



正基科技股份有限公司

AMPAK Technology Inc.

SPECIFICATION

PRODUCT NAME : AP12276_M2P

REVISION : 0.3(WEB)

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Customer APPROVED	
Company	
Representative Signature	

PREPARED	REVIEW			APPROVED	DCC ISSUE
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正基科技股份有限公司



AP12276_M2P Data Sheet

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Revision

Revision	Date	Description	Revised By
0.1	2022/07/19	Preliminary	Jason Shen
0.2	2023/08/08	Modify General Specification	Jason Shen
0.3	2024/05/16	Update Dimensions	Jason Shen

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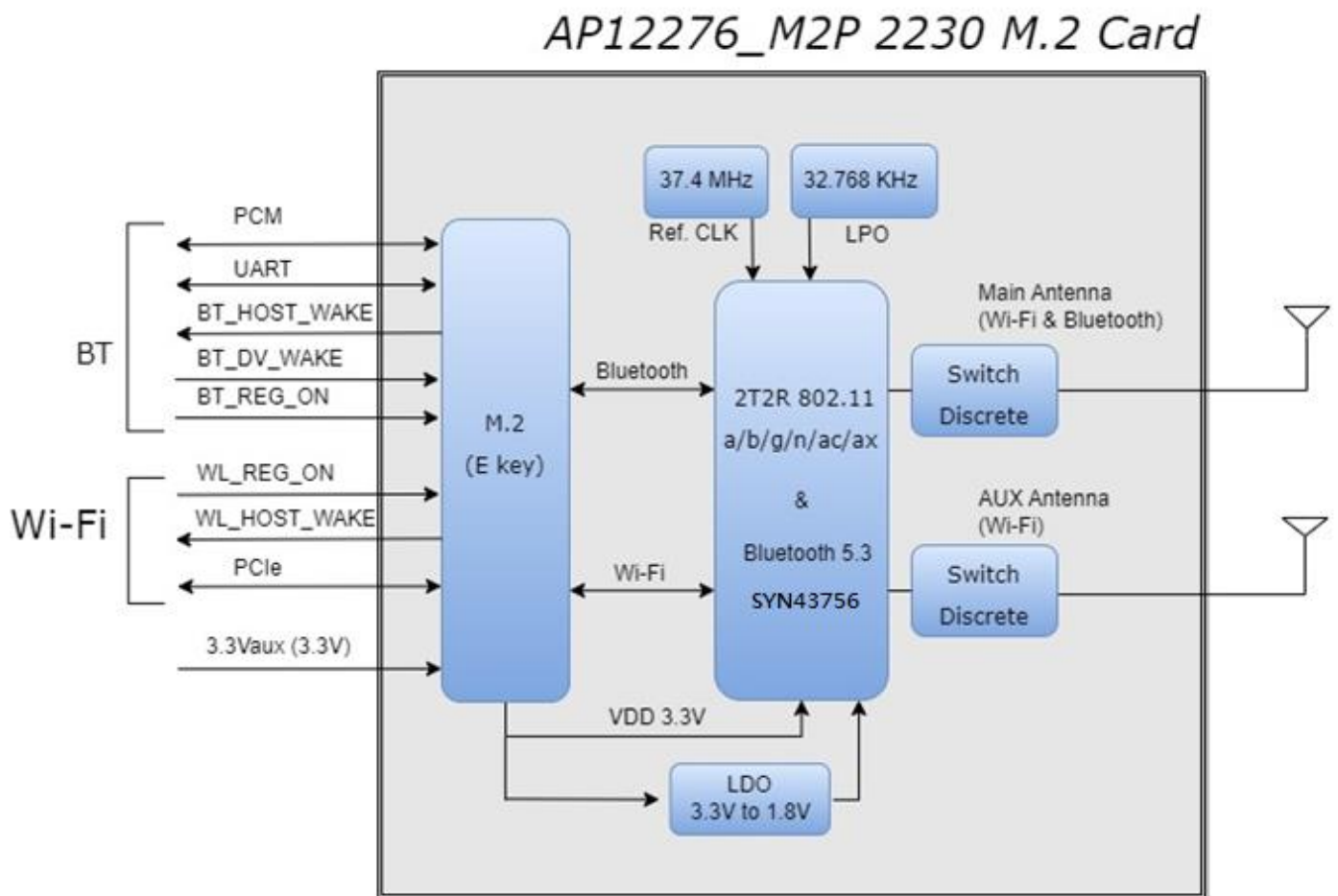


1. Introduction

1.1 Overview

The AMPAK Technology® AP12276_M2P is a fully Wi-Fi 6E(2.4/5/6 GHz) and Bluetooth functionalities 2230 M.2 card (KEY E) with seamless roaming capabilities and advance security, also it could interact with different vendors' 802.11a/b/g/n/ac/ax 2x2 Access Points with MIMO standard and can accomplish up to speed of 1200Mbps with dual stream in 802.11ax to connect the wireless LAN. Furthermore AP12276_M2P included PCIe interface for Wi-Fi, UART/ PCM interface for Bluetooth

In addition, this compact module is a total solution for a combination of Wi-Fi + BT technologies. The module is specifically developed for tablet, OTT box and portable devices.



1.2 Product Features

IEEE 802.11 Key Feature

- Lead Free design which is compliant with ROHS requirements.
- TX and RX low-density parity check (LDPC) support for improved range and power efficiency.
- Dual-stream spatial multiplexing up to 1200 Mbps data rate.
- 20/40/80 MHz channels for 5GHz and 6GHz (U-NII-5 and U-NII-6) radio, and 20MHz channels for 2.4GHz radio.
- Client MU-MIMO.
- Supports 2 antennas with two for shared BT and WLAN port.
 - Supports PCI express revision 3.0 and power management running at Gen1 speeds.

Bluetooth Key Feature

- BT host digital interface:
 - HCI UART (up to 4 Mbps)
 - PCM for audio data
 - Complies with Bluetooth Core Specification Version 5.3 with provisions for supporting future specifications. With Bluetooth Class 1 or Class2 transmitter operation.
 - Supports extended synchronous connections (eSCO), for enhanced voice quality by allowing for retransmission of dropped packets.
 - Adaptive frequency hopping (AFH) for reducing radio frequency interference.
- A simplified block diagram of the module is depicted in the figure above.
- Bluetooth Core Specification Version 5.3, including the following support:
 - Low energy(LE) isochronous channels
 - LE power control
 - LE enhanced connection update
 - LE channel classification
 - LE audio

2. General Specification

2.1 General Specification

Model Name	AP12276_M2P
Product Description	2T2R 802.11 a/b/g/n/ac/ax Wi-Fi + BT 5.3 2230 M.2 card (KEY E)
Dimension	L x W : 30 x 22 mm (typical); H : 3.0 mm (max.)
WiFi Interface	PCI express revision 3.0 at Gen1 speeds
BT Interface	UART / PCM
Operating temperature	-30°C to 85°C
Storage temperature	-40°C to 125°C
Humidity	Operating Humidity 10% to 95% Non-Condensing Storage Humidity 5% to 95% Non-Condensing

Note: The optimal RF performance specified in the data sheet, however, is guaranteed only -10 °C to +55 °C and $3.2V < 3.3V_{aux} < 3.6V$ without derating performance.

2.2 DC Characteristics

2.2.1 Absolute Maximum Ratings

Symbol	Description	Min.	Max.	Unit
3.3Vaux	Input supply voltage	-0.5	4.5	V
WL_REG_ON	Used by PMU to power up or power down the internal regulators used by the WLAN section.	-0.5	4.5	V
BT_REG_ON	Used by PMU to power up or power down the internal regulators used by the Bluetooth section.			
CLKREQ0#	PCIe clock request, active low.			
PCIE_PERST_L	PCIe host indication to reset the device.			
Digital Bus	UART / PCM Bus	-0.5	2.07	V
WL_HOST_WAKE	WLAN device wake-up HOST			
BT_HOST_WAKE	Bluetooth device wake-up HOST			
BT_DEV_WAKE	HOST wake-up Bluetooth device			
PEWAKE0#	PCIe PME Wake, active low.			

