



# AMPAK

## AP6356SDXX

### Evaluation Kits

### User manual

Version 1.0

#### Revision History

| Date       | Revision Content | Revised By | Version |
|------------|------------------|------------|---------|
| 2015/12/28 | Initial released | Aron       | 1.0     |
|            |                  |            |         |
|            |                  |            |         |

## **Federal Communication Commission Interference Statement**

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

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

**Radiation Exposure Statement:**

The product comply with the FCC portable RF exposure limit set forth for an uncontrolled environment and are safe for intended operation as described in this manual. The further RF exposure reduction can be achieved if the product can be kept as far as possible from the user body or set the device to lower output power if such function is available.

**This device is intended only for OEM integrators under the following conditions:**

- 1) The transmitter module may not be co-located with any other transmitter or antenna.

As long as **2** conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed

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

**End Product Labeling**

The product can be kept as far as possible from the user body or set the device to lower output power if such function is available. The final end product must be labeled in a visible area with the following: “Contains FCC ID:**ZQ6-AP6356SDXX**”. The grantee's FCC ID can be used only when all FCC compliance requirements are met.

**Manual Information To the End User**

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user’s manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

### **Industry Canada statement:**

This device complies with ISED's licence-exempt RSSs. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Le présent appareil est conforme aux CNR d'ISED applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) le dispositif ne doit pas produire de brouillage préjudiciable, et (2) ce dispositif doit accepter tout brouillage reçu, y compris un brouillage susceptible de provoquer un fonctionnement indésirable.

### **Radiation Exposure Statement:**

The product comply with the Canada portable RF exposure limit set forth for an uncontrolled environment and are safe for intended operation as described in this manual. The further RF exposure reduction can be achieved if the product can be kept as far as possible from the user body or set the device to lower output power if such function is available.

### **Déclaration d'exposition aux radiations:**

Le produit est conforme aux limites d'exposition pour les appareils portables RF pour les Etats-Unis et le Canada établies pour un environnement non contrôlé.

Le produit est sûr pour un fonctionnement tel que décrit dans ce manuel. La réduction aux expositions RF peut être augmentée si l'appareil peut être conservé aussi loin que possible du corps de l'utilisateur ou que le dispositif est réglé sur la puissance de sortie la plus faible si une telle fonction est disponible.

### **This device is intended only for OEM integrators under the following conditions: (For module device use)**

1) The transmitter module may not be co-located with any other transmitter or antenna.

As long as **2** conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

**Cet appareil est conçu uniquement pour les intégrateurs OEM dans les conditions suivantes: (Pour utilisation de dispositif module)**

1) Le module émetteur peut ne pas être coïmplanté avec un autre émetteur ou antenne.

Tant que les 2 conditions ci-dessus sont remplies, des essais supplémentaires sur l'émetteur ne seront pas nécessaires. Toutefois, l'intégrateur OEM est toujours responsable des essais sur son produit final pour toutes exigences de conformité supplémentaires requis pour ce module installé.

**IMPORTANT NOTE:**

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

**NOTE IMPORTANTE:**

Dans le cas où ces conditions ne peuvent être satisfaites (par exemple pour certaines configurations d'ordinateur portable ou de certaines co-localisation avec un autre émetteur), l'autorisation du Canada n'est plus considéré comme valide et l'ID IC ne peut pas être utilisé sur le produit final. Dans ces circonstances, l'intégrateur OEM sera chargé de réévaluer le produit final (y compris l'émetteur) et l'obtention d'une autorisation distincte au Canada.

**End Product Labeling**

The product can be kept as far as possible from the user body or set the device to lower output power if such function is available. The final end product must be labeled in a visible area with the following: “Contains IC:       ”.

**Plaque signalétique du produit final**

L'appareil peut être conservé aussi loin que possible du corps de l'utilisateur ou que le dispositif est réglé sur la puissance de sortie la plus faible si une telle fonction est disponible. Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante: "Contient des IC:       ”.

