正基科技股份有限公司

SPECIFICATION

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Customer APPROVED	
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PREPARED	REVIEW			APPROVED	DCC ISSUE
	PM	QA	ET		

正基科技股份有限公司

AMPAK Technology Inc.

AP12676_M2P

Data Sheet

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Revision

Revision	Date	Description	Revised By
0.1	2023/10/11	- Preliminary	Jason Shen
0.2	2024/05/16	- Update Dimensions	Jason Shen
0.3	2025/07/25	- Update Bluetooth Spec Version	Ming
0.4	2025/08/05	- Update Dimensions	Jason Shen
0.5	2026/06/10	Update Product Feature& General Specification	Jason

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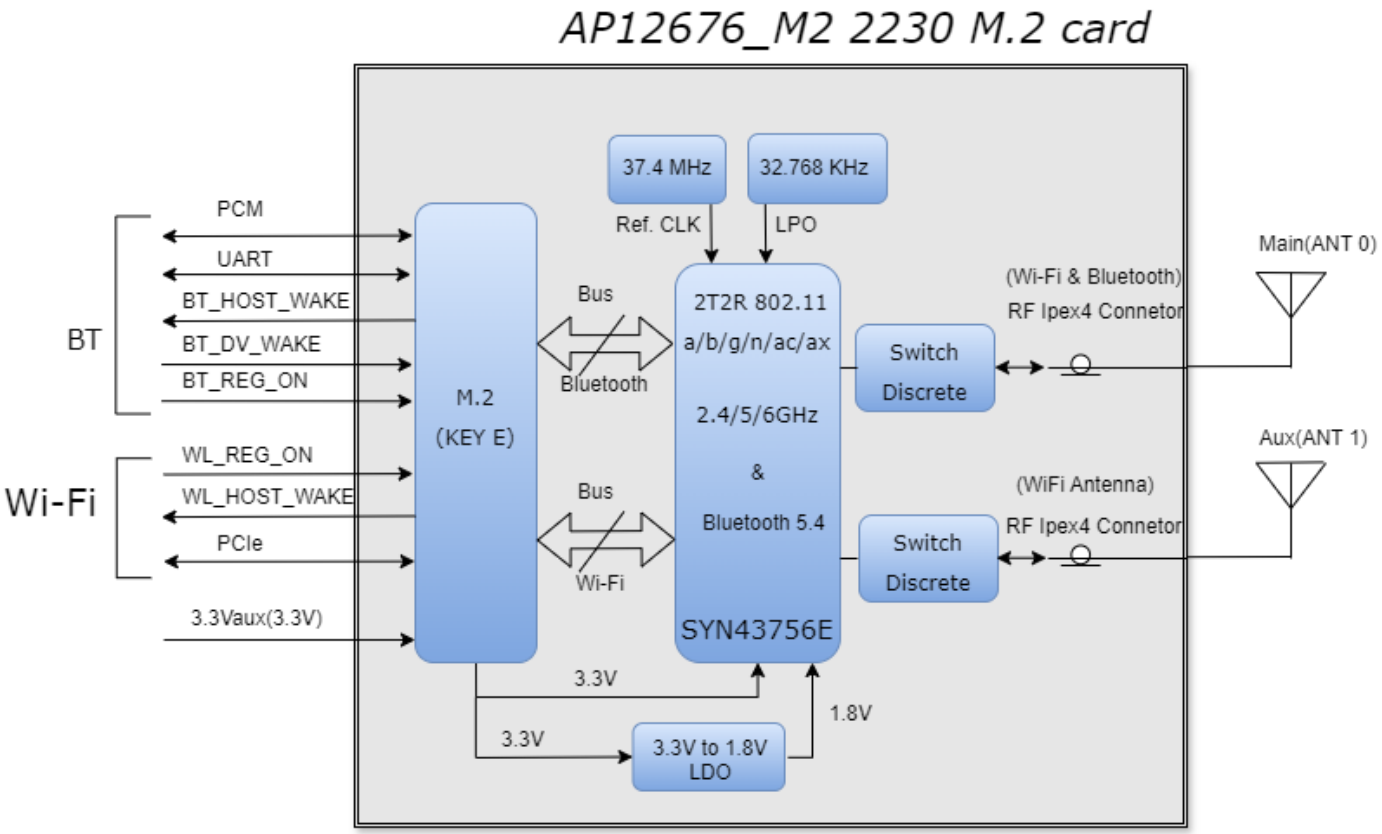
1. Introduction

1.1 Overview

The AMPAK Technology® AP12676_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 AP12676_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 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.
- Supported Partial RU(Resource Unit) in 802.11ax.
- Supported non-HT(802.11a) preamble in 6GHz.

Bluetooth Key Feature

- BT host digital interface:
    - HCI UART (up to 4 Mbps)
    - PCM for audio data
- Complies with Bluetooth Core Specification Version 5.4 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 5.4, including the following support:
    - Low energy(LE) isochronous channels
    - LE power control
    - LE enhanced connection update
    - LE channel classification
    - LE audio
    - LE Long Range(LE-LR)

2. General Specification

2.1 General Specification

Model Name	AP12676_M2P
Product Description	2T2R 802.11 a/b/g/n/ac/ax Wi-Fi 6E + Bluetooth 5.4 2230 M.2 card (KEY E)
Dimension	L x W : 30 x 22 mm (typical); H : 3.38 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 105°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 3.3V ≤ 3.3Vaux ≤ 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	3.3	--	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 = 3.6V

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 : 3.3Vaux=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
Resource Unit	Partial RU : BW20MHz : 26T、52T、106T、242T

Output Power(dBm) , 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				
802.11ac/ax 20MHz	**MCS0~2/HE0~2**	**MCS3/HE3**	**MCS4/HE4**	**MCS5/HE5**	**MCS6/HE6**
	18.5	17.5	17.5	17	17
	MCS7/HE7	**MCS8/HE8**	**HE9**		
	16	15	14		

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 ≦ 8%、OFDM modulation PER ≦ 10%

802.11b	**Data Rate**	**Spec.(dBm)**		
	1Mbps	-97		
	2Mbps	-95		
	5.5Mbps	-92		
	11Mbps	-89		

802.11g SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	6Mbps	-92	24Mbps	-85
	9Mbps	-91	36Mbps	-82
	12Mbps	-90	48Mbps	-77
	18Mbps	-88	54Mbps	-76
802.11n_20MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0	-91	MCS4	-81
	MCS1	-89	MCS5	-77
	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	-91	MCS6	-78
	MCS2	-89	MCS7	-76
	MCS3	-86	MCS8	-90
	MCS4	-83	MCS15	-73
802.11ac/ax_20MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0/HE0	-91	MCS6/HE6	-75
	MCS1/HE1	-88	MCS7/HE7	-74
	MCS2/HE2	-86	MCS8/HE8	-71
	MCS3/HE3	-83	HE9	-69
	MCS4/HE4	-80		
	MCS5/HE5	-77		
802.11ac/ax_20MHz MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0/HE0,NSS=2	-90	MCS6/HE6,NSS=2	-74
	MCS1/HE1,NSS=2	-87	MCS7/HE7,NSS=2	-73
	MCS2/HE2,NSS=2	-85	MCS8/HE8,NSS=2	-70
	MCS3/HE3,NSS=2	-84	HE9,NSS=2	-68
	MCS4/HE4,NSS=2	-79		
	MCS5/HE5,NSS=2	-76		
Maximum Input Level	802.11b : -10 dBm			
	802.11g/n/ax : -20 dBm			

3.2 5GHz RF Specification

Conditions : 3.3Vaux=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 ~ Ch144 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
Resource Unit	Partial RU : BW20MHz : 26T、52T、106T、242T BW40MHz : 26T、52T、106T、242T、484T BW80MHz : 26T、52T、106T、242T、484T、996T

Output Power(dBm) , 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	15	15	15
	5470~5720	15	15	15	15
	5725~5845	15	15	15	15
	Frequency (MHz)	**48Mbps**	**54Mbps**		
	5150~5350	15	15		
	5470~5720	15	15		
	5725~5845	15	15		
802.11n 20MHz	**Frequency (MHz)**	**MCS0~2**	**MCS3**	**MCS4**	**MCS5**
	5150~5350	15	15	15	15
	5470~5720	15	15	15	15
	5725~5845	15	15	15	15
	Frequency (MHz)	**MCS6**	**MCS7**		
	5150~5350	15	14		
	5470~5720	15	14		
	5725~5845	15	14		

