



博流智能
Bouffalo Lab
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BL616C50IQ07P00

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Product Specification

IEEE 802.11b/g/n/ax WLAN IoT Module

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1. Product Overview

BL616 is a highly integrated Wi-Fi 6 + Bluetooth 5.3 combo chipset for ultra-low-power application which mainly includes two subsystems (wireless and microcontroller).

Wireless subsystem contains 2.4G radio, Wi-Fi 802.11b/g/n/ax and BT/BLE baseband/MAC designs. Microcontroller subsystem contains a low-power 32-bit RISC-V CPU with floating point units, DSP units, high-speed cache and memories. Power Management Unit controls low-power modes. Moreover, variety of security features are supported. Peripheral interfaces include SDIO, SPI, UART, I2C, USB2.0, PWM, ADC, DAC, and GPIOs.

2. Features

- IEEE 802.11 b/g/n/ax (2.4GHz, 1x1), Bluetooth® 5.3 Dual-mode (BT+BLE)
- Wi-Fi 20/40MHz BW, 1T1R, up to 229.4 Mbps
- Wi-Fi Security WPS/WEP/WPA/WPA2/WPA3
- Support STA, SoftAP, STA+SoftAP and sniffer modes
- Smart connection
- Multi-cloud connectivity
- Wi-Fi fast connection with BLE assistance
- Wi-Fi and Bluetooth coexistence
- Integrated balun, PA/LNA
- Low power operation supporting hibernate and idle modes

3. Applications

- Low-power WiFi applications
- Internet of Things
- Smart Home
- Connected Appliances

