AzureWave Technologies, Inc.

AW-CB375NF

IEEE 802.11a/b/g/n/ac Wireless LAN 2T2R and Bluetooth 5.0 Combo Module (M.2 2230)

Datasheet

Rev. A

B2

(For STD)

Features

WLAN

General

- Support 802.11ac 2x2,Wave-2 compliant with MU-MIMO
- Complete 802.11n MIMO solution for 2.4GHz and 5Ghz band
- Maximum PHY data rate up to 173.3 Mbps using 20MHz bandwidth, 400Mbps using 40MHz bandwidth, and 866.7Mbps 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.

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
- Channel management and co-existence
- MIMO power saving mechanism
- PHY-level spoofing to enhance legacy compatibility
- Multiple BSSID feature allows the RTL8822CE-CG to assume multiple MAC identities when used as a wireless bridge
- Transmit Opportunity (TXOP) Short Inter-Frame Space (SIFS) bursting for higher multimedia bandwidth
- WiFi Direct supports wireless peer to peer applications

Other Features

- Supports Wake-On-WLAN via Magic Packet and Wake-up frame
- Transmit Beamforming
- Support S3/S4 AES/TKIP group key update
- Support Network List Offload
- CCA on secondary through RTS/CTS handshake.
- Support TCP/UDP/IP checksum offload

Peripheral Interfaces

- Up to 15 General Purpose Input/Output pins.
- Two configurable LED pins.
- Generates 40MHz clock for peripheral chip.
- Single external power source 3.3V only.

- Crystal frequency support 40MHz

PHY Features

- IEEE 802.11ac MIMO OFDM
- IEEE 802.11n MIMO OFDM
- Two Transmit and Two Receive paths
- 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, and5/6.
- Maximum data rate 54Mbps in 802.11g, 300Mbps in 11n and 866.7Mbps in 802.11ac.
- OFDM / DSSS receive diversity with MRC using up to 2 receive paths. Switch diversity used for CCK.
- Support STBC.
- Support LDPC.
- Hardware antenna diversity.
- Maximum-Likelihod Detection (MLD)
- 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

Bluetooth Controller

- Support Bluetooth 5.0 system
- Compatible with Bluetooth v2.1+EDR
- Integrated MCU to execute Bluetooth protocol stack
- Supports all packet types in basic rate and enhanced data rate
- Supports Secure Simple Pairing
- Enhanced BT/WIFI Coexistence Control to improve transmission quality in different profiles
- Dual Mode support: Simultaneous LE and BR/EDR
- Supports multiple Low Energy states

Bluetooth Transceiver

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

Revision History

Document NO: R2-2375NF-DST-02

Version	Revision Date	DCN NO.	Description	Initials	Approved
Version0.1	2018/11/30		Initial Version	Shihhua Huang	NC Chen
Version0.2	2018/12/10		1. Modify chapter 3.3 info 2. Modify chapter 4.1 info	Shihhua Huang	NC Chen
Version0.3	2019/1/10		1. Update Chapter 1.2 Features 2. Modify block diagram antenna info 3. Modify chapter 1.4 info	Shihhua Huang	NC Chen
Version0.4	2019/12/23		1. Update 5 Packing Information	Dionne Lin	Patrick Lin
A	2020/6/1	DCN016669	● Modify to new format ● Modify chapter 3.3.1 and 3.3.3 info ● Added 3.3.4 BT_DIS Timing Sequence	Shihhua Huang	NC Chen

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1. Introduction

1.1 Product Overview

AzureWave Technologies, Inc. introduces the pioneer of the IEEE 802.11 a/b/g/n/ac WIFI with Bluetooth 5.0 combo M.2 module --- AW-CB375NF. The AW-CB375NF is a highly integrated single-chip that support 2-stream 802.11ac solutions with Multi-user MIMO (Multiple-Input, Multiple-Output) with Wireless LAN (WLAN) PCI Express network interface controller with integrated Bluetooth 5 USB interface controller. It combines a WLAN MAC, a 2T2R capable WLAN baseband, and RF in single chip.

The AW-CB375NF baseband implements Multi-user Multiple Input, Multiple Output (MU-MIMO)Orthogonal Frequency Division Multiplexing (OFDM) with two transmit and two receive paths (2T2R).Features include two spatial stream transmissions, short Guard Interval (GI) of 400ns, spatial spreading, and support for variant channel bandwidth. Moreover, AW-CB375NF provides one spatial stream space-time block code (STBC), Transmit Beamforming (TxBF) and Low Density Parity Check (LDPC) to extend the range of transmission. At the receiver, extended range and good minimum sensitivity is achieved by having receiver diversity up to 2 antennas. As the recipient, the AW-CB375NF 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 866.7Mbps for IEEE 802.11ac MIMO OFDM.

