

Design Manual of AFM201T Module Hardware

V1.1 2019.08

Contents

| | | |
|-----|---------------------------------------|----|
| 1 | Introduction..... | 2 |
| 1.1 | Abstract | 2 |
| 1.2 | Basic characteristics of module | 2 |
| 1.3 | Module type | 2 |
| 1.4 | GPIOs of module..... | 3 |
| 1.5 | Block diagram of hardware | 4 |
| 2 | Design issues of hardware..... | 5 |
| 2.1 | Power design | 5 |
| 2.2 | Power OFF PIN | 5 |
| 2.3 | Reference circuit design | 6 |
| 3 | Log serial port | 7 |
| 4 | RF design and layout issues | 9 |
| 4.1 | RF selecting resistor | 9 |
| 4.2 | Directions for module layout..... | 9 |
| 4.3 | Advice on module layout..... | 10 |
| 5 | Purchase and support | 12 |

Patent statements

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1 Introduction

1.1 Abstract

The document mainly lists the issues that need attention in all stages during the use of 99 IoT Wi-Fi module AFM201T design by users in order to reduce design costs and increase product stability as far as possible.

AFM201T is a complete and self-contained WiFi network and Bluetooth(BLE4.2) solution module that can run either in MCU+WIFI mode or as a slave on other master MCU. The sensor and other applied specific devices can be integrated through GPIOs port.

1.2 Basic characteristics of module

- Standard: 802.11 b/g/n 1x1
- Working mode: STA, AP, STA+AP,BLE4.2
- Complete IoT solution (SDK, Cloud service, APP)
- Supporting Simple Configuration intelligent networking function (APP is provided)
- Supporting Amazon, Baidu cloud, Jingdong cloud, Ali cloud
- Each module has unique global MAC ID
- Antenna: outer antenna, IPEX antenna interface, onboard antenna
- Working ambient temperature: -20 to 85 °C

1.3 Module type

| Module name | Module description |
|-------------|-------------------------------|
| AFM201TI | PCB onboard antenna |
| AFM201TO | IPEX outer antenna (optional) |
| AFM201TP | RF-PinExternal antenna |

1.4 GPIOs of module

| 引脚 | 名称/主功能 | I/O | 类型 | 引脚功能 |
|----|-------------------------------------|----------|--------------------|-----------------------------------------------------|
| 1 | GND | | P ⁽¹⁾ | |
| 2 | ANTENA ⁽³⁾ | | O | |
| 3 | GND | | P | |
| 4 | GND | | P | |
| 5 | CHIP_EN ⁽²⁾ (RESET) | | I | Reset (Active low, internal pull-up resistor 10K) |
| 6 | PWM1 ⁽⁷⁾ | GPIOA_0 | I/O ⁽¹⁾ | JTAG_CLK/UART1_RX/EXT_32K/PWM0 |
| 7 | PWM2 ⁽⁷⁾ | GPIOA_1 | I/O | JTAG_TMS/UART1_TX/BT_LED/PWM1 |
| 8 | UART1_RX | GPIOA_2 | I/O | UART1_RX/JTAG_TDO/SPI_CS _n /I2C_SCL/PWM2 |
| 9 | UART1_TX | GPIOA_3 | I/O | UART1_TX /JTAG_TDI/SPI_SCL/I2C_SDA/PWM3 |
| 10 | PWM3 | GPIOA_4 | I/O | JTAG_TRST/UART1_CTS/SPI_MOSI/PWM4 |
| 11 | GND | | P | |
| 12 | GND | | P | |
| 13 | VBat_IN ⁽⁴⁾ | | P | 5V Input : 5V MCU |
| 14 | VD33 ⁽⁴⁾ | | P | 3.3V Input : 3.3V MCU |
| 15 | UART0_RX ⁽⁶⁾ | GPIOA_13 | I/O | UART0_RX/PWM7 |
| 16 | UART0_TX ⁽⁶⁾ | GPIOA_14 | I/O | UART0_TX/SDIO_INT/PWM2 |
| 17 | LOG_RX ⁽⁵⁾ | GPIOA_15 | I/O | UART2_RX/SD_D2/SPI_CS _n /I2C_SCL/PWM3 |
| 18 | LOG_TX ⁽⁵⁾ | GPIOA_16 | I/O | UART2_TX/SD_D3/SPI_SCL/I2C_SDA/PWM4 |
| 19 | PWM4 | GPIOA_17 | I/O | SD_CMD/PWM5 |
| 20 | PWM5 | GPIOA_18 | I/O | SD_CLK/PWM6 |
| 21 | GPIO1 | GPIOA_19 | I/O | SD_D0/SPI_MOSI/I2C_SCI/PWM7 |
| 22 | GPIO2 | GPIOA_20 | I/O | SD_D1/SPI_MISO/I2C_SDA/PWM0 |
| 23 | GPIO3 ⁽⁷⁾ | GPIOA_23 | I/O | PWM7 |

Description:

- 1、P is the power pin, I / O is the input and output pin, and CHIP_EN is the module hardware reset pin. It does not clear the WiFi network information.
- 2、Please keep CHIP_EN or other pins floating if they are not used

3、The ANTENA pin is a module antenna output pin that can be connected to an external antenna.