802.11n 40MHz	Frequency (MHz)	MCS0~2	MCS3	MCS4	MCS5
	5150~5350	15	14.5	14.5	14.5
	5470~5720	15	14.5	14.5	14.5
	5725~5845	15	14.5	14.5	14.5
	Frequency (MHz)	MCS6	MCS7		
	5150~5350	14.5	14		
	5470~5720	14.5	14		
	5725~5845	14.5	14		
802.11ac 20MHz	Frequency (MHz)	MCS0~2	MCS3	MCS4	MCS5
	5150~5350	15	15	15	15
	5470~5720	15	15	15	15
	5725~5845	15	15	15	15
	Frequency (MHz)	MCS6	MCS7	MCS8	
	5150~5350	15	14	12	
	5470~5720	15	14	12	
	5725~5845	15	14	12	
802.11ac 40MHz	Frequency (MHz)	MCS0~2	MCS3	MCS4	MCS5
	5150~5350	15	14.5	14.5	14.5
	5470~5720	15	14.5	14.5	14.5
	5725~5845	15	14.5	14.5	14.5
	Frequency (MHz)	MCS6	MCS7	MCS8	MCS9
	5150~5350	14.5	14	11	10
	5470~5720	14.5	14	11	10
	5725~5845	14.5	14	11	10
802.11ac 80MHz	Frequency (MHz)	MCS0~2	MCS3	MCS4	MCS5
	5150~5350	15	14.5	14.5	14.5
	5470~5720	15	14.5	14.5	14.5
	5725~5845	15	14.5	14.5	14.5
	Frequency (MHz)	MCS6	MCS7	MCS8	MCS9
	5150~5350	14.5	14	10	10
	5470~5720	14.5	14	10	10
	5725~5845	14.5	14	10	10

802.11ax 20MHz	Frequency (MHz)	HE0~2	HE3	HE4	HE5
	5150~5350	15	15	15	15
	5470~5720	15	15	15	15
	5725~5845	15	15	15	15
	Frequency (MHz)	HE6	HE7	HE8	HE9
	5150~5350	15	14	12	12
	5470~5720	15	14	12	12
	5725~5845	15	14	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	14.5	14.5	14.5
	5470~5720	15	14.5	14.5	14.5
	5725~5845	15	14.5	14.5	14.5
	Frequency (MHz)	HE6	HE7	HE8	HE9
	5150~5350	14.5	14	11	10
	5470~5720	14.5	14	11	10
	5725~5845	14.5	14	11	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	14.5	14.5	14.5
	5470~5720	15	14.5	14.5	14.5
	5725~5845	15	14.5	14.5	14.5
	Frequency (MHz)	HE6	HE7	HE8	HE9
	5150~5350	14.5	14	10	10
	5470~5720	14.5	14	10	10
	5725~5845	14.5	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.

Sensitivity, tolerance ± 2 dB OFDM modulation PER ≦ 10%				
802.11a SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	6Mbps	-89	24Mbps	-81
	9Mbps	-88	36Mbps	-78
	12Mbps	-87	48Mbps	-74
	18Mbps	-84	54Mbps	-72
802.11n_20MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0	-89	MCS4	-78
	MCS1	-87	MCS5	-75
	MCS2	-85	MCS6	-72
	MCS3	-81	MCS7	-71
802.11n_20MHz MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0	-91	MCS5	-77
	MCS1	-89	MCS6	-74
	MCS2	-87	MCS7	-73
	MCS3	-83	MCS8	-88
	MCS4	-80	MCS15	-70
802.11n_40MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0	-87	MCS4	-75
	MCS1	-84	MCS5	-72
	MCS2	-82	MCS6	-69
	MCS3	-78	MCS7	-68
802.11n_40MHz MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0	-88	MCS5	-74
	MCS1	-86	MCS6	-71
	MCS2	-84	MCS7	-70
	MCS3	-80	MCS8	-86
	MCS4	-77	MCS15	-67

802.11ac_20MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0	-89	MCS5	-75
	MCS1	-87	MCS6	-72
	MCS2	-84	MCS7	-70
	MCS3	-80	MCS8	-66
	MCS4	-78		
802.11ac_20MHz MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0,NSS=1	-91	MCS6,NSS=1	-74
	MCS1,NSS=1	-89	MCS7,NSS=1	-72
	MCS2,NSS=1	-86	MCS8,NSS=1	-68
	MCS3,NSS=1	-82	MCS0,NSS=2	-88
	MCS4,NSS=1	-80	MCS8,NSS=2	-65
	MCS5,NSS=1	-77		
802.11ac_40MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0	-87	MCS5	-72
	MCS1	-84	MCS6	-69
	MCS2	-82	MCS7	-67
	MCS3	-78	MCS8	-63
	MCS4	-75	MCS9	-62
802.11ac_40MHz MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0,NSS=1	-89	MCS6,NSS=1	-71
	MCS1,NSS=1	-86	MCS7,NSS=1	-69
	MCS2,NSS=1	-84	MCS8,NSS=1	-65
	MCS3,NSS=1	-80	MCS9,NSS=1	-64
	MCS4,NSS=1	-77	MCS0,NSS=2	-85
	MCS5,NSS=1	-74	MCS9,NSS=2	-60
802.11ac_80MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0	-84	MCS5	-69
	MCS1	-81	MCS6	-66
	MCS2	-79	MCS7	-65
	MCS3	-76	MCS8	-61
	MCS4	-72	MCS9	-59

802.11ac_80MHz MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0,NSS=1	-86	MCS6,NSS=1	-68
	MCS1,NSS=1	-83	MCS7,NSS=1	-67
	MCS2,NSS=1	-81	MCS8,NSS=1	-63
	MCS3,NSS=1	-78	MCS9,NSS=1	-61
	MCS4,NSS=1	-74	MCS0,NSS=2	-82
	MCS5,NSS=1	-71	MCS9,NSS=2	-57
802.11ax_20MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	HE0	-89	HE6	-72
	HE1	-87	HE7	-70
	HE2	-84	HE8	-66
	HE3	-80	HE9	-64
	HE4	-78	HE10	-59
	HE5	-75	HE11	-57
802.11ax_20MHz MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	HE0,NSS=2	-88	HE6,NSS=2	-71
	HE1,NSS=2	-86	HE7,NSS=2	-69
	HE2,NSS=2	-83	HE8,NSS=2	-65
	HE3,NSS=2	-79	HE9,NSS=2	-63
	HE4,NSS=2	-77	HE10,NSS=2	-58
	HE5,NSS=2	-74	HE11,NSS=2	-56
802.11ax_40MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	HE0	-87	HE6	-69
	HE1	-84	HE7	-67
	HE2	-82	HE8	-63
	HE3	-78	HE9	-62
	HE4	-75	HE10	-60
	HE5	-72	HE11	-55
802.11ax_40MHz MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	HE0,NSS=2	-86	HE6,NSS=2	-68
	HE1,NSS=2	-83	HE7,NSS=2	-66
	HE2,NSS=2	-81	HE8,NSS=2	-62
	HE3,NSS=2	-77	HE9,NSS=2	-61
	HE4,NSS=2	-74	HE10,NSS=2	-59
	HE5,NSS=2	-71	HE11,NSS=2	-54

802.11ax_80MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	HE0	-84	HE6	-66
	HE1	-81	HE7	-65
	HE2	-79	HE8	-61
	HE3	-76	HE9	-59
	HE4	-72	HE10	-57
	HE5	-69	HE11	-53
802.11ax_80MHz MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	HE0,NSS=2	-83	HE6,NSS=2	-65
	HE1,NSS=2	-80	HE7,NSS=2	-64
	HE2,NSS=2	-78	HE8,NSS=2	-60
	HE3,NSS=2	-75	HE9,NSS=2	-58
	HE4,NSS=2	-71	HE10,NSS=2	-56
	HE5,NSS=2	-68	HE11,NSS=2	-52
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 Non-HT(802.11a) preamble for ack/beacon
Frequency Range	5.925 ~ 7.125GHz
Number of Channels	5955~6415MHz：6G1 ~ 6G93、6435~6515MHz：6G97 ~ 6G113 6535~6855MHz：6G117 ~ 6G181、6875~7115MHz：6G185 ~ 6G233
Modulation	802.11ax : OFDMA /1024-QAM、256-QAM、64-QAM、16-QAM、QPSK、BPSK
Resource Unit	Partial RU : BW20MHz : 26T、52T、106T、242T BW40MHz : 26T、52T、106T、242T、484T BW80MHz : 26T、52T、106T、242T、484T、996T