Extreme caution must be exercised to prevent electrostatic discharge (ESD) damage.

Symbol	Condition	ESD Rating	Unit
ESD_HAND_HBM	Human body model contact discharge per JEDEC EID/JESD22-A114	1.5	kV
ESD_HAND_CDM	Charged device model contact discharge per JEDEC EIA/JESD22-C101	250	V

2.2.2 Recommended Operating Rating

Voltage rails	Min.	Typ.	Max.	Unit
3.3Vaux	3.0	3.3	3.6	V
WL_REG_ON	3.0	3.3	3.6	V
BT_REG_ON				
CLKREQ0#				
PCIE_PERST_L				
Digital Bus	1.62	1.8	1.98	V
WL_HOST_WAKE				
BT_HOST_WAKE				
BT_DEV_WAKE				
PEWAKE0#				

3.3Vaux current consumption 1200mA(Peak), when 3.3Vaux = 3.3V

I/O Voltage rails @ 1.8V	Min.	Max.	Unit
VIH	1.17	N/A	V
VIL	N/A	0.72	V

I/O Voltage rails @ 3.3V	Min.	Max.	Unit
VIH	2.31	N/A	V
VIL	N/A	0.99	V

3. Wi-Fi RF Specification

3.1 2.4GHz RF Specification

Conditions : 3.3V_{aux}=3.3V ; Temp:25°C

Feature		Description				
WLAN Standard		IEEE 802.11b/g/n/ax & Wi-Fi compliant				
Frequency Range		2.400 GHz ~ 2.4835 GHz (2.4GHz ISM Band)				
Number of Channels		2.4GHz：Ch1 ~ Ch13				
Modulation		802.11b：DQPSK、DBPSK、CCK 802.11 g/n：OFDM /64-QAM、16-QAM、QPSK、BPSK 802.11ax：OFDM /256-QAM、64-QAM、16-QAM、QPSK、BPSK				
Output Power , tolerance ± 1.5 dB						
The transmit EVM quality & spectrum mask are compliant with IEEE 802.11 standard						
802.11b	1Mbps	2Mbps	5.5Mbps	11Mbps		
	19.5	19.5	19.5	19.5		
802.11g	6、9Mbps	12、18Mbps	24Mbps	36Mbps	48Mbps	
	18.5	17.5	17.5	17	17	
	54Mbps					
	17					
802.11n 20MHz	MCS0~2	MCS3	MCS4	MCS5	MCS6	
	18.5	17.5	17.5	17	17	
	MCS7					
	16					
802.11ax 20MHz	HE0~2	HE3	HE4	HE5	HE6	
	18.5	17.5	17.5	17	17	
	HE7	HE8	HE9			
	16	15	14			
802.11ax_20MHz SISO_OFDMA	HE4	26	17.5	HE9	26	14
		52	17.5		52	14
		106	17.5		106	14
		242	17.5		242	14
	HE5	26	17			
		52	17			
		106	17			

Note: The specifications of RF output power are subject to change to fulfill the safety regulation and requirements in end-user product.

Sensitivity, tolerance ± 2 dB				
CCK modulation PER $\leq 8\%$ 、OFDM modulation PER $\leq 10\%$				
802.11b	Data Rate	Spec.(dBm)		
	1Mbps	-98		
	2Mbps	-93		
	5.5Mbps	-91		
	11Mbps	-89		
802.11g SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	6Mbps	-93	24Mbps	-85
	9Mbps	-92	36Mbps	-82
	12Mbps	-91	48Mbps	-78
	18Mbps	-88	54Mbps	-76
802.11g MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	6Mbps	-95	24Mbps	-87
	9Mbps	-94	36Mbps	-84
	12Mbps	-93	48Mbps	-81
	18Mbps	-90	54Mbps	-78
802.11n_20MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0	-93	MCS4	-81
	MCS1	-89	MCS5	-79
	MCS2	-87	MCS6	-76
	MCS3	-84	MCS7	-74
802.11n_20MHz MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0	-93	MCS5	-80
	MCS1	-92	MCS6	-78
	MCS2	-90	MCS7	-76
	MCS3	-87	MCS8	-92
	MCS4	-83	MCS15	-75
802.11ax_20MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	HE0	-92	HE6	-75
	HE1	-88	HE7	-74
	HE2	-86	HE8	-71
	HE3	-83	HE9	-69
	HE4	-80		
	HE5	-77		
802.11ax_20MHz MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	HE0	-93	HE6	-77

802.11ax_20MHz MIMO	HE1	-90	HE7	-76
	HE2	-88	HE8	-73
	HE3	-85	HE9	-71
	HE4	-81		
	HE5	-78		
Maximum Input Level	802.11b : -10 dBm			
	802.11g/n/ax : -20 dBm			

3.2 5GHz RF Specification

Conditions : 3.3V_{aux}=3.3V ; Temp:25°C

Feature		Description			
WLAN Standard		IEEE 802.11a/n/ac/ax & Wi-Fi compliant			
Frequency Range		5.15~5.35GHz 、 5.47~5.725GHz 、 5.725~5.85GHz （5GHz UNII Band）			
Number of Channels		5.15~5.35GHz ： Ch36 ~ Ch64 5.47~5.725GHz ： Ch100 ~ Ch140 5.725~5.85GHz ： Ch149 ~ Ch165			
Modulation		802.11a ： OFDM /64-QAM 、 16-QAM 、 QPSK 、 BPSK 802.11n ： OFDM /64-QAM 、 16-QAM 、 QPSK 、 BPSK 802.11ac ： OFDM /256-QAM 、 OFDM /64-QAM 、 16-QAM 、 QPSK 、 BPSK 802.11ax ： OFDM/ 1024-QAM 、 OFDM /256-QAM 、 OFDM /64-QAM 、 16-QAM 、 QPSK 、 BPSK			
Output Power , tolerance ± 2 dB					
The transmit EVM quality & spectrum mask are compliant with IEEE 802.11 standard					
802.11a	Frequency (MHz)	6~9Mbps	12~18Mbps	24Mbps	36Mbps
	5150~5350	15.5	15.5	15.5	15.5
	5470~5720	15.5	15.5	15.5	15.5
	5725~5845	15.5	15.5	15.5	15.5
	Frequency (MHz)	48Mbps	54Mbps		
	5150~5350	15.5	15.5		
	5470~5720	15.5	15.5		
	5725~5845	15.5	15.5		
802.11n 20MHz	Frequency (MHz)	MCS0~2	MCS3	MCS4	MCS5
	5150~5350	15.5	15.5	15.5	15.5
	5470~5720	15.5	15.5	15.5	15.5
	5725~5845	15.5	15.5	15.5	15.5
	Frequency (MHz)	MCS6	MCS7		
	5150~5350	15.5	14.5		
	5470~5720	15.5	14.5		
	5725~5845	15.5	14.5		