**Manual Information To the End User**

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

#### **Manuel d'information à l'utilisateur final**

L'intégrateur OEM doit être conscient de ne pas fournir des informations à l'utilisateur final quant à la façon d'installer ou de supprimer ce module RF dans le manuel de l'utilisateur du produit final qui intègre ce module.

Le manuel de l'utilisateur final doit inclure toutes les informations réglementaires requises et avertissements comme indiqué dans ce manuel.

#### **Caution :**

(i) the device for operation in the band 5150-5250 MHz is only for indoor use to reduce the potential for harmful interference to co-channel mobile satellite systems;

(ii) the maximum antenna gain permitted for devices in the bands 5250-5350 MHz and 5470-5725 MHz shall be such that the equipment still complies with the e.i.r.p. limit;

(iii) the maximum antenna gain permitted for devices in the band 5725-5850 MHz shall be such that the equipment still complies with the e.i.r.p. limits specified for point-to-point and non-point-to-point operation as appropriate; and

(iv) the worst-case tilt angle(s) necessary to remain compliant with the e.i.r.p. elevation mask requirement set forth in Section 6.2.2(3) shall be clearly indicated.

(v) Users should also be advised that high-power radars are allocated as primary users (i.e. priority users) of the bands 5250-5350 MHz and 5650-5850 MHz and that these radars could cause interference and/or damage to LE-LAN devices.

#### **Avertissement:**

Le guide d'utilisation des dispositifs pour réseaux locaux doit inclure des instructions précises sur les restrictions susmentionnées, notamment :

(i) les dispositifs fonctionnant dans la bande 5150-5250 MHz sont réservés uniquement pour une utilisation à l'intérieur afin de réduire les risques de brouillage préjudiciable aux systèmes de satellites mobiles utilisant les mêmes canaux;

(ii) le gain maximal d'antenne permis pour les dispositifs utilisant les bandes de 5250 à 5

350 MHz et de 5470 à 5725 MHz doit être conforme à la limite de la p.i.r.e;

(iii) le gain maximal d'antenne permis (pour les dispositifs utilisant la bande de 5 725 à 5 850 MHz) doit être conforme à la limite de la p.i.r.e. spécifiée pour l'exploitation point à point et l'exploitation non point à point, selon le cas;

(iv) les pires angles d'inclinaison nécessaires pour rester conforme à l'exigence de la p.i.r.e. applicable au masque d'élévation, et énoncée à la section 6.2.2 3), doivent être clairement indiqués.

(v) De plus, les utilisateurs devraient aussi être avisés que les utilisateurs de radars de haute puissance sont désignés utilisateurs principaux (c.-à-d., qu'ils ont la priorité) pour les bandes 5250-5350 MHz et 5650-5850 MHz et que ces radars pourraient causer du brouillage et/ou des dommages aux dispositifs LAN-EL.

第十二條 經型式認證合格之低功率射頻電機，非經許可，公司、商號或使用者均不得擅自變更頻率、加大功率或變更原設計之特性及功能。

第十四條 低功率射頻電機之使用不得影響飛航安全及干擾合法通信；經發現有干擾現象時，應立即停用，並改善至無干擾時方得繼續使用。

前項合法通信，指依電信法規定作業之無線電通信。

低功率射頻電機須忍受合法通信或工業、科學及醫療用電波輻射性電機設備之干擾。

1. 本模組於取得認證後將依規定於模組本體標示審驗合格標籤。
2. 系統廠商應於平台上標示「本產品內含射頻模組： XXXyyyLPDzzzz-x」字樣。

## 1. AP6356SDXX Evaluation Board Introduction

AP6356SDXX Evaluation board (EVB) likes as figure1. That is designed for IEEE802.11 a/b/g/n/ac 2x2 WLAN with integrated Bluetooth. It is subject to provide a convenient environment for customer's verification on WiFi or Bluetooth function. There are many controller pins and reserved GPIO on Evaluation board which describes as below.

