



# 正基科技股份有限公司

## SPECIFICATION

**PRODUCT NAME** : AP12275\_M2P

**REVISION** : 2.1(WEB)

**DATE** : Jun. 10<sup>th</sup> , 2026

| Customer APPROVED           |  |
|-----------------------------|--|
| Company                     |  |
| Representative<br>Signature |  |

| PREPARED | REVIEW |    |    | APPROVED | DCC ISSUE |
|----------|--------|----|----|----------|-----------|
|          | PM     | QA | ET |          |           |
|          |        |    |    |          |           |



# 正基科技股份有限公司



## AP12275\_M2P Data Sheet

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# Revision

| Revision | Date       | Description                                   | Revised By |
|----------|------------|-----------------------------------------------|------------|
| 0.1      | 2020/02/19 | - Preliminary                                 | Jason      |
| 0.2      | 2020/03/09 | - Modify RF Specification<br>- Modify Pin-out | Jason      |
| 0.3      | 2020/03/16 | - Modify RF Specification                     | Jason      |
| 0.4      | 2020/04/28 | - Modify RF Specification                     | Jason      |
| 0.5      | 2020/05/29 | - Modify RF Specification                     | Jason      |
| 0.6      | 2020/07/01 | - Modify DC Characteristics                   | Jason      |
| 0.7      | 2020/07/06 | - Modify Pin outline                          | Jason      |
| 0.8      | 2020/08/12 | - Modify RF Specification                     | Jason      |
| 0.9      | 2020/09/09 | - Modify Pin-out Description                  | Jason      |
| 1.0      | 2020/09/15 | - Modify Block Diagram                        | Jason      |
| 1.1      | 2020/09/22 | - Modify Block Diagram                        | Jason      |
| 1.2      | 2020/10/15 | - Modify Pin outline                          | Jason      |
| 1.3      | 2020/11/04 | - Modify Module Dimensions                    | Jason      |
| 1.4      | 2021/05/07 | - Modify Reference design                     | Richard    |
| 1.5      | 2021/06/25 | - Update Bluetooth Specification              | Richard    |
| 1.6      | 2022/10/27 | - Modify 5GHz supported channel               | Richard    |
| 1.7      | 2023/09/21 | - Update Bluetooth Specification              | Jason      |
| 1.8      | 2024/03/27 | - Modify Package Information                  | Jason      |
| 1.9      | 2025/03/11 | -Update Block Diagram                         | Jason      |
| 2.0      | 2025/08/05 | - Update Module Dimensions                    | Jason      |
| 2.1      | 2026/06/10 | - Update RF Specification                     | Jason      |

RED2014/53/EU

## Declaration of Conformity

Hereby, Ampak Technology Inc declares that this AP12275\_M2P product is in compliance with essential requirements and other relevant provisions of Directive 2014/53/EU. A copy of the Declaration of conformity can be found at <https://www.ampak.com.tw/tw>

The AP12275\_M2P used at 20cm from body.

When the device support wlan5G(5150-5250Mhz), Manufacture will list the following statement and country list (not EU country) on the user manual, and wlan5G only used to indoor

|                                                                                   |    |    |    |    |    |    |    |
|-----------------------------------------------------------------------------------|----|----|----|----|----|----|----|
|  | AT | BE | BG | HR | CY | CZ | DK |
|                                                                                   | EE | FI | FR | DE | EL | HU | IE |
|                                                                                   | IT | LV | LT | LU | MT | NL | PL |
|                                                                                   | PT | RO | SK | SI | ES | SE | UK |

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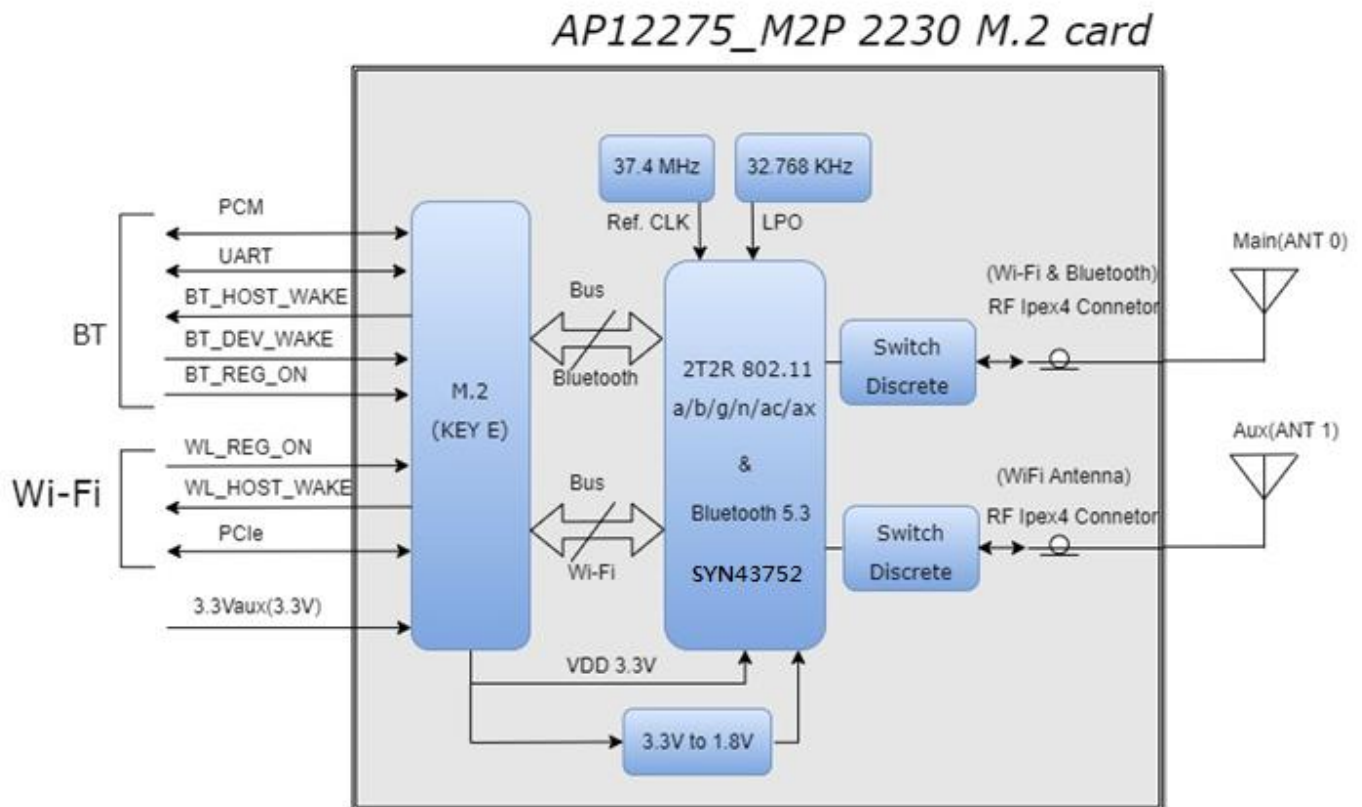
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# 1. Introduction

## 1.1 Overview

The AMPAK Technology® AP12275\_M2P is a fully Wi-Fi 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 AP12275\_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 with optional SGI (1024 QAM modulation)
- Supported Partial RU(Resource Unit) in 802.11ax.
- 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 Features

- Bluetooth 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            | AP12275_M2P                                                                               |
| Product Description   | 2T2R 802.11 a/b/g/n/ac/ax Wi-Fi + BT 5.3<br>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 105°C                                                                            |
| Humidity              | Operating Humidity 10% to 95% Non-Condensing<br>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<sub>aux</sub>=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<br>802.11 g/n : OFDM /64-QAM 、16-QAM 、QPSK 、BPSK<br>802.11ax : OFDM /256-QAM 、64-QAM 、16-QAM 、QPSK 、BPSK |          |          |          |
| Resource Unit                                                                                                                            |               | Partial RU :<br>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   |          |
|                                                                                                                                          | 18.5          | 18.5                                                                                                                                 | 18.5     | 18.5     |          |
| 802.11g                                                                                                                                  | 6 、9Mbps      | 12 、18Mbps                                                                                                                           | 24Mbps   | 36Mbps   | 48Mbps   |
|                                                                                                                                          | 18            | 18                                                                                                                                   | 17.5     | 17.5     | 17       |
|                                                                                                                                          | 54Mbps        |                                                                                                                                      |          |          |          |
|                                                                                                                                          | 17            |                                                                                                                                      |          |          |          |
| 802.11n<br>20MHz                                                                                                                         | MCS0~2        | MCS3                                                                                                                                 | MCS4     | MCS5     | MCS6     |
|                                                                                                                                          | 18            | 17.5                                                                                                                                 | 17.5     | 17       | 17       |
|                                                                                                                                          | MCS7          |                                                                                                                                      |          |          |          |
|                                                                                                                                          | 16            |                                                                                                                                      |          |          |          |
| 802.11ac/ax<br>20MHz                                                                                                                     | MCS0~2/HE 0~2 | MCS3/HE 3                                                                                                                            | MCS4/HE4 | MCS5/HE5 | MCS6/HE6 |
|                                                                                                                                          | 18            | 17.5                                                                                                                                 | 17.5     | 17       | 17       |
|                                                                                                                                          | MCS7/HE7      | MCS8/HE8                                                                                                                             | HE9      |          |          |
|                                                                                                                                          | 16            | 15                                                                                                                                   | 15       |          |          |
| 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         | -96                                                                                                                                  |          |          |          |
|                                                                                                                                          | 2Mbps         | -92                                                                                                                                  |          |          |          |
|                                                                                                                                          | 5.5Mbps       | -90                                                                                                                                  |          |          |          |
|                                                                                                                                          | 11Mbps        | -88                                                                                                                                  |          |          |          |