4. Product Specification

4.1 Block Diagram

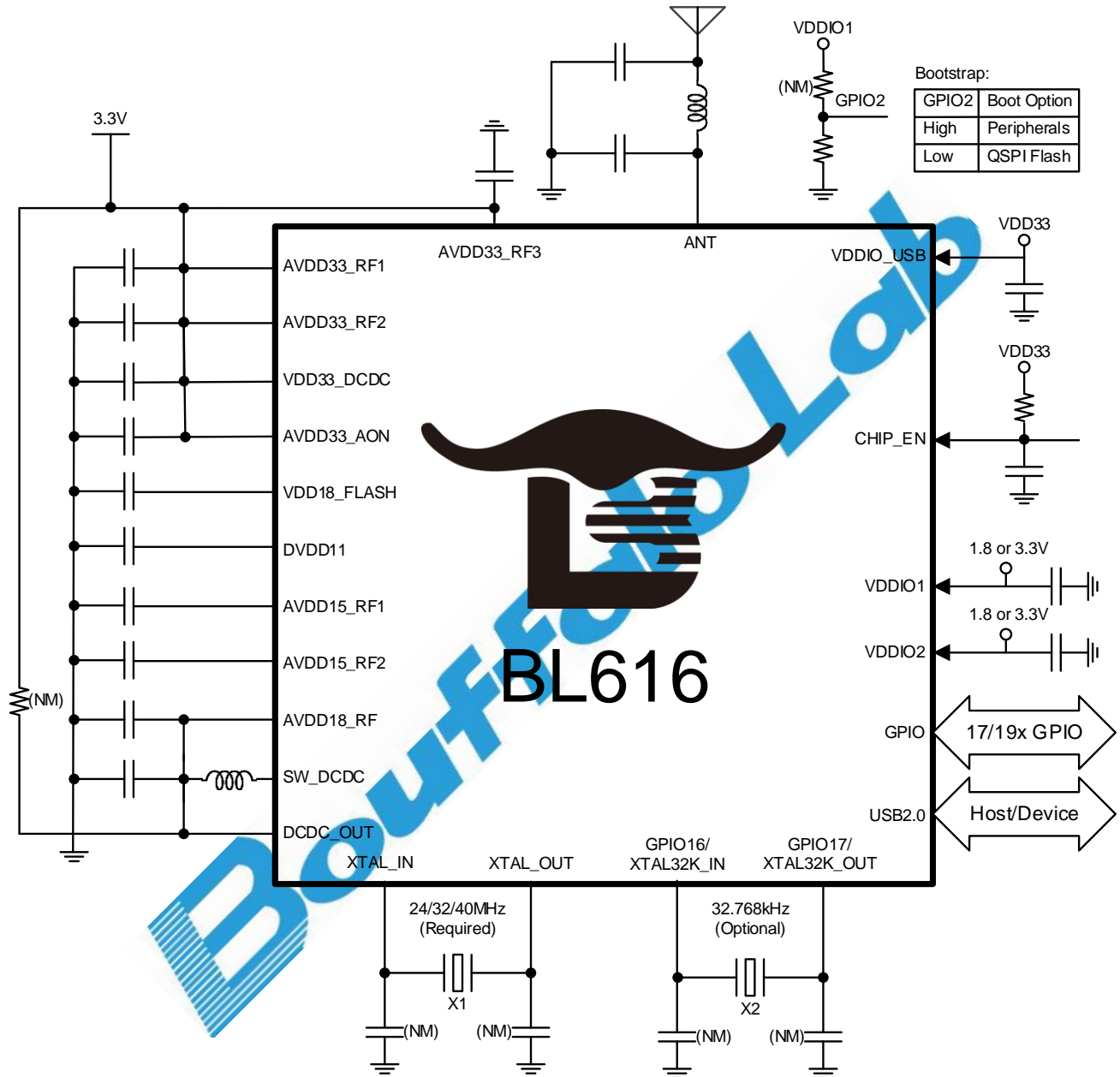


Figure 1. Block Diagram

Table 2. Electrical Specification

| Parameters | | Conditions | Min. | Typical value | Max. | Unit |
|--------------|------|------------|-----------|---------------|----------|------|
| Power Supply | | VDD | 2.9 | 3.3 | 3.6 | V |
| I/O | VIL | - | - | - | 0.3*VDDI | V |
| | VIH | - | 0.7*VDDIO | - | - | V |
| | VOL | - | - | 0.1*VDDIO | - | V |
| | VOH | - | - | 0.9*VDDIO | - | V |
| | IMAX | - | - | - | 22 | mA |

4.4 Wi-Fi RF Specification

Table 3. Wi-Fi RF Specification

| Description | Typical value | | | Unit |
|---------------------|------------------|---------|------|------|
| spectral range | 2400 ~ 2483.5MHz | | | MHz |
| Output Power | | | | |
| Mode | Min. | Typical | Max. | Unit |
| 11ax HE40 | - | 15 | - | dBm |
| 11ax HE20 | - | 15 | - | dBm |
| 11n HT40 | - | 15 | - | dBm |
| 11n HT20 | - | 15 | - | dBm |
| 11g | - | 17 | - | dBm |
| 11b | - | 19 | - | dBm |
| Receive Sensitivity | | | | |
| Mode & Rate | Min. | Typical | Max. | Unit |
| 11b 1 Mbps | - | -98 | - | dBm |
| 11b 11 Mbps | - | -90 | - | dBm |
| 11g 6 Mbps | - | -93 | - | dBm |
| 11g 54 Mbps | - | -76 | - | dBm |
| 11n HT20 (MCS7) | - | -73 | - | dBm |
| 11n HT40 (MCS7) | - | -70 | - | dBm |
| 11ax HE20 (MCS9) | - | -70 | - | dBm |
| 11ax HE40 (MCS9) | - | -67 | - | dBm |

4.5 BLE RF Specification

Table 4. BLE RF Specification

| Description | Typical value | | | Unit |
|---------------------|------------------|---------|------|------|
| spectral range | 2400 ~ 2483.5MHz | | | MHz |
| Output Power | | | | |
| Rate Mode | Min. | Typical | Max. | Unit |
| 1Mbps | - | 10 | 20 | dBm |
| 2Mbps | - | 10 | 20 | dBm |
| S2 (500Kbps) | - | 10 | 20 | dBm |
| S8 (125Kbps) | - | 10 | 15 | dBm |
| Receive Sensitivity | | | | |
| Rate Mode | Min. | Typical | Max. | Unit |
| 1Mbps | - | -98 | - | dBm |
| 2Mbps | - | -96 | - | dBm |
| S2 (500Kbps) | - | -101 | - | dBm |
| S8 (125Kbps) | - | -104 | - | dBm |

4.6 BT RF Specification

Table 5. BT RF Specification

| Description | Typical value | | | Unit |
|---------------------|------------------|---------|------|------|
| spectral range | 2400 ~ 2483.5MHz | | | MHz |
| Output Power | | | | |
| Rate Mode | Min. | Typical | Max. | Unit |
| BR 1Mbps | - | 10 | - | dBm |
| EDR 2Mbps | - | 8 | - | dBm |
| EDR 3Mbps | - | 8 | - | dBm |
| Receive Sensitivity | | | | |

| Rate Mode | Min. | Typical | Max. | Unit |
|-----------|------|---------|------|------|
| BR 1Mbps | - | -93 | - | dBm |
| EDR 2Mbps | - | -95 | - | dBm |
| EDR 3Mbps | - | -89 | - | dBm |