4、PIN13 and PIN14 are 5V and 3.3v input pins respectively:

When connected to a 5V MCU, PIN13 is directly supplied with 5V voltage, and PIN14 is directly suspended.

When connected to a 3.3V MCU, PIN13 and PIN14 are directly shorted and connected to 3.3V.

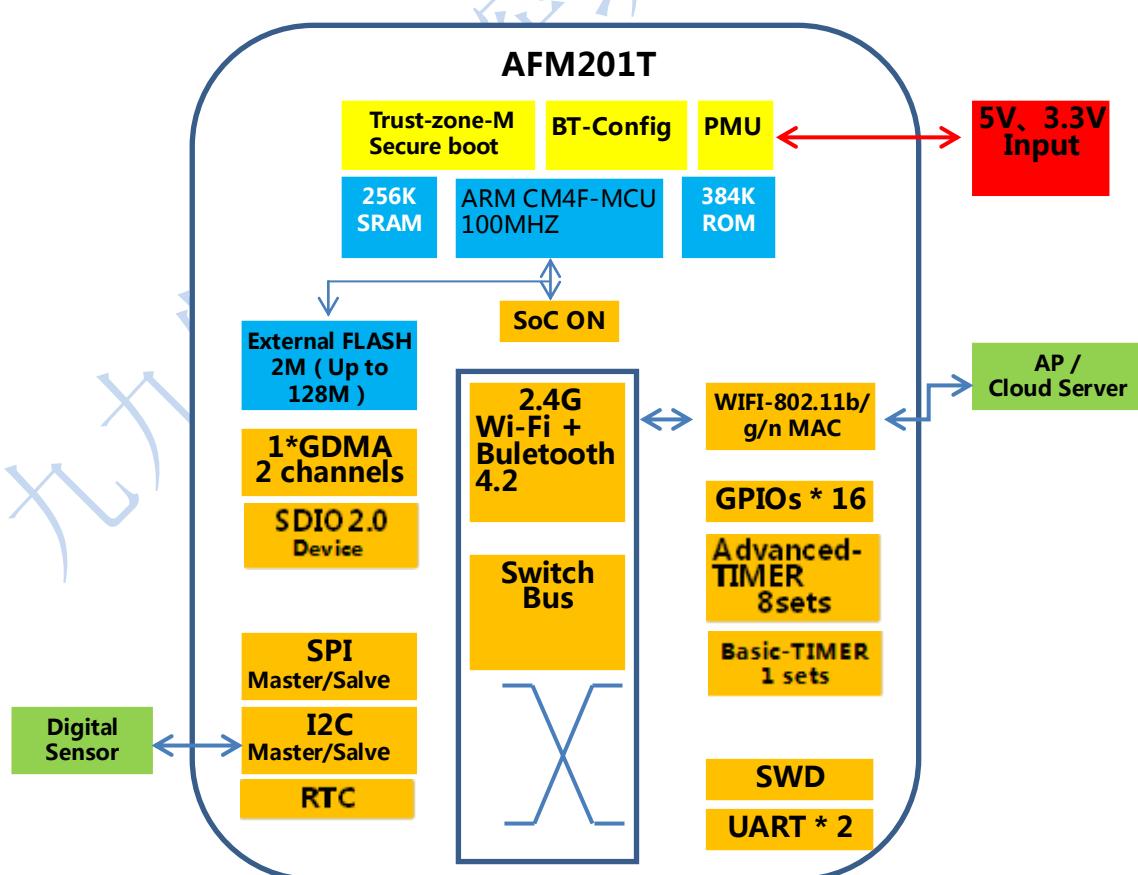
5、PIN17 and 18 pins are module download I/O and debug ports.

6、5V power supply, only PIN15, 16 can be configured as 5V UART, other PINs are 3.3v level

7、PIN6, PIN7, and PIN23 are used as I/O ports and can only be used as output.

PIN6 is used as Download auxiliary pin, which needs to be short-circuited to power on to enter Download mode.

