SPECIFICATIONS

IEEE 802.11b/g/n AC 1T1R WLAN with Integrated Bluetooth 2.1/4.2 Controller w/PCI Express / USB2.0 Mixed Interfaces

RL-EM02G-8821CE-V1.1（亿道专用）

Version: V1.1

Contents

Change History of Revision

Revisio	Date	Contents of Revision Change	Remark
V1.1	2018-04-03	First release of product specifications.	2018-04-03
V1.1	2019-06-18	Modify the module picture and size thickness	2019-06-18
V1.1	2019-07-29	Modify RF parameters according to customer needs	2019-07-29

1. General Description

The Realtek RTL8821CE is a highly integrated single-chip that support 1-stream 802.11ac solutions with Wireless LAN (WLAN) PCI Express network interface controller with integrated Bluetooth 2.1/4.2 USB interface controller. It combines a WLAN MAC, a 1T1R capable WLAN baseband, and RF in s single chip. The RTL8821CE provides a complete solution for a high-performance integrated wireless and Bluetooth device.

The RTL8821CE baseband implements Multi-user Multiple Input, Multiple Output (MU MIMO)Orthogonal Frequency Division Multiplexing (OFDM) STA mode with one transmit and one receive paths(1T1R). Features include one spatial stream transmissions, short Guard Interval (GI) of 400ns, spatial spreading, and support for variant channel bandwidth. Moreover, RTL8821CE provides one spatial stream space-time block code (STBC), Transmit Beamforming (TxBF) and Low Density Parity Check (LDPC) to extend the range of transmission. As the recipient, the RTL8821CE also supports explicit sounding packet feedback that helps senders with beamforming capability.

For legacy compatibility, Direct Sequence Spread Spectrum (DSSS), Complementary Code Keying (CCK)and OFDM baseband processing are included to support all IEEE 802.11b, 802.11g and 802.11a data rates.Differential phase shift keying modulation schemes, DBPSK and DQPSK with data scrambling capability are available, and CCK provides support for legacy data rates, with long or short preamble. The high speed FFT/IFFT paths, combined with BPSK, QPSK, 16QAM, 64QAM and 256QAM modulation of the individual subcarriers, and rate compatible coding rate of 1/2, 2/3, 3/4, and 5/6, provide up to 433.3Mbps for IEEE 802.11ac OFDM.

The RTL8821CE builds in an enhanced signal detector, an adaptive frequency domain equalizer, and a soft-decision Viterbi decoder to alleviate severe multi-path effects and mutual interference in the reception of multiple streams. Robust interference detection and suppression are provided to protect against Bluetooth, cordless phone, and microwave oven interference.

Receive vector diversity for multi-stream application is implemented for efficient utilization of the MIMO channel. Efficient IQ-imbalance, DC offset, phase noise, frequency offset, and timing offset compensations are provided for the radio frequency front-end.

The RTL8821CE supports fast receiver Automatic Gain Control (AGC) with synchronous and asynchronous control loops among antennas, antenna diversity functions, and adaptive transmit power control functions to obtain better performance in the analog portions of the transceiver.

The RTL8821CE MAC supports 802.11e for multimedia applications, 802.11i and WAPI (Wireless Authentication Privacy Infrastructure) for security, and 802.11n/802.11ac for enhanced MAC protocol efficiency. Using packet aggregation techniques such as A-MPDU with BA and A-MSDU, protocol efficiency is significantly improved. Power saving mechanisms such as Legacy Power Save, U-APSD, and MIMO power saving reduce the power wasted during idle time, and compensate for the extra power required to transmit OFDM. The RTL8821CE provides simple legacy, 20MHz/40MHz/80MHz co-existence mechanisms to ensure backward and network compatibility.

2.Features

General Information

- CMOS MAC, Baseband PHY and RF in a single chip for IEEE 802.11a/b/g/n/ac compatible WLAN
- Support 802.11ac 1x1,Wave-2 compliant with STA mode
- Complete 802.11n solution for 2.4GHz and 5Ghz band
- Maximum PHY data rate up to 86.7Mbps using 20MHz bandwidth, 200Mbps using 40MHz bandwidth, and 433.3Mbps using 80MHz bandwidth.
- Backward compatible with 802.11a/b/g devices while operating at 802.11n data rates
- Backward compatible with 802.11a/n devices while operating at 802.11ac data rates.