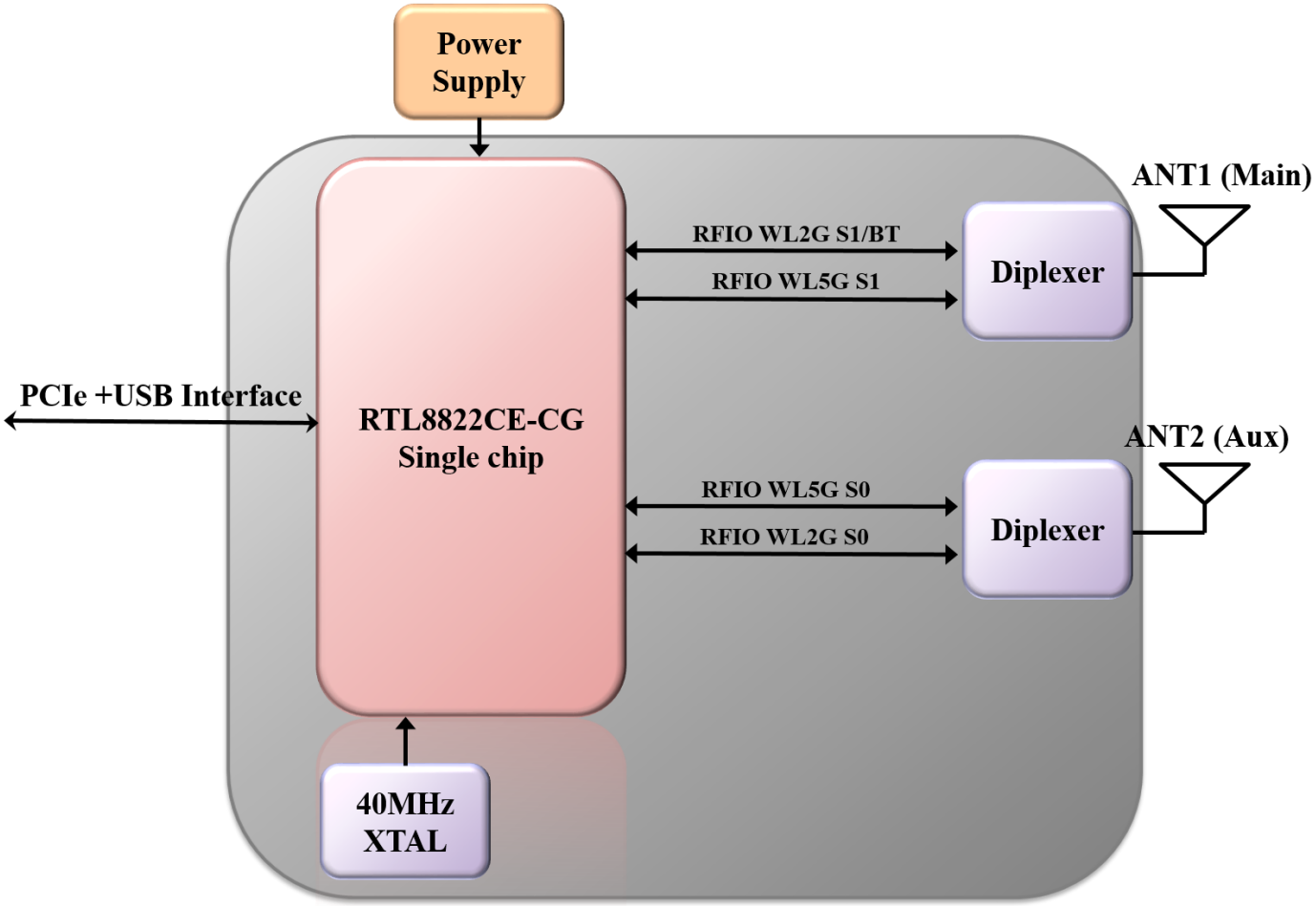
The RTL8822CE-CG builds in an enhanced signal detector, an adaptive frequency domain equalizer, and a soft-decision Viterbi decoder to alleviate severe multi-path effects and mutual interference in the reception of multiple streams. For better detection quality, receive diversity with Maximal-Ratio-Combine (MRC) applying up to two receive paths, and Maximum-Likelihood Detection (MLD) are implemented. 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 RTL8822CE-CG 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 RTL8822CE-CG MAC supports 802.11e for multimedia applications, 802.11i and WAPI 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 MIMO OFDM. The RTL8822CE-CG provides simple legacy, 20MHz/40MHz/80MHz co-existence mechanisms to ensure backward and network compatibility.