4.7 Pin Definition

Table 6. Pin Function Definition

| NO | Name | IO Type | Description |
|----|--------|---------|--------------------------------|
| 1 | GPIO12 | I/O | GPIO12/ PWM0 |
| 2 | GPIO11 | I/O | GPIO11/ PWM3 |
| 3 | GPIO13 | I/O | GPIO13/ PWM1 |
| 4 | GPIO14 | I/O | GPIO14/ PWM2 |
| 5 | GPIO15 | I/O | GPIO15/ PWM4 |
| 6 | GND | P | Ground connections |
| 7 | VCC | P | Power supply. 3.3V is required |

Note1: P means power pin, I/O means input/output pin, AI means analog input pin.

5. Dimension & Footprint

Module dimension: Typical (W x L x H): 15mm×17.3mm×2.8mm Tolerance : +/-0.2mm

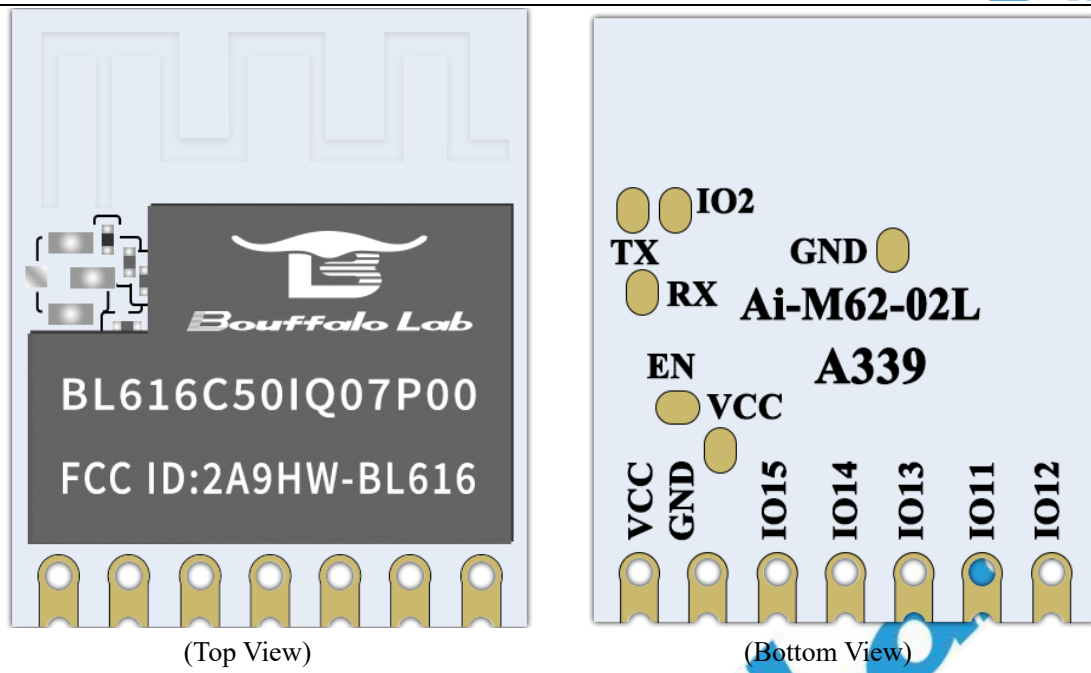


Figure 3. Module View

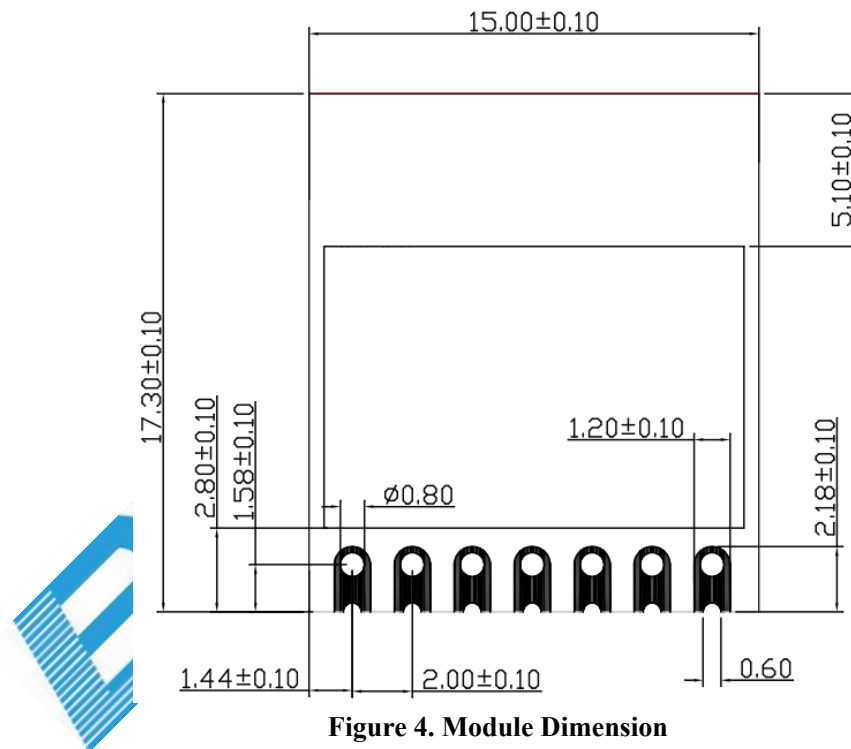


Figure 4. Module Dimension

PCB land pattern:

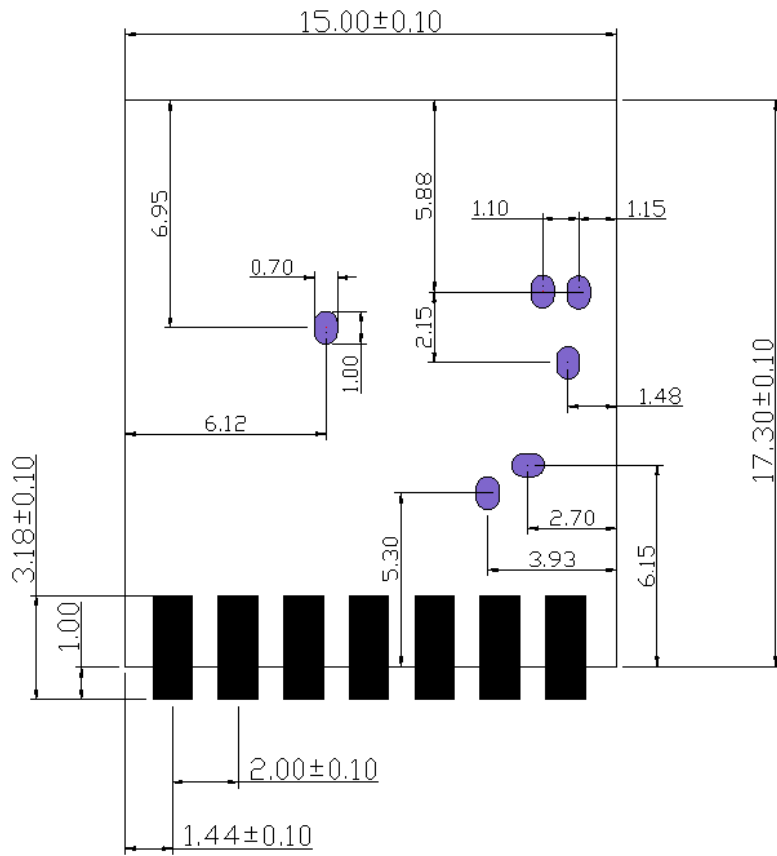


Figure 5. Recommended PCB Land Pattern

In order to meet the performance of onboard antenna, it is forbidden to place metal material or high frequency devices around the antenna.

The figure shown as below is the recommended keep-out for users.