802.11n 40MHz	Frequency (MHz)	MCS0~2	MCS3	MCS4	MCS5
	5150~5350	15.5	15.5	15	15
	5470~5720	15.5	15.5	15	15
	5725~5845	15.5	15.5	15	15
	Frequency (MHz)	MCS6	MCS7		
	5150~5350	14.5	14.5		
	5470~5720	14.5	14.5		
	5725~5845	14.5	14.5		
802.11ac 20MHz	Frequency (MHz)	MCS0~2	MCS3	MCS4	MCS5
	5150~5350	15.5	15.5	15.5	15.5
	5470~5720	15.5	15.5	15.5	15.5
	5725~5845	15.5	15.5	15.5	15.5
	Frequency (MHz)	MCS6	MCS7	MCS8	
	5150~5350	15.5	14.5	12	
	5470~5720	15.5	14.5	12	
	5725~5845	15.5	14.5	12	
802.11ac 40MHz	Frequency (MHz)	MCS0~2	MCS3	MCS4	MCS5
	5150~5350	15.5	15.5	15	15
	5470~5720	15.5	15.5	15	15
	5725~5845	15.5	15.5	15	15
	Frequency (MHz)	MCS6	MCS7	MCS8	MCS9
	5150~5350	14.5	14.5	12	10
	5470~5720	14.5	14.5	12	10
	5725~5845	14.5	14.5	12	10
802.11ac 80MHz	Frequency (MHz)	MCS0~2	MCS3	MCS4	MCS5
	5150~5350	15.5	15	14.5	14.5
	5470~5720	15.5	15	14.5	14.5
	5725~5845	15.5	15	14.5	14.5
	Frequency (MHz)	MCS6	MCS7	MCS8	MCS9
	5150~5350	14	14	10	10
	5470~5720	14	14	10	10
	5725~5845	14	14	10	10

802.11ax 20MHz	Frequency (MHz)	HE0~2	HE3	HE4	HE5
	5150~5350	15.5	15.5	15.5	15.5
	5470~5720	15.5	15.5	15.5	15.5
	5725~5845	15.5	15.5	15.5	15.5
	Frequency (MHz)	HE6	HE7	HE8	HE9
	5150~5350	14.5	14.5	12	12
	5470~5720	14.5	14.5	12	12
	5725~5845	14.5	14.5	12	12
	Frequency (MHz)	HE10	HE11		
	5150~5350	10	10		
	5470~5720	10	10		
	5725~5845	10	10		
802.11ax 40MHz	Frequency (MHz)	HE0~2	HE3	HE4	HE5
	5150~5350	15.5	15.5	15	15
	5470~5720	15.5	15.5	15	15
	5725~5845	15.5	15.5	15	15
	Frequency (MHz)	HE6	HE7	HE8	HE9
	5150~5350	14.5	14.5	12	10
	5470~5720	14.5	14.5	12	10
	5725~5845	14.5	14.5	12	10
	Frequency (MHz)	HE10	HE11		
	5150~5350	8	8		
	5470~5720	8	8		
	5725~5845	8	8		
802.11ax 80MHz	Frequency (MHz)	HE0~2	HE3	HE4	HE5
	5150~5350	15.5	15	14.5	14.5
	5470~5720	15.5	15	14.5	14.5
	5725~5845	15.5	15	14.5	14.5
	Frequency (MHz)	HE6	HE7	HE8	HE9
	5150~5350	14	14	10	10
	5470~5720	14	14	10	10
	5725~5845	14	14	10	10
	Frequency (MHz)	HE10	HE11		
	5150~5350	8	8		
	5470~5720	8	8		
	5725~5845	8	8		

Note: The specifications of RF output power are subject to change to fulfill the safety regulation and requirements in end-user product.

802.11ax_20MHz SISO_OFDMA	Dara rate	Tones	Frequency	Spec.(dBm)
	HE0	26	5150~5350	15.5
			5470~5720	15.5
			5725~5845	15.5
		52	5150~5350	15.5
			5470~5720	15.5
			5725~5845	15.5
		106	5150~5350	15.5
			5470~5720	15.5
			5725~5845	15.5
		242	5150~5350	14.5
			5470~5720	14
			5725~5845	14
	HE1~2	26	5150~5350	15.5
			5470~5720	15.5
			5725~5845	15.5
		52	5150~5350	15.5
			5470~5720	15.5
			5725~5845	15.5
		106	5150~5350	15.5
			5470~5720	15.5
			5725~5845	15.5
		242	5150~5350	14.5
			5470~5720	14
			5725~5845	14
	HE3~4	26	5150~5350	15.5
			5470~5720	15.5
			5725~5845	15.5
		52	5150~5350	15.5
			5470~5720	15.5
			5725~5845	15.5
		106	5150~5350	15.5
			5470~5720	15.5
			5725~5845	15.5
		242	5150~5350	14.5
			5470~5720	14
			5725~5845	14
	HE5~7	26	5150~5350	14.5

802.11ax_20MHz SISO_OFDMA	HE5~7		5470~5720	14.5
			5725~5845	14.5
		52	5150~5350	14.5
			5470~5720	14.5
			5725~5845	14.5
		106	5150~5350	14.5
			5470~5720	14.5
			5725~5845	14.5
		242	5150~5350	14.5
			5470~5720	14
			5725~5845	14
	HE8~9	26	5150~5350	12
			5470~5720	12
			5725~5845	12
		52	5150~5350	12
			5470~5720	12
			5725~5845	12
		106	5150~5350	12
			5470~5720	12
			5725~5845	12
		242	5150~5350	12
			5470~5720	12
			5725~5845	12
	HE10~11	242	5150~5350	10
			5470~5720	9.5
			5725~5845	9.5

	Dara rate	Tones	Frequency	Spec.(dBm)
802.11ax_40MHz SISO_OFDMA	HE0	26	5150~5350	15.5
			5470~5720	15
			5725~5845	15
		52	5150~5350	15.5
			5470~5720	15
			5725~5845	15
		106	5150~5350	15.5
			5470~5720	15
			5725~5845	15
		242	5150~5350	15.5
			5470~5720	15
			5725~5845	15
		484	5150~5350	14.5
			5470~5720	14.5
			5725~5845	14.5
	HE1~2	26	5150~5350	15.5
			5470~5720	15
			5725~5845	15
		52	5150~5350	15.5
			5470~5720	15
			5725~5845	15
		106	5150~5350	15.5
			5470~5720	15
			5725~5845	15
		242	5150~5350	15.5
			5470~5720	15
			5725~5845	15
		484	5150~5350	14.5
			5470~5720	14.5
			5725~5845	14.5

802.11ax_40MHz SISO_OFDMA	HE3~4	26	5150~5350	15.5
			5470~5720	15
			5725~5845	15
		52	5150~5350	15.5
			5470~5720	15
			5725~5845	15
		106	5150~5350	15.5
			5470~5720	15
			5725~5845	15
		242	5150~5350	15.5
			5470~5720	15
			5725~5845	15
		484	5150~5350	14.5
			5470~5720	14.5
			5725~5845	14.5
	HE5~7	26	5150~5350	14.5
			5470~5720	14.5
			5725~5845	14.5
		52	5150~5350	14.5
			5470~5720	14.5
			5725~5845	14.5
		106	5150~5350	14.5
			5470~5720	14.5
			5725~5845	14.5
		242	5150~5350	14.5
			5470~5720	14.5
			5725~5845	14.5
		484	5150~5350	14.5
			5470~5720	14.5
			5725~5845	14.5
	HE8~9	26	5150~5350	12
			5470~5720	12
			5725~5845	12
		52	5150~5350	12
			5470~5720	12
			5725~5845	12
		106	5150~5350	10

802.11ax_40MHz SISO_OFDMA	HE8~9	106	5470~5720	10
			5725~5845	10
		242	5150~5350	10
			5470~5720	10
			5725~5845	10
		484	5150~5350	10
			5470~5720	10
			5725~5845	10
	HE10~11	242	5150~5350	8
			5470~5720	8
			5725~5845	8
		484	5150~5350	8
			5470~5720	8
			5725~5845	8

	Dara rate	Tones	Frequency	Spec.(dBm)
802.11ax_80MHz SISO_OFDMA	HE0	26	5150~5350	15.5
			5470~5720	15
			5725~5845	15
		52	5150~5350	15.5
			5470~5720	15
			5725~5845	15
		106	5150~5350	15.5
			5470~5720	15
			5725~5845	15
		242	5150~5350	15.5
			5470~5720	15
			5725~5845	15
		484	5150~5350	15.5
			5470~5720	15
			5725~5845	15
		996	5150~5350	15.5
			5470~5720	15
			5725~5845	15
	HE1~2	26	5150~5350	15.5
			5470~5720	15
			5725~5845	15
		52	5150~5350	15.5
			5470~5720	15
			5725~5845	15
		106	5150~5350	15.5
			5470~5720	15
			5725~5845	15
		242	5150~5350	15.5
			5470~5720	15
			5725~5845	15
		484	5150~5350	15.5
			5470~5720	15
			5725~5845	15
		996	5150~5350	15.5
			5470~5720	15
			5725~5845	15

