



# WBUA31

IEEE 802.11 a/b/g/n/ac 2x2 +BT Combo Module

Product Specification 1.0

Approved:	Approved:	Prepared by:
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**Revision History**

Date	Number	Approver	Comments
Jun. 16, 2016	1.0	Mark Hsu	Initial Draft
Aug. 16, 2016	1.1	Mark Hsu	Update Photos

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**TABLE OF CONTENTS**

<b>Revision History</b> .....	<b>1</b>
<b>Chapter 1. Module Overview</b> .....	<b>4</b>
1-1 Key Characteristic .....	4
1-2 LGA Pin Definition .....	5
<b>Chapter 2. Electrical and RF Specificaiton</b> .....	<b>7</b>
2-1 Recommended Operation Rating .....	7
2-2 Power Consumption.....	7
2-3 WiFi RF Specification – TX.....	8
2-4 WiFi RF Specification – RX.....	10
2-5 Bluetooth RF Specification .....	12
2-6 Bluetooth Low Energy RF Specification .....	14
2-7 Antenna Specification Requirment.....	15
<b>Chapter 3. MECHANICAL SPECIFICATION</b> .....	<b>16</b>
3-1 Module Assembly Dimension .....	16
3-2 Label Specification .....	16
<b>Chapter 4. Additional Information</b> .....	<b>17</b>
4-1 Module Photo .....	17
4-2 Environment Specifications .....	17

**Figures:**

Figure 1 Pin Definitions(Module Bottom View) .....5  
 Figure 2 Mechanical Drawing .....16  
 Figure 3 Label Drawing .....16  
 Figure 4 Top Side Photo.....17  
 Figure 5 Bottom Side Photo.....17

**Tables**

Table 1 Pin Definitions .....5  
 Table 2 Operation Rating .....7  
 Table 3 Power Consumption.....7  
 Table 4 IEEE 802.11 b/g/n TX Output Power (WLAN0 & WLAN1) .....8  
 Table 5 IEEE 802.11 a/n/ac TX Output Power (WLAN0 & WLAN1).....9  
 Table 6 IEEE 802.11 b/g/n/ac Rx sensitivity (WLAN0 & WLAN1).....10  
 Table 7 IEEE 802.11 a/n/ac Rx sensitivity (WLAN0 & WLAN1) .....11

## CHAPTER 1. MODULE OVERVIEW

The Foxconn WBUA31 WLAN/BT module contains the Qualcomm Atheros QCA9378 single-chip which is a highly integrated IEEE 802.11 a/b/g/n/ac and Bluetooth 4.1 +HS. It provides a small form-factor solution with minimal external components to drive down cost for

### 1-1 Key Characteristic

- Highly integrated wireless local area network (WLAN) system-on-chip(SoC) for 5GHz 802.11ac, or 2.4/5 GHz 802.11n WLAN applications.
- Bluetooth 4.1 + HS, BLE, ANT+ and be backwards compatible with BT 1.X, 2.X+Enhanced Datarate.
- Concurrent Bluetooth and WLAN operation.
- 20/40 MHz at 2.4GHz and 20/40/80MHz MHz at 5 GHz.
- Reverse direction grant data flow and frame aggregation
- Security : WEP ,WPA ,WPA2, TKIP, AES, CKIP
- QoS-WMM, WMM-PS, WMM-SA
- A full-speed USB 2.0-compliant interface for WLAN and Bluetooth
- Bluetooth SmartAudio® technology improves voice and music quality to headsets
- Bluetooth low-power (BLE) support
- Bluetooth packet loss concealment(PLC)