|                        |                        |            |           |            |
|------------------------|------------------------|------------|-----------|------------|
| 802.11g SISO           | Data Rate              | Spec.(dBm) | Data Rate | Spec.(dBm) |
|                        | 6Mbps                  | -92        | 24Mbps    | -84        |
|                        | 9Mbps                  | -91        | 36Mbps    | -81        |
|                        | 12Mbps                 | -90        | 48Mbps    | -77        |
|                        | 18Mbps                 | -87        | 54Mbps    | -75        |
| 802.11n_20MHz SISO     | Data Rate              | Spec.(dBm) | Data Rate | Spec.(dBm) |
|                        | MCS0                   | -91        | MCS4      | -80        |
|                        | MCS1                   | -88        | MCS5      | -78        |
|                        | MCS2                   | -86        | MCS6      | -75        |
|                        | MCS3                   | -83        | MCS7      | -74        |
| 802.11n_20MHz MIMO     | Data Rate              | Spec.(dBm) | Data Rate | Spec.(dBm) |
|                        | MCS0                   | -92        | MCS5      | -79        |
|                        | MCS1                   | -91        | MCS6      | -77        |
|                        | MCS2                   | -89        | MCS7      | -75        |
|                        | MCS3                   | -86        | MCS8      | -71        |
|                        | MCS4                   | -82        | MCS15     | -72        |
| 802.11ac/ax_20MHz SISO | Data Rate              | Spec.(dBm) | Data Rate | Spec.(dBm) |
|                        | MCS0/HE0               | -92        | MCS6/HE6  | -75        |
|                        | MCS1/HE1               | -88        | MCS7/HE7  | -75        |
|                        | MCS2/HE2               | -86        | MCS8/HE8  | -71        |
|                        | MCS3/HE3               | -83        | HE9       | -69        |
|                        | MCS4/HE4               | -80        |           |            |
|                        | MCS5/HE5               | -78        |           |            |
| 802.11ac/ax_20MHz MIMO | Data Rate              | Spec.(dBm) | Data Rate | Spec.(dBm) |
|                        | MCS0/HE0               | -91        | MCS6/HE6  | -74        |
|                        | MCS1/HE1               | -87        | MCS7/HE7  | -74        |
|                        | MCS2/HE2               | -85        | MCS8/HE8  | -70        |
|                        | MCS3/HE3               | -82        | HE9       | -68        |
|                        | MCS4/HE4               | -79        |           |            |
|                        | MCS5/HE5               | -77        |           |            |
| 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<br>5.47~5.725GHz ： Ch100 ~ Ch144<br>5.725~5.85GHz ： Ch149 ~ Ch165                                                                                                                                                        |           |        |        |
| Modulation                                                                       |                 | 802.11a ： OFDM /64-QAM 、 16-QAM 、 QPSK 、 BPSK<br>802.11n ： OFDM /64-QAM 、 16-QAM 、 QPSK 、 BPSK<br>802.11ac ： OFDM /256-QAM 、 OFDM /64-QAM 、 16-QAM 、 QPSK 、 BPSK<br>802.11ax ： OFDM/ 1024-QAM 、 OFDM /256-QAM 、 OFDM /64-QAM 、 16-QAM 、 QPSK 、 BPSK |           |        |        |
| Resource Unit                                                                    |                 | Partial RU ：<br>BW20MHz ： 26T 、 52T 、 106T 、 242T<br>BW40MHz ： 26T 、 52T 、 106T 、 242T 、 484T<br>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       | 15.5                                                                                                                                                                                                                                                | 15.5      | 15     | 15     |
|                                                                                  | 5470~5725       | 15.5                                                                                                                                                                                                                                                | 15.5      | 15     | 15     |
|                                                                                  | 5725~5845       | 15.5                                                                                                                                                                                                                                                | 15.5      | 15     | 15     |
|                                                                                  | Frequency (MHz) | 48Mbps                                                                                                                                                                                                                                              | 54Mbps    |        |        |
|                                                                                  | 5150~5350       | 14.5                                                                                                                                                                                                                                                | 14.5      |        |        |
|                                                                                  | 5470~5725       | 14.5                                                                                                                                                                                                                                                | 14.5      |        |        |
|                                                                                  | 5725~5845       | 14.5                                                                                                                                                                                                                                                | 14.5      |        |        |
| 802.11n<br>20MHz                                                                 | Frequency (MHz) | MCS0~2                                                                                                                                                                                                                                              | MCS3      | MCS4   | MCS5   |
|                                                                                  | 5150~5350       | 15                                                                                                                                                                                                                                                  | 15        | 14.5   | 14.5   |
|                                                                                  | 5470~5725       | 15                                                                                                                                                                                                                                                  | 15        | 14.5   | 14.5   |
|                                                                                  | 5725~5845       | 15                                                                                                                                                                                                                                                  | 15        | 14.5   | 14.5   |
|                                                                                  | Frequency (MHz) | MCS6                                                                                                                                                                                                                                                | MCS7      |        |        |
|                                                                                  | 5150~5350       | 13.5                                                                                                                                                                                                                                                | 13.5      |        |        |
|                                                                                  | 5470~5725       | 13.5                                                                                                                                                                                                                                                | 13.5      |        |        |
|                                                                                  | 5725~5845       | 13.5                                                                                                                                                                                                                                                | 13.5      |        |        |

|                   |                 |        |      |      |      |
|-------------------|-----------------|--------|------|------|------|
| 802.11n<br>40MHz  | Frequency (MHz) | MCS0~2 | MCS3 | MCS4 | MCS5 |
|                   | 5150~5350       | 15     | 15   | 14   | 14   |
|                   | 5470~5725       | 15     | 15   | 14   | 14   |
|                   | 5725~5845       | 15     | 15   | 14   | 14   |
|                   | Frequency (MHz) | MCS6   | MCS7 |      |      |
|                   | 5150~5350       | 13.5   | 13.5 |      |      |
|                   | 5470~5725       | 13.5   | 13.5 |      |      |
|                   | 5725~5845       | 13.5   | 13.5 |      |      |
| 802.11ac<br>20MHz | Frequency (MHz) | MCS0~2 | MCS3 | MCS4 | MCS5 |
|                   | 5150~5350       | 15     | 15   | 14.5 | 14.5 |
|                   | 5470~5725       | 15     | 15   | 14.5 | 14.5 |
|                   | 5725~5845       | 15     | 15   | 14.5 | 14.5 |
|                   | Frequency (MHz) | MCS6   | MCS7 | MCS8 |      |
|                   | 5150~5350       | 13.5   | 13.5 | 11   |      |
|                   | 5470~5725       | 13.5   | 13.5 | 11   |      |
|                   | 5725~5845       | 13.5   | 13.5 | 11   |      |
| 802.11ac<br>40MHz | Frequency (MHz) | MCS0~2 | MCS3 | MCS4 | MCS5 |
|                   | 5150~5350       | 15     | 14   | 14   | 14   |
|                   | 5470~5725       | 15     | 14   | 14   | 14   |
|                   | 5725~5845       | 15     | 14   | 14   | 14   |
|                   | Frequency (MHz) | MCS6   | MCS7 | MCS8 | MCS9 |
|                   | 5150~5350       | 13.5   | 13.5 | 11   | 9    |
|                   | 5470~5725       | 13.5   | 13.5 | 11   | 9    |
|                   | 5725~5845       | 13.5   | 13.5 | 11   | 9    |
| 802.11ac<br>80MHz | Frequency (MHz) | MCS0~2 | MCS3 | MCS4 | MCS5 |
|                   | 5150~5350       | 15     | 14   | 13.5 | 13.5 |
|                   | 5470~5725       | 15     | 14   | 13.5 | 13.5 |
|                   | 5725~5845       | 15     | 14   | 13.5 | 13.5 |
|                   | Frequency (MHz) | MCS6   | MCS7 | MCS8 | MCS9 |
|                   | 5150~5350       | 13     | 13   | 9    | 9    |
|                   | 5470~5725       | 13     | 13   | 9    | 9    |
|                   | 5725~5845       | 13     | 13   | 9    | 9    |