Host Interface

- Complies with PCI Express Base Specification Revision 2.1
- Complies with USB2.0 FS-mode Specification for Bluetooth
- PCIe LTR / L1.OFF state supported
- USB Selective Suspend supported

Standards Supported

- IEEE 802.11a/b/g/n/ac compatible WLAN
- IEEE 802.11e QoS Enhancement (WMM)
- IEEE 802.11i (WPA, WPA2). Open, shared key, and pair-wise key authentication services
- IEEE 802.11h DFS, TPC, Spectrum Measurement
- IEEE 802.11k Radio Resource Measurement
- WAPI (Wireless Authentication Privacy Infrastructure) certified.
- Cisco Compatible Extensions (CCX) for WLAN devices

MAC Features

- Frame aggregation for increased MAC efficiency (A-MSDU, A-MPDU)
- Low latency immediate Block Acknowledgement (BA)
- Long NAV for media reservation with CF-End for NAV release
- Transmit Opportunity (TXOP) Short Inter-Frame Space (SIFS) bursting for higher multimedia bandwidth
- WiFi Direct supports wireless peer to peer applications.
- WiFi NAN (Neighborhood Area Network) support
- PHY-level spoofing to enhance legacy compatibility
- Channel management and co-existence
- Multiple BSSID feature allows the RTL8821CU-CG to assume multiple MAC identities when used as a wireless bridge
- WiFi FTM (Fine Time Measurement) supported
- WiFi TDLS (Tunneled Direct Link Setup) Supported

Other Features

- Supports Wake-On-WLAN via Magic
- Support Network List Offload

Packet and Wake-up frame
- Transmit Beamforming
- Support S3/S4 AES/TKIP group key update
- CCA on secondary through RTS/CTS handshake.
- Support TCP/UDP/IP checksum offload

Peripheral Interfaces

- Up to 15 General Purpose Input/Output pins
- Three configurable LED pins (mux with GPIO pins)
- Generates 40MHz clock for peripheral chip.
- Single external power source 3.3V only

PHY Features

- IEEE 802.11ac OFDM
- IEEE 802.11n OFDM
- One Transmit and One Receive path
- 5MHz / 10MHz / 20MHz / 40MHz / 80MHz bandwidth transmission
- Support 2.4GHz and 5GHz band channels
- Short Guard Interval (400ns)
- Sounding packet.
- DSSS with DBPSK and DQPSK, CCK modulation with long and short preamble
- OFDM with BPSK, QPSK, 16QAM, 64QAM and 256QAM modulation. Convolutional Coding Rate: 1/2, 2/3, 3/4, and 5/6
- Maximum data rate 54Mbps in 802.11g, 150Mbps in 802.11n and 433.3bps in 802.11ac.
- Switch diversity used for DSSS/CCK
- Support STBC Receiving
- Support LDPC Transmitting
- Hardware antenna diversity
- Fast receiver Automatic Gain Control (AGC)
- On-chip ADC and DAC
- Build-in both 2.4GHz and 5GHz PA
- Build-in both 2.4GHz and 5GHz LNA

Bluetooth Controller

- Compatible with Bluetooth 2.1+EDR
- Support Bluetooth 4.2 system
- Integrated MCU to execute Bluetooth protocol stack
- Supports all packet types in basic rate and enhanced data rate
- Supports piconets in a scatternet
- Supports Secure Simple Pairing
- Supports Low Power Mode (Sniff/Sniff Sub-rating)
- Enhanced BT/WIFI Coexistence Control to improve transmission quality in different profiles
- Bluetooth 4.0 Dual Mode support: Simultaneous LE and BR/EDR
- Supports multiple Low Energy states

Bluetooth Transceiver

- Fast AGC control to improve receiving dynamic range
- Supports AFH to dynamically detect channel quality to improve transmission quality
- Integrated internal Class 1, Class 2, and Class 3 PA
- Supports Enhanced Power Control
- Supports Bluetooth Low Energy
- Integrated 32K oscillator for power management