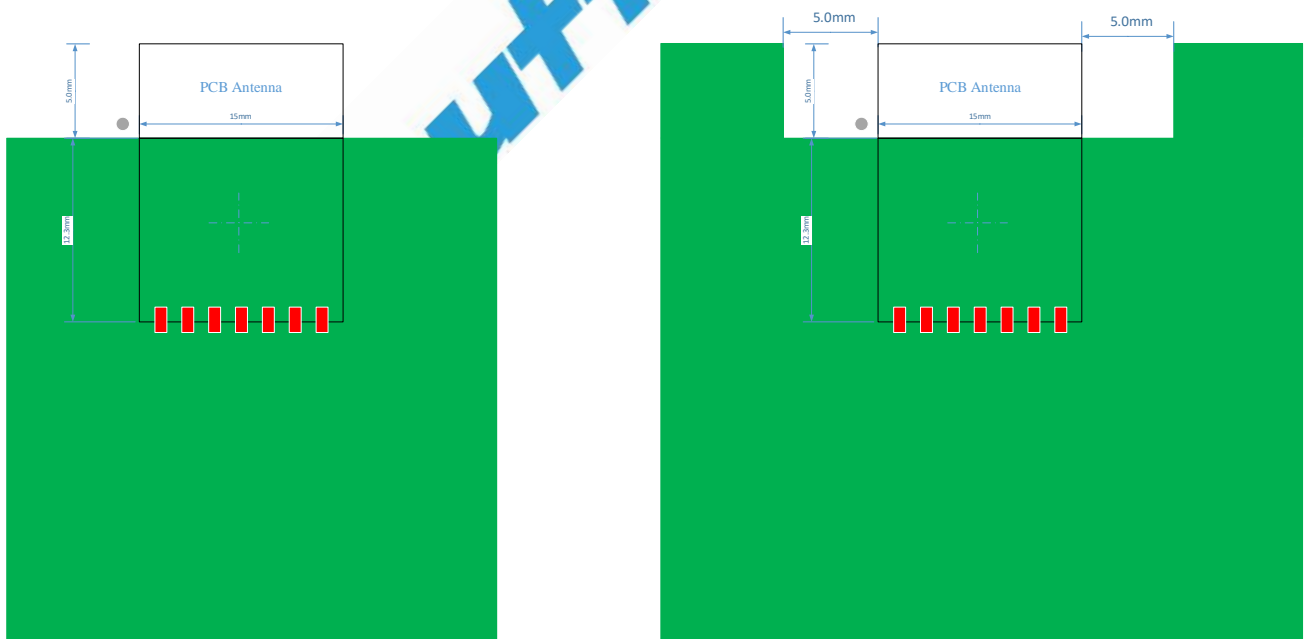


Figure 6. Recommended Keep-Out

6. Storage conditions

Products sealed in moisture-proof bags should be stored in a non-condensing atmosphere of $<40^{\circ}\text{C} / 90\%\text{RH}$.

The module has a moisture sensitivity rating of MSL3.

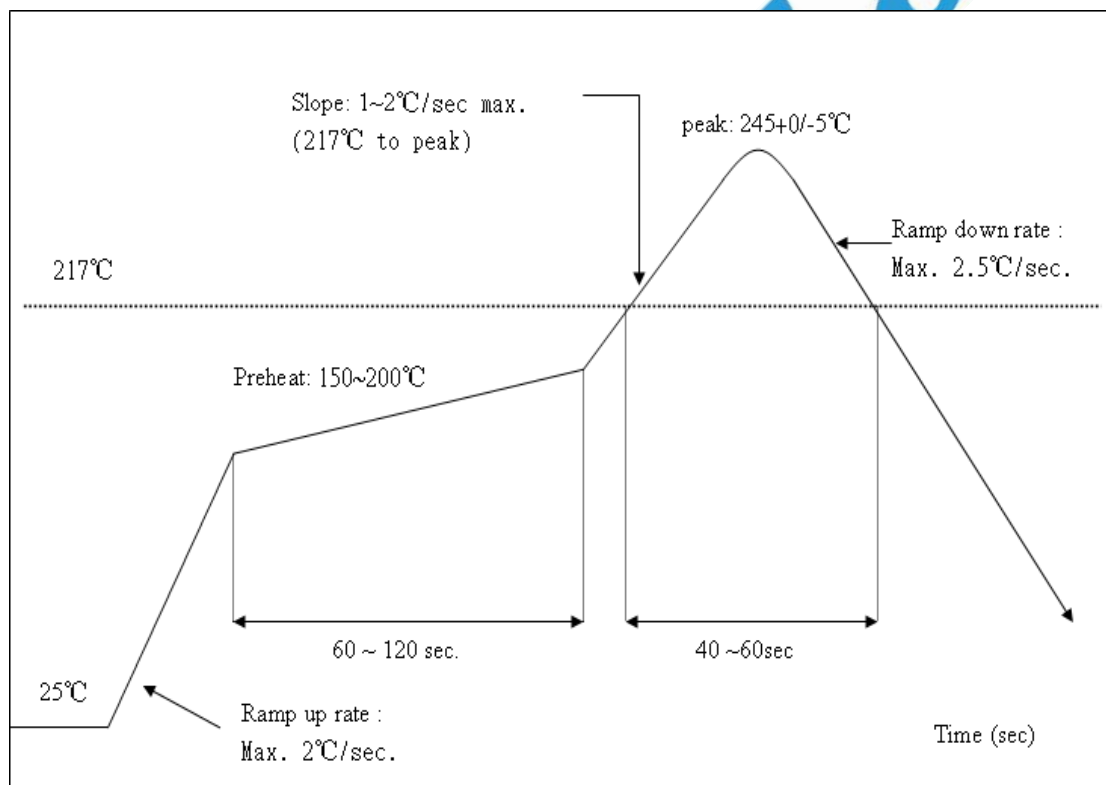
Once the vacuum bag is opened, it must be used within 168 hours at $25\pm 5^{\circ}\text{C} / 60\%\text{RH}$, otherwise it should be baked again.