|                   |                 |       |      |      |      |
|-------------------|-----------------|-------|------|------|------|
| 802.11ax<br>20MHz | Frequency (MHz) | HE0~2 | HE3  | HE4  | HE5  |
|                   | 5150~5350       | 15    | 14.5 | 14.5 | 14.5 |
|                   | 5470~5725       | 15    | 14.5 | 14.5 | 14.5 |
|                   | 5725~5845       | 15    | 14.5 | 14.5 | 14.5 |
|                   | Frequency (MHz) | HE6   | HE7  | HE8  | HE9  |
|                   | 5150~5350       | 13.5  | 13.5 | 11   | 11   |
|                   | 5470~5725       | 13.5  | 13.5 | 11   | 11   |
|                   | 5725~5845       | 13.5  | 13.5 | 11   | 11   |
|                   | Frequency (MHz) | HE10  | HE11 |      |      |
|                   | 5150~5350       | 9     | 9    |      |      |
|                   | 5470~5725       | 9     | 9    |      |      |
|                   | 5725~5845       | 9     | 9    |      |      |
| 802.11ax<br>40MHz | Frequency (MHz) | HE0~2 | HE3  | HE4  | HE5  |
|                   | 5150~5350       | 15    | 14   | 14   | 14   |
|                   | 5470~5725       | 15    | 14   | 14   | 14   |
|                   | 5725~5845       | 15    | 14   | 14   | 14   |
|                   | Frequency (MHz) | HE6   | HE7  | HE8  | HE9  |
|                   | 5150~5350       | 13.5  | 13.5 | 11   | 9    |
|                   | 5470~5725       | 13.5  | 13.5 | 11   | 9    |
|                   | 5725~5845       | 13.5  | 13.5 | 11   | 9    |
|                   | Frequency (MHz) | HE10  | HE11 |      |      |
|                   | 5150~5350       | 7     | 7    |      |      |
|                   | 5470~5725       | 7     | 7    |      |      |
|                   | 5725~5845       | 7     | 7    |      |      |
| 802.11ax<br>80MHz | Frequency (MHz) | HE0~2 | HE3  | HE4  | HE5  |
|                   | 5150~5350       | 15    | 14   | 13.5 | 13.5 |
|                   | 5470~5725       | 15    | 14   | 13.5 | 13.5 |
|                   | 5725~5845       | 15    | 14   | 13.5 | 13.5 |
|                   | Frequency (MHz) | HE6   | HE7  | HE8  | HE9  |
|                   | 5150~5350       | 13    | 13   | 9    | 9    |
|                   | 5470~5725       | 13    | 13   | 9    | 9    |
|                   | 5725~5845       | 13    | 13   | 9    | 9    |
|                   | Frequency (MHz) | HE10  | HE11 |      |      |
|                   | 5150~5350       | 7     | 7    |      |      |
|                   | 5470~5725       | 7     | 7    |      |      |
|                   | 5725~5845       | 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 $\pm 2$ dB |           |            |           |            |
|-----------------------------------|-----------|------------|-----------|------------|
| OFDM modulation PER $\leq 10\%$   |           |            |           |            |
| 802.11a<br>SISO                   | Data Rate | Spec.(dBm) | Data Rate | Spec.(dBm) |
|                                   | 6Mbps     | -89        | 24Mbps    | -82        |
|                                   | 9Mbps     | -88        | 36Mbps    | -79        |
|                                   | 12Mbps    | -87        | 48Mbps    | -74        |
|                                   | 18Mbps    | -85        | 54Mbps    | -72        |
| 802.11n_20MHz<br>SISO             | Data Rate | Spec.(dBm) | Data Rate | Spec.(dBm) |
|                                   | MCS0      | -89        | MCS4      | -78        |
|                                   | MCS1      | -87        | MCS5      | -75        |
|                                   | MCS2      | -85        | MCS6      | -72        |
|                                   | MCS3      | -82        | MCS7      | -70        |
| 802.11n_20MHz<br>MIMO             | Data Rate | Spec.(dBm) | Data Rate | Spec.(dBm) |
|                                   | MCS0      | -91        | MCS5      | -77        |
|                                   | MCS1      | -90        | MCS6      | -75        |
|                                   | MCS2      | -88        | MCS7      | -73        |
|                                   | MCS3      | -85        | MCS8      | -88        |
|                                   | MCS4      | -81        | MCS15     | -69        |
| 802.11n_40MHz<br>SISO             | Data Rate | Spec.(dBm) | Data Rate | Spec.(dBm) |
|                                   | MCS0      | -87        | MCS4      | -76        |
|                                   | MCS1      | -85        | MCS5      | -71        |
|                                   | MCS2      | -82        | MCS6      | -69        |
|                                   | MCS3      | -79        | MCS7      | -67        |
| 802.11n_40MHz<br>MIMO             | Data Rate | Spec.(dBm) | Data Rate | Spec.(dBm) |
|                                   | MCS0      | -87        | MCS5      | -74        |
|                                   | MCS1      | -87        | MCS6      | -72        |
|                                   | MCS2      | -85        | MCS7      | -70        |
|                                   | MCS3      | -82        | MCS8      | -85        |
|                                   | MCS4      | -78        | MCS15     | -66        |

|                        |            |            |            |            |
|------------------------|------------|------------|------------|------------|
| 802.11ac_20MHz<br>SISO | Data Rate  | Spec.(dBm) | Data Rate  | Spec.(dBm) |
|                        | MCS0       | -89        | MCS5       | -74        |
|                        | MCS1       | -87        | MCS6       | -72        |
|                        | MCS2       | -85        | MCS7       | -69        |
|                        | MCS3       | -82        | MCS8       | -67        |
|                        | MCS4       | -78        |            |            |
| 802.11ac_20MHz<br>MIMO | Data Rate  | Spec.(dBm) | Data Rate  | Spec.(dBm) |
|                        | MCS0,NSS=1 | -91        | MCS6,NSS=1 | -75        |
|                        | MCS1,NSS=1 | -90        | MCS7,NSS=1 | -74        |
|                        | MCS2,NSS=1 | -87        | MCS8,NSS=1 | -71        |
|                        | MCS3,NSS=1 | -84        | MCS0,NSS=2 | -87        |
|                        | MCS4,NSS=1 | -81        | MCS8,NSS=2 | -64        |
|                        | MCS5,NSS=1 | -76        |            |            |
| 802.11ac_40MHz<br>SISO | Data Rate  | Spec.(dBm) | Data Rate  | Spec.(dBm) |
|                        | MCS0       | -87        | MCS5       | -71        |
|                        | MCS1       | -85        | MCS6       | -69        |
|                        | MCS2       | -82        | MCS7       | -68        |
|                        | MCS3       | -79        | MCS8       | -64        |
|                        | MCS4       | -75        | MCS9       | -63        |
| 802.11ac_40MHz<br>MIMO | Data Rate  | Spec.(dBm) | Data Rate  | Spec.(dBm) |
|                        | MCS0,NSS=1 | -89        | MCS6,NSS=1 | -72        |
|                        | MCS1,NSS=1 | -87        | MCS7,NSS=1 | -71        |
|                        | MCS2,NSS=1 | -85        | MCS8,NSS=1 | -67        |
|                        | MCS3,NSS=1 | -81        | MCS9,NSS=1 | -65        |
|                        | MCS4,NSS=1 | -78        | MCS0,NSS=2 | -85        |
|                        | MCS5,NSS=1 | -76        | MCS9,NSS=2 | -59        |
| 802.11ac_80MHz<br>SISO | Data Rate  | Spec.(dBm) | Data Rate  | Spec.(dBm) |
|                        | MCS0       | -84        | MCS5       | -67        |
|                        | MCS1       | -81        | MCS6       | -66        |
|                        | MCS2       | -78        | MCS7       | -64        |
|                        | MCS3       | -75        | MCS8       | -61        |
|                        | MCS4       | -72        | MCS9       | -60        |