1.5 Block diagram of hardware



2 Design issues of hardware

2.1 Power design

As shown in Figure 1.4 above

- (1) Input pin of main power supply is [PIN13], module supply voltage is DC 3.0~3.6, filter capacitor of 4.7-10uF needs to be placed near its location; loading capability of 3.3V power supply, the power supply with rated output current $\geq 500\text{mA}$ is recommended.
- (2) Use of DC/DC powerchip: voltage output meets 3.3V and the maximum current output meets 500mA, input capacitor is as close as possible to voltage input pin, thickening ground wire width or grounded copper area, punching more via holes for different layers.
- (3) For LDO design, the voltage output meets 3.3V and the maximum current output meets 500mA, paying attention to device junction temperature, the formula of power consumption is $\text{PD}=(\text{Vin}-\text{Vout}) * \text{Iload} + \text{Vin} * \text{IGND}$, in which Vin is input voltage, Vout is output voltage, Iload is load current, IGND is ground current.

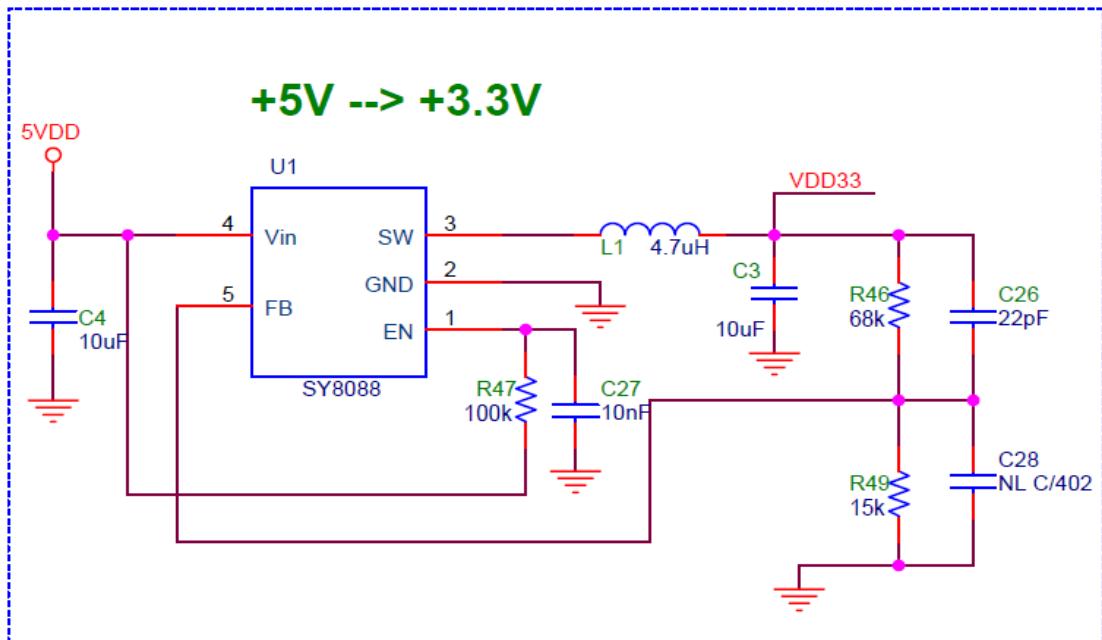
2.2 Power OFF PIN

As shown in Figure 1.4 above

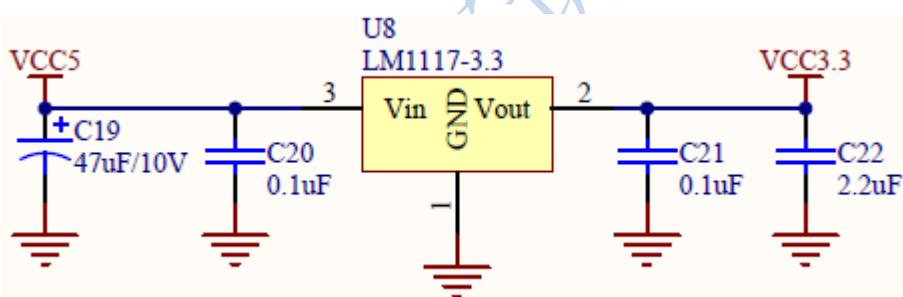
- (1) [PIN5] is module reset pin: Power OFF (RESET) . The pull-up of the 10K resistor has been done inside the module, If this PIN is not controlled by the MCU, it can be left unconnected . If it is low, the module is shutdown mode.
- (2) If the module is not controlled by other MCU, the decoupling capacitor of 100nF is recommended to be added near its location to enhance the stability of the system.
- (3) If other MCU is needed to reset-control the module through the pin, a low pulse signal is needed and the duration of low level is at least 10ms.
- (4) If the voltage of power supply is unstable (lower than 3.0V), it may cause module halt. It is recommended to add Brown out reset circuit, and the recommended chip is as follows:
【ONSEMI/MAX809STR/SOT23/LM1117-3.3】 . It can also be monitored by other (master control) MCU.