1-2 LGA Pin Definition

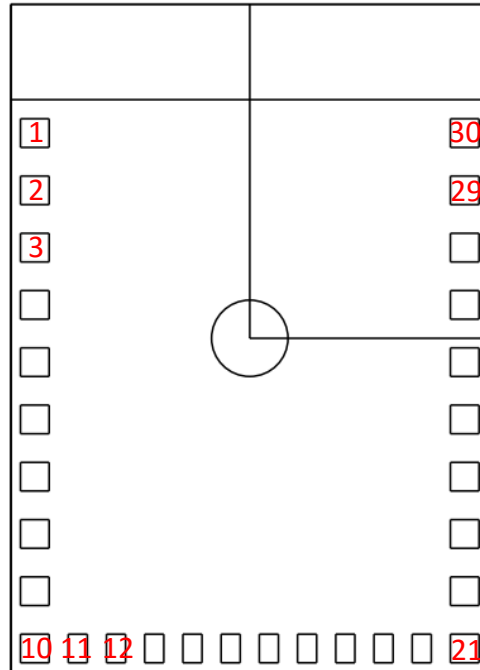


Figure 1 Pin Definitions (Module Bottom View)

Table 1 Pin Definitions

Pin Number	Symbol Name	Type	Pin Description
1	GND	GND	Ground
2	GND	GND	Ground
3	GND	GND	Ground
4	VDD3_3	Power	3.3V
5	GND	GND	Ground
6	GND	GND	Ground
7	BT_Host_Wake	O	Host wake up
8	BT_DEV_WAKE	I	Bluetooth device wake up
9	NC	NC	NC
10	GND	GND	Ground
11	USB_D-	I/O	USB 2.0 D-
12	USB_D+	Power	USB 2.0 D+
13	GND	GND	Ground
14	GND	GND	Ground
15	BT_REG_ON	I	Power-up/Power-Down/Reset Control Signal

<b>16</b>	WL_REG_ON	I	Power-up/Power-Down/Reset Control Signal
<b>17</b>	WLAN_WOW	O	Host wake up
<b>18</b>	NC	NC	NC
<b>19</b>	GND	GND	Ground
<b>20</b>	VDD3_3	Power	3.3V
<b>21</b>	GND	GND	Ground
<b>22</b>	GND	GND	Ground
<b>23</b>	GND	GND	Ground
<b>24</b>	GND	GND	Ground
<b>25</b>	GND	GND	Ground
<b>26</b>	GND	GND	Ground
<b>27</b>	GND	GND	Ground
<b>28</b>	GND	GND	Ground
<b>29</b>	GND	GND	Ground
<b>30</b>	GND	GND	Ground

## CHAPTER 2. ELECTRICAL AND RF SPECIFICATION

### 2-1 Recommended Operation Rating

**Table 2 Operation Rating**

Parameter	Condition	Min	Typ.	Max.	Unit
VDD3_3	3.3V	3.3V	3.3V	3.6V	V
RF Interface	Zo		50		Ohm

### 2-2 Power Consumption

Power consumption is measured using current probe loop on the Power rails of the USB interface (Pins).

**Table 3 Power Consumption**

Description	Typical	Unit
IDLE	150	mA
2G/2T- N mode HT 40MHz MCS 7(14dBm)	450	mA
2G/2T- N mode HT 20MHz MCS 7(14dBm)	510	mA
2G/1T- G mode OFDM54M(15dBm)	320	mA
2G/1T- B mode CCK11M (15dBm)	350	mA
5G/2T- AC mode HT 80MHz MCS 9(7dBm)	460	mA
5G/2T- N mode HT 40MHz MCS 7(10dBm)	560	mA
5G/2T- N mode HT 20MHz MCS 7(11dBm)	490	mA
5G/1T- A mode OFDM54M(12dBm)	300	mA
2G/2R- N mode HT 40MHz MCS 7 (-60dBm)	128	mA
2G/2R- N mode HT 20MHz MCS 7 (-60dBm)	125	mA
2G/1R- G mode OFDM54M (-60dBm)	127	mA
2G/1R- B mode CCK11M (-60dBm)	126	mA
5G/1R- AC mode HT 80MHz MCS 9(-60dBm)	157	mA
5G/2R- N mode HT 40MHz MCS 7(-60dBm)	150	mA
5G/2R- N mode HT 20MHz MCS 7(-60dBm)	147	mA
5G/1R- A mode OFDM54M(-60dBm)	147	mA