1.2 Block Diagram



AW-CB375NF BLOCK DIAGRAM

1.3 Specifications Table

1.3.1 General

Features	Description
Product Description	Wireless LAN & Bluetooth Combo M.2 Module
Major Chipset	RTL8822CE-CG
Host Interface	Wi-Fi: PCI-E; Bluetooth: USB
Dimension	22mm x 30mm x 2.25mm (Tolerance remarked in mechanical drawing)
Package	M.2 2230
Antenna	I-PEX MHF4 Connector Receptacle (20449) ANT1：WiFi/Bluetooth → TX/RX ANT2：WiFi → TX/RX
Weight	2.5g

1.3.2 WLAN

Features	Description
WLAN Standard	IEEE 802.11 a/b/g/n/ac
WLAN VID/PID	10EC/C822
WLAN SVID/SPID	1A3B/3751
Frequency Rage	2.4 GHz：2.412 ~ 2.484 GHz 5 GHz：4.915 ~5.925GHz
Modulation	DSSS, OFDM, DBPSK, DQPSK, CCK, 16-QAM, 64-QAM, 256-QAM
Number of Channels	**2.4GHz** ■ USA, NORTH AMERICA, Canada and Taiwan – 1 ~ 11 ■ China, Australia, Most European Countries – 1 ~ 13 ■ Japan, 1 ~ 14 (CH14 only for 802.11b) **5GHz** ■ USA, EUROPE – 36, 40, 44, 48, 52, 56, 60, 64, 100, 104, 108, 112, 116, 120, 124, 128, 132, 136, 140, 149, 153, 157, 161, 165
Output Power (Board Level Limit)*	**2.4G** 11b (11Mbps): Min 16.5, Typ 18, Max 19, dBm 11g (54Mbps): Min 15.5, Typ 17, Max 18, dBm

<table>
<tr><td></td><td>
<table>
<tr><td>11n (HT20 MCS7)</td><td>14.5</td><td>16</td><td>17</td><td>dBm</td></tr>
<tr><td>11n (HT40 MCS7)</td><td>14.5</td><td>16</td><td>17</td><td>dBm</td></tr>
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5G
<table>
<tr><td></td><td>Min</td><td>Typ</td><td>Max</td><td>Unit</td></tr>
<tr><td>11a (54Mbps)</td><td>15</td><td>17</td><td>18.5</td><td>dBm</td></tr>
<tr><td>11n (HT20 MCS7)</td><td>14</td><td>16</td><td>17.5</td><td>dBm</td></tr>
<tr><td>11n (HT40 MCS7)</td><td>14</td><td>16</td><td>17.5</td><td>dBm</td></tr>
<tr><td>11ac (VHT80 MCS9)</td><td>12</td><td>14</td><td>15.5</td><td>dBm</td></tr>
</table>
</td></tr>
<tr><td>Receiver Sensitivity</td><td>
2.4G
<table>
<tr><td></td><td>Min</td><td>Typ</td><td>Max</td><td>Unit</td></tr>
<tr><td>11b (11Mbps)</td><td></td><td>-82</td><td>-79</td><td>dBm</td></tr>
<tr><td>11g (54Mbps)</td><td></td><td>-68</td><td>-65</td><td>dBm</td></tr>
<tr><td>11n (HT20 MCS7)</td><td></td><td>-67</td><td>-64</td><td>dBm</td></tr>
<tr><td>11n (HT40 MCS7)</td><td></td><td>-64</td><td>-61</td><td>dBm</td></tr>
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5G
<table>
<tr><td></td><td>Min</td><td>Typ</td><td>Max</td><td>Unit</td></tr>
<tr><td>11a (54Mbps)</td><td></td><td>-68</td><td>-65</td><td>dBm</td></tr>
<tr><td>11n (HT20 MCS7)</td><td></td><td>-67</td><td>-64</td><td>dBm</td></tr>
<tr><td>11n (HT40 MCS7)</td><td></td><td>-64</td><td>-61</td><td>dBm</td></tr>
<tr><td>11ac (VHT80 MCS9)</td><td></td><td>-54</td><td>-51</td><td>dBm</td></tr>
</table>
</td></tr>
<tr><td>Data Rate</td><td>WLAN:
802.11b: 1, 2, 5.5, 11Mbps
802.11a/g: 6, 9, 12, 18, 24, 36, 48, 54Mbps
802.11n: up to 150Mbps-single
802.11n: up to 300Mbps-2x2 MIMO
802.11ac:up to 173.3Mbps (20MHz channel)
802.11ac:up to 400Mbps (40MHz channel)
802.11ac:up to 866.7Mbps (80MHz channel)</td></tr>
<tr><td>Security</td><td>WAPI
WEP 64-bit and 128-bit encryption with H/W TKIP processing
WPA/WPA2 (Wi-Fi Protected Access)
AES-CCMP hardware implementation as part of 802.11i security standard</td></tr>
</table>

* If you have any certification questions about output power please contact FAE directly.