2.3 Reference circuit design

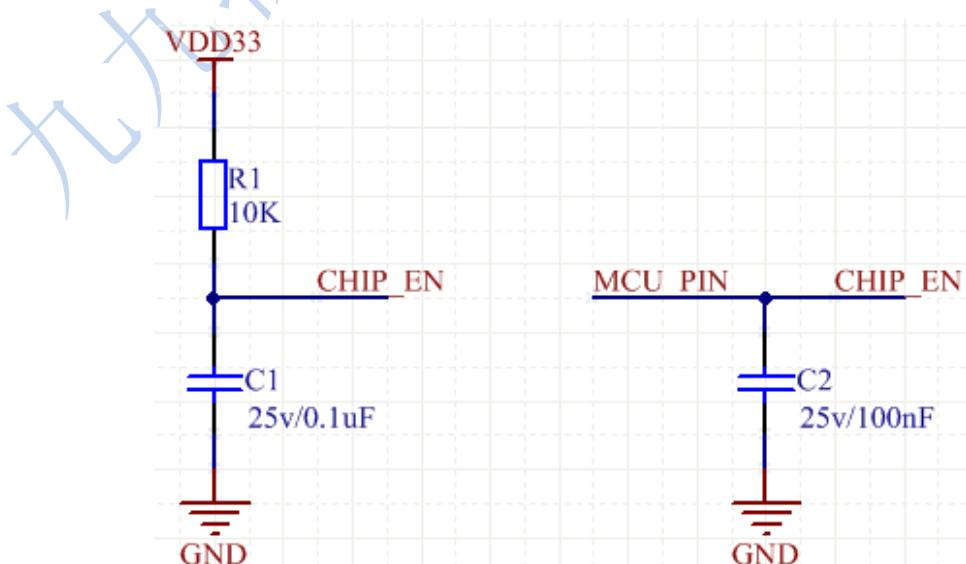
Reference circuit design of module AFW121Tx/AFW122Tx, 5V to 3.3V conversion