## 2-3 WiFi RF Specification – TX

Table 4 IEEE 802.11 b/g/n TX Output Power (WLAN0&amp;WLAN1)

Data Rate (Mbps)	Modulation	Tx Typical Power (dBm)	Data Rate (Mbps)	Modulation	Tx Typical Power (dBm)
1	DBPSK	15	HT20-MCS0	BPSK	14
2	DQPSK	15	HT20-MCS1	BPSK	14
5.5	CCK	15	HT20-MCS2	QPSK	14
11	CCK	15	HT20-MCS3	QPSK	14
6	OFDM	15	HT20-MCS4	16-QAM	14
9	OFDM	15	HT20-MCS5	16-QAM	14
12	OFDM	15	HT20-MCS6	64-QAM	14
18	OFDM	15	HT20-MCS7	64-QAM	14
24	OFDM	15	HT40-MCS0	BPSK	14
36	OFDM	15	HT40-MCS1	QPSK	14
48	OFDM	15	HT40-MCS2	QPSK	14
54	OFDM	15	HT40-MCS3	16-QAM	14
			HT40-MCS4	16-QAM	14
			HT40-MCS5	64-QAM	14
			HT40-MCS6	64-QAM	14
			HT40-MCS7	64-QAM	14

Tolerance : +/- 2dBm

Table 5 IEEE 802.11 a/n/ac TX Output Power(WLAN0&amp;WLAN1)

Data Rate (Mbps)	Modulation	Tx Typical Power (dBm)	Data Rate (Mbps)	Modulation	Tx Typical Power (dBm)
6	OFDM	10	HT20-MCS0	BPSK	11
9	OFDM	10	HT20-MCS1	BPSK	11
12	OFDM	10	HT20-MCS2	QPSK	11
18	OFDM	10	HT20-MCS3	QPSK	11
24	OFDM	10	HT20-MCS4	16-QAM	11
36	OFDM	10	HT20-MCS5	16-QAM	11
48	OFDM	10	HT20-MCS6	64-QAM	11
54	OFDM	10	HT20-MCS7	64-QAM	11
			HT40-MCS0	BPSK	10
			HT40-MCS1	QPSK	10
			HT40-MCS2	QPSK	10
			HT40-MCS3	16-QAM	10
			HT40-MCS4	16-QAM	10
			HT40-MCS5	64-QAM	10
			HT40-MCS6	64-QAM	10
			HT40-MCS7	64-QAM	10
			HT80_MCS0	BPSK	7
			HT80_MCS1	QPSK	7
			HT80_MCS2	QPSK	7
			HT80_MCS3	16-QAM	7
			HT80_MCS4	16-QAM	7
			HT80_MCS5	64-QAM	7
			HT80_MCS6	64-QAM	7
			HT80_MCS7	64-QAM	7
			HT80_MCS8	256-QAM	7
			HT80_MCS9	256-QAM	7

Tolerance : +/- 2dBm

## 2-4 WiFi RF Specification – RX

Table 6 IEEE 802.11 b/g/n RX Sensitivity (WLAN0&amp;WLAN1)

Data Rate (Mbps)	Modulation	Rx Sensitivity (dBm)		Data Rate (Mbps)	Modulation	Rx Sensitivity (dBm)	
		Max.	Typ.			Max.	Typ.
1	DBPSK	-83	-94	HT20-7.22	BPSK	-82	-89.5
2	DQPSK	-80	-93.5	HT20-14.44	QPSK	-79	-87.5
5.5	CCK	-83	-91	HT20-21.67	QPSK	-77	-85.5
11	CCK	-80	-88.5	HT20-28.89	16-QAM	-74	-82.5
6	OFDM	-85	-90	HT20-43.33	16-QAM	-70	-80.5
9	OFDM	-84	-89.5	HT20-57.78	64-QAM	-66	-76
12	OFDM	-82	-89	HT20-65	64-QAM	-65	-75
18	OFDM	-80	-86	HT20-72.22	64-QAM	-64	-73.5
24	OFDM	-77	-83.5	HT40-15	BPSK	-79	-89.5
36	OFDM	-73	-80	HT40-30	QPSK	-76	-86.5
48	OFDM	-69	-76	HT40-45	QPSK	-74	-84
54	OFDM	-68	-74.5	HT40-60	16-QAM	-71	-81
				HT40-90	16-QAM	-67	-78.5
				HT40-120	64-QAM	-63	-74
				HT40-135	64-QAM	-62	-71.5
				HT40-150	64-QAM	-61	-68