1.3.3 Bluetooth

Features	Description
Bluetooth Standard	Bluetooth 2.1 and 3.0+Enhanced Data Rate (EDR) + BT 5.0
Bluetooth VID/PID	13D3/3549

<table>
<tr><td>Frequency Rage</td><td>2402~2480MHz</td></tr>
<tr><td>Modulation</td><td>GFSK (1Mbps), Π/4 DQPSK (2Mbps) and 8DPSK (3Mbps)</td></tr>
<tr><td>Output Power</td><td>
<table>
<tr><th></th><th>Min</th><th>Typ</th><th>Max</th><th>Unit</th></tr>
<tr><td>1M</td><td>2</td><td>4</td><td>6</td><td>dBm</td></tr>
<tr><td>2M</td><td>2</td><td>4</td><td>6</td><td>dBm</td></tr>
<tr><td>3M</td><td>2</td><td>4</td><td>6</td><td>dBm</td></tr>
<tr><td>LE</td><td>2</td><td>4</td><td>6</td><td>dBm</td></tr>
</table>
</td></tr>
<tr><td>Receiver Sensitivity</td><td>
<table>
<tr><th></th><th>Min</th><th>Typ</th><th>Max</th><th>Unit</th><th>Remark</th></tr>
<tr><td>BR</td><td></td><td></td><td>-70</td><td>dBm</td><td><0.1%</td></tr>
<tr><td>EDR</td><td></td><td></td><td>-70</td><td>dBm</td><td><0.007%</td></tr>
<tr><td>LE</td><td></td><td></td><td>-70</td><td>dBm</td><td><30.8%</td></tr>
</table>
</td></tr>
</table>

1.3.4 Operating Conditions

Features	Description
Operating Conditions	
Voltage	Power supply for host:3.3V
Operating Temperature	0~70 ℃
Operating Humidity	less than 85%R.H.
Storage Temperature	-30~85 ℃
Storage Humidity	less than 60%R.H.

2. Pin Definition

2.1 Pin Table

Pin No	Definition	Basic Description	Voltage	Type
1	GND	Ground.		GND
2	3.3V	3.3V power supply	3.3V	VCC
3	USB_D_P	USB Differential signal		I/O
4	3.3V	3.3V power supply	3.3V	VCC
5	USB_D_N	USB Differential signal		I/O
6	LED_WLAN_L	Active low signal. The signal is used to provide status indicators via LED.		Output
7	GND	Ground.		GND
16	LED_BT_L	Active low signal. The signal is used to provide status indicators via LED.		Output
18	GND	Ground.		GND
33	GND	Ground.		GND
35	PERp0	Differential receive.		Input
37	PERn0	Differential receive.		Input
38	BT_WAKE	Host wake BT. No function, please don't connect to this pin.		N/A
39	GND	Ground.		GND
41	PETp0	Differential transmit.		Output
43	PETn0	Differential transmit.		Output
44	NC	Floating Pin, No connect to anything.		Floating
45	GND	Ground.		GND

46	NC	Floating Pin, No connect to anything.		Floating
47	REFCLKP	Differential reference clock.		Input
48	NC	Floating Pin, No connect to anything.		Floating
49	REFCLKN	Differential reference clock.		Input
50	SUSCLK	External 32K or RTC clock input.		input
51	GND	Ground.		GND
52	PERST0	PCI Express Reset Signal: active low. When the PERST# is asserted at power-on state, the RTL8822CE-CG returns to a pre-defined reset state and is ready for initialization and configuration after the de-assertion of the PERST#		Input
53	CLKREQ0	Reference clock request	3.3V	Output
54	BT_DISABLE	BT disable control.	3.3V	Input
55	PEWAKE#	Open Drain active Low signal. This signal is used to request that the system return from a sleep/suspended state to service a function initiated wake event.		OUT
56	W_DISABLE1#	This pin can be defined as the WLAN Radio-off function with host interface remaining connected. When this pin is pulled low, WLAN function will be Radio-off. When this function is not required,external pull high is not required.		IN
57	GND	Ground.		GND
63	GND	Ground.		GND
66	NC	Floating Pin, No connect to anything.		Floating
68	NC	Floating Pin, No connect to anything.		Floating
69	GND	Ground.		GND
70	NC	Floating Pin, No connect to anything.		Floating
72	3.3V	3.3V power supply	3.3V	VCC
74	3.3V	3.3V power supply	3.3V	VCC

75	**GND**	**Ground.**		**GND**
76	**GND**	**Ground.**		**GND**
77	**GND**	**Ground.**		**GND**