5V to 3.3V conversion, LDO reference circuit design

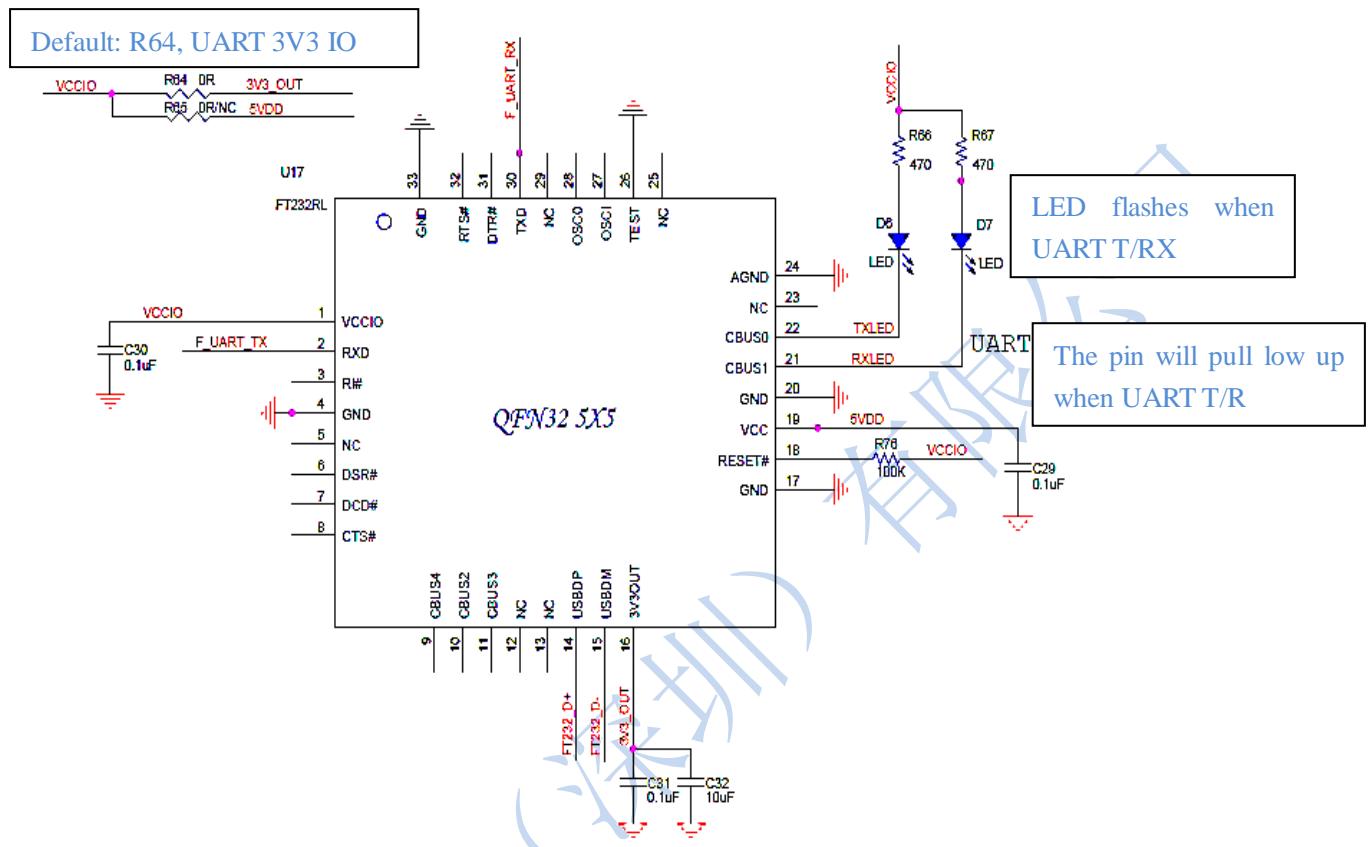


Reset reference circuit design

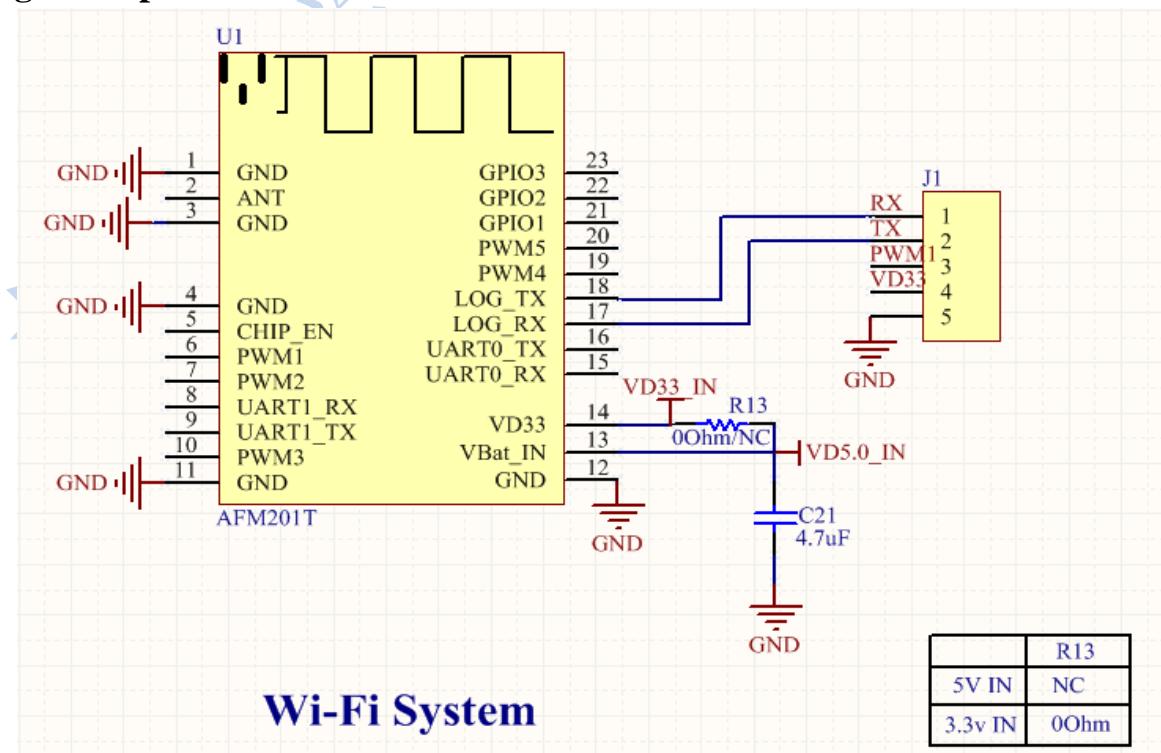


UART level switching circuit

USB to UART