|                        |            |            |            |            |
|------------------------|------------|------------|------------|------------|
| 802.11ac_80MHz<br>MIMO | Data Rate  | Spec.(dBm) | Data Rate  | Spec.(dBm) |
|                        | MCS0,NSS=1 | -86        | MCS6,NSS=1 | -69        |
|                        | MCS1,NSS=1 | -84        | MCS7,NSS=1 | -67        |
|                        | MCS2,NSS=1 | -81        | MCS8,NSS=1 | -65        |
|                        | MCS3,NSS=1 | -78        | MCS9,NSS=1 | -62        |
|                        | MCS4,NSS=1 | -75        | MCS0,NSS=2 | -82        |
|                        | MCS5,NSS=1 | -70        | MCS9,NSS=2 | -57        |
| 802.11ax_20MHz<br>SISO | Data Rate  | Spec.(dBm) | Data Rate  | Spec.(dBm) |
|                        | HE0        | -89        | HE6        | -72        |
|                        | HE1        | -87        | HE7        | -69        |
|                        | HE2        | -85        | HE8        | -67        |
|                        | HE3        | -82        | HE9        | -63        |
|                        | HE4        | -78        | HE10       | -58        |
|                        | HE5        | -74        | HE11       | -56        |
| 802.11ax_20MHz<br>MIMO | Data Rate  | Spec.(dBm) | Data Rate  | Spec.(dBm) |
|                        | HE0        | -88        | HE6        | -71        |
|                        | HE1        | -86        | HE7        | -68        |
|                        | HE2        | -84        | HE8        | -66        |
|                        | HE3        | -81        | HE9        | -62        |
|                        | HE4        | -77        | HE10       | -57        |
|                        | HE5        | -73        | HE11       | -55        |
| 802.11ax_40MHz<br>SISO | Data Rate  | Spec.(dBm) | Data Rate  | Spec.(dBm) |
|                        | HE0        | -87        | HE6        | -69        |
|                        | HE1        | -85        | HE7        | -68        |
|                        | HE2        | -82        | HE8        | -64        |
|                        | HE3        | -79        | HE9        | -63        |
|                        | HE4        | -75        | HE10       | -59        |
|                        | HE5        | -71        | HE11       | -54        |
| 802.11ax_40MHz<br>MIMO | 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_80MHz<br>SISO | Data Rate                 | Spec.(dBm) | Data Rate | Spec.(dBm) |
|                        | HE0                       | -84        | HE6       | -66        |
|                        | HE1                       | -81        | HE7       | -64        |
|                        | HE2                       | -78        | HE8       | -61        |
|                        | HE3                       | -75        | HE9       | -60        |
|                        | HE4                       | -72        | HE10      | -54        |
|                        | HE5                       | -67        | HE11      | -50        |
| 802.11ax_80MHz<br>MIMO | 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      | -53        |
|                        | HE5                       | -66        | HE11      | -49        |
| Maximum Input<br>Level | 802.11a/n/ac/ax : -30 dBm |            |           |            |

## 4. Bluetooth Specification

### 4.1 Bluetooth Specification

Conditions : 3.3V<sub>aux</sub>=3.3V ; Temp:25°C

| Feature                                                 | Description                                      |
|---------------------------------------------------------|--------------------------------------------------|
| <b>General Specification</b>                            |                                                  |
| 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            |
| <b>RF Specification</b>                                 |                                                  |
| <b>Output Power , tolerance <math>\pm 1.5</math> dB</b> |                                                  |
|                                                         | <b>CL1 (dBm)</b>                                 |
| BDR Output Power                                        | 8                                                |
| EDR Output Power                                        | 6                                                |
| BLE Output Power                                        | 7                                                |
| <b>Sensitivity, tolerance <math>\pm 1.5</math> dB</b>   |                                                  |
| Sensitivity @ BER=0.1%<br>for GFSK (1Mbps)              | -88 dBm                                          |
| Sensitivity @ BER=0.01%<br>for $\pi/4$ -DQPSK (2Mbps)   | -91 dBm                                          |
| Sensitivity @ BER=0.01%<br>for 8DPSK (3Mbps)            | -85 dBm                                          |
| Sensitivity @ PER=30.8%<br>for LE (1Mbps)               | -91 dBm                                          |
| Sensitivity @ PER=30.8%<br>for 2LE (2Mbps)              | -90 dBm                                          |
| Sensitivity @ PER=30.8%<br>for LELR (125Kbps)           | -100 dBm                                         |
| Sensitivity @ PER=30.8%<br>for LELR (500Kbps)           | -95 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             | 3.3Vaux             | 2  |
| 3  | NC              | 3.3Vaux             | 4  |
| 5  | NC              | NC                  | 6  |
| 7  | GND             | PCM_CLK (1.8V)      | 8  |
| 9  | NC              | PCM_SYNC (1.8V)     | 10 |
| 11 | NC              | PCM_OUT (1.8V)      | 12 |
| 13 | NC              | PCM_IN (1.8V)       | 14 |
| 15 | NC              | NC                  | 16 |
| 17 | NC              | GND                 | 18 |
| 19 | NC              | BT_HOST_WAKE (1.8V) | 20 |
| 21 | NC              | UART TXD (1.8V)     | 22 |
| 23 | NC              | Key                 | 24 |
| 25 | NC              | Key                 | 26 |
| 27 | Key             | Key                 | 28 |
| 29 | Key             | Key                 | 30 |
| 31 | Key             | Key                 | 32 |
| 33 | Key             | UART RXD (1.8V)     | 34 |
| 35 | GND             | UART RTS (1.8V)     | 36 |
| 37 | PERp0           | UART CTS_N (1.8V)   | 38 |
| 39 | PERn0           | BT_DEV_WAKE (1.8V)  | 40 |
| 41 | GND             | WL_HOST_WAKE (1.8V) | 42 |
| 43 | PETp0           | NC                  | 44 |
| 45 | PETn0           | NC                  | 46 |
| 47 | GND             | NC                  | 48 |
| 49 | REFCLKP0        | NC                  | 50 |
| 51 | REFCLKN0        | NC                  | 52 |
| 53 | GND             | PERST0# (3.3V)      | 54 |
| 55 | CLKREQ0# (3.3V) | BT_REG_ON (3.3V)    | 56 |
| 57 | PEWake0# (1.8V) | WL_REG_ON (3.3V)    | 58 |
| 59 | GND             | NC                  | 60 |
| 61 | NC              | NC                  | 62 |
| 63 | NC              | NC                  | 64 |
| 65 | GND             | NC                  | 66 |
| 67 | NC              | NC                  | 68 |
| 69 | NC              | NC                  | 70 |
| 71 | GND             | NC                  | 72 |
| 73 | NC              | 3.3Vaux             | 74 |
| 75 | NC              | 3.3Vaux             |    |
|    | GND             |                     |    |

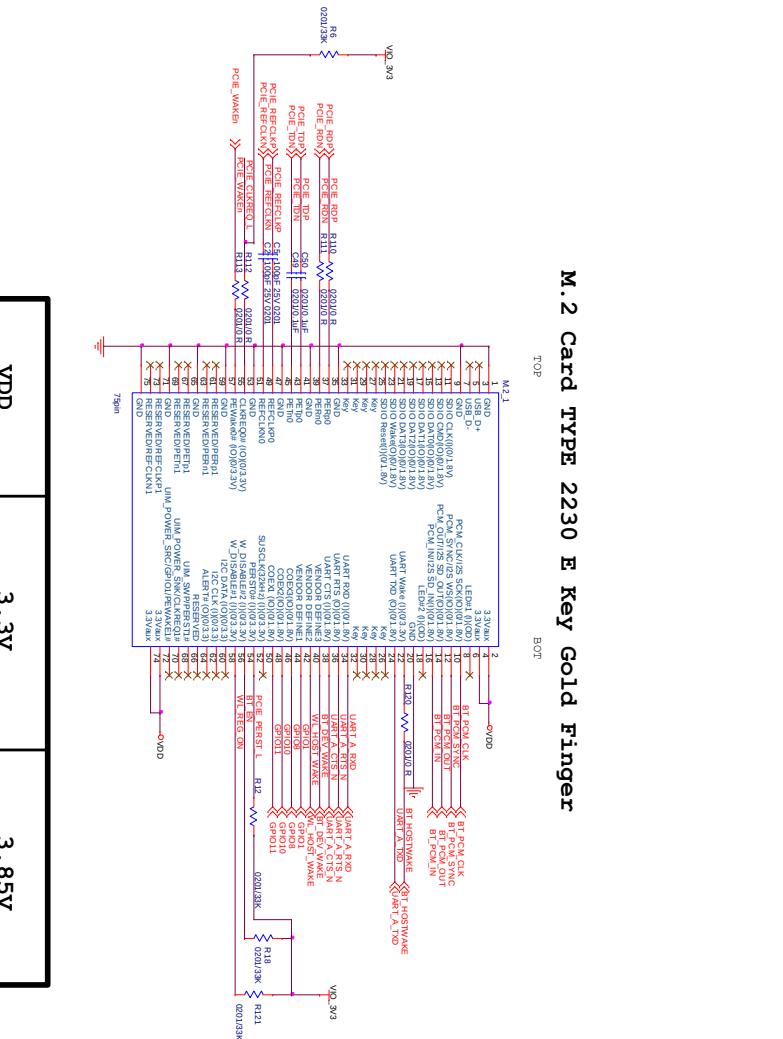
### 5.2 Pin Assignment

| 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                                                                       |