3. Electrical Characteristics

3.1 Recommended Operating Conditions

Symbol	Parameter	Minimum	Typical	Maximum	Unit
VD33	I/O voltage	3.0	3.3	3.6	V

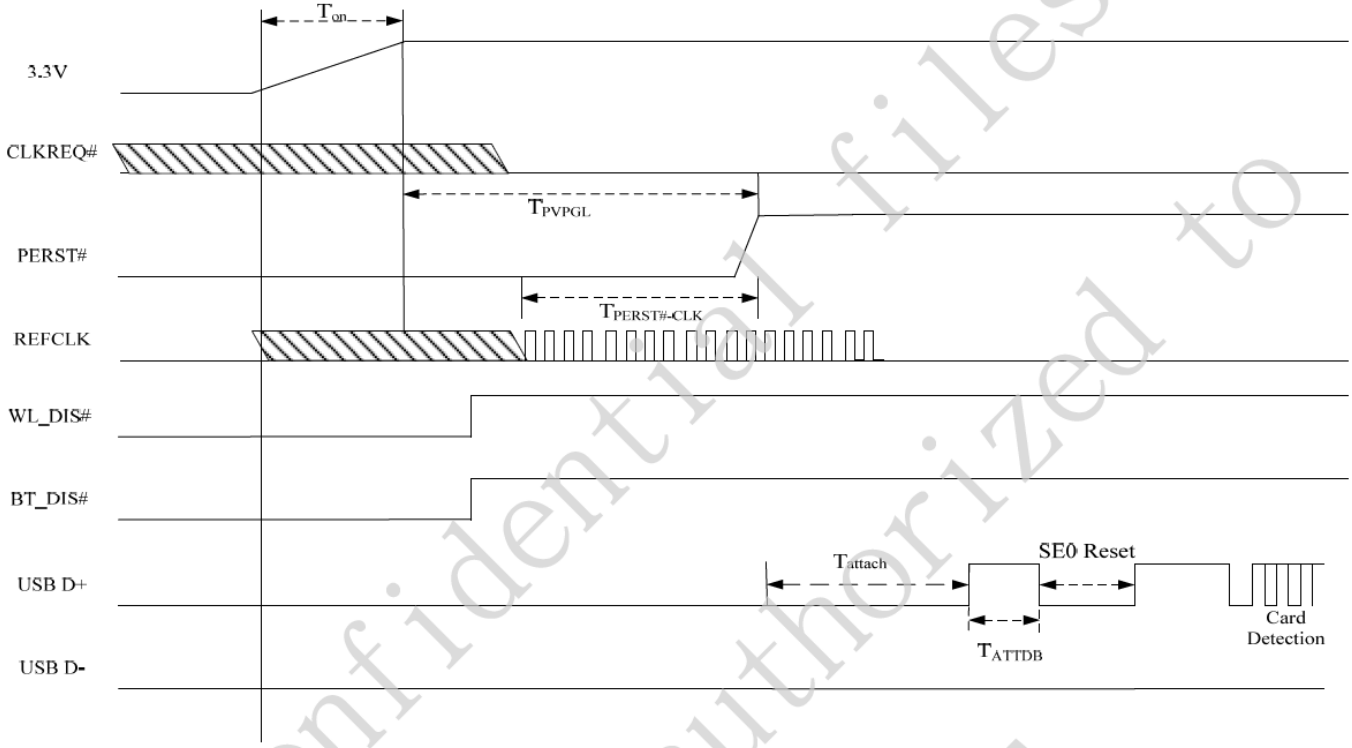
3.2 Digital IO Pin DC Characteristics

Table 1. 3.3V IO DC Characteristics

Symbol	Parameter	Minimum	Typical	Maximum	Unit
V_{IH}	Input high voltage	2.0	3.3	3.6	V
V_{IL}	Input low voltage	--	0	0.9	V
V_{OH}	Output high voltage	2.97	--	3.3	V
V_{OL}	Output low voltage	0	--	0.33	V

3.3 PCIE Interface

3.3.1 Power up Timing Sequence



T_{on}: The main power ramp up duration

T_{PVPGL}: Power valid PERST# input inactive

$T_{PERST\#-CLK}$: Reference clock stable before PERST# inactive

T_{attach}: The interval to turn on BT after PERST# de-asserted

T_{ATTDB}: The debounce interval with a minimal duration of 100ms that provided by the USB system software

$T_{SE0\ Reset}$: USB host send SE0 Reset duration

Table 3. The typical timing range

Symbol	Unit	Min	Typical	Max
T_{on}	ms	0.5	1.5	5
T_{PVPGL}	ms	Implementation specific; recommended 50ms		--
$T_{PERST\#-CLK}$	us	100		--