7. Recommended Reflow Profile

Refer to IPC/JEDEC standard.

Peak Temperature: $<250^{\circ}\text{C}$

Number of Times: ≤ 2 times



8. Contact us

- 1、Bouffalo Lab official website: <https://www.bouffalolab.com>
- 2、Intelligent Technology Forum: <https://bbs.bouffalolab.com>
- 3、Open source community: <https://github.com/bouffalolab>
- 4、Developer community: <https://dev.bouffalolab.com/home>
- 5、Video tutorial support: <https://space.bilibili.com/411372413>
- 6、Business Cooperation: info@bouffalolab.com
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Due to product version upgrades or other reasons, the contents of this manual may be changed.

Bouffalo Lab (Nanjing) Co., Ltd. reserves the right to modify the contents of this manual without any notice or prompt.

This manual is only used as a guide. Bouffalo Lab (Nanjing) Co., Ltd. makes every effort to provide accurate information in this manual. However, Bouffalo Lab (Nanjing) Co., Ltd. does not guarantee that the contents of the manual are completely free of errors. All statements and information in this manual and the suggestion does not constitute any express or implied guarantee.

Federal Communication Commission Statement (FCC, U.S.)

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 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 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.

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.

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.

IMPORTANT NOTES

Co-location warning:

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

OEM integration instructions:

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

The transmitter module may not be co-located with any other transmitter or antenna. The module shall be only used with the external antenna(s) that has been originally tested and certified with this module.

As long as the 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.).

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.

End product labeling:

The final end product must be labeled in a visible area with the following: “Contains Transmitter Module FCC ID: 2A9HW-BL616”.

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.

Integration instructions for host product manufactures according to KDB 996369 D03 OEM Manual v01**2.2 List of applicable FCC rules**

FCC Part 15 Subpart C 15.247

2.3 Specific operational use conditions

The module is a WiFi module with BT& BLE 2.4G function.

WiFi Specification:

Operation Frequency: 2412~2462MHz

Number of Channel: 11

Modulation: DSSS, OFDM

Type: PCB Antenna

Gain: 1.67 dBi

BLE Specification:

Operation Frequency: 2402~2480MHz

Number of Channel: 40

Modulation: GFSK

Type: PCB Antenna

Gain: 1.67 dBi

BT Specification:

Operation Frequency: 2402~2480MHz

Number of Channel: 79

Modulation: GFSK, $\pi/4$ DQPSK, 8DPSK

Type: PCB Antenna

Gain: 1.67 dBi

The module can be used for mobile or applications with a maximum 1.67dBi antenna. The host manufacturer installing this module into their product must ensure that the final composite product complies with the FCC requirements by a technical assessment or evaluation to the FCC rules, including the transmitter operation. The host manufacturer 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.

2.4 Limited module procedures

Not applicable.

2.5 Trace antenna designs

Not applicable. The module has its own antenna, and doesn't need a host's printed board microstrip trace antenna etc.