Table 7 IEEE 802.11 a/n/ac RX Sensitivity (WLAN0&amp;WLAN1)

Data Rate (Mbps)	Modulation	Rx Sensitivity (dBm)		Data Rate (Mbps)	Modulation	Rx Sensitivity (dBm)	
		Max.	Typ.			Max.	Typ.
6	OFDM	-85	-88	HT20-7.22	BPSK	-82	-88
9	OFDM	-84	-88	HT20-14.44	QPSK	-79	-87
12	OFDM	-82	-86.5	HT20-21.67	QPSK	-77	-85
18	OFDM	-80	-84.5	HT20-28.89	16-QAM	-74	-82
24	OFDM	-77	-82	HT20-43.33	16-QAM	-70	-79
36	OFDM	-73	-78.5	HT20-57.78	64-QAM	-66	-75
48	OFDM	-69	-74.5	HT20-65	64-QAM	-65	-73
54	OFDM	-68	-73	HT20-72.22	64-QAM	-64	-72
				HT40-15	BPSK	-79	-85
				HT40-30	QPSK	-76	-84
				HT40-45	QPSK	-74	-82
				HT40-60	16-QAM	-71	-79
				HT40-90	16-QAM	-67	-75.5
				HT40-120	64-QAM	-63	-71.5
				HT40-135	64-QAM	-62	-70
				HT40-150	64-QAM	-61	-68.5
				HT80_MCS0	BPSK	-76	-87
				HT80_MCS1	QPSK	-73	-83
				HT80_MCS2	QPSK	-71	-81
				HT80_MCS3	16-QAM	-68	-78
				HT80_MCS4	16-QAM	-64	-75
				HT80_MCS5	64-QAM	-60	-70
				HT80_MCS6	64-QAM	-59	-69
				HT80_MCS7	64-QAM	-58	-67
				HT80_MCS8	256-QAM	-53	-62
				HT80_MCS9	256-QAM	-51	-60

## 2-5 Bluetooth RF Specification

Parameter	Condition	Min.	Typ.	Max.	Unit
<b>Basic Data Rate – Transmit Performance</b>					
RF Transmit Power (TRM01)		4	8	12	dBm
Power Density (TRM02)	Per 100kHz	≤20			dBm
Power Control (TRM03)		2 ≤ step size ≤ 8			dB
TX Output Spectrum – Freq. Range (TRM04)	F(low)- CH0	> 2400			MHz
	F(high)-CH78	< 2483.5			
TX Output Spectrum – 20dB BW (TRM05)		f <sub>H</sub> -f <sub>L</sub>   < 1000			MHz
TX Output Spectrum – Adjacent Channel Power (TRM06)	f-f <sub>0</sub>   = 2MHz	≤ -20			dBm
	f-f <sub>0</sub>   ≥ 3MHz	≤ -40			
TX Output Spectrum – Out of Band Spurious Emission	30MHz – 1GHz	≤ -36			dBm
	1GHz -12.75GHz	≤ -30			
	5.15GHz -5.35GHz	≤ -47			
	5.725GHz-5.825GHz	≤ -47			
Modulation Characteristic (TRM07)	Delta f1 avg	140 ≤ Δf <sub>1-avg</sub> ≤ 175			kHz
	Delta f2 max	≥ 115 at 99.9%			
	Delta f2 avg/Delta f1 avg	≥ 0.8			
Initial Carrier Frequency Tolerance (TRM08)		≤ ± 75			kHz
Carrier Frequency Drift (TRM09)	DH1	≤ ± 25			kHz
	DH3	≤ ± 40			
	DH5	≤ ± 40			
Maximum Drift Rate (TRM09)		20 kHz/50 us			
<b>Enhanced Data Rate – Transmit Performance</b>					
RF Transmit Power	π/4 DQPSK	1	5	9	dBm
	8DPSK	1	5	9	
Relative Transmit Power (TRM10)	All pairs	(P <sub>GFSK</sub> -4 dB) < P <sub>DPSK</sub> < (P <sub>GFSK</sub> +1 dB)			
Carrier Frequency Stability (TRM11)	All packets	-75 ≤ w <sub>i</sub> ≤ 75			kHz
	All blocks	-75 ≤ (w <sub>0</sub> +w <sub>i</sub> ) ≤ 75			
	All blocks	-10 ≤ w <sub>0</sub> ≤ 10			
Modulation Accuracy – RMS DEVM (TRM11)	π/4 DQPSK	≤ 20			%
	8DPSK	≤ 13			
Modulation Accuracy – Peak DEVM (TRM11)	π/4 DQPSK	≤ 35			
	8DPSK	≤ 25			
Modulation Accuracy – 99% DEVM (TRM11)	π/4 DQPSK	≤ 30			
	8DPSK	≤ 20			
EDR Differential Phase Emissions (TRM12)		≥ 99			%
In-band Spurious Emission (TRM13)	f-f <sub>0</sub>   = 1MHz	≤ -26			dB
	f-f <sub>0</sub>   = 2MHz	≤ -20			dBm
	f-f <sub>0</sub>   ≥ 3MHz	≤ -40			