3.General Specification

Model	RL-EM02G-8821CE-V1.1
PCB Version	RL-EM02G-8821CE-V1.0
Product Name	802.11a/b/g/n/ac PCIE module
Major Chipset	Realtek RTL8821CE-VL-CG
Standard	WIFI: 802.11a/b/g/n/ac/e/i/h BT : V2.1+ EDR and V4.2, For BR/EDR,V4.0BLE
Bus Interface	WiFi：PCIE BT: USB2.0
Modulation Method	DSSS,DBPSK, DQPSK, CCK and OFDM (BPSK, QPSK, 16QAM, 64QAM and 256-QAM)
Frequency Band	2.4GHz ~ 2.472GHz 5.15GHz ~ 5.25GHz 5.725GHz~5.85GHz
Operating Channel	WiFi 2.4GHz: 11: (Ch. 1-11) – United States

	13: (Ch. 1-13) – Europe BT 2.4GHz: Ch. 0 ~78
OS Support	Linux/Android/Windows32,64
Security	WMM, WPA, WPA2
Operating Temperature	0 ~ +60° C ambient temperature
Storage Temperature	-20 ~ 70°C ambient temperature
Humidity	5 to 90 % maximum (non-condensing)
Dimension	16.0x 12,.0 x 1.75mm (LxWxH) ±0.2MM

4.DC Characteristics

1） Power Supply Characteristics

Symbol	**Parameter**	**Minimum**	**Typical**	**Maximum**	**Units**
VDD33	3.3V I/O Supply Voltage	3.0	3.3	3.6	V
VD10	1.05V Core Supply Voltage	0.945	1.05	1.155	V

2) DC Characteristics

Module	Voltage	Current Consumption (linking)
RL-EM02G-8821CE-V1.1	2.4G	(Power consumption when surfing the internet or watching a movie)
	5G	(Power consumption when surfing the internet or watching a movie)

5.Electrical Specifications

1)RF Characteristics for IEEE802.11b (11Mbps mode unless otherwise specified)

Items	Contents			
Specification	IEEE802.11b			
Mode	CCK 11 Mbps			
Channel frequency	2412 ~ 2472 MHz (Ch. 1-11) – United States,13: (Ch. 1-13) – Europe			
RX (per≤85 dBm@8%)	-85 dBm			
TX Characteristics	Min.	Typ.	Max.	Unit
Power Level (±2 dBm)		15		dBm
EVM (≤-18)		-18		dB

2) RF Characteristics for IEEE802.11g (54Mbps mode unless otherwise specified)

Items	Contents

Specification	IEEE802.11g			
Mode	OFDM 54 Mbps			
Channel frequency	2412 ~ 2472 MHz (Ch. 1-11) – United States,13: (Ch. 1-13) – Europe)			
RX (per≤70 dBm@10%)	-70 dBm			
TX Characteristics	Min.	Typ.	Max.	Unit
Power Level (±2 dBm)		14		dBm
EVM (≤-25)		-25		dB

3) RF Characteristics for IEEE802.11n (BW20_MCS7)

Items	Contents			
Specification	IEEE802.11n (BW20_MCS7)			
Mode	OFDM 65 Mbps			
Channel frequency	2412 ~ 2472 MHz (Ch. 1-11) – United States,13: (Ch. 1-13) – Europe			
RX (per≤65 dBm@10%)	-65 dBm			
TX Characteristics	Min.	Typ.	Max.	Unit
Power Level (±2 dBm)		13		dBm
EVM (≤-28)		-28		dB

4) RF Characteristics for IEEE802.11n (BW40_MCS7)

Items	Contents			
Specification	IEEE802.11n (BW40_MCS7)			
Mode	OFDM 135 Mbps			
Channel frequency	2422 ~ 2462 MHz (Ch. 3-9) – United States,13: (Ch. 3-11) – Europe			
RX (per≤65 dBm@10%)	-65 dBm			
TX Characteristics	Min.	Typ.	Max.	Unit
Power Level (±2 dBm)		12		dBm
EVM (≤-28)		-28		dB