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**
	5955~6415	14.5	14	13.5	13.5
	6435~6515	14.5	14	13.5	13.5
	6535~6855	14.5	14	13.5	13.5
	6875~7115	14.5	14	13.5	13.5
	Frequency (MHz)	**HE6**	**HE7**	**HE8**	**HE9**
	5955~6415	13.5	12.5	10.5	10.5
	6435~6515	13.5	12.5	10.5	10.5
	6535~6855	13.5	12.5	10.5	10.5
	6875~7115	13.5	12.5	10.5	10.5
	Frequency (MHz)	**HE10**	**HE11**		
	5955~6415	8.5	8.5		
	6435~6515	8.5	8.5		
	6535~6855	8.5	8.5		
	6875~7115	8.5	8.5		
802.11ax 40MHz	**Frequency (MHz)**	**HE0~2**	**HE3**	**HE4**	**HE5**
	5955~6415	14.5	14	13	13
	6435~6515	14.5	14	13	13
	6535~6855	14.5	14	13	13
	6875~7115	14.5	14	13	13
	Frequency (MHz)	**HE6**	**HE7**	**HE8**	**HE9**
	5955~6415	12.5	12.5	10.5	8

	6435~6515	12.5	12.5	10.5	8
	6535~6855	12.5	12.5	10.5	8
	6875~7115	12.5	12.5	10.5	8
	Frequency (MHz)	**HE10**	**HE11**		
	5955~6415	7	7		
	6435~6515	7	7		
	6535~6855	7	7		
	6875~7115	7	7		
802.11ax 80MHz	**Frequency (MHz)**	**HE0~2**	**HE3**	**HE4**	**HE5**
	5955~6415	14.5	14	13	13
	6435~6515	14.5	14	13	13
	6535~6855	14.5	14	13	13
	6875~7115	14.5	14	13	13
	Frequency (MHz)	**HE6**	**HE7**	**HE8**	**HE9**
	5955~6415	12.5	12.5	8	8
	6435~6515	12.5	12.5	8	8
	6535~6855	12.5	12.5	8	8
	6875~7115	12.5	12.5	8	8
	Frequency (MHz)	**HE10**	**HE11**		
	5955~6415	7	7		
	6435~6515	7	7		
	6535~6855	7	7		
	6875~7115	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 ≦ 10%

802.11ax_20MHz SISO	**Data Rate**	**Spec.(dBm)**	**Data Rate**	**Spec.(dBm)**
	HE0	-87	**HE6**	-72
	HE1	-86	**HE7**	-70
	HE2	-83	**HE8**	-66
	HE3	-80	**HE9**	-64
	HE4	-77	**HE10**	-59
	HE5	-75	**HE11**	-55
802.11ax_20MHz MIMO	**Data Rate**	**Spec.(dBm)**	**Data Rate**	**Spec.(dBm)**
	HE0,NSS=2	-86	**HE6,NSS=2**	-71
	HE1,NSS=2	-85	**HE7,NSS=2**	-69
	HE2,NSS=2	-83	**HE8,NSS=2**	-65

	HE3,NSS=2	-80	HE9,NSS=2	-63
	HE4,NSS=2	-76	HE10,NSS=2	-58
	HE5,NSS=2	-74	HE11,NSS=2	-54
802.11ax_40MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	HE0	-86	HE6	-69
	HE1	-84	HE7	-67
	HE2	-82	HE8	-63
	HE3	-78	HE9	-62
	HE4	-75	HE10	-58
	HE5	-72	HE11	-53
802.11ax_40MHz MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	HE0,NSS=2	-85	HE6,NSS=2	-68
	HE1,NSS=2	-83	HE7,NSS=2	-66
	HE2,NSS=2	-81	HE8,NSS=2	-62
	HE3,NSS=2	-77	HE9,NSS=2	-61
	HE4,NSS=2	-74	HE10,NSS=2	-57
	HE5,NSS=2	-71	HE11,NSS=2	-52
802.11ax_80MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	HE0	-83	HE6	-66
	HE1	-81	HE7	-65
	HE2	-79	HE8	-61
	HE3	-76	HE9	-58
	HE4	-72	HE10	-55
	HE5	-69	HE11	-51
802.11ax_80MHz MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	HE0,NSS=2	-82	HE6,NSS=2	-65
	HE1,NSS=2	-80	HE7,NSS=2	-64
	HE2,NSS=2	-79	HE8,NSS=2	-60
	HE3,NSS=2	-76	HE9,NSS=2	-57
	HE4,NSS=2	-71	HE10,NSS=2	-54
	HE5,NSS=2	-68	HE11,NSS=2	-50
Maximum Input Level	802.11ax : -30dBm			

4. Bluetooth Specification

4.1 Bluetooth Specification

Conditions : 3.3Vaux=3.3V ; Temp:25°C

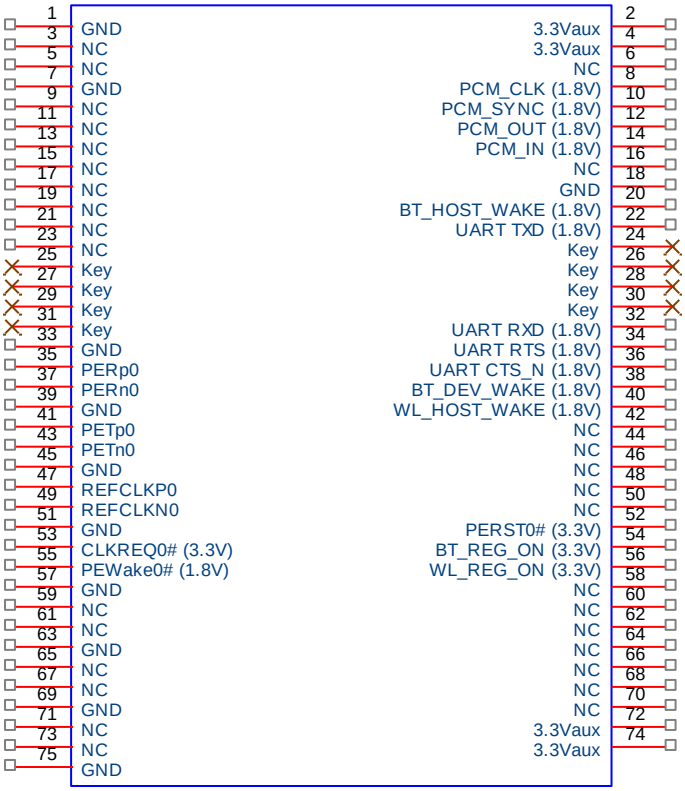
Feature	**Description**
General Specification	
Bluetooth Standard	BDR、EDR(2Mbps & 3Mbps)、LE(1/2Mbps)、LELR(128/512Kbps)
Host Interface	UART
Frequency Band	2402 MHz ~ 2480 MHz
Number of Channels	79 channels for classic、40 channels for BLE
Modulation	FHSS with GFSK, π/4-DQPSK, 8DPSK
RF Specification	
Output 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 π/4-DQPSK (2Mbps)	-91 dBm
Sensitivity @ BER=0.01% for 8DPSK (3Mbps)	-85 dBm
Sensitivity @ BER=0.01% for LE (1Mbps)	-90 dBm
Sensitivity @ BER=0.01% for 2LE (2Mbps)	-91dBm
Sensitivity @ PER=30.8% for 2LE (2Mbps)	-91dBm
Sensitivity @ PER=30.8% for LELR (125Kbps)	-100 dBm

Maximum Input Level	GFSK (1Mbps):-20dBm
	π/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