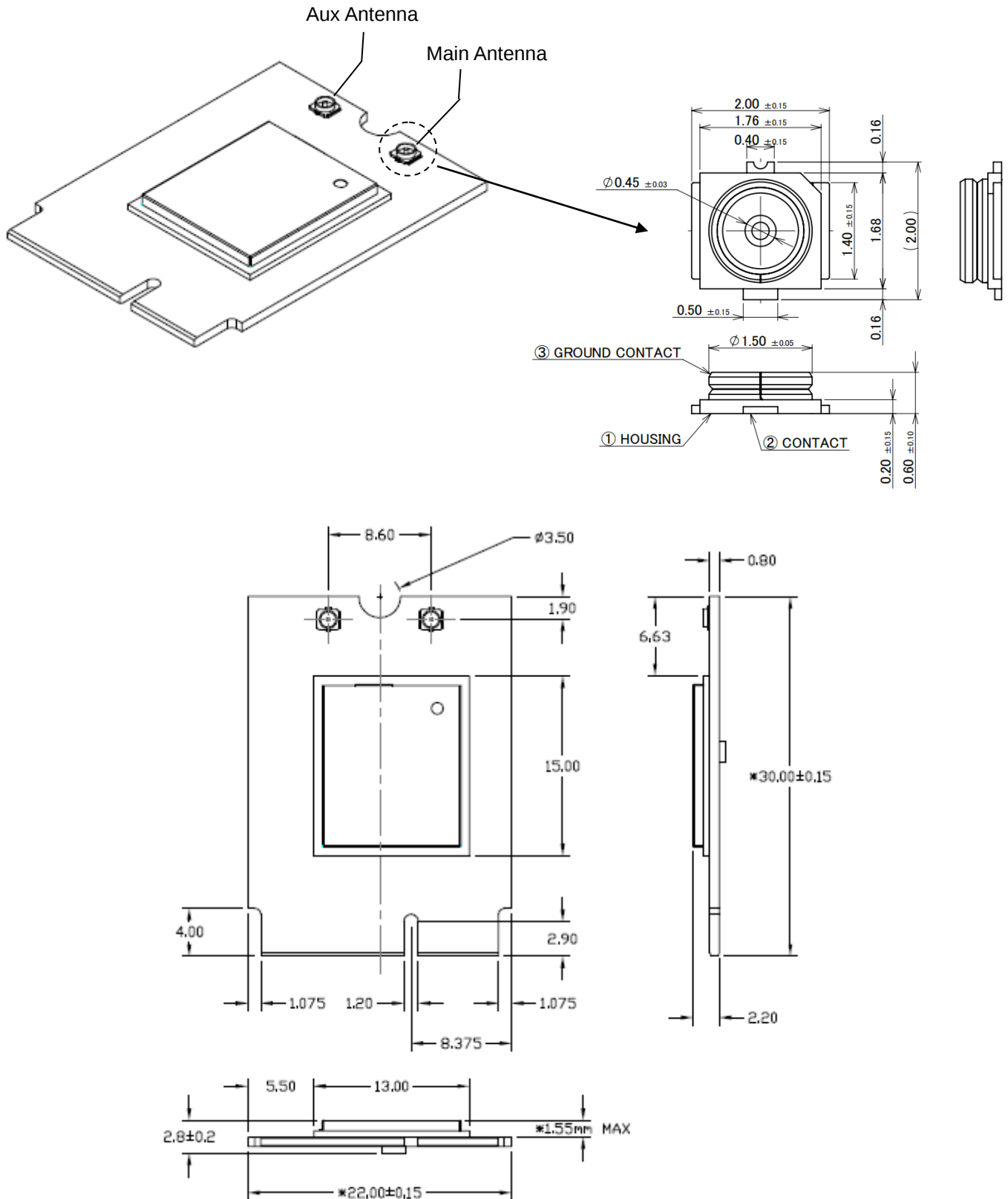
# AMPAK Wi-Fi 6 & 6E & 7 PCIe Module M.2 Card (E Key) Reference Design Circuit



|          |                                           |               |
|----------|-------------------------------------------|---------------|
| VDD      | 3.3V                                      | 3.85V         |
| M.2 Card | AP12275_M2P<br>AP12276_M2P<br>AP12676_M2P | AP12684PL_M2P |

## 7. Dimensions

### 7.1 Module Dimensions



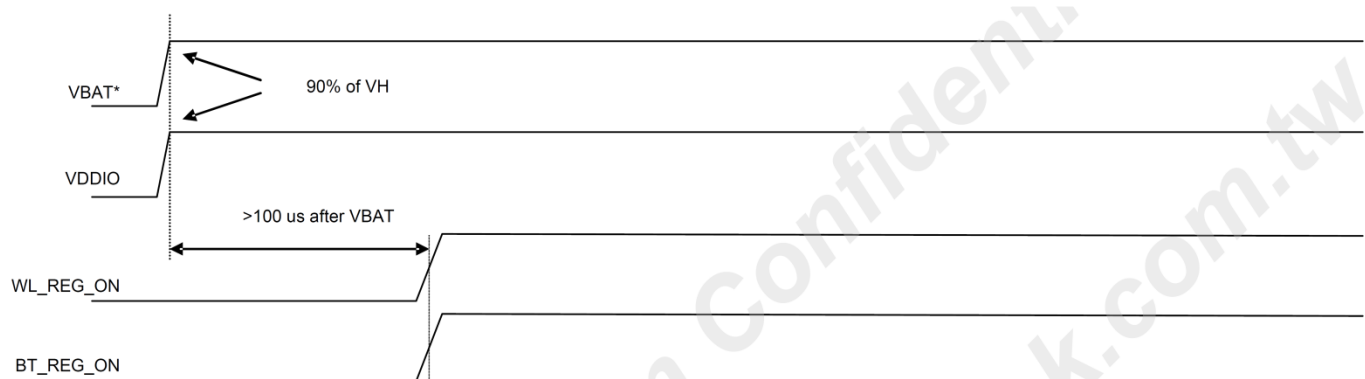
## 8. Host Interface Timing Diagram

### 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 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.

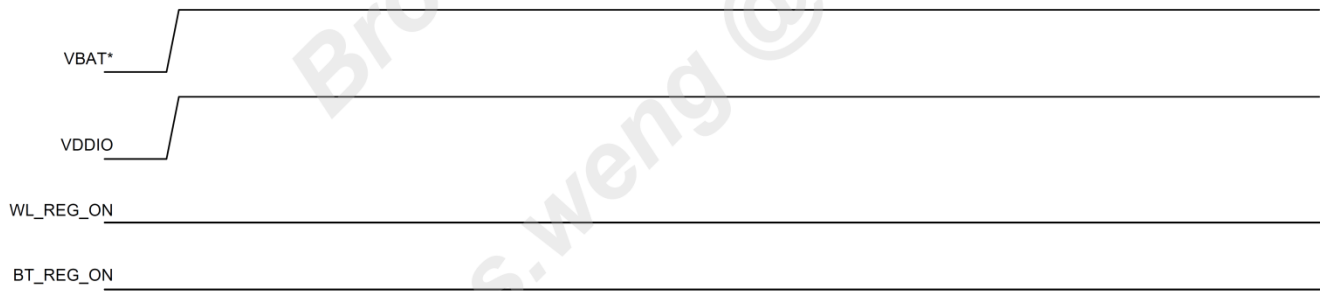


**\*Notes:**

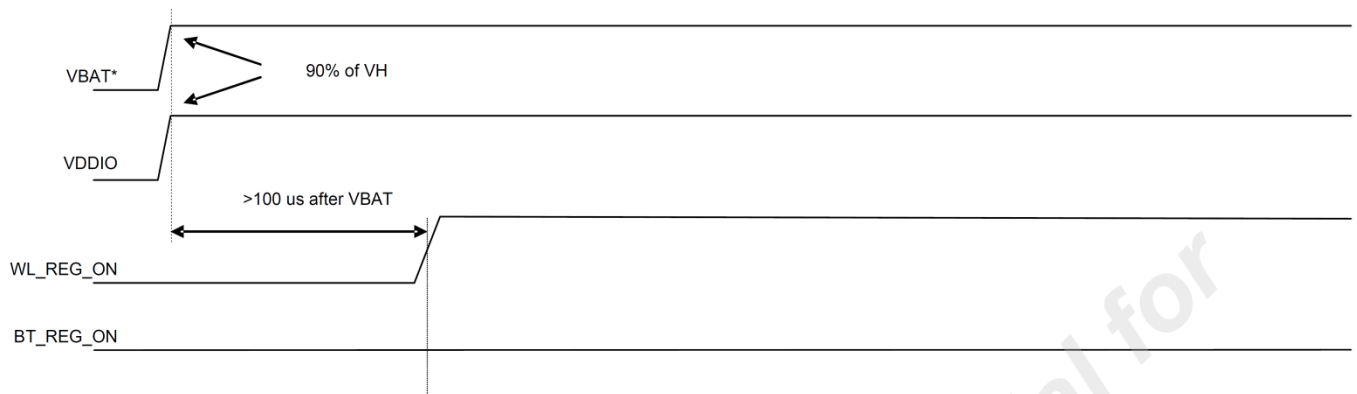
1. The VBAT and VDDIO 10%–90% rise-time slopes must be greater than 50 microseconds/V.
2. VBAT should be up before or at the same time as VDDIO. VDDIO should NOT be present first or be held high before VBAT is high.