802.11ax_80MHz SISO_OFDMA	HE3~4	26	5150~5350	15.5
			5470~5720	15
			5725~5845	15
		52	5150~5350	15.5
			5470~5720	15
			5725~5845	15
		106	5150~5350	15.5
			5470~5720	15
			5725~5845	15
		242	5150~5350	15.5
			5470~5720	15
			5725~5845	15
		484	5150~5350	15.5
			5470~5720	15
			5725~5845	15
		996	5150~5350	15.5
			5470~5720	15
			5725~5845	15
	HE5~7	26	5150~5350	14.5
			5470~5720	14.5
			5725~5845	14.5
		52	5150~5350	14.5
			5470~5720	14.5
			5725~5845	14.5
		106	5150~5350	14.5
			5470~5720	14.5
			5725~5845	14.5
		242	5150~5350	14.5
			5470~5720	14.5
			5725~5845	14.5
		484	5150~5350	14.5
			5470~5720	14
			5725~5845	14
		996	5150~5350	14
			5470~5720	14
			5725~5845	14

802.11ax_80MHz SISO_OFDMA	HE8~9	26	5150~5350	10
			5470~5720	10
			5725~5845	10
		52	5150~5350	10
			5470~5720	10
			5725~5845	10
		106	5150~5350	10
			5470~5720	10
			5725~5845	10
		242	5150~5350	10
			5470~5720	10
			5725~5845	10
		484	5150~5350	10
			5470~5720	10
			5725~5845	10
		996	5150~5350	10
			5470~5720	10
			5725~5845	10
	HE10~11	242	5150~5350	8.5
			5470~5720	8.5
			5725~5845	8.5
		484	5150~5350	8.5
			5470~5720	8.5
			5725~5845	8.5
		996	5150~5350	8
			5470~5720	8
			5725~5845	8

Sensitivity, tolerance ± 2 dB
OFDM modulation PER $\leq 10\%$

802.11a SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	6Mbps	-90	24Mbps	-83
	9Mbps	-89	36Mbps	-80
	12Mbps	-88	48Mbps	-75
	18Mbps	-86	54Mbps	-73
MIMO802.11a MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	6Mbps	-92	24Mbps	-86
	9Mbps	-91	36Mbps	-83
	12Mbps	-90	48Mbps	-78
	18Mbps	-89	54Mbps	-76
802.11n_20MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0	-90	MCS4	-79
	MCS1	-88	MCS5	-76
	MCS2	-86	MCS6	-73
	MCS3	-83	MCS7	-71
802.11n_20MHz MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0	-92	MCS5	-78
	MCS1	-91	MCS6	-76
	MCS2	-89	MCS7	-74
	MCS3	-86	MCS8	-90
	MCS4	-82	MCS15	-70
802.11n_40MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0	-88	MCS4	-77
	MCS1	-86	MCS5	-72
	MCS2	-83	MCS6	-70
	MCS3	-80	MCS7	-68
802.11n_40MHz MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0	-90	MCS5	-75
	MCS1	-88	MCS6	-73
	MCS2	-86	MCS7	-71
	MCS3	-83	MCS8	-87
	MCS4	-79	MCS15	-67

802.11ac_20MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0	-90	MCS5	-75
	MCS1	-88	MCS6	-73
	MCS2	-86	MCS7	-70
	MCS3	-83	MCS8	-68
	MCS4	-79		
802.11ac_20MHz MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0,NSS=1	-92	MCS6,NSS=1	-76
	MCS1,NSS=1	-91	MCS7,NSS=1	-73
	MCS2,NSS=1	-88	MCS8,NSS=1	-71
	MCS3,NSS=1	-85	MCS0,NSS=2	-89
	MCS4,NSS=1	-82	MCS8,NSS=2	-65
	MCS5,NSS=1	-77		
802.11ac_40MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0	-88	MCS5	-72
	MCS1	-86	MCS6	-70
	MCS2	-83	MCS7	-69
	MCS3	-80	MCS8	-65
	MCS4	-76	MCS9	-64
802.11ac_40MHz MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0,NSS=1	-90	MCS6,NSS=1	-73
	MCS1,NSS=1	-88	MCS7,NSS=1	-72
	MCS2,NSS=1	-86	MCS8,NSS=1	-68
	MCS3,NSS=1	-82	MCS9,NSS=1	-66
	MCS4,NSS=1	-79	MCS0,NSS=2	-86
	MCS5,NSS=1	-75	MCS9,NSS=2	-62
802.11ac_80MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0	-85	MCS5	-68
	MCS1	-82	MCS6	-67
	MCS2	-79	MCS7	-65
	MCS3	-76	MCS8	-62
	MCS4	-73	MCS9	-61

802.11ac_80MHz MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0,NSS=1	-87	MCS6,NSS=1	-70
	MCS1,NSS=1	-85	MCS7,NSS=1	-68
	MCS2,NSS=1	-82	MCS8,NSS=1	-65
	MCS3,NSS=1	-79	MCS9,NSS=1	-63
	MCS4,NSS=1	-76	MCS0,NSS=2	-83
	MCS5,NSS=1	-71	MCS9,NSS=2	-58
802.11ax_20MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	HE0	-90	HE6	-73
	HE1	-88	HE7	-70
	HE2	-86	HE8	-68
	HE3	-83	HE9	-64
	HE4	-79	HE10	-59
	HE5	-75	HE11	-57
802.11ax_40MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	HE0	-88	HE6	-70
	HE1	-86	HE7	-69
	HE2	-83	HE8	-65
	HE3	-80	HE9	-64
	HE4	-76	HE10	-60
	HE5	-72	HE11	-55
802.11ax_80MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	HE0	-85	HE6	-67
	HE1	-82	HE7	-65
	HE2	-79	HE8	-62
	HE3	-76	HE9	-61
	HE4	-73	HE10	-55
	HE5	-68	HE11	-51
Maximum Input Level	802.11a/n/ac/ax : -30 dBm			

3.3 6GHz RF Specification

Conditions : VBAT=3.3V ; VDDIO=1.8V ; Temp:25°C

Feature		Description			
WLAN Standard		IEEE 802.11ax			
Frequency Range		5.925~6525GHz (6GHz U-NII5 & U-NII6 Band)			
Number of Channels		5.955~6.415GHz：6G1 ~ Ch93 6.435~6.515GHz：Ch97 ~ Ch113			
Modulation		802.11ax：OFDMA /1024-QAM、256-QAM、64-QAM、16-QAM、QPSK、BPSK			
Output Power(dBm) , tolerance ± 2 dB					
The transmit EVM quality & spectrum mask are compliant with IEEE 802.11 standard					
802.11ax 20MHz	Frequency (MHz)	HE0~2	HE3	HE4	HE5
	5955~5415	14.5	14	13.5	13.5
	6435~6515	14.5	14	13.5	13.5
	Frequency (MHz)	HE6	HE7	HE8	HE9
	5955~5415	13.5	12.5	10.5	10.5
	6435~6515	13.5	12.5	10.5	10.5
	Frequency (MHz)	HE10	HE11		
	5955~5415	8.5	8.5		
	6435~6515	8.5	8.5		
802.11ax 40MHz	Frequency (MHz)	HE0~2	HE3	HE4	HE5
	5955~5415	14.5	14	13	13
	6435~6515	14.5	14	13	13
	Frequency (MHz)	HE6	HE7	HE8	HE9
	5955~5415	12.5	12.5	10.5	8
	6435~6515	12.5	12.5	10.5	8
	Frequency (MHz)	HE10	HE11		
	5955~5415	7	7		
	6435~6515	7	7		



802.11ax 80MHz	Frequency (MHz)	HE0~2	HE3	HE4	HE5
	5955~5415	14.5	14	13	13
	6435~6515	14.5	14	13	13
	Frequency (MHz)	HE6	HE7	HE8	HE9
	5955~5415	12.5	12.5	8	8
	6435~6515	12.5	12.5	8	8
	Frequency (MHz)	HE10	HE11		
	5955~5415	7	7		
	6435~6515	7	7		

Note: The specifications of RF output power are subject to change to fulfill the safety regulation and requirements in end-user product.