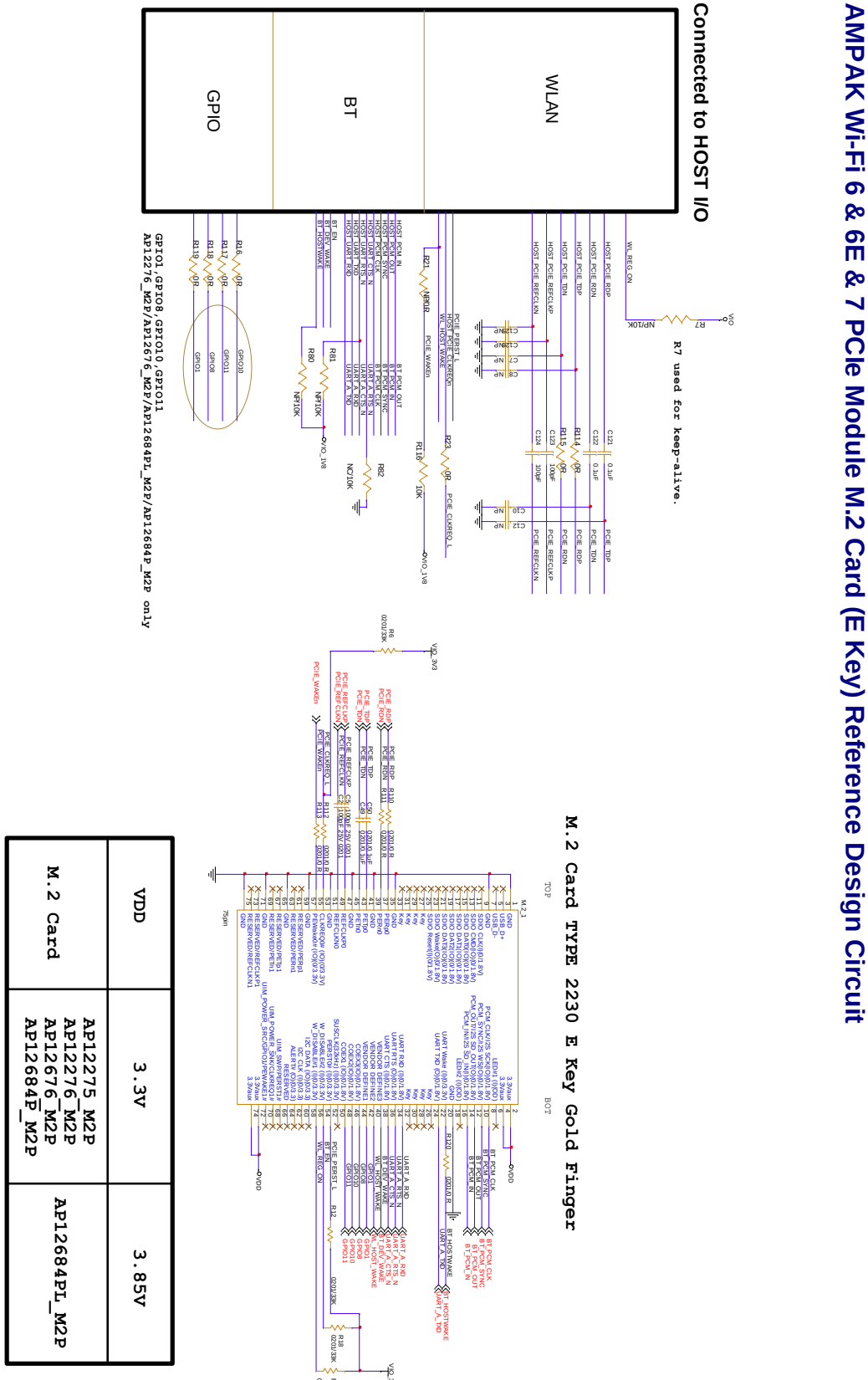
5.2 Pin Assignment

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

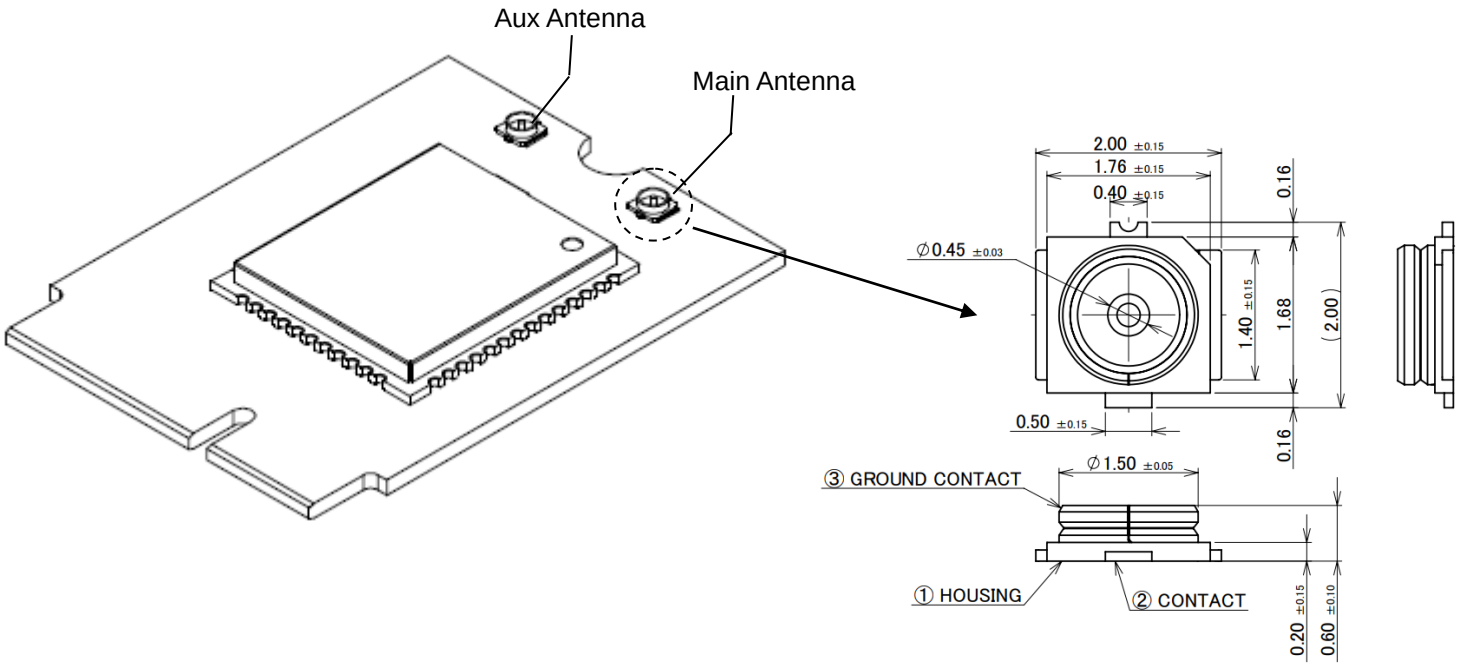
6. Reference Design

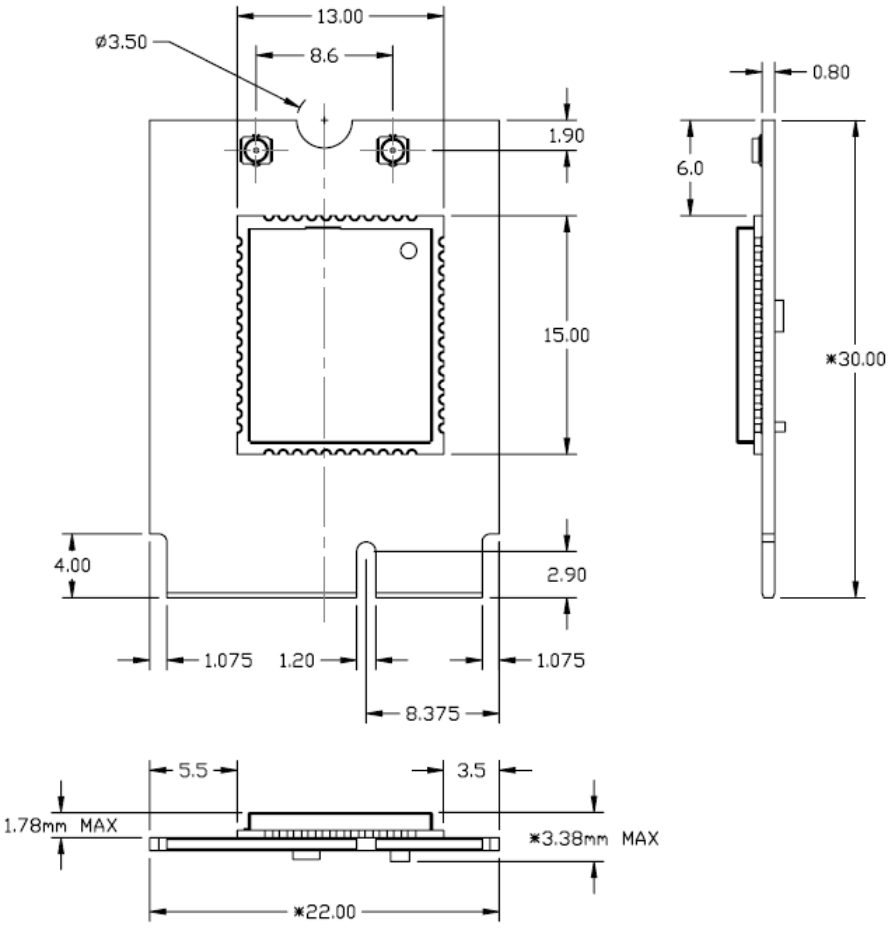


M.2 Card	VDD	3.3V	3.85V
		AP12275_M2P AP12276_M2P AP12676_M2P AP12684P_M2P	AP12684PL_M2P

7. Dimensions

7.1 Module Dimensions



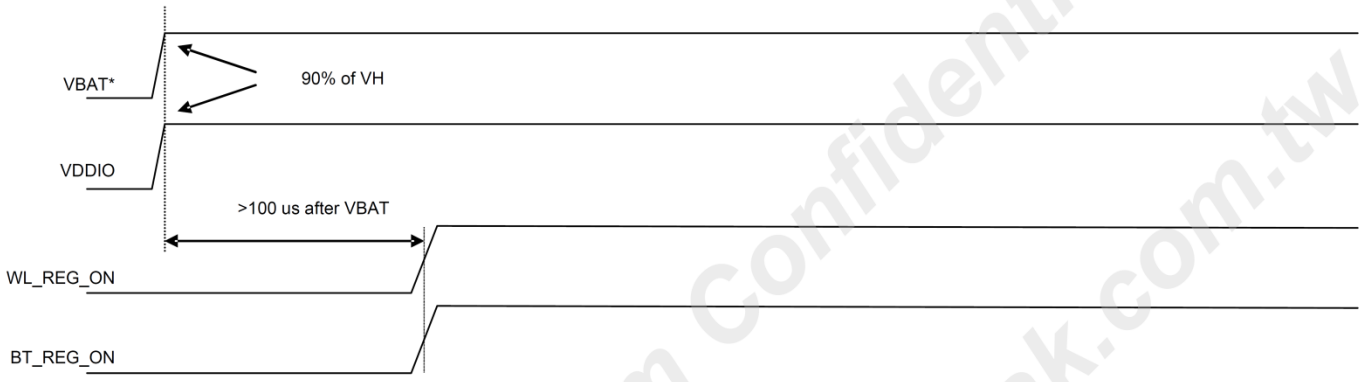


8. Host Interface Timing Diagram

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 carious 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

