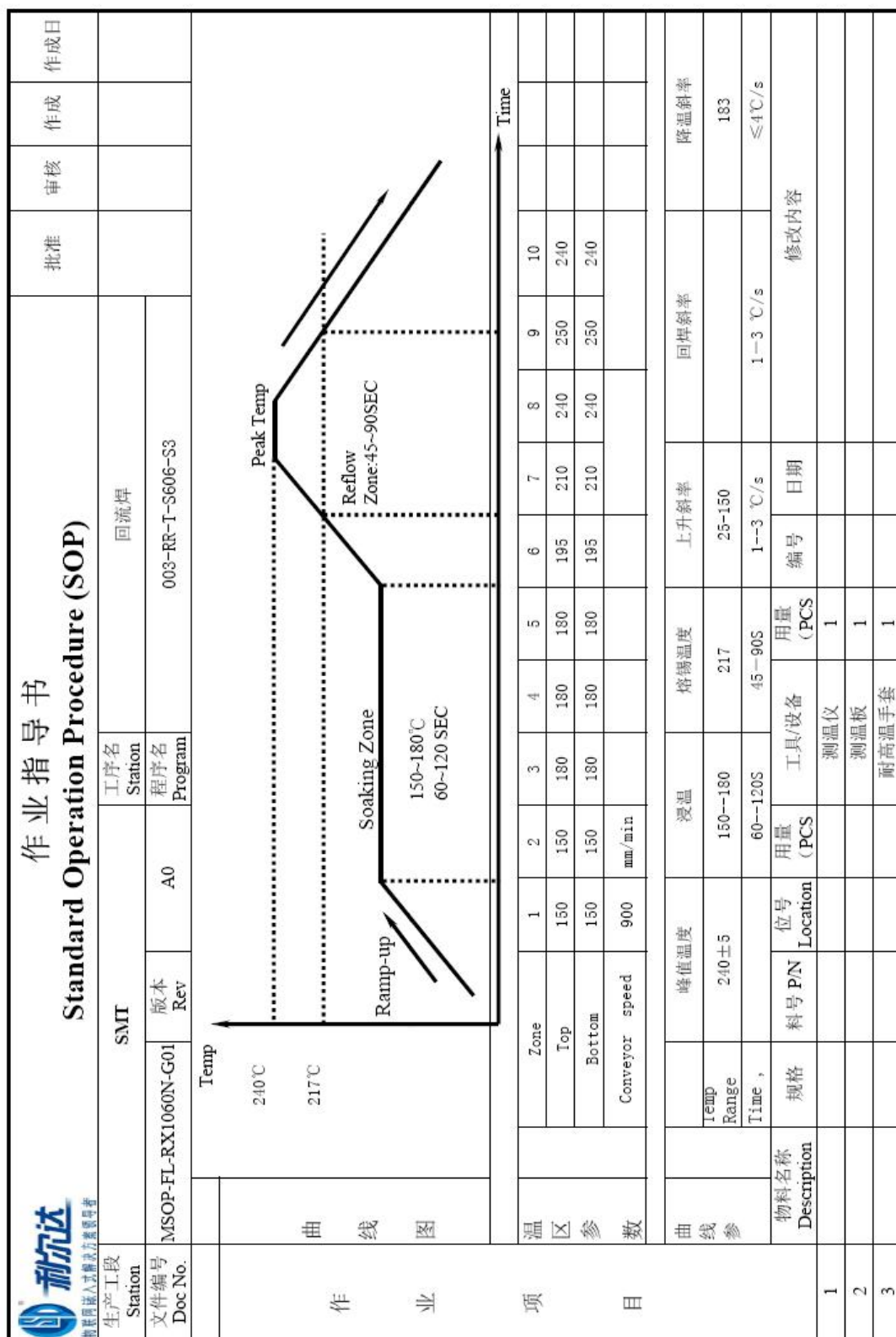


Figure 9.1 Reflow Soldering Operating Instructions

9.2 Packaging specification

9.2.1 Packaging

model number	Packaging	Full Carton(PCS)	Minimum Packing Quantity (PCS)	Number of reels per case
L-WFMUB6U-G5NI4	reel	6500	1300	5