Sensitivity, tolerance ± 2 dB, OFDM modulation PER $\leq 10\%$

802.11ax_20MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	HE0	-88	HE6	-71
	HE1	-86	HE7	-68
	HE2	-84	HE8	-66
	HE3	-83	HE9	-62
	HE4	-77	HE10	-57
	HE5	-73	HE11	-55
802.11ax_20MHz MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	HE0	-90	HE6	-73
	HE1	-88	HE7	-70
	HE2	-86	HE8	-69
	HE3	-85	HE9	-65
	HE4	-79	HE10	-60
	HE5	-75	HE11	-57
802.11ax_40MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	HE0	-86	HE6	-68
	HE1	-84	HE7	-67
	HE2	-81	HE8	-63
	HE3	-78	HE9	-62
	HE4	-74	HE10	-58
	HE5	-70	HE11	-53

802.11ax_40MHz MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	HE0	-88	HE6	-71
	HE1	-87	HE7	-69
	HE2	-83	HE8	-65
	HE3	-80	HE9	-64
	HE4	-77	HE10	-60
	HE5	-73	HE11	-55
802.11ax_80MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	HE0	-83	HE6	-65
	HE1	-80	HE7	-63
	HE2	-77	HE8	-60
	HE3	-74	HE9	-59
	HE4	-71	HE10	-55
	HE5	-66	HE11	-51
802.11ax_80MHz MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	HE0	-85	HE6	-67
	HE1	-83	HE7	-65
	HE2	-80	HE8	-63
	HE3	-77	HE9	-61
	HE4	-73	HE10	-57
	HE5	-68	HE11	-54
Maximum Input Level	802.11ax : -30dBm			

4. Bluetooth Specification

4.1 Bluetooth Specification

Conditions : 3.3V_{aux}=3.3V ; Temp:25°C

Feature	Description
General Specification	
Bluetooth Standard	BDR(1Mbps) 、EDR(2 、3Mbps) 、LE(1Mbps) 、2LE(2Mbps)
Host Interface	UART
Frequency Band	2402 MHz ~ 2480 MHz
Number of Channels	79 channels for classic 、40 channels for BLE
Modulation	FHSS with GFSK, $\pi/4$ -DQPSK, 8DPSK
RF Specification	
Output Power , tolerance ± 1.5 dB	
	CL1 (dBm)
BDR Output Power	6
EDR Output Power	6
BLE Output Power	6
Sensitivity, tolerance ± 1.5 dB	
Sensitivity @ BER=0.1% for GFSK (1Mbps)	-88 dBm
Sensitivity @ BER=0.01% for $\pi/4$ -DQPSK (2Mbps)	-91 dBm
Sensitivity @ BER=0.01% for 8DPSK (3Mbps)	-85 dBm
Sensitivity @ BER=0.01% for LE (1Mbps)	-91 dBm
Sensitivity @ BER=0.01% for 2LE (2Mbps)	-90 dBm
Maximum Input Level	GFSK (1Mbps):-20dBm
	$\pi/4$ -DQPSK (2Mbps) :-20dBm
	8DPSK (3Mbps) :-20dBm

Note* : The Bluetooth BDR output power is able to be configured by firmware (hcd file).

5. Pin Definition

5.1 Pin Outline

1	GND	2	3.3Vaux
3	NC	4	3.3Vaux
5	NC	6	NC
7	NC	8	NC
9	GND	10	PCM_CLK (1.8V)
11	NC	12	PCM_SYNC (1.8V)
13	NC	14	PCM_OUT (1.8V)
15	NC	16	PCM_IN (1.8V)
17	NC	18	NC
19	NC	20	GND
21	NC	22	BT_HOST_WAKE (1.8V)
23	NC	24	UART TXD (1.8V)
25	NC	26	Key
27	Key	28	Key
29	Key	30	Key
31	Key	32	Key
33	Key	34	UART RXD (1.8V)
35	GND	36	UART RTS (1.8V)
37	PERp0	38	UART CTS_N (1.8V)
39	PERn0	40	BT_DEV_WAKE (1.8V)
41	GND	42	WL_HOST_WAKE (1.8V)
43	PETp0	44	NC
45	PETn0	46	NC
47	GND	48	NC
49	REFCLKP0	50	NC
51	REFCLKN0	52	NC
53	GND	54	PERST0# (3.3V)
55	CLKREQ0# (3.3V)	56	BT_REG_ON (3.3V)
57	PEWake0# (1.8V)	58	WL_REG_ON (3.3V)
59	GND	60	NC
61	NC	62	NC
63	NC	64	NC
65	GND	66	NC
67	NC	68	NC
69	NC	70	NC
71	GND	72	NC
73	NC	74	3.3Vaux
75	NC	75	3.3Vaux
	GND		