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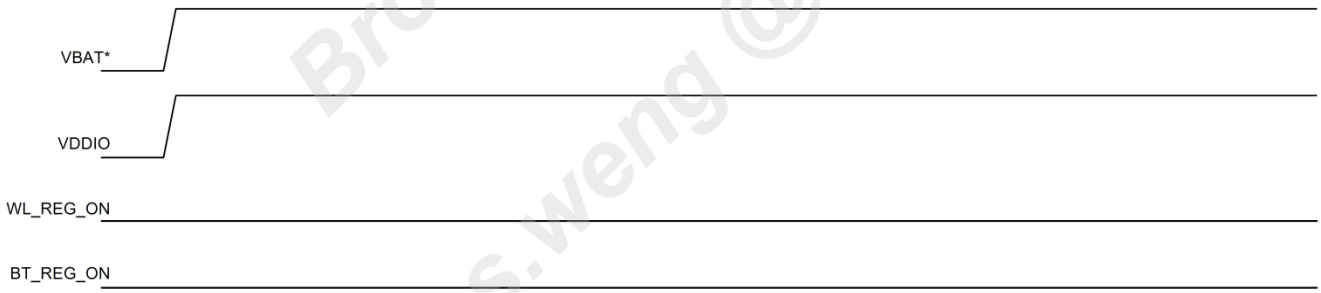
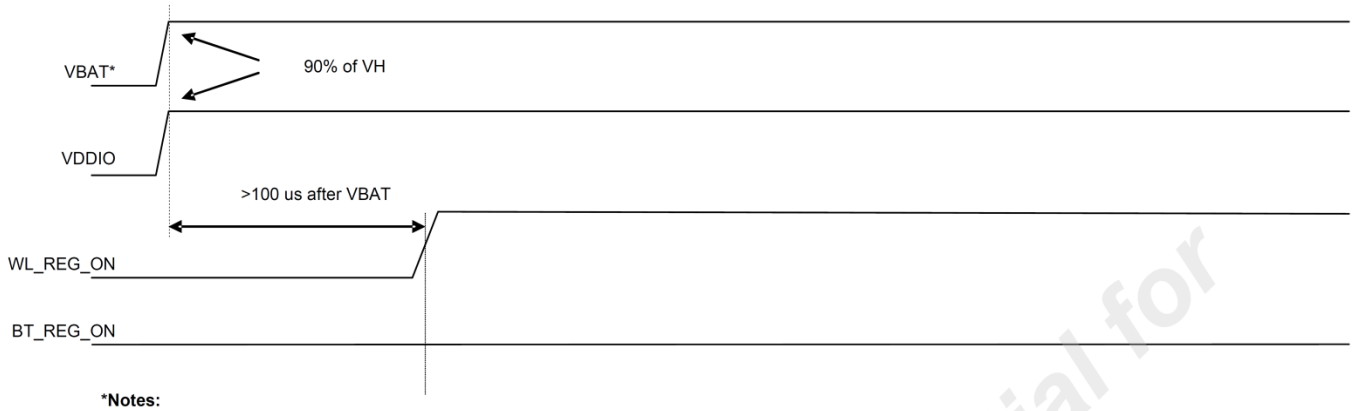


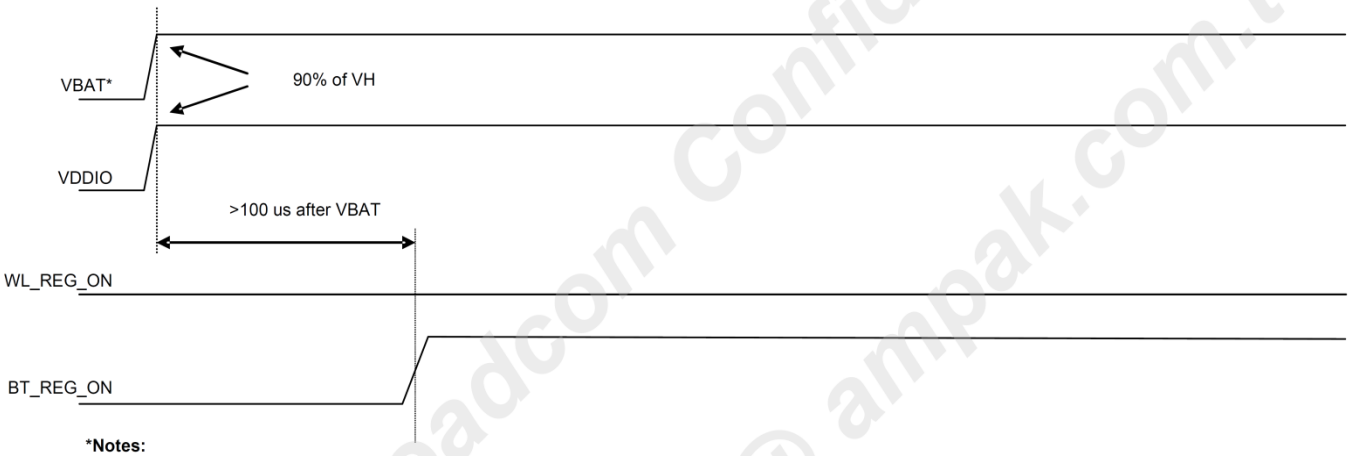
*Notes:
1. The VBAT and VDDIO 10%–90% rise-time slopes must be greater than 50 microseconds/V.
2. VBAT should be up before or at the same time as VDDIO. VDDIO should NOT be present first or be held high before VBAT is high.

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 AP12676_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.