T_{attach}	ms	0.5	2	5
T_{ATTDB}	ms	100	--	--
$T_{SE0\ Reset}$	ms	10	--	--

3.3.2 PCIE PERST# Timing Sequence

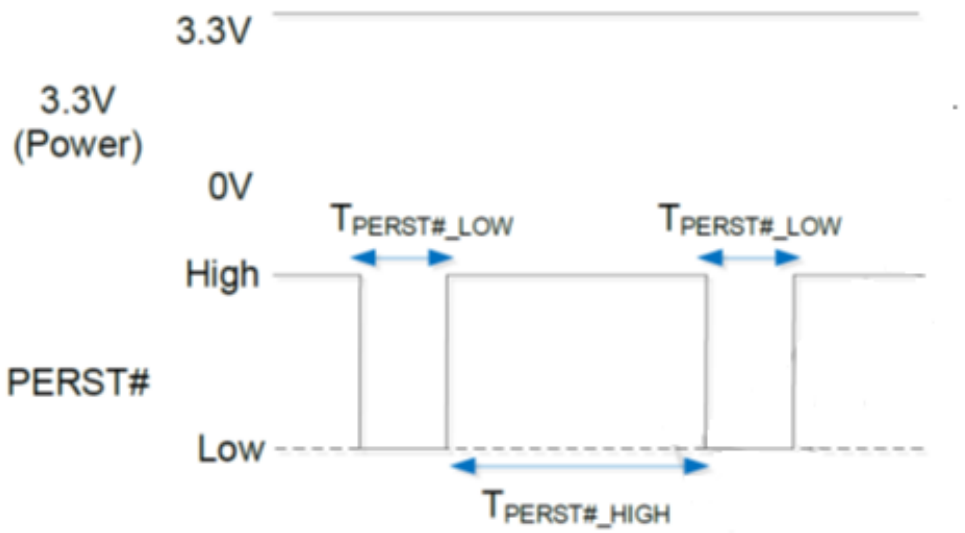


Table 4. PERST# Timing Parameters

	Min	Typical	Max	Unit	Description
$T_{PERST\#\_LOW}$	6	10	X	ms	PERST# low duration
$T_{PERST\#\_HIGH}$	400	500	X	ms	PERST# high duration

3.3.3 PCIE Power Off Sequence

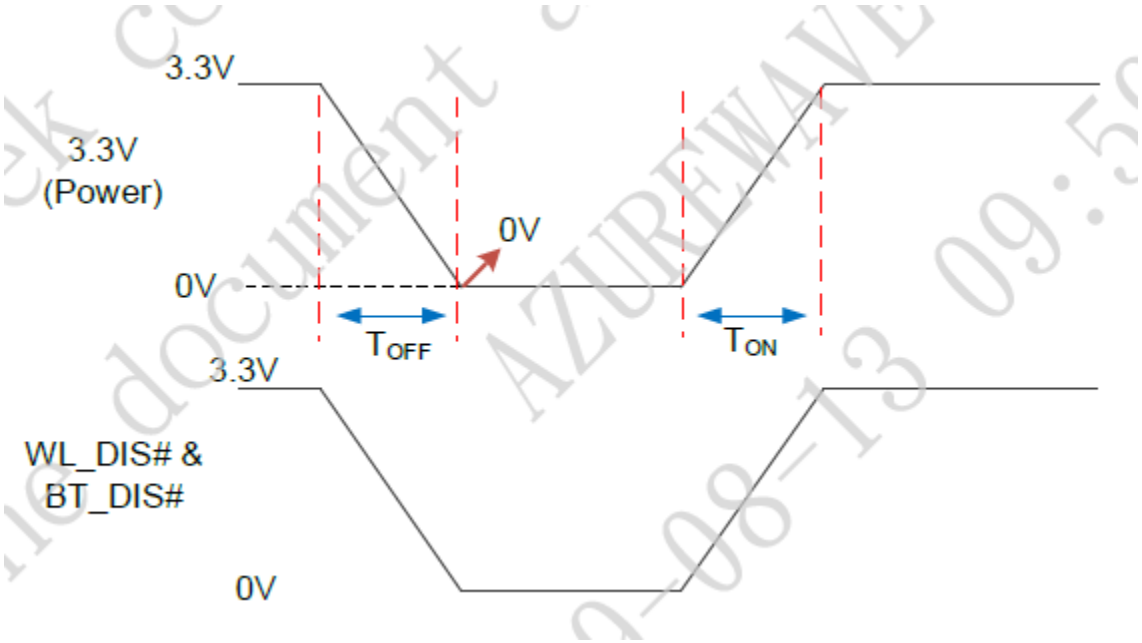
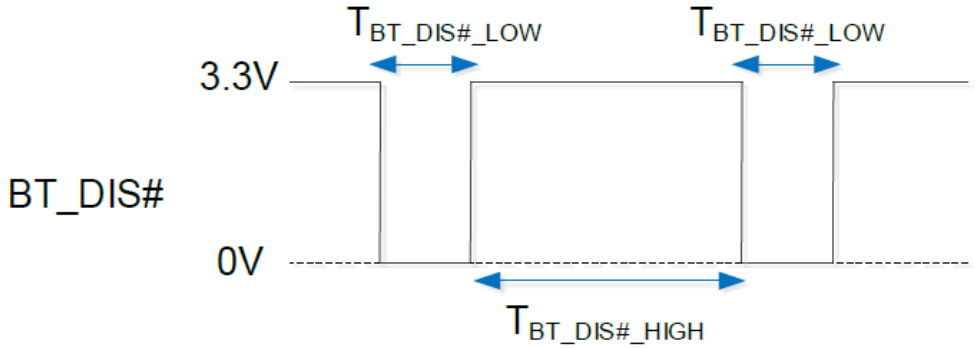


Table 5. PCIE Power Off Timing Parameters

	Min	Typical	Max	Unit	Description
T OFF	5	--	--	ms	Measure point start on 100% Measure point end on 0% (must be 0V)
TON	0.5	1.5	5	ms	Measure point start on 0%(must be 0V) Measure point end on 100%

Note: If BT_DIS# can't connect to the same power source with 3.3V, it need to be de-asserted before PERST# with 100ms in power on sequence.