5.2 Pin Assignment

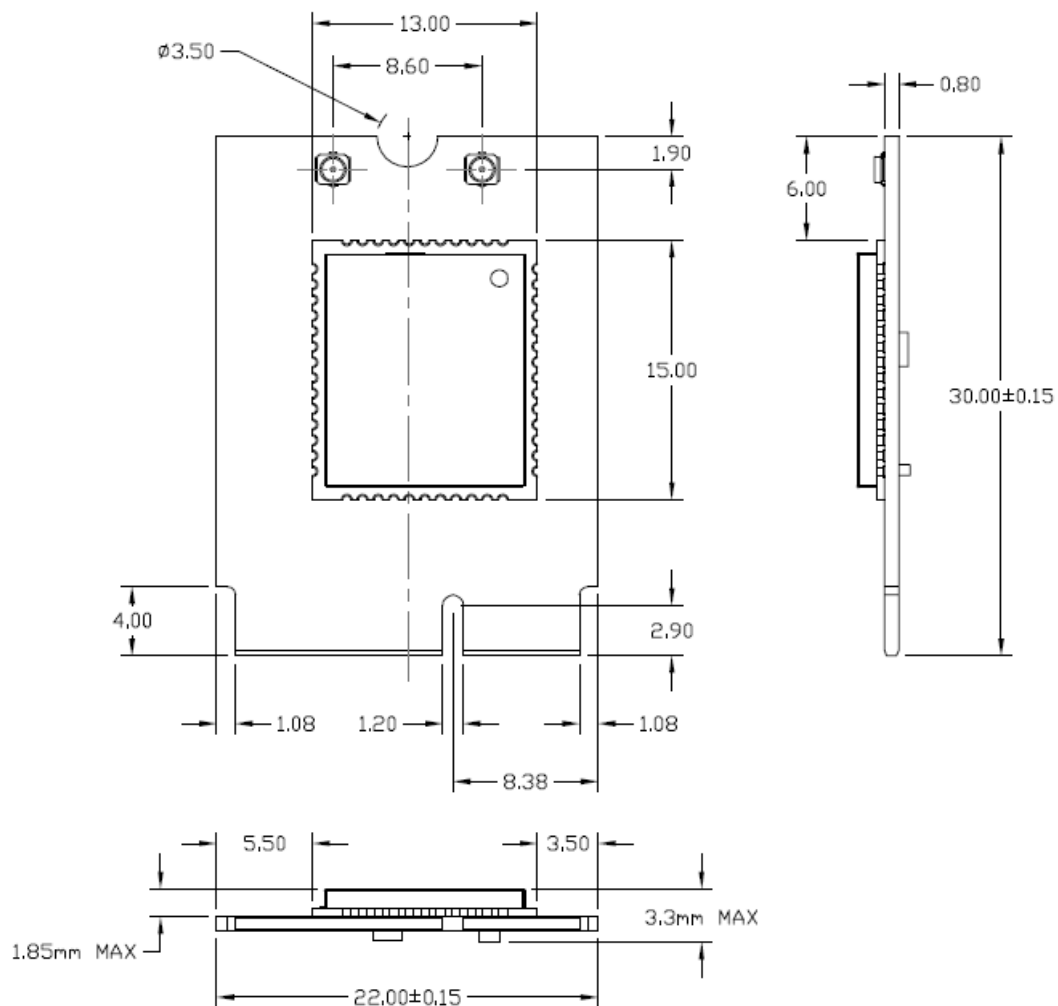
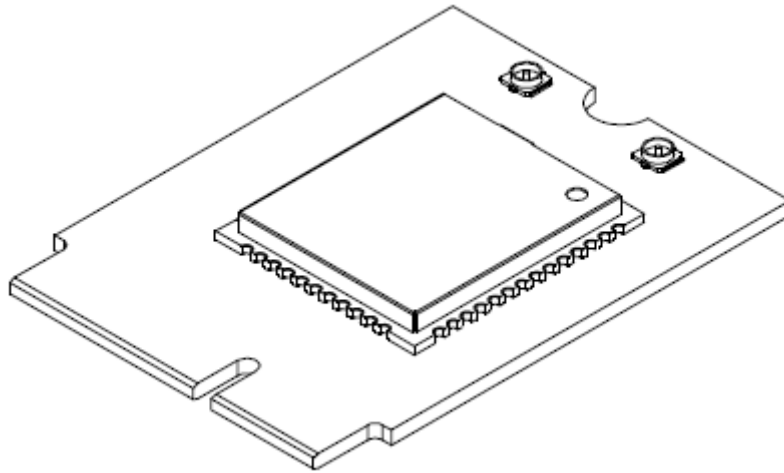
NO	Name	Type	Description
TOP			
1	GND	G	Ground connections
3	NC	—	No connect
5	NC	—	No connect
7	GND	G	Ground connections
9	NC	—	No connect
11	NC	—	No connect
13	NC	—	No connect
15	NC	—	No connect
17	NC	—	No connect
19	NC	—	No connect
21	NC	—	No connect

23	NC	—	No connect
	Module Key	—	Mechanical Key
	Module Key	—	Mechanical Key
	Module Key	—	Mechanical Key
	Module Key	—	Mechanical Key
33	GND	G	Ground connections
35	PERp0	I	PCI Express receive data-Positive
37	PERn0	I	PCI Express receive data-Negative
39	GND	G	Ground connections
41	PETp0	O	PCI Express transmit data-Positive
43	PETn0	O	PCI Express transmit data-Negative
45	GND	G	Ground connections
47	REFCLKP0	I	PCI Express differential clock input-Positive
49	REFCLKN0	I	PCI Express differential clock input-Negative
51	GND	G	Ground connections
53	CLKREQ0# (3.3V)	I/O	PCIe clock request
55	PEWAKE0# (1.8V)	OD	PCIe PME Wake
57	GND	G	Ground connections
59	NC	—	No connect
61	NC	—	No connect
63	GND	G	Ground connections
65	NC	—	No connect
67	NC	—	No connect
69	GND	G	Ground connections
71	NC	—	No connect
73	NC	—	No connect
75	GND	G	Ground connections
BOTTOM			
2	3.3Vaux	P	VDD system power supply input
4	3.3Vaux	P	VDD system power supply input
6	NC	—	No connect
8	PCM_CLK (1.8V)	I/O	PCM clock
10	PCM_SYNC (1.8V)	I/O	PCM sync signal
12	PCM_OUT (1.8V)	O	PCM Data output
14	PCM_IN (1.8V)	I	PCM data input
16	NC	—	No connect

18	GND	G	Ground connections
20	BT_HOST_WAKE (1.8V)	O	Bluetooth wake up Host
22	UART_TXD (1.8V)	O	Bluetooth UART interface
	Module Key	—	Mechanical Key
	Module Key	—	Mechanical Key
	Module Key	—	Mechanical Key
	Module Key	—	Mechanical Key
32	UART_RXD (1.8V)	I	Bluetooth UART interface
34	UART_RTS_N (1.8V)	O	Bluetooth UART interface
36	UART_CTS_N (1.8V)	I	Bluetooth UART interface
38	BT_DEV_WAKE (1.8V)	I	HOST wake-up Bluetooth device
40	WL_HOST_WAKE (1.8V)	O	WLAN wake up HOST
42	NC	—	No connect
44	NC	—	No connect
46	NC	—	No connect
48	NC	—	No connect
50	NC	—	No connect
52	PERST0# (3.3V)	I	PCIe host indication to reset the device
54	BT_REG_ON (3.3V)	I	Used by PMU to power up or power down the internal module regulators used by the Bluetooth section.
56	WL_REG_ON (3.3V)	I	Used by PMU to power up or power down the internal module regulators used by the WLAN section.
58	NC	—	No connect
60	NC	—	No connect
62	NC	—	No connect
64	NC	—	No connect
66	NC	—	No connect
68	NC	—	No connect
70	NC	—	No connect
72	3.3Vaux	P	VDD system power supply input
74	3.3Vaux	P	VDD system power supply input

7. Dimensions

7.1 Module Dimensions



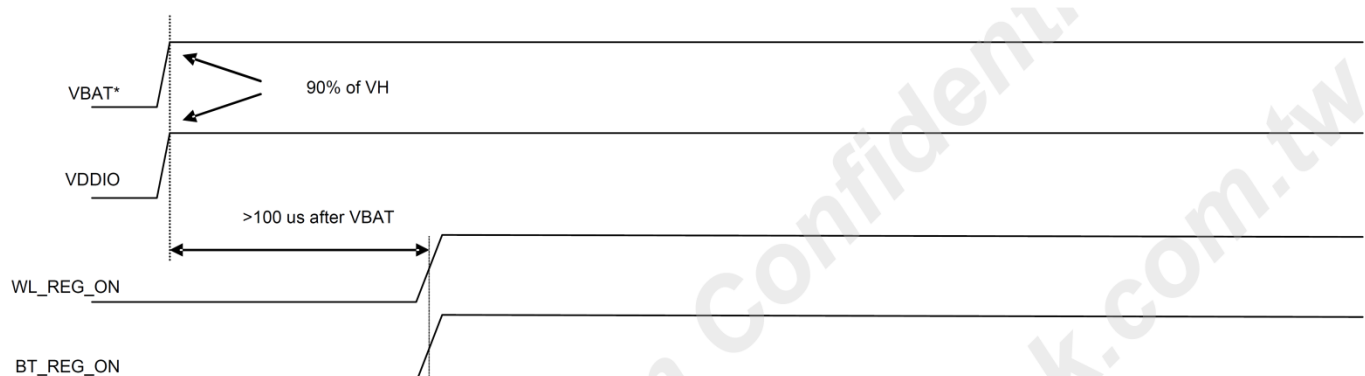
8. Host Interface Timing Diagram

8.1 Power-up Sequence Timing Diagram

The module has signals that allow the host to control power consumption by enabling or disabling the Bluetooth, WLAN and internal regulator blocks. These signals are described below.

Additionally, diagrams are provided to indicate proper sequencing of the signals for various operating states. The timing value indicated are minimum required values: longer delays are also acceptable.