Parameter	Symbol	Comments	Minimum	Typical	Maximum	Unit
General[1]						
Baud rate	BPS	—	—	5	—	Gbaud
Reference clock peak-to-peak differential[2]	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 returnloss	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

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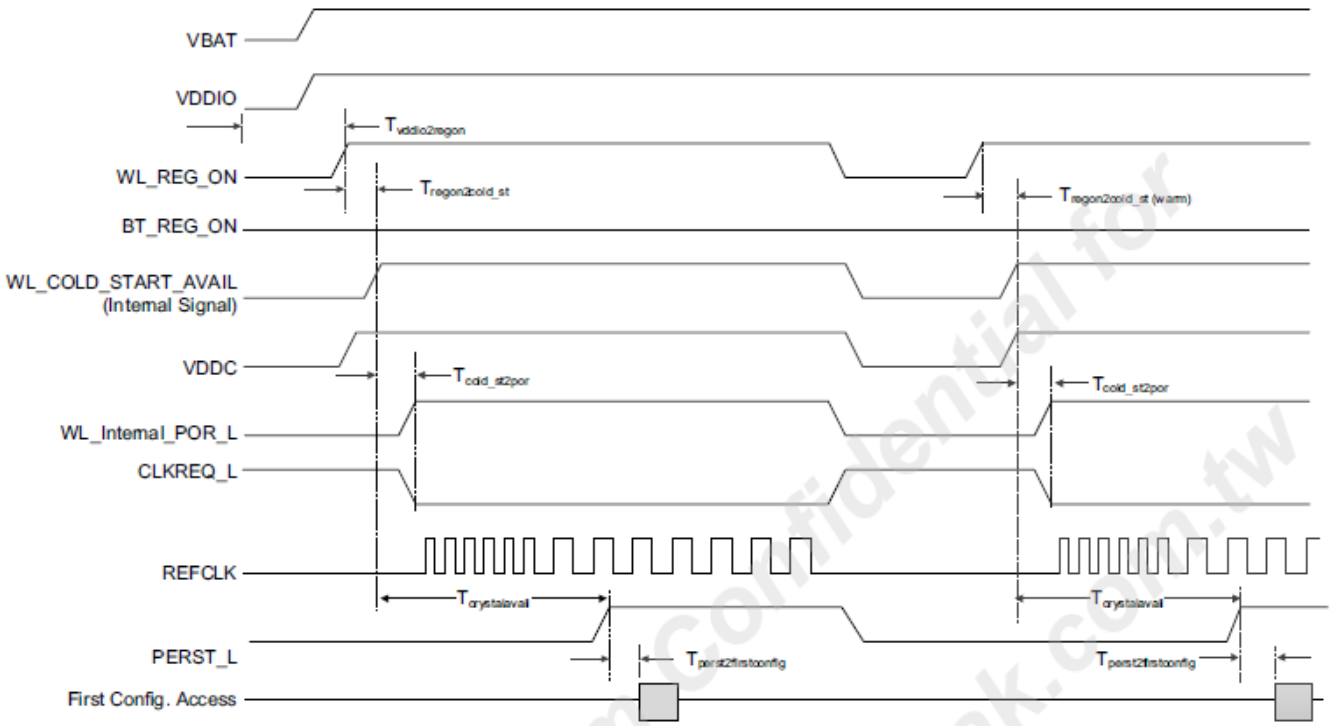
Transmitter						
Output voltage	VTX-DIFFp-p	Differential p-p, programmable in 16 steps	0.8	–	1200	mV
RX detection voltage swing	VTX-RCV-DETECT	The amount of voltage change allowed during receiver detection.	–	–	600	mV
TX AC peak common- mode voltage (2.5 GT/s)	VTX-CM-AC-P	TX AC common-mode voltage (2.5 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 electricalidle.	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
Parameter	**Symbol**	**Comments**	**Minimum**	**Typical**	**Maximum**	**Unit**
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	Differentialreturn 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

The reference clock inputs comply with the requirements of the PCI Express CEM v2.0 Specification.

PCIe Power-On Timing



Timing Parameter	Notes	Value[a]	Unit
$T_{vddio2regon}$	–	0.1	ms
$T_{regon2cold_st}$	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
$T_{vddioon2firstconfig}$	$T_{vddio2regon}$ + $T_{regon2cold_st}$ + $T_{crystalavail}$ + $T_{perst2firstconfig}$	37.4[b]	ms
$T_{regon2cold_st\ (warm)}$	162 ILP cycles	6.73	ms

a. The time values assume an ILP tolerance of ±30%.

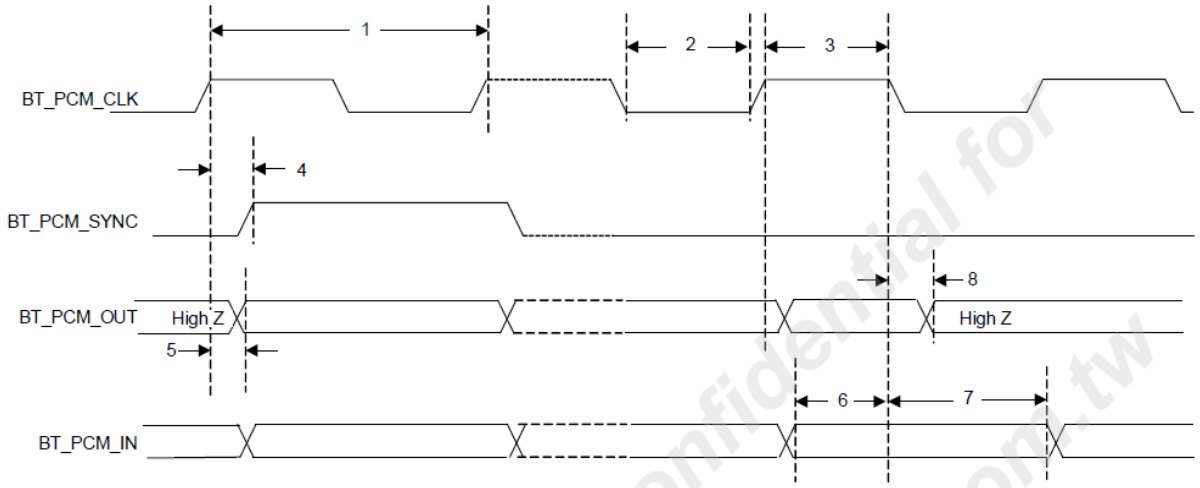
b. With VDDIO as a reference, 37.4 ms is the minimum system wait time before issuing the first configuration access.

8.3 PCM Interface Description

The PCM Interface on the AP12676_M2P can connect to linear PCM Codec devices in master or slave mode. In master mode, the AP12676_M2P generates the PCM_CLK and PCM_SYNC signals, and in slave mode, these signals are provided by another master on the PCM interface and are inputs to the AP12676_M2P. The configuration of the PCM interface may be adjusted by the host through the use of vendor-specific HCI commands.

PCM Timing

Short Frame Sync, Master Mode



PCM interfcde timing spec(short frame sync, master mode)

Reference	Characteristics	Minimum	Typical	Maximum	Unit
1	PCM bit clock frequency	—	—	12	MHz
2	PCM bit clock low	41	—	—	ns
3	PCM bit clock high	41	—	—	ns
4	BT_PCM_SYNC delay	0	—	25	ns
5	BT_PCM_OUT delay	0	—	25	ns
6	BT_PCM_IN setup	8	—	—	ns
7	BT_PCM_IN hold	8	—	—	ns
8	Delay from falling edge of BT_PCM_CLK during the last bit period to BT_PCM_OUT becoming high impedance.	0	—	25	ns