3.3.4 BT_DIS Timing Sequence



	Min	Typical	Max	Unit	Description
BT_DIS#_LOW	200	--	--	ms	BT_DIS# low duration
BT_DIS#_HIGH	500	--	--	ms	BT_DIS# high duration

3.3.5 Platform State Transitions

Table 6. USB Platform Power Rail Requirements

3.3V Power range	**3.3V Ripple**	**3.3V Noise**	**Rise time**	
			Min	Max
+/- 0.165V	300mVpp@ switching frequency > 1MHz		1ms	5ms

3.4 Power Consumption*

3.4.1 WLAN

Band (GHz)	Mode	BW (MHz)	Link Speed	Voltage=3.3 V			
				Transmit		Receive	
				Max.	Avg.	Max.	Avg.
2.4	802.11b	20	11M	433.3	368.7	321.9	234.2
	802.11n	20	144.5M	672.5	636.3	261.5	247.7
		40	300M	567.2	542.0	269.6	256.3
5	802.11n	20	144.5M	772.5	722.4	264.7	246.0
		40	300M	789.6	716.5	273.4	263.5
	802.11ac	20	173.5M	725.4	693.2	269.0	246.2
		40	400M	739.8	673.2	315.4	290.1
		80	867.0M	703.1	686.2	365.9	348.1

* The power consumption is based on AzureWave test environment, these data for reference only.

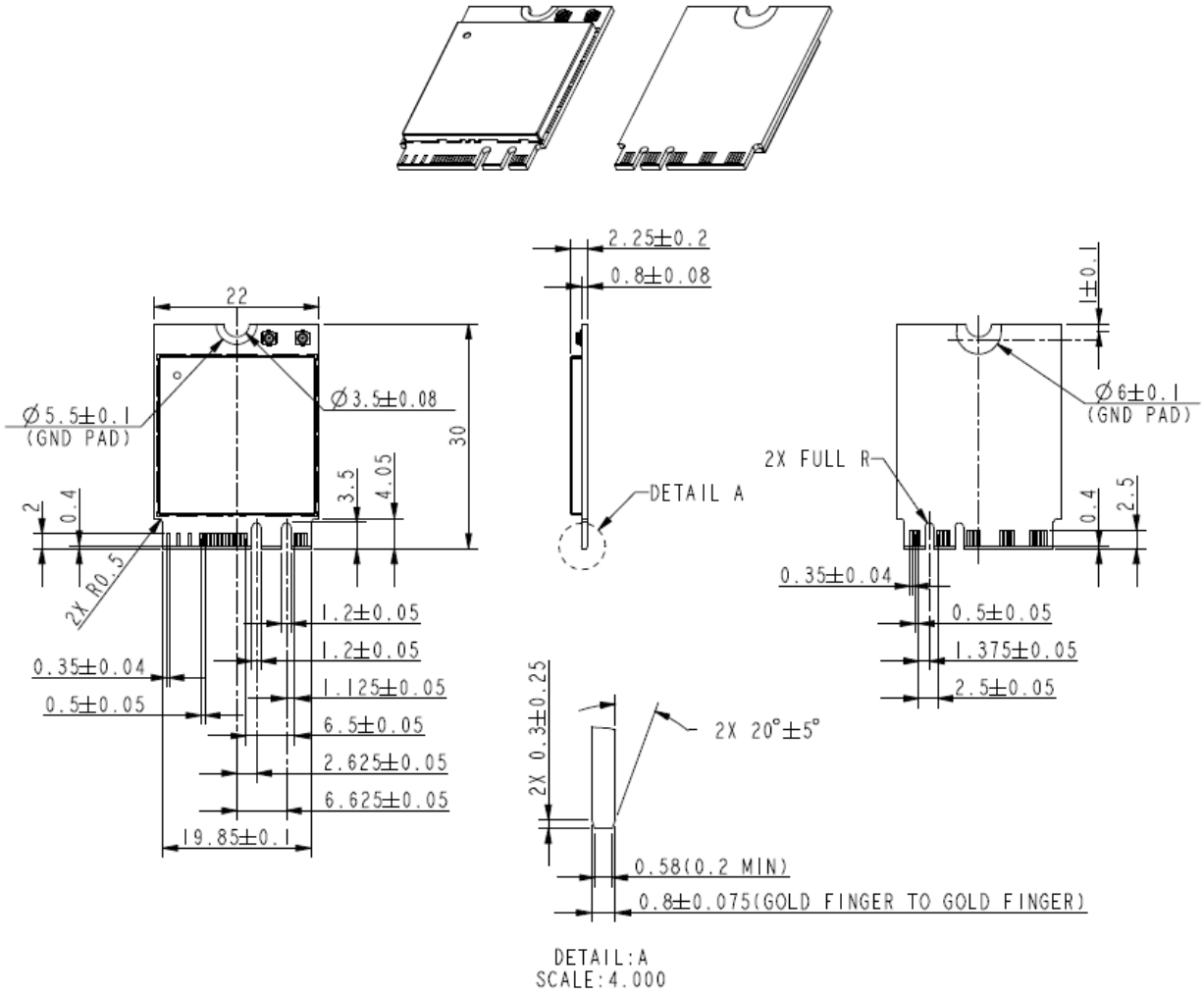
3.4.2 Bluetooth

No.	Mode	Voltage=3.3 V	
		Max.	Avg.
1	No Connection with any BT device	25.1	8.7
2	Connect BT Device	28.9	13.8
3	Transmit by BER 2.1	55.9	45.7
4	Receiver by BER 2.1	35.5	28.7

* The power consumption is based on AzureWave test environment, these data for reference only.