- **WL_REG_ON:** This signal is used by the PMU to power up the WLAN section. It is also OR-gated with the BT_REG_ON input to control the internal regulators. When this pin is high, the regulators are enabled and the WLAN section is out of reset. When this pin is low, the WLAN section is in reset. If BT_REG_ON and WL_REG_ON are both low, the regulators are disabled. This pin has an internal 33kΩ pull-high resistor.
- **BT_REG_ON:** This signal is used by the PMU to decide whether or not to power down the internal regulators. If BT_REG_ON and WL_REG_ON are low, the regulators will be disabled. This pin has an internal 33 kΩ pull-high resistor.
- It suggests customers connect WL_REG_ON and BT_REG_ON to GPIOs for control, otherwise unexpected errors may occur when boot-up the device.
- In the figure, VBAT is represented as 3.3Vaux. The VDDIO power supply has been included in the module. When VBAT is power-up, VDDIO will rise to high level after 15 ms.
- The module main chip has an internal power-on reset (POR) circuit. The device will be held in reset for a maximum of 110 ms after VDDC and VDDIO have both passed the POR threshold. Wait at least 150 ms after VDDC and VDDIO are available before initiating PCIe accesses.

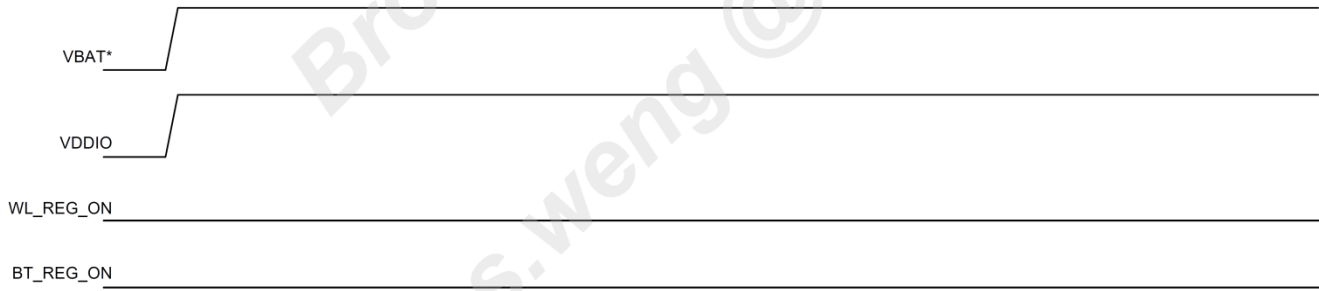


***Notes:**

1. The VBAT and VDDIO 10%–90% rise-time slopes must be greater than 50 microseconds/V.
2. VBAT should be up before or at the same time as VDDIO. VDDIO should NOT be present first or be held high before VBAT is high.

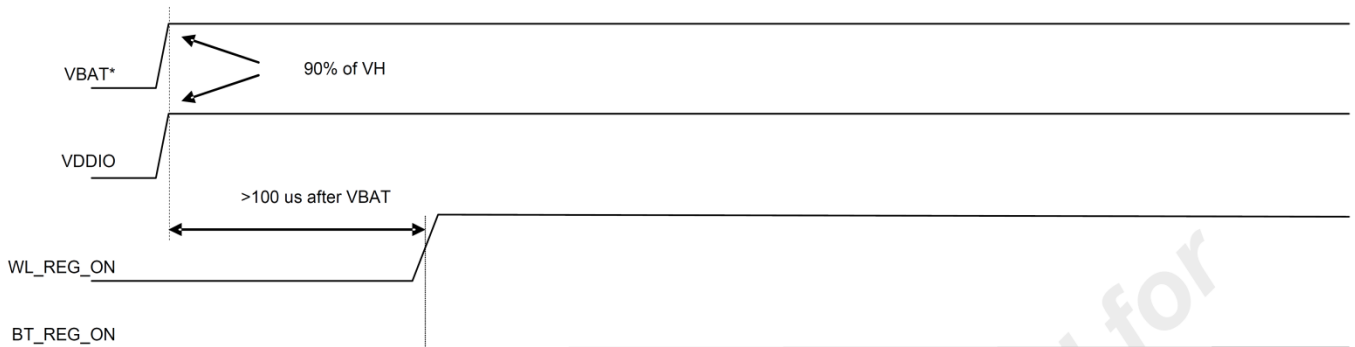
WLAN=ON, Bluetooth=ON



***Notes:**

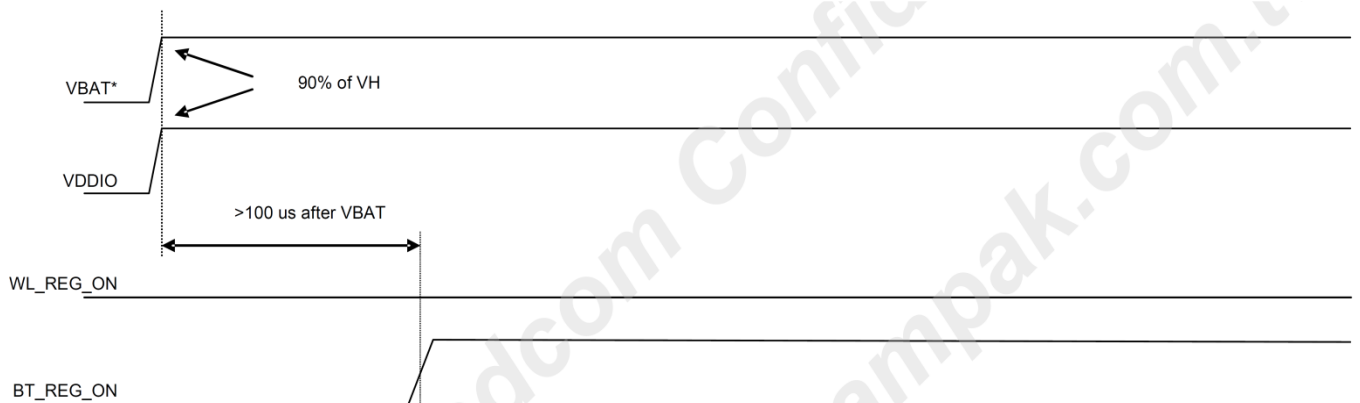
1. The VBAT and VDDIO 10%–90% rise-time slopes must be greater than 50 microseconds/V.
2. VBAT should be up before or at the same time as VDDIO. VDDIO should NOT be present first or be held high before VBAT is high.

WLAN=OFF, Bluetooth=OFF

***Notes:**

1. The VBAT and VDDIO 10%–90% rise-time slopes must be greater than 50 microseconds/V.
2. VBAT should be up before or at the same time as VDDIO. VDDIO should NOT be present first or be held high before VBAT is high.

WLAN=ON, Bluetooth=OFF

***Notes:**

1. The VBAT and VDDIO 10%–90% rise-time slopes must be greater than 50 microseconds/V.
2. VBAT should be up before or at the same time as VDDIO. VDDIO should NOT be present first or be held high before VBAT is high.

WLAN=OFF, Bluetooth=ON

8.2 PCIe Interface Description

The PCI Express(Pcie) core on the AP12275_M2P is a high-performance serial I/O interconnect that is protocol compliant and electrically compatible with the PCI Express Base Specification v3.0 running at Gen1 speeds.