TX Output Spectrum – Out of Band Spurious Emission	30MHz – 1GHz	$\leq -36$	dBm	
	1GHz -12.75GHz	$\leq -30$		
	5.15GHz -5.35GHz	$\leq -47$		
	5.725GHz-5.825GHz	$\leq -47$		
Enhanced power control (TRM14)	Step Size	$2 \leq \text{Step Size} \leq 8$	dB	
	Difference. Btw. GFSK, $\pi/4$ DQPSK,&8DPSK	$\leq 10$		
<b>Basic Data Rate – Receiver Performance</b>				
Sensitivity at 0.1% BER (RCV01-02)		$\leq -81$	dBm	
C/I Co-Channel interference (RCV03)		$\leq 11$	dB	
C/I Adjacent CH interference (RCV03)	$ f-f_0  = 1\text{MHz}$	$\leq 0$		
	$ f-f_0  = 2\text{MHz}$	$\leq -30$		
	$ f-f_0  \geq 3\text{MHz}$	$\leq -40$		
C/I Image CH interference (RCV03)	$C/I_{\text{image}}$	$\leq -9$		
	$C/I_{\text{image}\pm 1\text{MHz}}$	$\leq -20$		
Out of band Blocking (RCV04)	30MHz – 2000 MHz	-10	dBm	
	2003MHz – 2399MHz	-27		
	2484MHz – 2997MHz	-27		
	3000MHz – 12750MHz	-10		
Intermodulation Performance at $\leq 0.1\%$ BER (RCV05)		-64	dBm	
Maximum input power level		$\geq -20$	dBm	
Spurious Emission		30MHz – 12.75GHz	$\leq -57$	dBm
<b>Enhanced Data Rate – Receiver Performance</b>				
Sensitivity at 0.1% BER (RCV07)	$\pi/4$ DQPSK	$\leq -85$	dBm	
	8DPSK	$\leq -77$		
EDR BER Floor Performance at $\leq 0.0007\%$ BER (RCV08)		-60	dBm	
C/I Co-Channel interference (RCV09)	$\pi/4$ DQPSK	$\leq +13$	dB	
	8DPSK	$\leq +21$		
C/I Adjacent Channel C/I $ f-f_0  = 1\text{MHz}$ (RCV09)	$\pi/4$ DQPSK	$\leq 0$		
	8DPSK	$\leq +5$		
C/I Adjacent Channel C/I $ f-f_0  = 2\text{MHz}$ (RCV09)	$\pi/4$ DQPSK	$\leq -30$		
	8DPSK	$\leq -25$		
C/I Adjacent Channel C/I $ f-f_0  \geq 3\text{MHz}$ (RCV09)	$\pi/4$ DQPSK	$\leq -40$		
	8DPSK	$\leq -33$		
C/I Image Channel $C/I_{\text{image}}$ (RCV09)	$\pi/4$ DQPSK	$\leq -7$		
	8DPSK	$\leq 0$		
C/I Image Channel $C/I_{\text{image}\pm 1\text{MHz}}$ (RCV09)	$\pi/4$ DQPSK	$\leq -20$		
	8DPSK	$\leq -13$		
Maximum input power level (RCV10)		$\geq -20$	dBm	
Spurious Emission		30MHz – 12.75GHz	$\leq -57$	Pass