5) RF Characteristics for IEEE802.11A (54 Mbps)

Items	Contents			
Specification	IEEE802.11A (54 Mbps)			
Channel frequency	5.15GHz ~ 5.25GHz 5.725GHz~5.85GHz			
RX (per≤68 dBm@10%)	-70 dBm			
Freq.Error(±10ppm)	±10ppm			
TX Characteristics	Min.	Typ.	Max.	Unit
Power Level (±2 dBm)		14		dBm
EVM (≤-25)		-25		dB

6) RF Characteristics for IEEE802.11N (BW20_MCS7)

Items	Contents			
Specification	IEEE802.11n (BW20_MCS7)			
Channel frequency	5.15GHz ~ 5.25GHz 5.725GHz~5.85GHz			
RX (per≤63 dBm@10%)	-65 dBm			
Freq.Error(±10ppm)	±10ppm			
TX Characteristics	Min.	Typ.	Max.	Unit
Power Level (±2 dBm)		13		dBm

EVM (≤-28)		-28		dB

7) RF Characteristics for IEEE802.11n (BW40_MCS7)

Items	Contents			
Specification	IEEE802.11n (BW40_MCS7)			
Channel frequency	5.15GHz ~ 5.25GHz 5.725GHz~5.85GHz			
RX (per≤63 dBm@10%)	-63dBm			
Freq.Error(±10ppm)	±10ppm			
TX Characteristics	Min.	Typ.	Max.	Unit
Power Level (±2 dBm)		12		dBm
EVM (≤-28)		-28		dB

8) RF Characteristics for IEEE802.11ac (BW80_MCS9)

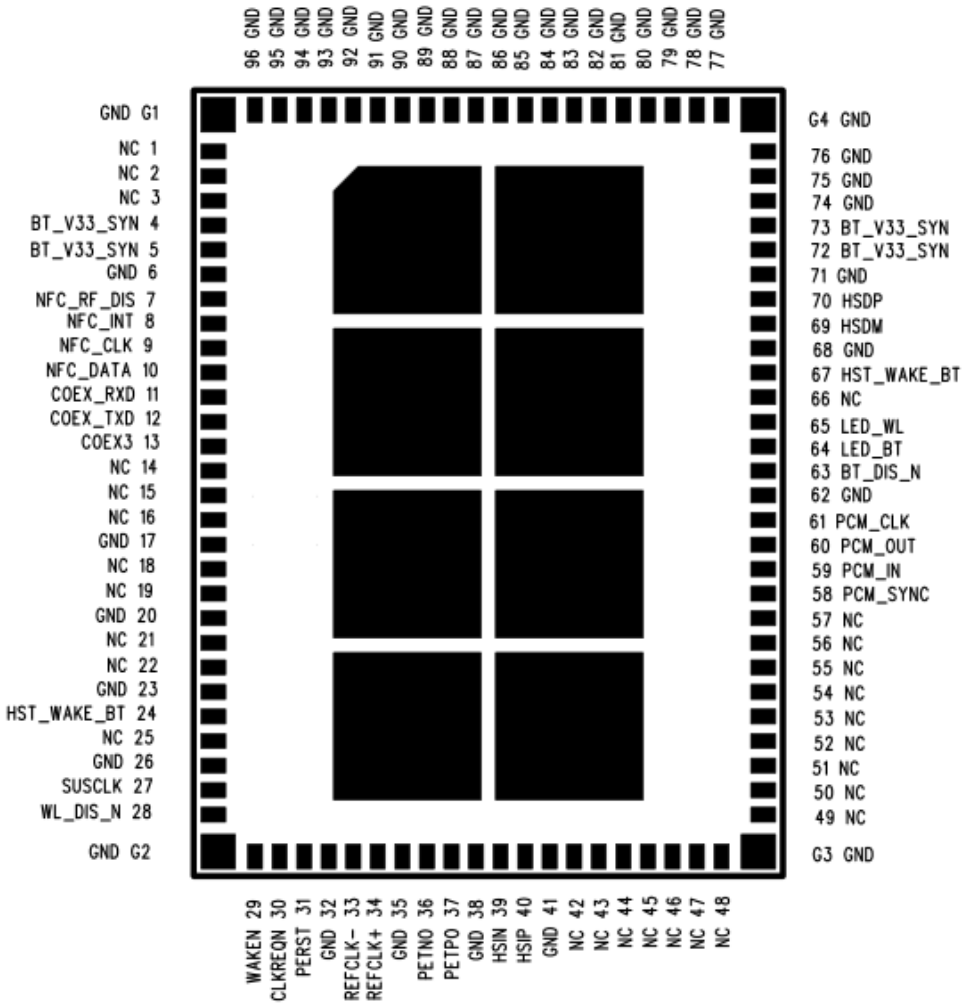
Items	Contents			
Specification	IEEE802.11ac (BW80_MCS9)			
Channel frequency	5.15GHz ~ 5.25GHz 5.725GHz~5.85GHz			
RX (per≤56dBm@10%)	-57 dBm			
Freq.Error(±10ppm)	±10ppm			
TX Characteristics	Min.	Typ.	Max.	Unit
Power Level (±2 dBm)		10		dBm
EVM (≤-32)		-32		dB