PCI Express Interface Parameters

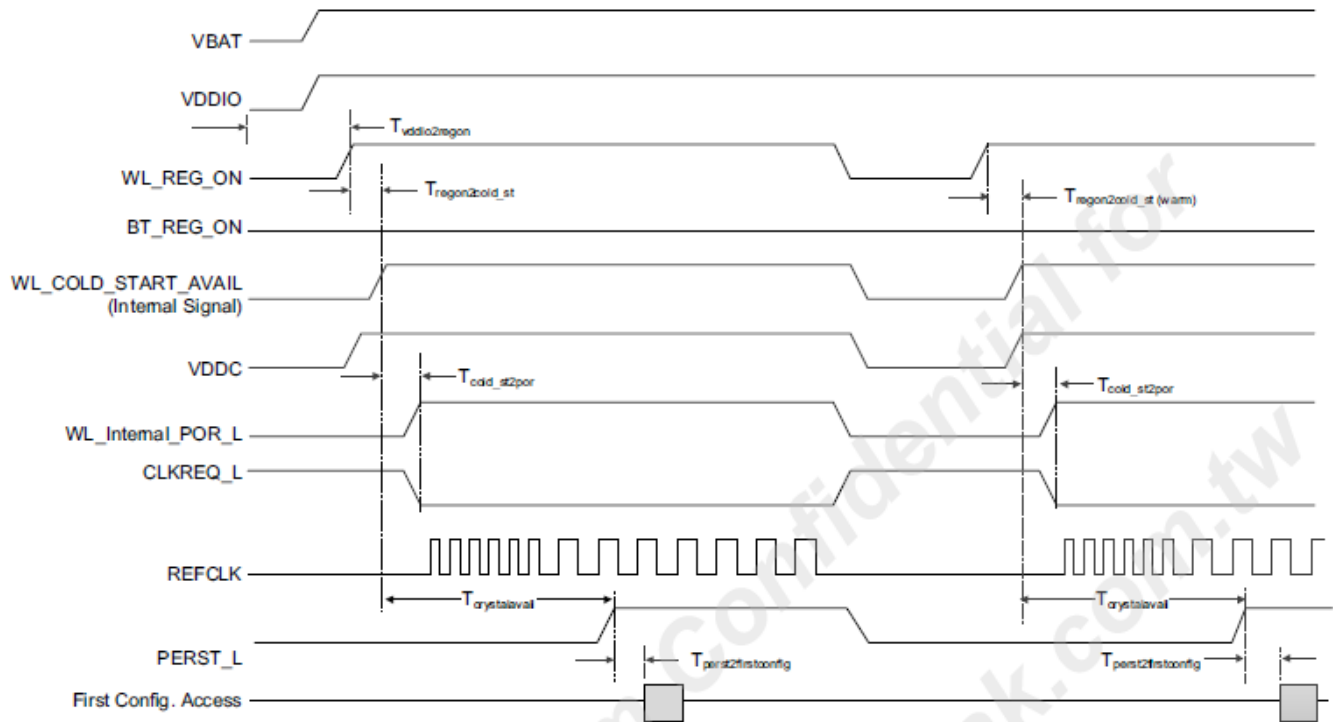
Parameter	Symbol	Comments	Min.	Typ.	Max.	Unit
General^a						
Baud rate	BPS	—	—	5	—	Gbaud
Reference clock peak-to-peak differential ^b	Vref	LVPECL, AC coupled	0.95	—	—	V
Receiver						
Differential termination	ZRX-DIFF-DC	Differential termination	80	100	120	Ω
DC impedance	ZRX-DC	DC common-mode impedance	40	50	60	Ω
Powered down termination (POS)	ZRX-HIGH-IMP-DC-POS	Power-down or RESET high impedance	100k	—	—	Ω
Powered down termination (NEG)	ZRX-HIGH-IMP-DC-NEG	Power-down or RESET high impedance	1k	—	—	Ω
Input voltage	VRX-DIFFp-p	AC coupled, differential p-p	175	—	—	mV
Jitter tolerance	TRX-EYE	Minimum receiver eye width	0.4	—	—	UI
Differential return loss	RLRX-DIFF	Differential return loss	10	—	—	dB
Common-mode return loss	RLRX-CM	Common-mode return loss	6	—	—	dB
Unexpected electrical idle enter detect threshold integration time	TRX-IDEL-DET-DIFF-ENTERTIME	An unexpected electrical idle must be recognized no longer than this time to signal an unexpected idle condition.	—	—	10	ms
Signal detect threshold	VRX-IDLE-DET-DIFFp-p	Electrical idle detect threshold	65	—	175	mV
Transmitter						
Output voltage	VTX-DIFFp-p	Differential p-p, programmable in 16 steps	0.8	—	1200	mV
Output voltage rise time	VTX-RISE	20% to 80%	0.125 (2.5 GT/s) 0.15 (5 GT/s)	—	—	UI
Output voltage fall time	VTX-FALL	80% to 20%	0.125 (2.5 GT/s) 0.15 (5 GT/s)	—	—	UI
RX detection voltage swing	VTX-RCV-DETECT	The amount of voltage change allowed during receiver detection.	—	—	600	mV

PCI Express Interface Parameters (Continued)

Parameter	Symbol	Comments	Min.	Typ.	Max.	Unit
TX AC peak common-mode voltage (5 GT/s)	VTX-CM-AC-PP	TX AC common mode voltage (5 GT/s)	—	—	100	mV
TX AC peak common-mode voltage (2.5 GT/s)	VTX-CM-AC-P	TX AC common mode voltage (2.5 GT/s)	—	—	20	mV
Absolute delta of DC common-mode voltage during L0 and electrical idle	VTX-CM-DC-ACTIVE-IDLE-DELTA	Absolute delta of DC common-mode voltage during L0 and electrical idle.	0	—	100	mV
Absolute delta of DC common-mode voltage between D+ and D-	VTX-CM-DC-LINE-DELTA	DC offset between D+ and D-	0	—	25	mV
Electrical idle differential peak output voltage	VTX-IDLE-DIFF-AC-p	Peak-to-peak voltage	0	—	20	mV
TX short circuit current	ITX-SHORT	Current limit when TX output is shorted to ground.	—	—	90	mA
DC differential TX termination	ZTX-DIFF-DC	Low impedance defined during signaling (parameter is captured for 5.0 GHz by RLTX-DIFF)	80	—	120	Ω
Differential return loss	RLTX-DIFF	Differential return loss	10 (min) for 0.05: 1.25 GHz	—	—	dB
Common-mode return loss	RLTX-CM	Common-mode return loss	6	—	—	dB
TX eye width	TTX-EYE	Minimum TX eye width	0.75	—	—	UI



PCIe Power-On Timing



Timing Parameter	Notes	Value ^a	Unit
$T_{vddio2region}$	—	0.1	ms
$T_{region2cold_st}$	3.4 ms + 162 instruction-level parallelism (ILP) cycles	10.13	ms
T_{cold_st2por}	54 ILP cycles	2.24	ms
$T_{crystalavail}$	509 ILP cycles	21.17	ms
$T_{perst2firstconfig}$	—	6.0	ms
$T_{vddioon2firstconfig}$	$T_{vddio2region} + T_{region2cold_st} + T_{crystalavail} + T_{perst2firstconfig}$	37.4 ^b	ms
$T_{region2cold_st} (warm)$	162 ILP cycles	6.73	ms

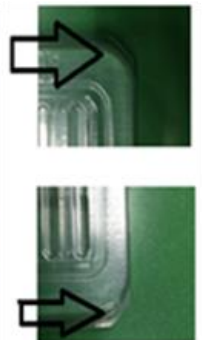
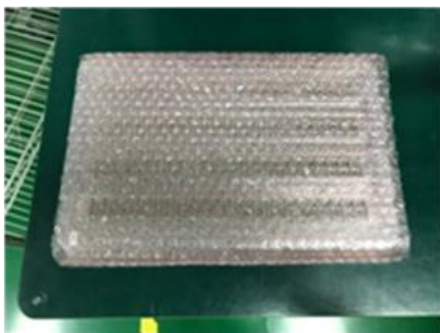
a. The time values assume an ILP tolerance of $\pm 30\%$.

b. With VDDIO as a reference, 37.4 ms is the minimum system wait time before issuing the first configuration access.

9. Package Information

9.1 Tray box

BOX : 100 PCS (100 PCS/Tray)



9.2 Carton

Carton: 400 PCS (Box*4/Carton)