## 2-6 Bluetooth Low Energy RF Specification

Parameter	Condition	Min.	Typ.	Max.	Unit
<b>Transmit Performance</b>					
RF Transmit Power (TRM-LE01,02)		0	4	8	dBm
In-Band Emission (TRM-LE03,04)	$ f-f_0  = 2\text{MHz}$	$\leq -20$			dBm
	$ f-f_0  \geq 3\text{MHz}$	$\leq -30$			
TX Output Spectrum – Out of Band Spurious Emission	30MHz – 1GHz	$\leq -36$			dBm
	1GHz -12.75GHz	$\leq -30$			
	5.15GHz -5.35GHz	$\leq -47$			
	5.725GHz-5.825GHz	$\leq -47$			
Modulation Characteristic (TRM-LE05)	Delta f1 avg	$225 \leq \Delta f_{1\text{avg}} \leq 275$			kHz
	Delta f2 max	$\geq 185$ at 99.9%			
	Delta f2 avg/Delta f1 avg	$\geq 0.8$			
Carrier Frequency Drift (TRM-LE06,07)	Center frequency	$\leq \pm 150$			kHz
	During any packet	$\leq \pm 50$			
Maximum Drift Rate (TRM-LE06,07)		20 Hz/50 us			
<b>Receiver Performance</b>					
Sensitivity at 30.8% PER(0.1%BER) (RCV-LE01,02)		$\leq -81$			dBm
C/I Co-Channel interference (RCV-LE03)	Co-channel	$\leq 21$			dB
C/I Adjacent CH interference (RCV-LE03)	$ f-f_0  = 1\text{MHz}$	$\leq 15$			
	$ f-f_0  = 2\text{MHz}$	$\leq -17$			
	$ f-f_0  \geq 3\text{MHz}$	$\leq -27$			
C/I Image CH interference (RCV-LE03)	$C/I_{\text{image}}$	$\leq -9$			
	$C/I_{\text{image} \pm 1\text{MHz}}$	$\leq -15$			
Out of band Blocking (RCV-LE04)	30MHz – 2000 MHz	-30			dBm
	2003MHz – 2399MHz	-35			
	2484MHz – 2997MHz	-35			
	3000MHz – 12750MHz	-30			
Intermodulation Performance at $\leq 30.8\%$ ( $\leq 0.1\%$ BER) (RCV-LE05)		-64			dBm
Maximum input power level (RCV-LE06)		$\geq -10$			dBm
PER Report Integrity $50\% \leq \text{PER} \leq 65.4\%$ (RCV-LE07)		-30			dBm
Spurious Emission	30MHz – 12.75GHz	$\leq -57$			dBm

## 2-7 Antenna Specification Requirement

Nominal antenna port impedance specification is 50 ohms for the Foxconn WBUB15.