6.Bluetooth Specification

Feature	Description		
General Specification			
Bluetooth Standard	Bluetooth V3.3 of 1, 2 and 3 Mbps.		
Host Interface	USB 2.0		
Antenna Reference	Small antennas with 0~2 dBi peak gain		
Frequency Band	2.400 GHz ~ 2483.5 GHz		
Number of Channels	79 channels		
Modulation	FHSS, GFSK, DPSK, DQPSK		
RF Specification			
	Min	Typical	Max
Output Power (Class 1.5)	-6	8	10
Output Power (Class 2)		2	
Sensitivity @ BER=0.1% for GFSK (1Mbps)		-89	
Sensitivity @ BER=0.01% for π/4-DQPSK (2Mbps)		-85	
Sensitivity @ BER=0.01% for 8DPSK		-83	

(3Mbps)			
Maximum Input Level	GFSK (1Mbps):-20dBm		
	π/4-DQPSK (2Mbps) :-20dBm		
	8DPSK (3Mbps) :-20dBm		

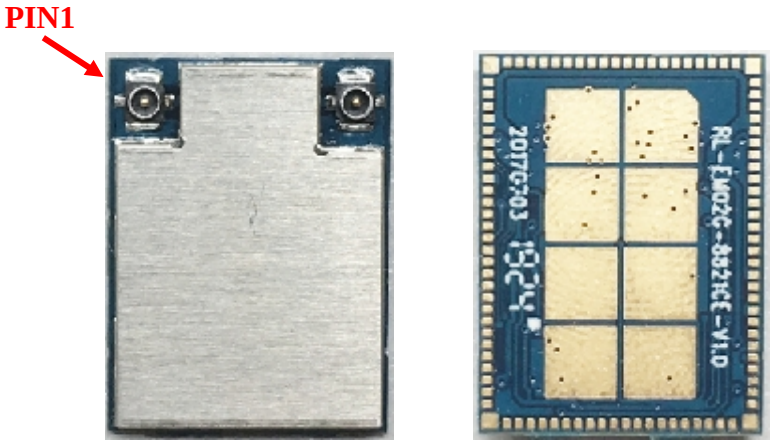
7. Pin Definition



Pin	Definition	Description
G1	GND	Ground
1	NC	NC
2~3	NC	NC
4	VDD33	3.3V
5	VDD33	3.3V

6	GND	Ground
7	NFC_RF_DIS	NC
8	NFC_INT	NC
9	NFC_CLK	NC
10	NFC_DATA	NC
11	COEX_RXD	GPIO6
12	COEX_TXD	GPIO12
13	COEX3	GPIO7
14~16	NC	NC
17	GND	Ground
18~19	NC	NC
20	GND	Ground
21~22	NC	NC
23	GND	Ground
24	HST_WAKE_DEV	GPIO13
25	NC	NC
26	GND	GND
27	SUSCLK	Shared with EECS. External 32K or RTC clock input
28	WL_DIS_N	GPIO9
G2	GND	Ground
29	WAKE_N	GPIO
30	CLKREQ	GPIO
31	PERSTB	PCI Express Reset Signal: active low. When the PERST# is asserted at power-on state, the RTL8821CE returns to a pre-defined reset state and is ready for initialization and configuration after the de-assertion of the PERST#.
32	GND	Ground
33	REFCLK_N	PCI Express Differential Reference Clock Source: 100MHz±300ppm
34	REFCLK_P	PCI Express Differential Reference Clock Source: 100MHz±300ppm
35	GND	Ground