WLAN=ON, Bluetooth=ON

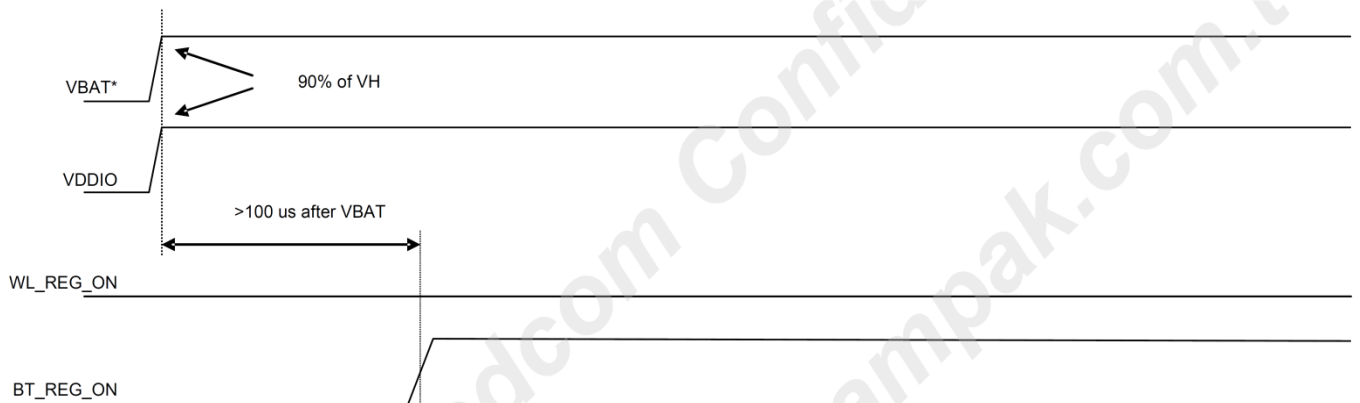


**\*Notes:**

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.

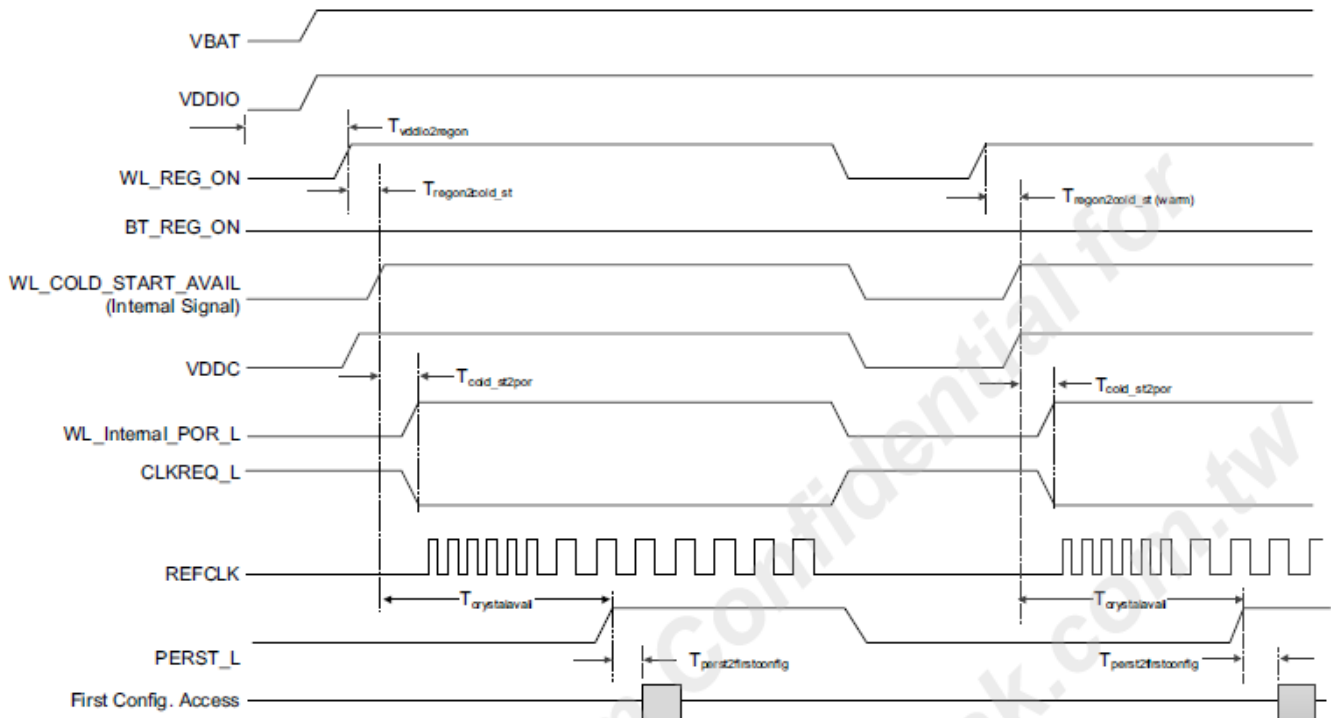
PCI Express Interface Parameters

| Parameter                                                          | Symbol                      | Comments                                                                                                          | Min.                                    | Typ. | Max. | Unit  |
|--------------------------------------------------------------------|-----------------------------|-------------------------------------------------------------------------------------------------------------------|-----------------------------------------|------|------|-------|
| <b>General<sup>a</sup></b>                                         |                             |                                                                                                                   |                                         |      |      |       |
| Baud rate                                                          | BPS                         | —                                                                                                                 | —                                       | 5    | —    | Gbaud |
| Reference clock peak-to-peak differential <sup>b</sup>             | Vref                        | LVPECL, AC coupled                                                                                                | 0.95                                    | —    | —    | V     |
| <b>Receiver</b>                                                    |                             |                                                                                                                   |                                         |      |      |       |
| 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    |
| <b>Transmitter</b>                                                 |                             |                                                                                                                   |                                         |      |      |       |
| 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<br>(2.5 GT/s)<br>0.15<br>(5 GT/s) | —    | —    | UI    |
| Output voltage fall time                                           | VTX-FALL                    | 80% to 20%                                                                                                        | 0.125<br>(2.5 GT/s)<br>0.15<br>(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  | $\Omega$ |
| 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 <sup>a</sup> | Unit |
|------------------------------|------------------------------------------------------------------------------------|--------------------|------|
| $T_{vddio2regon}$            | —                                                                                  | 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   |
| $T_{vddioon2firstconfig}$    | $T_{vddio2regon} + T_{region2cold\_st} + T_{crystalavail} + T_{perst2firstconfig}$ | 37.4 <sup>b</sup>  | ms   |
| $T_{region2cold\_st} (warm)$ | 162 ILP cycles                                                                     | 6.73               | ms   |

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

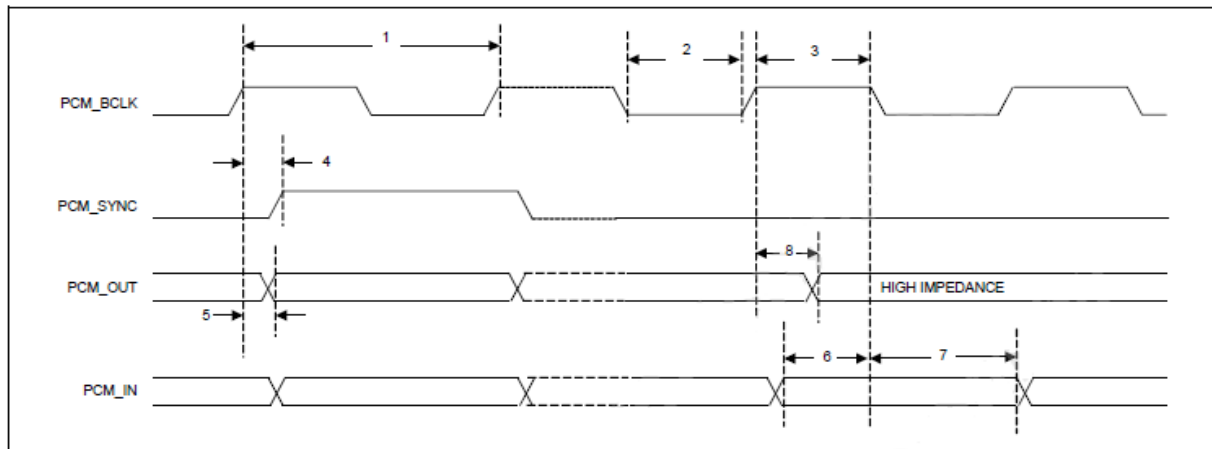
b. With VDDIO as a reference, 37.4 ms is the minimum system wait time before issuing the first configuration access.