2.6 RF exposure considerations

The module must be installed in the host equipment such that at least 20cm is maintained between the antenna and users' body; and if RF exposure statement or module layout is changed, then the host product manufacturer required to take responsibility of the module through a change in FCC ID or new application. The FCC ID of the module cannot be used on the final product. In these circumstances, the host manufacturer will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization

2.7 Antennas

Antenna Specification are as follows:

Type: PCB Antenna

Gain: 1.67 dBi

This device is intended only for host manufacturers under the following conditions: The transmitter module may not be co-located with any other transmitter or antenna; The module shall be only used with the internal antenna(s) that has been originally tested and certified with this module. The antenna must be either permanently attached or employ a 'unique' antenna coupler.

As long as the conditions above are met, further transmitter test will not be required. However, the host manufacturer 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.)

2.8 Label and compliance information

Host product manufacturers need to provide a physical or e-label stating "Contains Transmitter Module FCC ID: 2A9HW-BL616" with their finished product.

2.9 Information on test modes and additional testing requirements

WIFI

Operation Frequency: 2412~2462MHz

Number of Channel: 11

Modulation: DSSS, OFDM

BLE

Operation Frequency: 2402~2480MHz

Number of Channel: 40

Modulation: GFSK

BT Specification:

Operation Frequency: 2402~2480MHz

Number of Channel: 79

Modulation: GFSK, $\pi/4$ DQPSK, 8DPSK

Host manufacturer must perform test of radiated & conducted emission and spurious emission, etc according to the actual test modes for a stand-alone modular transmitter in a host, as well as for multiple simultaneously transmitting modules or other transmitters in a host product. Only when all the test results of test modes comply with FCC requirements, then the end product can be sold legally.

2.10 Additional testing, Part 15 Subpart B disclaimer

The modular transmitter is only FCC authorized for FCC Part 15 Subpart C 15.247 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.

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Canada Regulations:

This device complies with Industry Canada's licence-exempt RSSs. Operation is subject to the following two conditions:

- (1) This device may not cause interference; and
- (2) This device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

- (1) l'appareil ne doit pas produire de brouillage;
- (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Caution:

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter. This equipment should be installed and operated with a minimum distance of 20 centimeters between the radiator and your body.

Cet émetteur ne doit pas être Co-placé ou ne fonctionnant en même temps qu'aucune autre antenne ou émetteur. Cet équipement devrait être installé et actionné avec une distance minimum de 20 centimètres entre le radiateur et votre corps.

The host product shall be properly labelled to identify the modules within the host product.

The Innovation, Science and Economic Development Canada certification label of a module shall be clearly visible at all times when installed in the host product; otherwise, the host product must be labelled to display the Innovation, Science and Economic Development Canada certification number for the module, preceded by the word "Contains" or similar wording expressing the same meaning, as follows: "Contains IC: 31996-BL616" or "where: 31996-BL616 is the module's certification number".

Le produit hôte doit être correctement étiqueté pour identifier les modules dans le produit hôte.

L'étiquette de certification d'Innovation, Sciences et Développement économique Canada d'un module doit être clairement visible en tout temps lorsqu'il est installé dans le produit hôte; sinon, le produit hôte doit porter une étiquette indiquant le numéro de certification d'Innovation, Sciences et Développement économique Canada pour le module, précédé du mot «Contient» ou d'un libellé semblable exprimant la même signification, comme suit:

"Contient IC: 31996-BL616 " ou "où: 31996-BL616 est le numéro de certification du module".

A label with the following statements must be attached to the host end product: This device contains IC: 31996-BL616.

The manual provides guidance to the host manufacturer will be included in the documentation that will be provided to the OEM.

The module is limited to installation in mobile or fixed applications.

The separate approval is required for all other operating configurations, including portable configurations and different antenna configurations.

The OEM integrators are responsible for ensuring that the end-user has no manual or instructions to remove or install module.

The module is limited to OEM installation ONLY.

Une étiquette avec les instructions suivantes doit être attachée au produit final hôte:

Cet appareil contient IC: 31996-BL616

Le manuel fournit des conseils au fabricant hôte sera inclus dans la documentation qui sera fournie à l'OEM.

Le module est limité à l'installation dans des applications mobiles ou fixes.

L'approbation distincte est requise pour toutes les autres configurations de fonctionnement, y compris les configurations portables et différentes configurations d'antenne.

Les intégrateurs OEM sont responsables de s'assurer que l'utilisateur n'a pas de manuel ou d'instructions pour retirer ou installer le module.

Le module est limité à l'installation OEM SEULEMENT.

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