36	HSON	PCI Express Transmit Differential Pair
37	HSOP	PCI Express Transmit Differential Pair
38	GND	Ground
39	HSIN	PCI Express Receive Differential Pair
40	HSIP	PCI Express Receive Differential Pair
41	GND	Ground
42~48	NC	NC
G3	GND	Ground
49~56	NC	NC
57	GND	Ground
58	PCM_SYNC	GPIO2
59	PCM_IN	GPIO0
60	PCM_OUT	GPIO1
61	PCM_CLK	GPIO3
62	GND	Ground
63	BT_DIS	GPIO11
64	BT_LED	LED1
65	WL_LED	LED2
66	NC	NC
67	HOST_WAKE_BT	GPIO13
68	GND	Ground
69	HSDM	High-Speed USB D- Signal
70	HSDP	High-Speed USB D+ Signal
71	GND	GND
72	VDD33	3.3V
73	VDD33	3.3V
74~76	GND	Ground
G4	GND	Ground
77~96	GND	Ground



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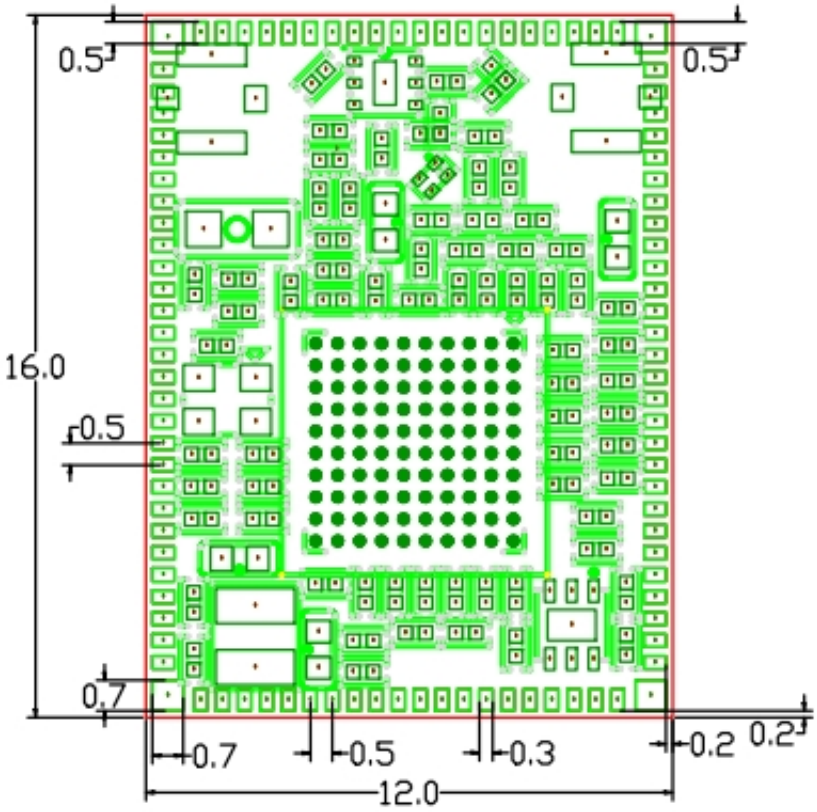
8. Size reference