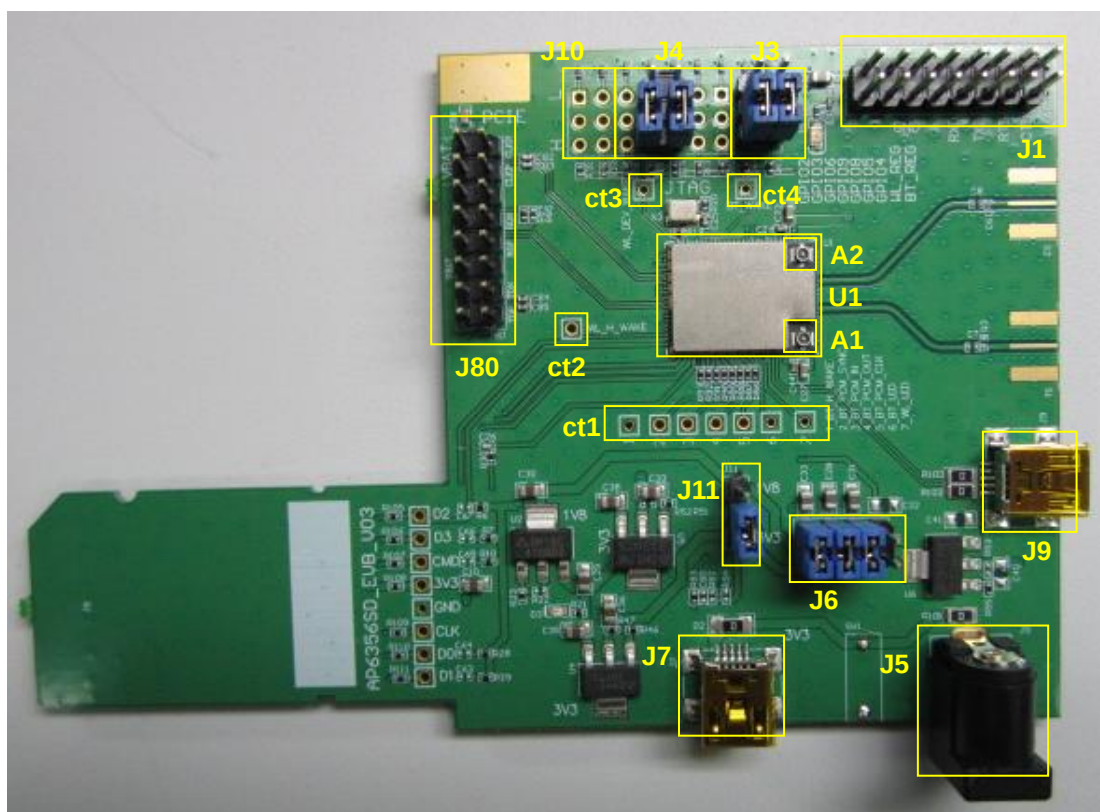


Figure1. Top view of AP6356SDXX EVB

### Interface highlights:

1. U1: AP6356SDXX SIP module.
2. J1: UART interface connects with UART transport board for BT.
3. J80: PCIE interface connects with PCIE transport board for WIFI.
4. J3: Enable(H) or disable(L) Bluetooth and WiFi function.
5. J4: PCIE interface strapping option
6. J5: 5V DC adaptor input connector.
7. J6: 3V3 RF/ VBAT / WL\_VIO / BT\_VIO for main system I/O power path.
8. J7/J9: 5V DC mini USB input connector.
9. J10: GPIO\_2 (input/output) and GPIO\_3 (input/output)
10. J11: WL\_VIO power path for 1V8 or 3V3 selection.
11. A1: I-PEX connector let RF signal in/out path, you could connect with RF cable or

Dipole antenna.