3 Log serial port



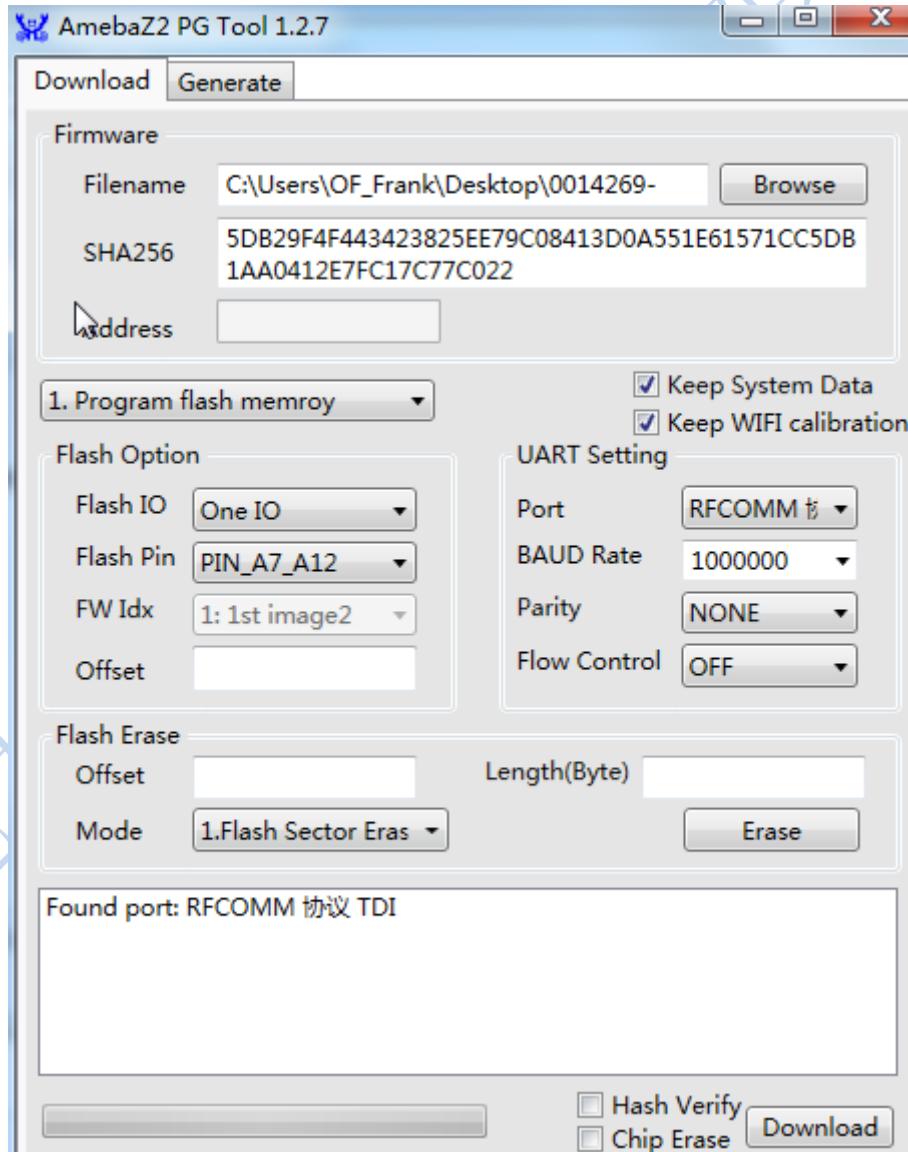
The function of J1

(1) PIN5 (PWM1) is a boot PIN:

| Level | Function |
|-------|--------------------------|
| 1 | Download image from UART |
| 0 | Boot from Flash |