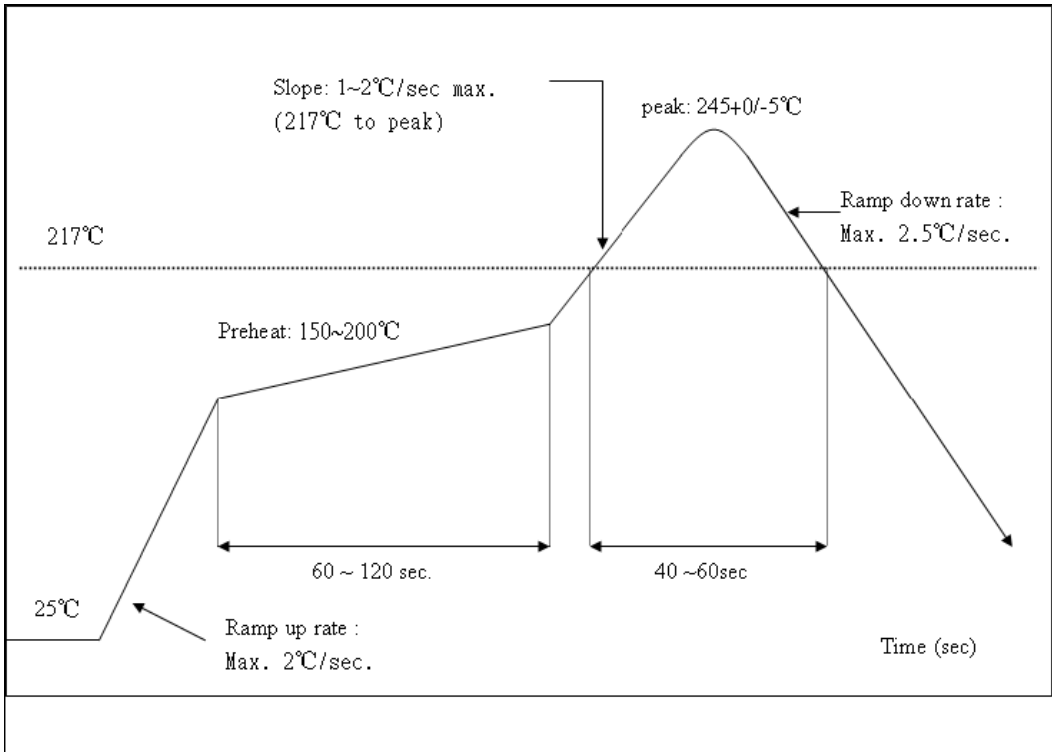
Dimensions (mm)	Length	Width	Height
	16.0	12.0	1.75
	(Tolerance:±0.2mm)	**(Tolerance:±0.2mm)**	**(Tolerance:±0.2mm)**



The PCB tolerances within + / -0.2 or so

9.Recommended Reflow Profile

Referred to IPC/JEDEC standard.
Peak Temperature : <250°C
Number of Times : ≤2 times



ENVIRONMENTAL

Operating

Operating Temperature: 0°C to +60 °C
Relative Humidity: 5-90% (non-condensing)

Storage

Temperature: -20°C to +70°C (non-operating)
Relevant Humidity: 5-95% (non-condensing)

10. RoHS compliance.

This product is RoHS compliance.

12.Wireless module before the SMT note:

1.When customers Open stencil must be sure the hole bigger to the Wireless module plate, please press 1 to 1 and 0.7 mm is widened to open outward, the thickness of 0.12 mm.

2.Can't get the wifi module bare hands when needs,must we wear the gloves and static ring.

3.The furnace temperature according to the size of the customer the mainboard ,generally like to stick on a tablet standard temperature of 250 + - 5,can do 260 + - 5.

Storage and use Wifi module control should pay attention to the following matters:

1.Module of the storage life of vacuum packaging:

1-1.Storage life：12 months. Storage conditions:<40℃. Relative humidity:<90%R.H.

1-2.After this bag is opened , devices that will be subjected to infrared reflow, vWIFIor-phase reflow, or equivalent processing must be :

1-3.Check the humidity card :stored at ≦20%RH.If :30%~40%(pink)or greater than 40%(red).Labeling module has moisture absorption.

① Mounthed within 168 hours at factory conditions of: t≦30%℃， ≦60%R.H.

② Once opened, the workshop the preservation of life for 168 hours.

1-4.If baking is required,devices may be baked for:

① Modules must be to remove module moisture problem.

② Baking temperature: 125 ℃, 8 hours.