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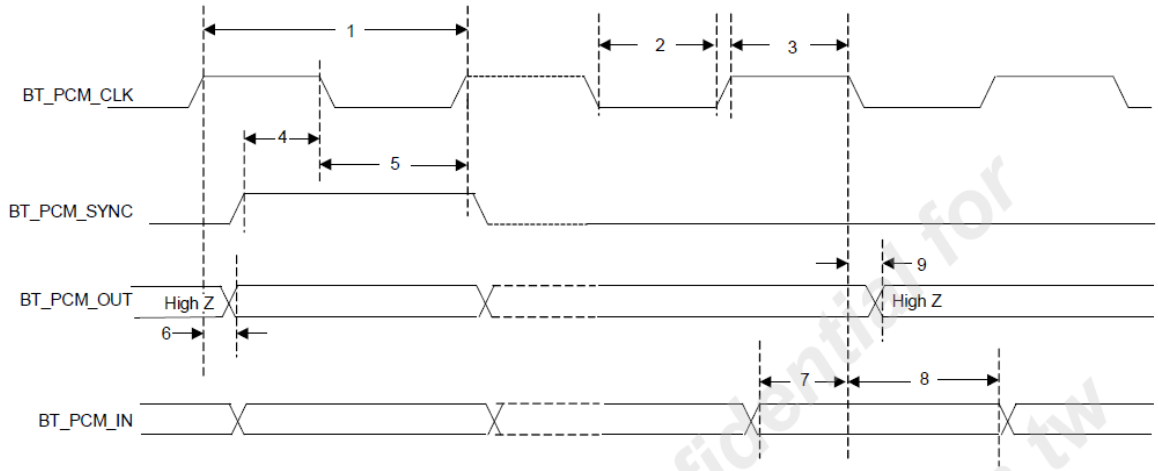
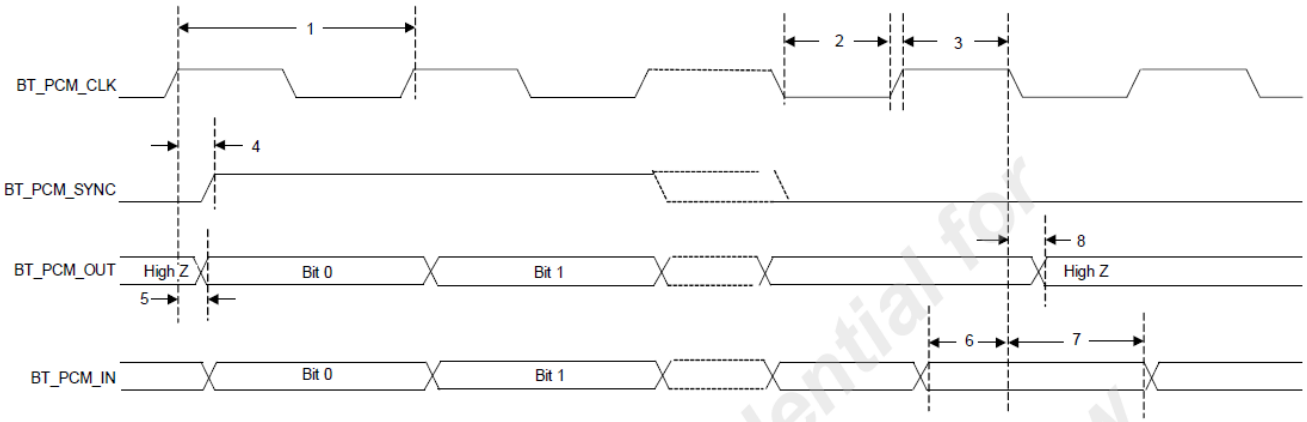
Short Frame Sync, Slave Mode



PCM interface timing spec (short frame sync, slave mode)

Reference	Characteristics	Minimum	Typical	Maximum	Unit
1	PCM bit clock frequency	—	—	12	MHz
2	PCM bit clock low	41	—	—	ns
3	PCM bit clock high	41	—	—	ns
4	BT_PCM_SYNC setup	8	—	—	ns
5	BT_PCM_SYNC hold	8	—	—	ns
6	BT_PCM_OUT delay	0	—	25	ns
7	BT_PCM_IN setup	8	—	—	ns
8	BT_PCM_IN hold	8	—	—	ns
9	Delay from falling edge of BT_PCM_CLK during the last bit period to BT_PCM_OUT becoming high impedance.	0	—	25	ns

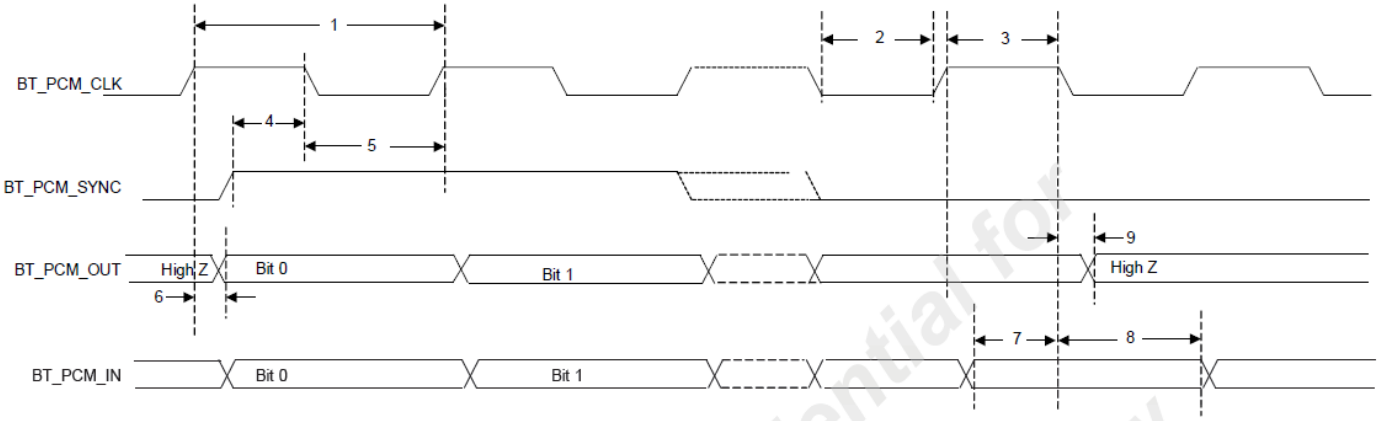
Long Frame Sync, Master Mode



PCM interface timing spec (long frame sync, master mode)

Reference	Characteristics	Minimum	Typical	Maximum	Unit
1	PCM bit clock frequency	—	—	12	MHz
2	PCM bit clock low	41	—	—	ns
3	PCM bit clock high	41	—	—	ns
4	BT_PCM_SYNC delay	0	—	25	ns
5	BT_PCM_OUT delay	0	—	25	ns
6	BT_PCM_IN setup	8	—	—	ns
7	BT_PCM_IN hold	8	—	—	ns
8	Delay from falling edge of BT_PCM_CLK during the last bit period to BT_PCM_OUT becoming high impedance.	0	—	25	ns

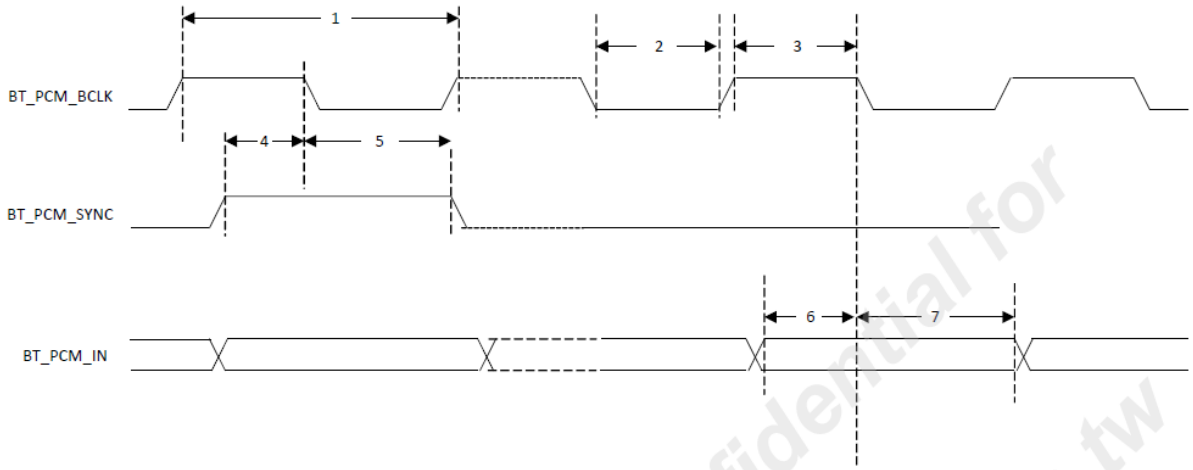
Long Frame Sync, Slave Mode



PCM interface timing spec (long frame sync, slave mode)