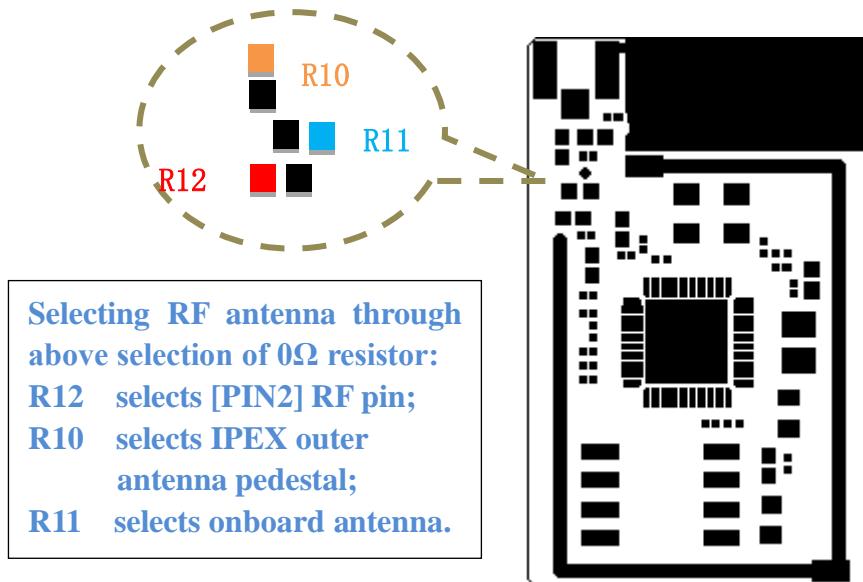
(2) Serial port pinboard is used to observe output log by connecting abovementioned PIN to find abnormality of module software conveniently.

(3) Serial port pinboard is used to achieve firmware programming by connecting abovementioned PIN.