③ After baking, put proper amount of desiccant to seal packages.

1-5. The actual number of module vacuum packing which is based on the actual number of packages to the customer requirements.

2.Module reel packaging items as follows.

2-1.Storage life：12 months. Storage conditions:<40℃. Relative humidity:<90%R.H.

2-2.Module WIFIart packing after 168 hours，To launch patch need to bake, to remove the module hygroscopic, baking temperature conditions：125℃，8hours.

2-3. The actual number of module reel packing which is based on the actual number of packages to the customer requirements.

3.Module pallet packaging items as follows:

3-1.Storage life：3 months. Storage conditions:<40℃. Relative humidity:<90%R.H.

3-2.Module if not used within 48 hours, before launch the need for baking, baking temperature: 125 ℃, 8 hours.

3-3. Pallet packaging each plate is 100 PCS.The actual number of module pallet packing which is based on the actual number of packages to the customer requirements.

12.Wifi 模块贴片装机前注意事项：

1.客户在开钢网时一定要将 wifi 模块焊盘的孔开大，请按 1 比 1 再向外扩大 0.7mm 比例开钢网，厚度按 0.12mm.

2.有需要拿 wifi 模块时不可以光手去拿，一定要戴上手套以及静电环.

3.过炉温度要根据客户主板的大小而定，一般像平板电脑上的标准温度为250+-5°，也可以做到260+-5°

Wifi 模块储存及使用管制应注意事项如下：

1.模块的真空包装之储存期限：

1-1.保存期限：12个月，储存环境条件：温度在：<40℃，相对湿度：<90%R.H.

1-2.模块包装被拆后，SMT 组装之时限：

1-3.检查湿度卡：显示值应小于30%（蓝色），如：30%~40%(粉红色）或者大于40%（红色）表示模块已吸湿气.

① 工厂环境温度湿度管制：≦30%℃，≦60%R.H。

② 拆封后，车间的保存寿命为 168 小时.

1-4.如在拆封后的 168 个小时内未使用完，需要烘烤，烘烤条件如下：

① 模块须重新烘烤，以除去模块吸湿问题.

② 烘烤温度条件：125℃，8 小时.

③ 烘烤后，放入适量的干燥剂再密封包装.

1-5. 模块真空包装数量以客户要求的实际包装数量为准.

2.模块卷盘包装事项如下：

2-1.保存期限：12个月，储存环境条件：温度在：<40℃，相对湿度：<90%R.H.

2-2.模块拆开包装168小时后，如要上线贴片需要重新烘烤，以除去模块吸湿问题，烘烤温度条件：125℃，8小时。

2-3. 模块卷盘包装以客户要求的实际包装数量为准.

3.模块托盘包装事项如下：

3-1.保存期限：3个月，储存环境条件：温度在：<40℃，相对湿度：<90%R.H.

3-2.模块如在 48 小时内未使用，在上线之前需要进行烘烤，烘烤温度条件：125℃，8 小时。

3-3. 托盘包装每盘为 100pcs，模块托盘包装以客户要求的实际包装数量为准.

注：以上包装方式根据客户要求而定，包装以实际出货为准.

FCC warning：

1. This device should be installed and operated with minimum distance 20cm between the radiator&your body.

2. 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.

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

4. 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.

5. The devices must be installed and used in strict accordance with the manufacturer's instructions as described in the user documentation that comes with the product.

Any company of the host device which install this modular should perform the test of radiated emission and spurious emission according to FCC part 15C : 15.247 15.407 and 15.209 requirement, and the module should comply with the KDB file 996369 Module approval, Only if the test result comply with these requirement，then the host can be sold legally.

6. During operation, the separation distance between user and the antenna shall be at least 20cm.

7. The host product shall be properly labelled to identify the modules within the host product. The FCC 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 FCC certification number for the
module, preceded by the word "contains" or similar wording expressing the same meaning, as follows:

Contains FCC ID: 2AGQ3-8821

In this case, 2AGQ3-8821 is the module's certification number.

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

1)The antenna must be installed such that 20 cm is maintained between the antenna and users, and

2)The transmitter module may not be co-located with any other transmitter or antenna.