### 8.3 PCM Interface Description

The PCM Interface on the AP12275\_M2P can connect to linear PCM Codec devices in master or slave mode. In master mode, the AP12275\_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 AP12275\_M2P. The configuration of the PCM interface may be adjusted by the host through the use of vendor-specific HCI commands.

#### Short Frame Sync, Master Modem

##### PCM Timing Diagram (Short Frame Sync, Master Mode)



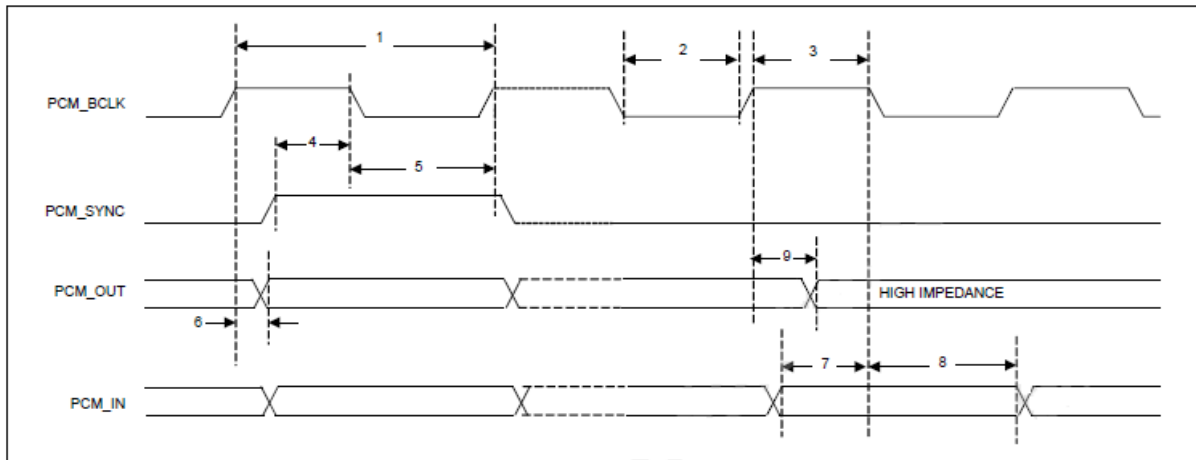
##### PCM Interface Timing Specifications (Short Frame Sync, Master Mode)

| 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         | PCM_SYNC delay                                                                               | 0       | –       | 25      | ns   |
| 5         | PCM_OUT delay                                                                                | 0       | –       | 25      | ns   |
| 6         | PCM_IN setup                                                                                 | 8       | –       | –       | ns   |
| 7         | PCM_IN hold                                                                                  | 8       | –       | –       | ns   |
| 8         | Delay from rising edge of PCM_BCLK during last bit period to PCM_OUT becoming high impedance | 0       | –       | 25      | ns   |



## Short Frame Sync, Slave Mode

## PCM Timing Diagram (Short Frame Sync, Slave Mode)

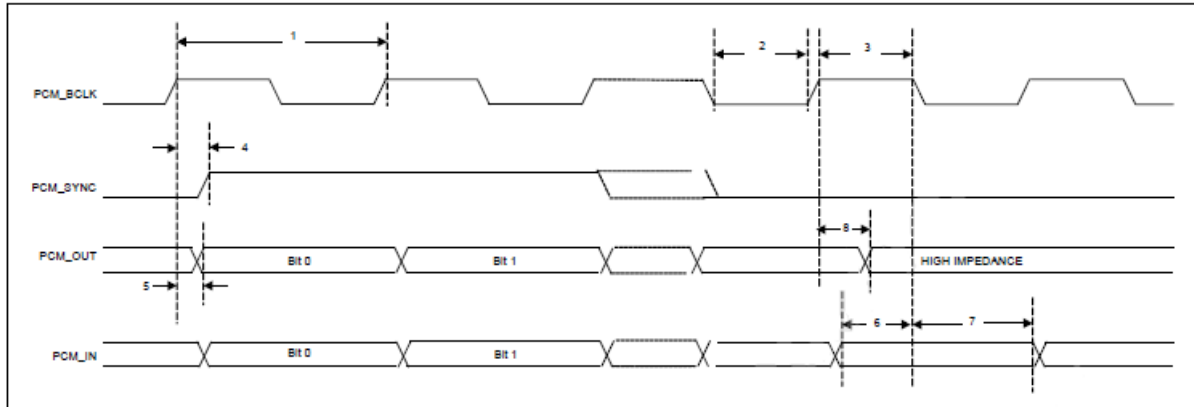


## PCM Interface Timing Specifications (Short Frame Sync, Slave Mode)

| 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         | PCM_SYNC setup                                                                               | 8       | –       | –       | ns   |
| 5         | PCM_SYNC hold                                                                                | 8       | –       | –       | ns   |
| 6         | PCM_OUT delay                                                                                | 0       | –       | 25      | ns   |
| 7         | PCM_IN setup                                                                                 | 8       | –       | –       | ns   |
| 8         | PCM_IN hold                                                                                  | 8       | –       | –       | ns   |
| 9         | Delay from rising edge of PCM_BCLK during last bit period to PCM_OUT becoming high impedance | 0       | –       | 25      | ns   |

## Long Frame Sync, Master Mode

### PCM Timing Diagram (Long Frame Sync, Master Mode)

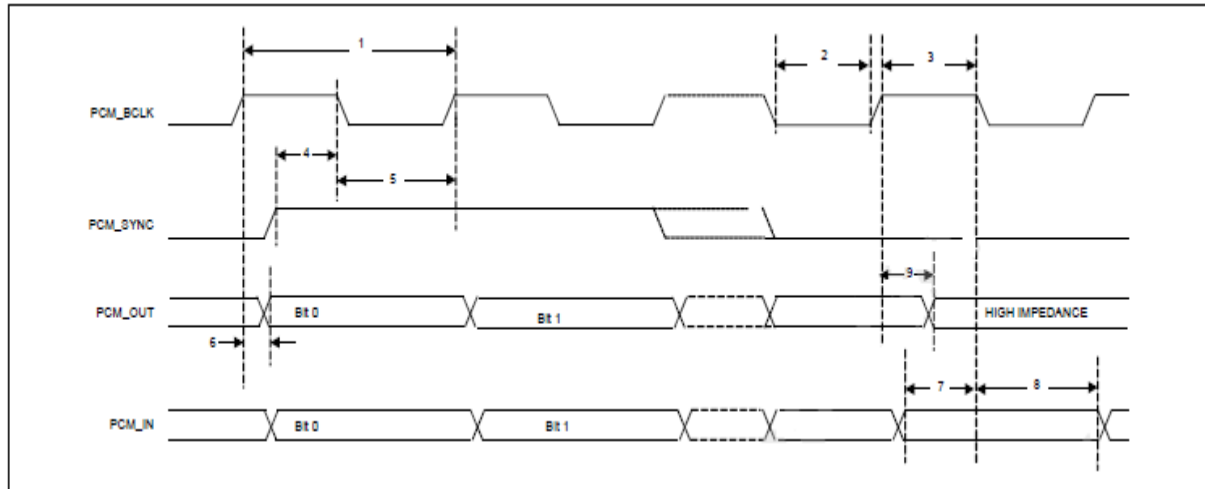


### PCM Interface Timing Specifications (Long Frame Sync, Master Mode)

| 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         | PCM_SYNC delay                                                                               | 0       | –       | 25      | ns   |
| 5         | PCM_OUT delay                                                                                | 0       | –       | 25      | ns   |
| 6         | PCM_IN setup                                                                                 | 8       | –       | –       | ns   |
| 7         | PCM_IN hold                                                                                  | 8       | –       | –       | ns   |
| 8         | Delay from rising edge of PCM_BCLK during last bit period to PCM_OUT becoming high impedance | 0       | –       | 25      | ns   |