Reference	Characteristics	Minimum	Typical	Maximum	Unit
1	PCM bit clock frequency	—	—	12	MHz
2	PCM bit clock low	41	—	—	ns
3	PCM bit clock high	41	—	—	ns
4	BT_PCM_SYNC setup	8	—	—	ns
5	BT_PCM_SYNC hold	8	—	—	ns
6	BT_PCM_OUT delay	0	—	25	ns
7	BT_PCM_IN setup	8	—	—	ns
8	BT_PCM_IN hold	8	—	—	ns
9	Delay from falling edge of BT_PCM_CLK during the last bit period to BT_PCM_OUT becoming high impedance.	0	—	25	ns

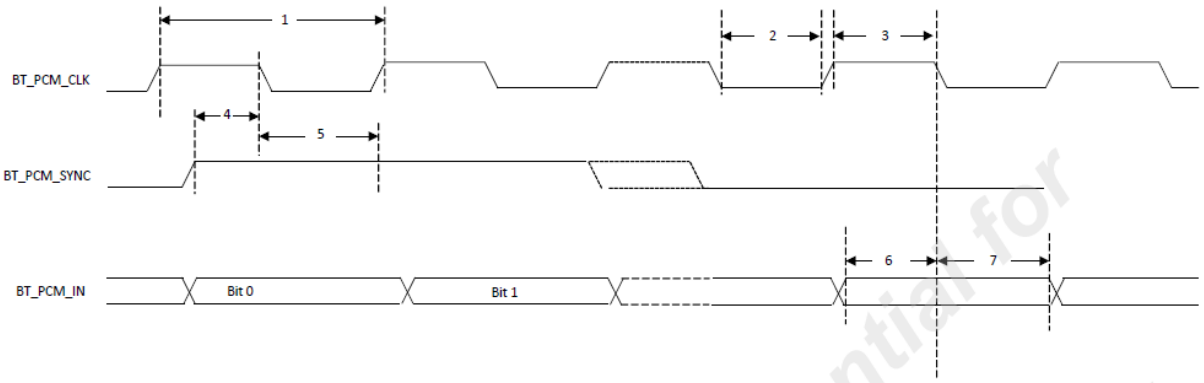
Short Frame Sync, Burst Mod



PCM burst mode (receive only, short trame sync)

Reference	Characteristics	Minimum	Typical	Maximum	Unit
1	PCM bit clock frequency	—	—	24	MHz
2	PCM bit clock low	20.8	—	—	ns
3	PCM bit clock high	20.8	—	—	ns
4	BT_PCM_SYNC setup	8	—	—	ns
5	BT_PCM_SYNC hold	8	—	—	ns
6	BT_PCM_IN setup	8	—	—	ns
7	BT_PCM_IN hold	8	—	—	ns

Long Frame Sync, Burst Mode



PCM burst mode (receive only, long frams sync)

Reference	Characteristics	Minimum	Typical	Maximum	Unit
1	PCM bit clock frequency	—	—	24	MHz
2	PCM bit clock low	20.8	—	—	ns
3	PCM bit clock high	20.8	—	—	ns
4	BT_PCM_SYNC setup	8	—	—	ns
5	BT_PCM_SYNC hold	8	—	—	ns
6	BT_PCM_IN setup	8	—	—	ns
7	BT_PCM_IN hold	8	—	—	ns

8.4 UART Interface Description

The UART is a standard 4-wire interface (RX, TX, RTS, and CTS) with adjustable baud rates from 9600 bps to 4.0 Mbps. The interface features an automatic baud rate detection capability that returns a baud rate selection. Alternatively, the baud rate may be selected through a vendor-specific UART HCI command.

UART has a 1040-byte receive FIFO and a 1040-byte transmit FIFO to support EDR. Access to the FIFOs is conducted through the AHB interface through either DMA or the CPU. The UART supports the Bluetooth UART HCI specification: H4, a custom Extended H4, and H5. The default baud rate is 115.2 Kbaud.

The UART supports the 3-wire H5 UART transport, as described in the Bluetooth specification (Three-wire UART Transport Layer). Compared to H4, the H5 UART transport reduces the number of signal lines required by eliminating the CTS and RTS signals.

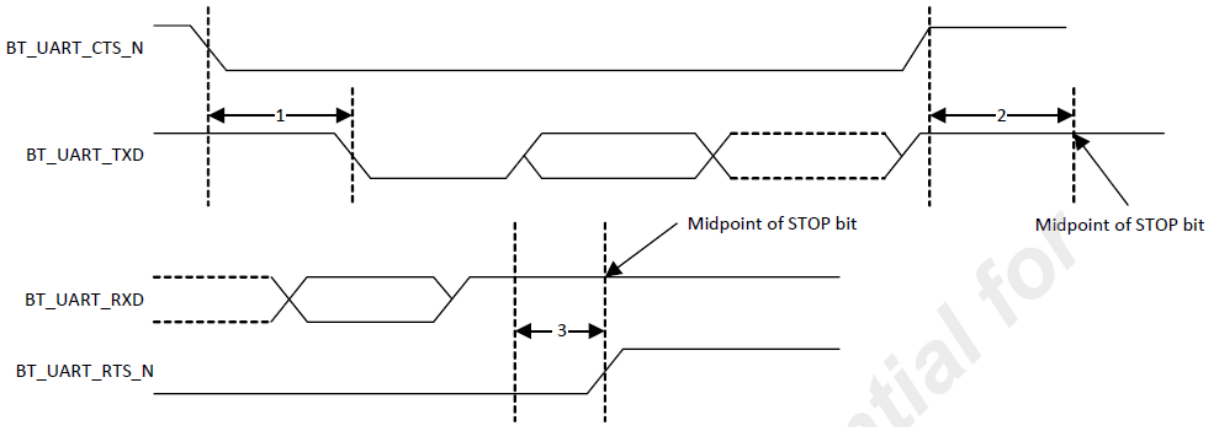
The UART can perform XON/XOFF flow control and includes hardware support for the Serial Line Input Protocol (SLIP). It can also perform wake-on activity. For example, activity on the RX or CTS inputs can wake the chip from a sleep state.

Normally, the UART baud rate is set by a configuration record downloaded after device reset, or by automatic baud rate detection, and the host does not need to adjust the baud rate. Support for changing the baud rate during normal HCI UART operation is included through a vendor-specific command that allows the host to adjust the contents of the baud rate registers. The UARTs operate correctly with the host UART as long as the combined baud rate error of the two devices is within ±2%.

Example of Common Baud Rates

Desired Rate	Actual Rate	Error (%)
4000000	4000000	0.00
3692000	3692308	0.01
3000000	3000000	0.00
2000000	2000000	0.00
1500000	1500000	0.00
1444444	1454544	0.70
921600	923077	0.16
460800	461538	0.16
230400	230796	0.17
115200	115385	0.16
57600	57692	0.16
38400	38400	0.00
28800	28846	0.16
19200	19200	0.00
14400	14423	0.16
9600	9600	0.00

UART Timing

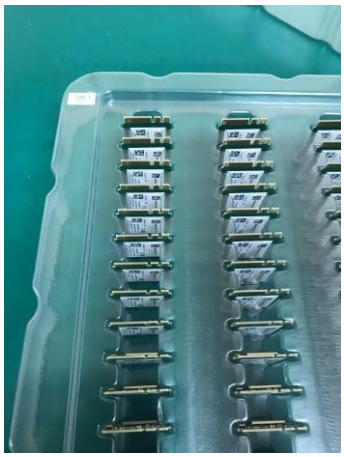


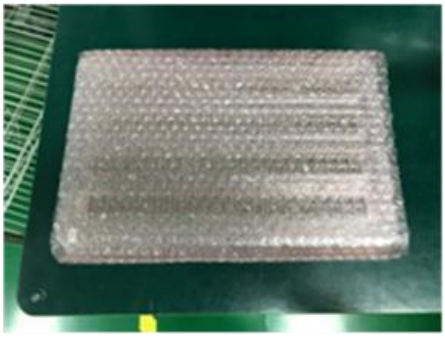
Reference	Characteristics	Minimum	Typical	Maximum	Unit
1	Delay time, BT_UART_CTS_N low to BT_UART_TXD valid	—	—	1.5	Bit periods
2	Setup time, BT_UART_CTS_N high before midpoint of stop bit	—	—	0.5	Bit periods
3	Delay time, midpoint of stop bit to BT_UART_RTS_N high	—	—	0.5	Bit periods

9. Package Information

9.1 Tray box

BOX : 100 PCS (100 PCS/Try)





9.2 Carton

Carton: 400 PCS (Box*4/Carton)