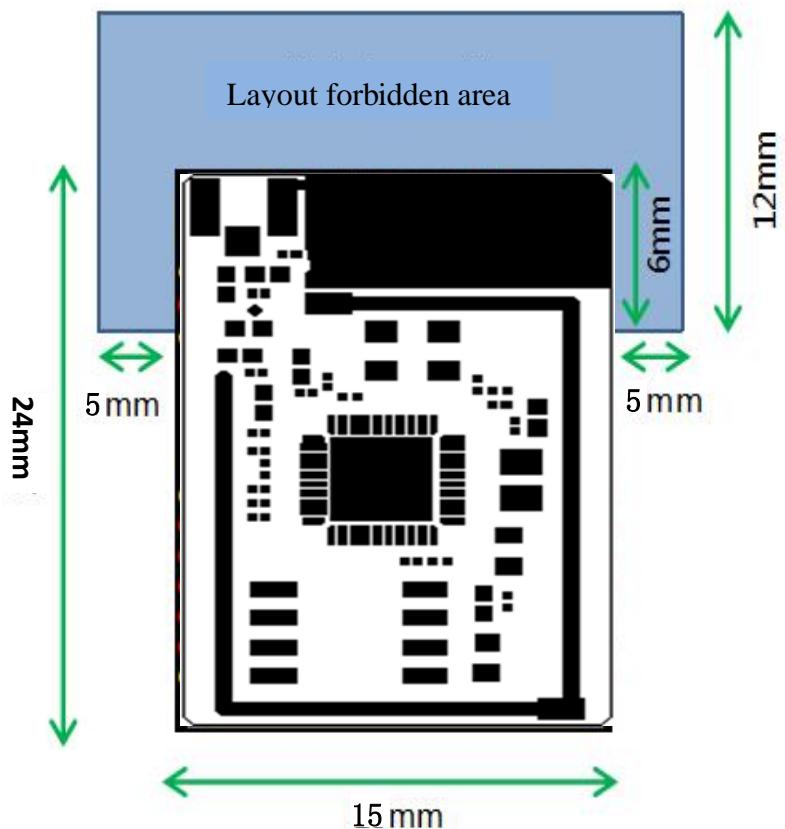
4 RF design and layout issues

4.1 RF selecting resistor



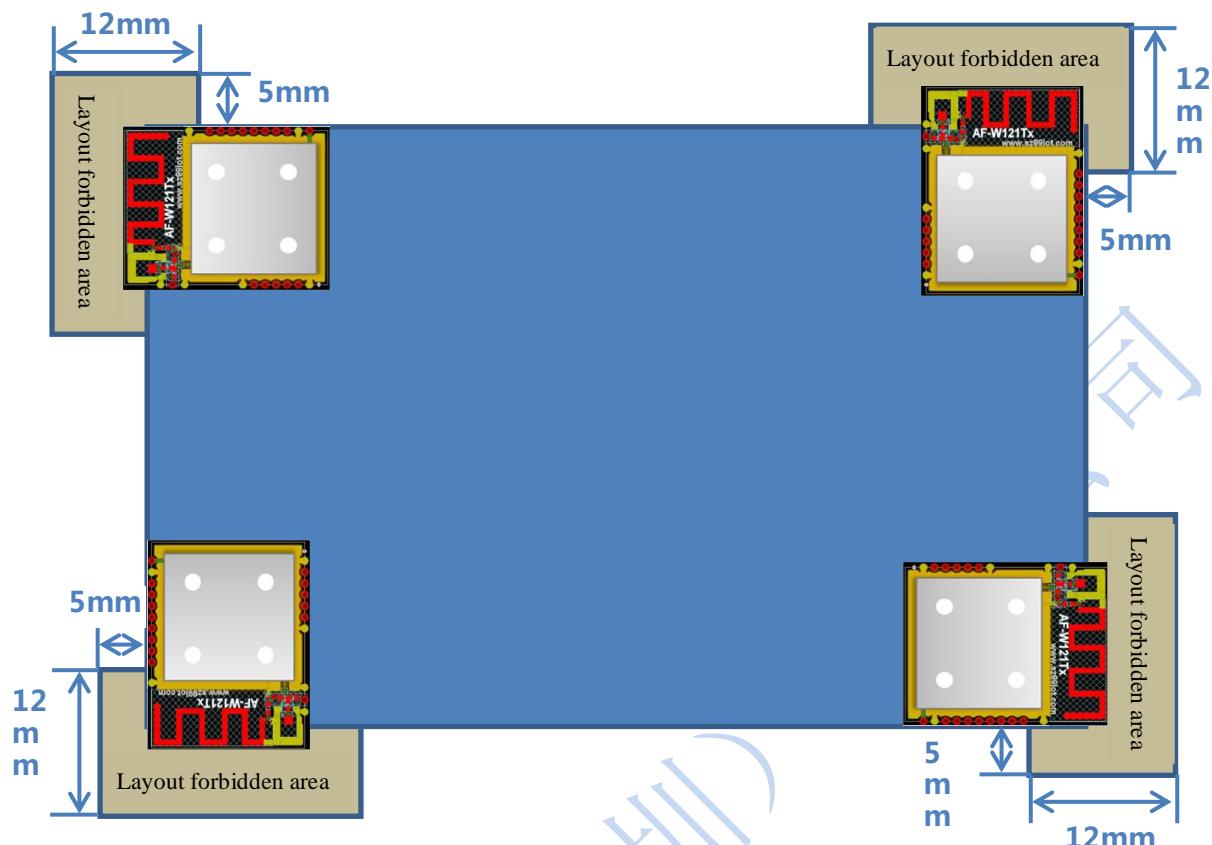
4.2 Directions for module layout

- (1) When using onboard antenna, layout forbidden area is seen in the figure below;
- (2) The module must be placed vertically with the onboard antenna top located or the module is placed horizontally with component side up;
- (3) When the module is placed vertically, the clear height of module's both sides is at least over 12mm;
When the module is placed horizontally, the clear height under the module is over 6mm;
Cable and other metals are prohibited above the module;
- (4) Neither can copper be cladded nor can metal devices, sensors, interference sources or other materials that have an impact on signal be placed under the layout forbidden area.



4.3 Advice on module layout

When users use the module with onboard PCB antenna, they can put the module in the following areas of the baseboard, or place the antenna of module outside the baseboard, so the module onboard antenna has a larger clearance area compared to the bottom to reduce the impact of metal devices on PCB antenna and wireless signals. Or PCB is hollowed under the antenna.



Updating description of historical versions

| Revision | Release Data | Summary |
|----------|--------------|-----------------------------------------------------------------|
| V1.0 | 2019/08/15 | First draft |
| V1.1 | 2019/08/27 | Adding module layout description, firmware download description |

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Date: 15/8/2019

5 Purchase and support

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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.

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: 2ANN4-AFM201T".

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 manufacturers according to KDB 996369 D03 OEM
Manual v01**

2.2 List of applicable FCC rules

FCC Part 15 Subpart C 15.247 & 15.207 & 15.209

2.3 Specific operational use conditions

The module is a Bluetooth WIFI module with BLE and WIFI 2.4G function.

Operation Frequency: 2402-2480MHz, 2412~2462MHz

Number of Channel: 40, 11

Modulation: GFSK, 802.11b CCK; 802.11g/n OFDM

Type: PCB Antenna

Gain: 1.3 dBi Max.

The module can be used for mobile or applications with a maximum 1.3dBi antenna. The host manufacturer installing this module into their product must ensure that the final composit 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. The module is a Single module and complies with the requirement of FCC Part 15.212.

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: 1.3 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 FCC ID: 2ANN4-AFM201T" with their finished product.

2.9 Information on test modes and additional testing requirements

Operation Frequency: 2402-2480MHz, 2412~2462MHz

Number of Channel: 40, 11

Modulation: GFSK, 802.11b CCK; 802.11g/n OFDM

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 & 15.207 & 15.209 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.

FCC STATEMENT :

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.

Warning: 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.