## Long Frame Sync, Slave Mode

## PCM Timing Diagram (Long Frame Sync, Slave Mode)

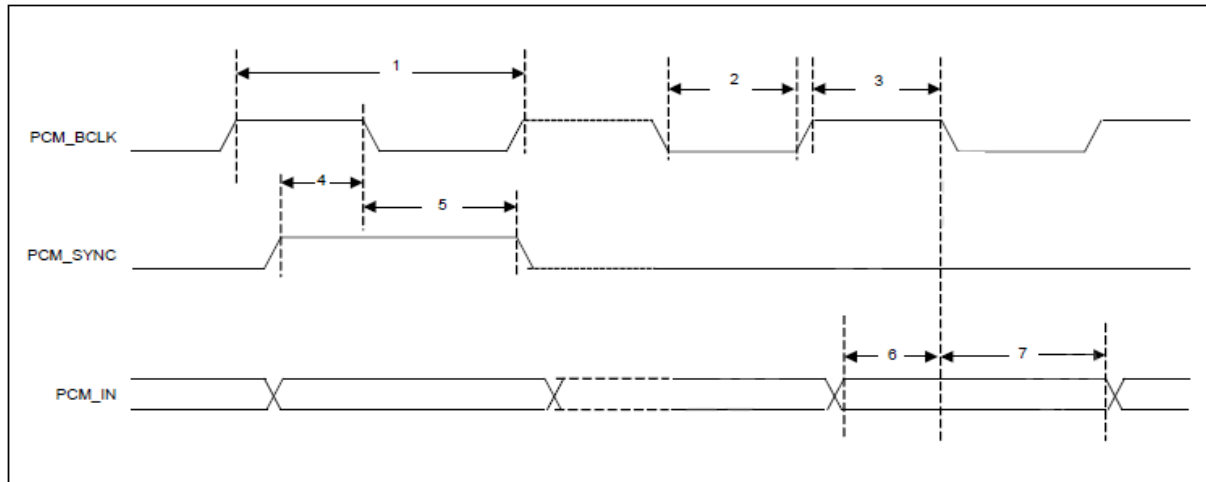


## PCM Interface Timing Specifications (Long Frame Sync, Slave Mode)

| 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         | PCM_SYNC setup                                                                               | 8       | –       | –       | ns   |
| 5         | PCM_SYNC hold                                                                                | 8       | –       | –       | ns   |
| 6         | PCM_OUT delay                                                                                | 0       | –       | 25      | ns   |
| 7         | PCM_IN setup                                                                                 | 8       | –       | –       | ns   |
| 8         | PCM_IN hold                                                                                  | 8       | –       | –       | ns   |
| 9         | Delay from rising edge of PCM_BCLK during last bit period to PCM_OUT becoming high impedance | 0       | –       | 25      | ns   |

## Short Frame Sync, Burst Mode

### PCM Burst Mode Timing (Receive Only, Short Frame Sync)

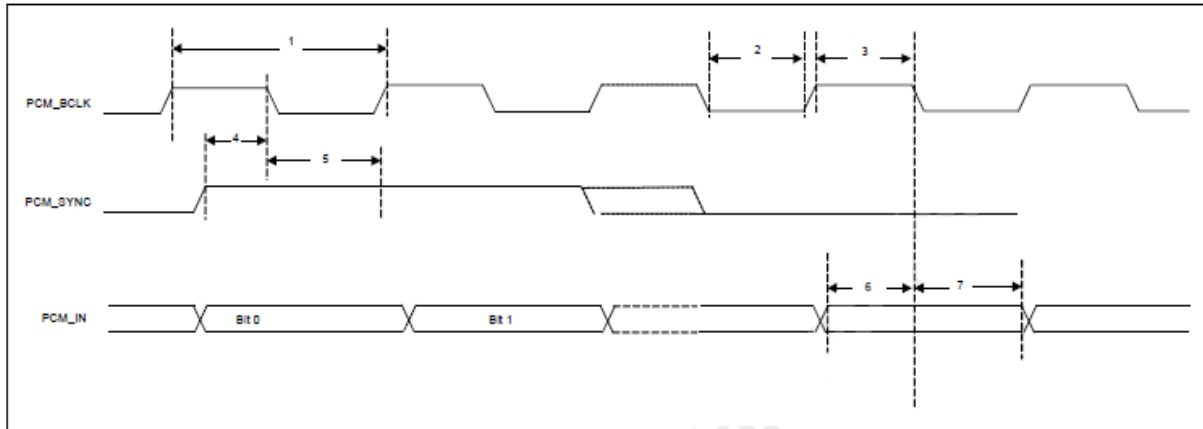


### PCM Burst Mode (Receive Only, Short Frame Sync)

| 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         | PCM_SYNC setup          | 8       | –       | –       | ns   |
| 5         | PCM_SYNC hold           | 8       | –       | –       | ns   |
| 6         | PCM_IN setup            | 8       | –       | –       | ns   |
| 7         | PCM_IN hold             | 8       | –       | –       | ns   |

## Long Frame Sync, Burst Mode

### PCM Burst Mode Timing (Receive Only, Long Frame Sync)



### PCM Burst Mode (Receive Only, Long Frame 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         | PCM_SYNC setup          | 8       | –       | –       | ns   |
| 5         | PCM_SYNC hold           | 8       | –       | –       | ns   |
| 6         | PCM_IN setup            | 8       | –       | –       | ns   |
| 7         | 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.

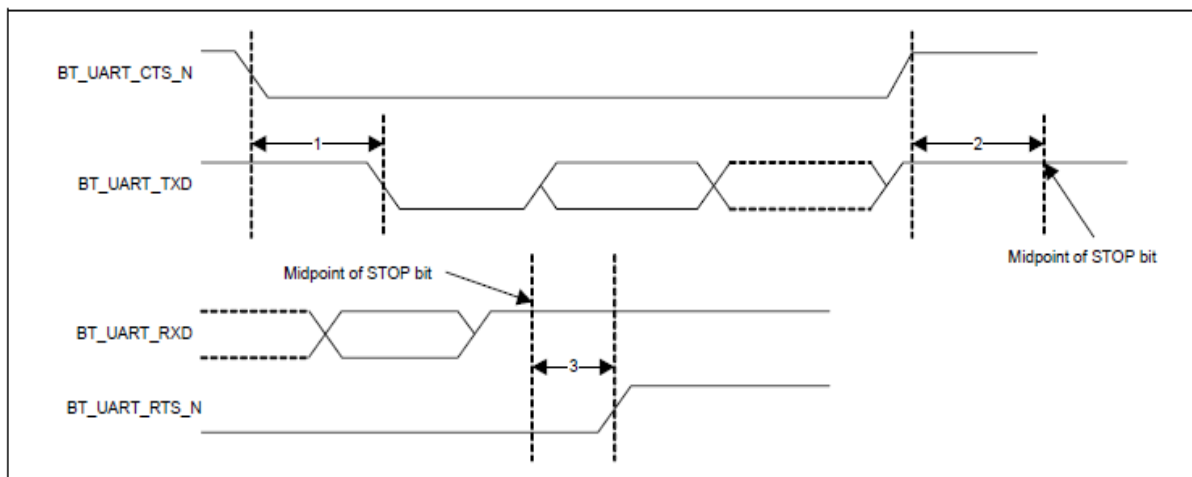
The UART can perform XON/XOFF flow control and includes hardware support for the Serial Line Input Protocol (SLIP). It can also perform wake-on activity. For example, activity on the RX or CTS inputs can wake the chip from a sleep state.

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  $\pm 2\%$ .

## 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



## UART Timing Specifications

| Ref | Characteristics                                            | Min. | Typ. | Max. | 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 Label

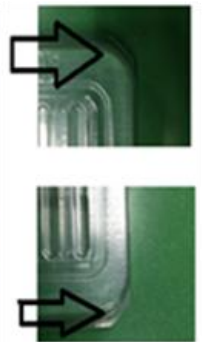
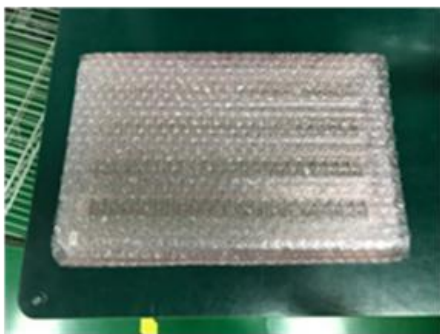


MAC



## 9.2 Tray box

BOX : 100 PCS (100 PCS/Try )



### 9.3 Carton

Carton: 400 PCS (Box\*4/Carton)