For regulatory requirements, it is assumed that the antenna gain is:

For WLAN0 & WLAN1(WLAN):

WLAN0→

**Antenna gain for the 2.4GHz band : 2.46 dBi**

**Antenna gain for the 5GHz band : 4.57 dBi**

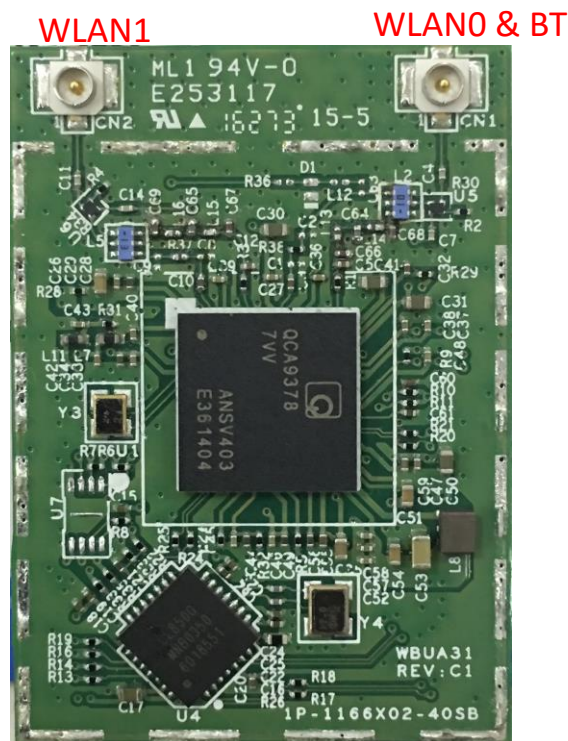
WLAN1→

**Antenna gain for the 2.4GHz band : 3.22 dBi**

**Antenna gain for the 5GHz band : 5.35 dBi**

For Bluetooth:

**Antenna gain for the 2.4GHz band : 0.09 dBi**





# CHAPTER 3. MECHANICAL SPECIFICATION

## 3-1 Module Assembly Dimension

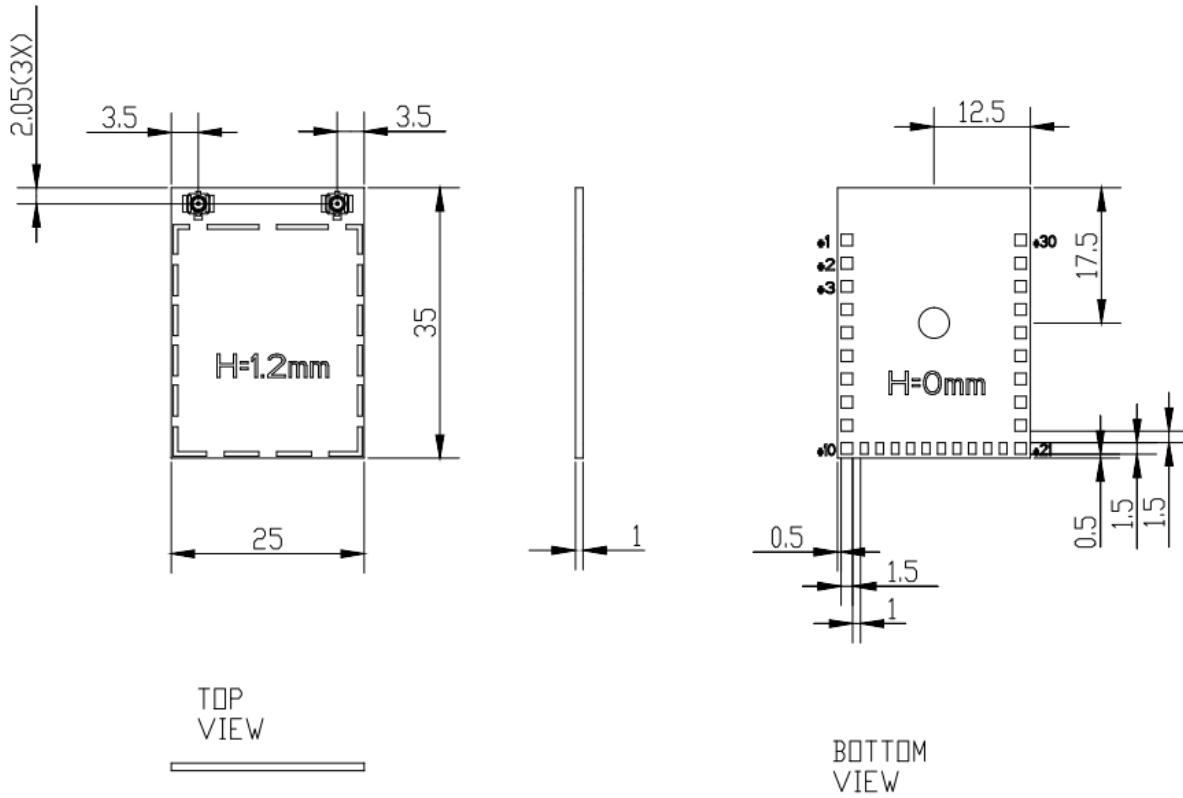


Figure 2 Mechanical Drawing

## 3-2 Label Specification



Figure 3 Label Drawing

# CHAPTER 4. ADDITIONAL INFORMATION

## 4-1 Module Photo

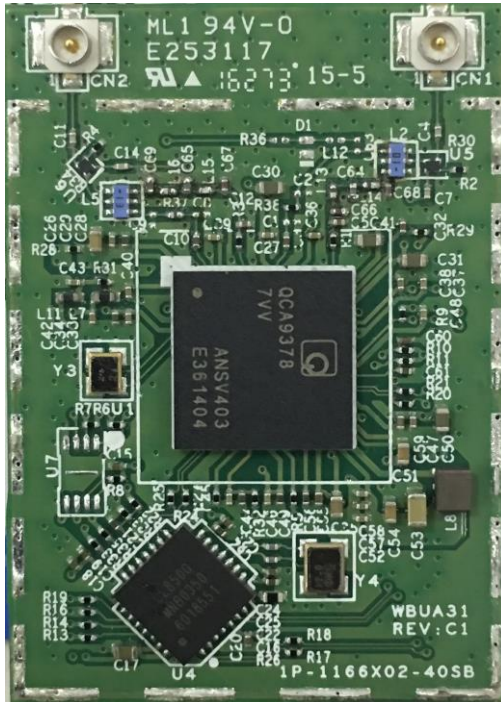


Figure 1 Top Side Photo

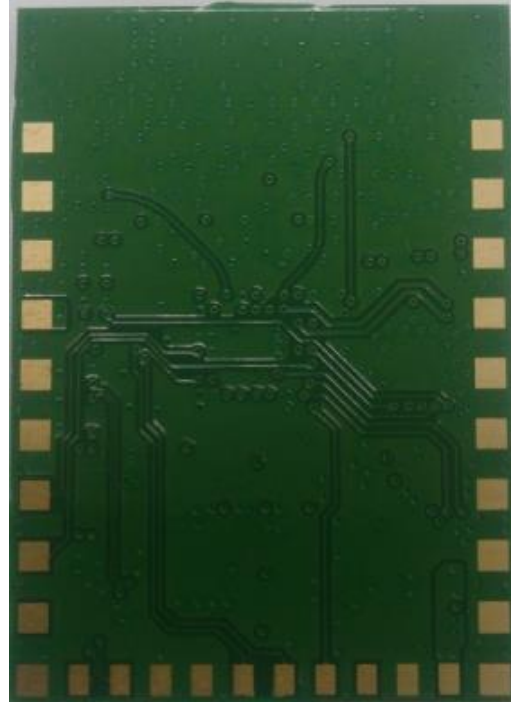


Figure 2 Bottom Side Photo

## 4-2 Environment Specifications

### Operation

Operation Temperature : 0~55 degree  
 Relevant Humidity: 5 ~ 90% (non-condensing)

### Storage

Operation Temperature : 0~55 degree  
 Relevant Humidity: 5 ~ 90% (non-condensing)

## **Federal Communication Commission Interference 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.

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

### ***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.

### ***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.

As long as 2 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

***IMPORTANT NOTE:*** In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for reevaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

***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: RX3-WBUA31". The grantee's FCC ID can be used only when all FCC compliance requirements are met.

***Manual Information To the End User***

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.