9.2.2 Belt size and product orientation

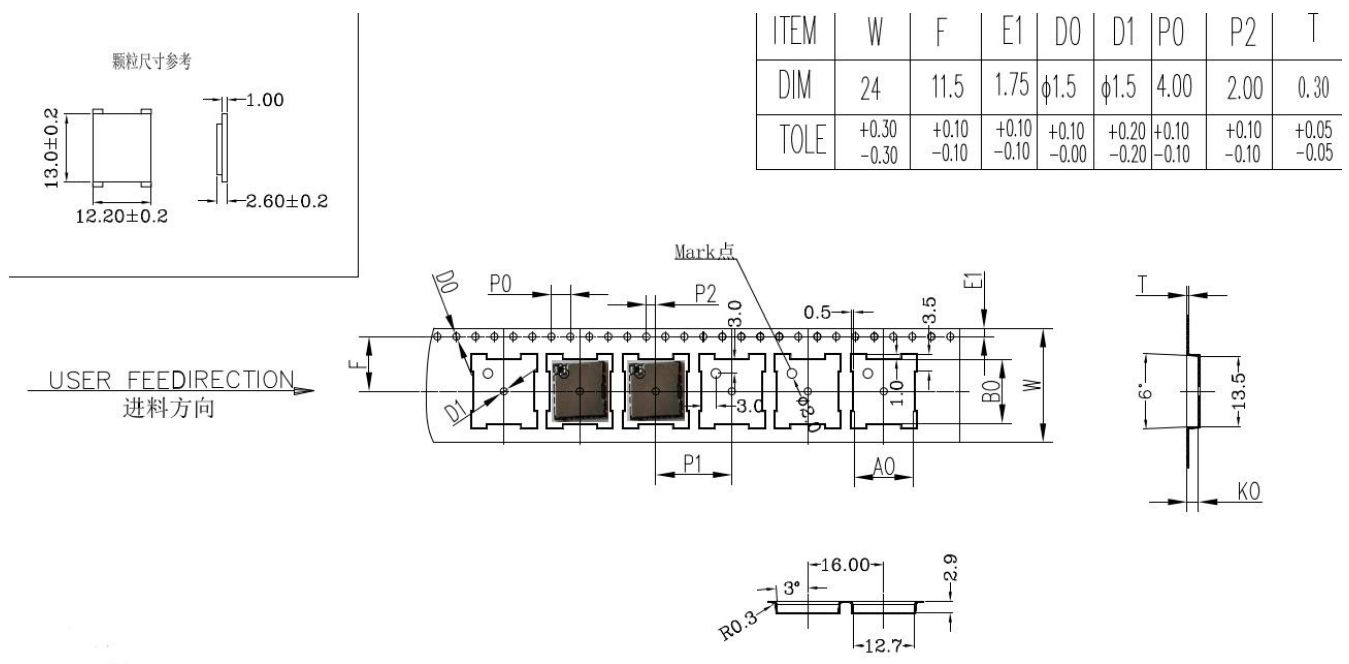


Figure 9.2 Strip Size and Product Orientation

C2/C3PC Test plan for Host changes:

Rule Part	Item	Scope
15.247(b)	Output Power	New host device
15.209;	Radiated Spurious Emission	New host device
15.247(d)	Band Edge(Restricted-band band-edge)	New host device
2.1093	Radio frequency radiation exposure evaluation: portable devices	Applicable for portable host device

Module with no shield Class II or Class III Permissive Change (C2/3PC) Guidance

A Module with no shield is limited and requires a PAG "MODLIM" before it can be granted. The Grantee's⁴³ Integration Instructions must provide a test plan (required by rule 47 CFR 15.212(b)) for a Class II or Class III⁴⁴ filling⁴⁵ (herein referenced as PC), whichever is appropriate. The PC is required for every different specific host using the module. A specific host is the same series or similar models having the same form factor, physical size, and component layout and construction.

The objective of this PC is to confirm that all host's emissions remain compliant with all the applicable FCC rules.

If the transmitter's power is measured as conducted or as field strength, and if the PC investigation indicates that the module's power has increased from the original filing test report, the manufacturer, lab, and TCB must investigate to determine if the initial module tested in a standalone module was improperly granted. The module may require a new FCC ID. An inquiry can be submitted to review a specific case, but the PC can only be granted once the issue is resolved.

An increase from the initial grant for conducted power shall be treated as if the initial module tested in a standalone mode was improperly granted, irrespective of whether the rise still complies with the appropriate rules.

Suppose the investigation shows that host properties caused the increased radiated emissions (including EIRP for rules specified in EIRP), and the emission is still compliant. In that case, a statement is required in the test report indicating that "an increase in strength in field strength or EIRP over the modules teste field strength is the result of being integrated into the host, and this increased emission remains compliant to the rules."

Any radiated emission out of compliance with regulations must be corrected, and the C2/3PC can only be granted once it is resolved.

It is permitted for the test plan to allow for test reduction based on a

"worst-case scenario." The manufacturer can use sound engineering judgment and justification to identify a 'worst-case' data rate and bandwidth setting for test reduction.

The test plan shall confirm and demonstrate compliance with the following:

- ✓ Confirm and document the continued compliance for the fundamentals for each band under each specific rule part granted for the module.
- ✓ The test shall demonstrate each band's worst-case modulation mode(s).
- ✓ Test Band edge compliance for the widest and narrowest bandwidths per modulation type.
- ✓ Include radiated spurious emissions with the antenna connected. Testing shall be performed for each supported modulation teasing 15.31(m). In all cases, a test of each modulation is required for channels over the frequency range defined in 15.33(a) for unlicensed transmitters and 2.1057(a) for licensed transmitters.
- ✓ Confirm and demonstrate with the radiated test that no additional parasitic, non-compliant emissions exist due to ingress (parasitic oscillations, radiation of stray signals within a host, etc.), are present.
- ✓ These tests can be based on C63.10 and C63.26 as guidance:

Examples: Wi-Fi devices that support 802.11 (up to 6e or 7 modes,) all support a plethora of OFDM, bandwidths, and data rates. Testing may be documented for a limited selection of 802.11 (g, n, or ax) modes for worst-case OFMD subcarrier or tone arrangements. The worst-case modes can be selected from the radio module's initial test report.

The widest bandwidth, highest aggregate power, and highest power spectral density should be tested. If these conditions do not all combine in the same mode, then multiple modes require testing until the modes with these three parameters have been tested and confirmed.

Full compliance testing is necessary if the manufacturer does not identify the worst-case settings for each modulation and data rate.

FCC MODULAR APPROVAL INFORMATION

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-WFMD6L".

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

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.

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). 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-WFMD6L”

2.9 Information on test modes and additional testing requirements%

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 circuitry), 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 circuitry, so the module does not require an evaluation by FCC Part 15 Subpart B. The host should be evaluated by the FCC Subpart B.