4. Mechanical Information

4.1 Mechanical Drawing



5. Packaging Information

1. Module Photo (模組照片)

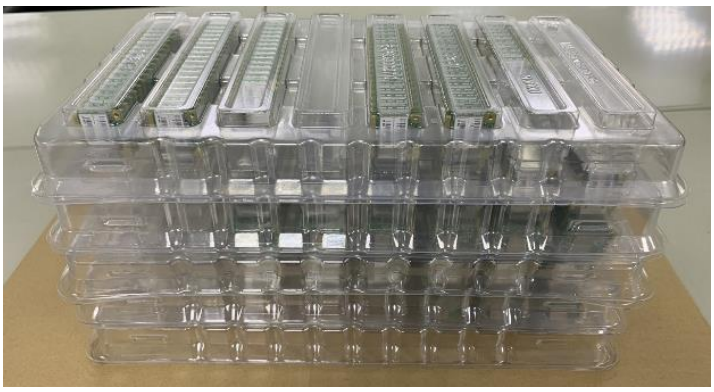
正面 (Front)

背面(Back)

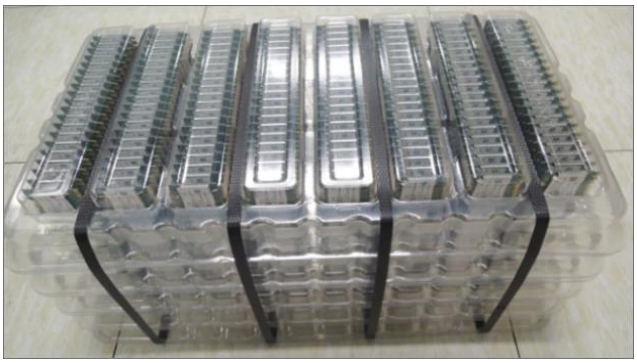
2. 160pcs M.2 2230 modules put in the one bottom tray
(將產品插入 Tray 盤內，金手指端在右側處，天線端在左側處，遮罩蓋面向 Tray 盤上面右下角的箭頭，按照順序（1~160）將產品放入 Tray 盤內，整盤 Tray 可放 160 片產品)

3. One cover tray put on bottom tray
(將 Tray 盤的上蓋蓋上，注意 Cover 的箭頭要與 Tray 盤的箭頭對應)

4. **5pcs tray** (cover + bottom) stacked together
   重複步驟 1 和步驟 2，將 **5 盤**產品疊加起來，注意 **5 盤**產品的 Tray 及 Cover 的箭頭對應在同一個位置



5. Use P.P Strap to pack 5 trays
   (**5 盤**為一疊，用打帶機將 **5 盤**產品打上束線帶)



備註：1pcs Tray 可以裝的產品數量為 160pcs，1pcs 內箱可以裝 5pcs Tray，所以可以裝的產品數量為 800pcs，1 整箱內有 2 內箱共 1600pcs

6. Put packed trays into inner box
   (將捆綁好的產品放入內箱)

7. Seal the inner box by AzureWave tape
(使用海華 Logo 膠帶將內箱進行工字型封箱)

8. One package label pasted in side of inner box
(在內箱的側邊位置處 (如圖) 貼上**包裝單號標籤**)

Example:

9. Two inner boxes put into one carton; If only one inner box has modules, “Empty” label pasted on the other one inner box
(將兩個內箱裝入外箱，內箱開口處一面朝外箱有標識的一面；若只有 1 個內箱產品，需放 1 個空箱做填充並在空內箱上貼附**空箱標籤**)

Example:

10. Seal the carton by AzureWave tape
(使用海華 Logo 膠帶將外箱進行工字型封箱)

11. One carton label and box label pasted on the carton. If the carton is not full, one balance label pasted on the carton
(外箱上貼附**出貨標籤**和**箱號標籤**；如不滿箱，需貼附**尾數標籤**)

Example of carton label (出貨標籤的範例)	AzureWave AzureWave P/N Customer 由業務提供 Customer P/N 由業務提供 Customer PO 由業務提供 Description AW-XXXXXX QTY pcs C/N N.W. G.W. RoHS COMPLIANT
Example of box label (箱號標籤)	BOX0012018
Example of balance label (尾數標籤)	尾 数 Balance