12. A2: I-PEX connector let RF signal in/out path, you could connect with RF cable or Dipole antenna.

13. Ct1-Ct4: WLAN and BT control pins, strongly recommended WL\_H\_WAKE(IRQ) connected to MCU.

## 2. WiFi function verification step

WiFi PCIe: PCIe interface definition as below J80 dip connector and this should be used 3.3V for PCIe voltage.

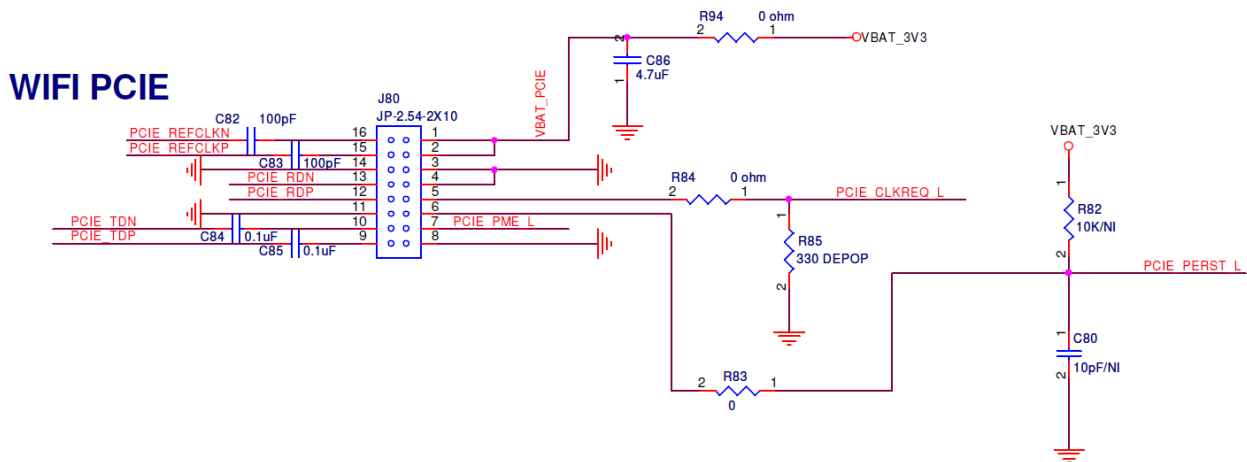


Figure3. WiFi verification connection interface to Host PCIe

### Hardware Setup:

- ❖ Refer to Figure3 PCIe pin definition connects the J80 interface of AP6356SDXX evaluation board to Host PCIe control interface.
- ❖ Connects an external antenna at I-PEX connector on the evaluation board.
- ❖ Note to the VDDIO voltage level should be the same with GPIO voltage level of Host CPU. (VDDIO 3.3V or 1.8V selection by jump J11)
- ❖ Pull High J4 are necessary .

### WiFi software setup:

Please follow up software guideline of Ampak official released.

### 3. Bluetooth function verification step

UART :

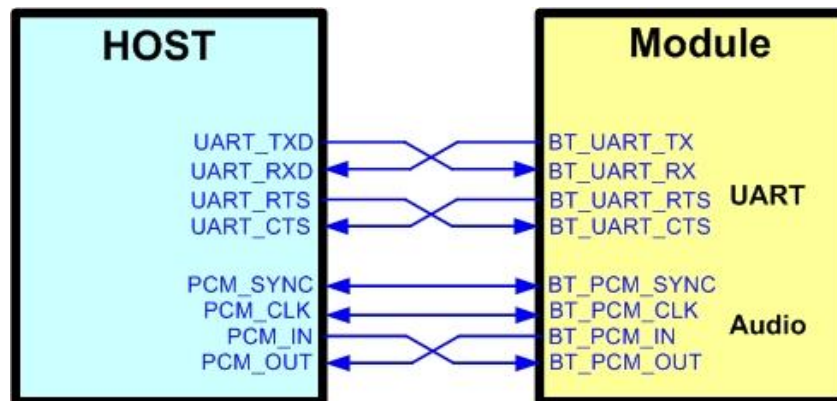


Figure4. Bluetooth verification connection interface to Host UART

Hardware Setup:

- ❖ Refer to Figure4 UART pin definition connects the J1 interface of AP6356SDXX evaluation board to Host UART control interface.
- ❖ Connects an external antenna at I-PEX connector on the evaluation board.
- ❖ Note to the VDDIO voltage level should be the same as GPIO voltage level of Host CPU.

USB :

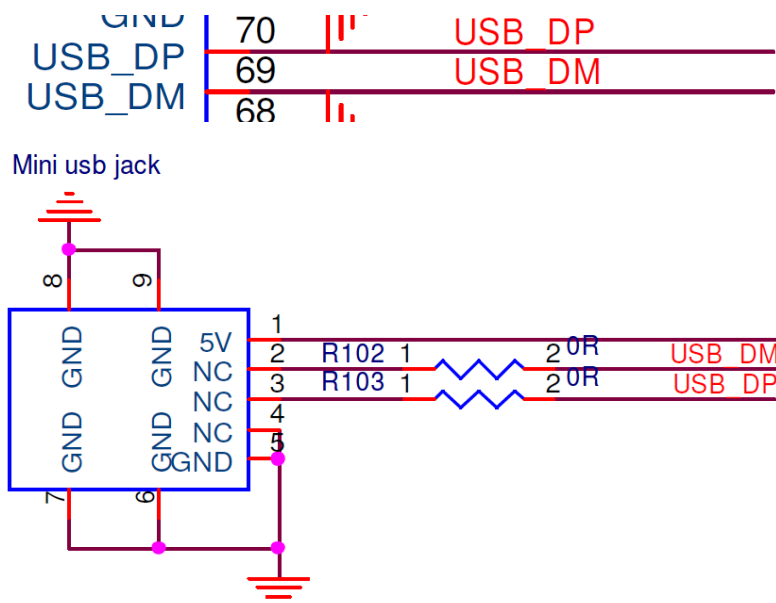


Figure5. Bluetooth verification connection interface to Host USB



#### Hardware Setup:

- ❖ Refer to Figure5 USB pin definition connects the J9 interface of AP6356SDXX evaluation board to Host USB control interface.
- ❖ Connects an external antenna at I-PEX connector on the evaluation board.

#### WiFi and Bluetooth software setup:

Please follow up software guideline of Ampak official released.



正基科技股份有限公司

## SPECIFICATION

SPEC. NO. : \_\_\_\_\_ REV : 1.6

DATE : 09. 07.2015

PRODUCT NAME : AP6356SDXX

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

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

# AMPAK

## AP6356SDXX

2x2 WiFi + Bluetooth4.1  
Module Spec Sheet

# Revision History

| Date       | Revision Content                                                                 | Revised By | Version |
|------------|----------------------------------------------------------------------------------|------------|---------|
| 2014/09/25 | -Preliminary                                                                     | Brian      | 1.0     |
| 2014/10/26 | -Pin definition modified                                                         | Brian      | 1.1     |
| 2014/12/11 | -Pin definition modified                                                         | Brian      | 1.2     |
| 2015/03/18 | -Layout and Bluetooth Spec modified<br>- Pin map and physical dimension modified | Dora       | 1.3     |
| 2015/05/12 | -Add Part Number Description                                                     | Dora       | 1.4     |
| 2015/06/29 | -Add Packet type and total pins                                                  | Dora       | 1.5     |
| 2015/09/07 | -Modify label quantity and MSL                                                   | Dora       | 1.6     |

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# 1. Introduction

AMPAK Technology would like to announce a low-cost and low-power consumption module which has all of the WiFi and Bluetooth functionalities. The highly integrated module makes the possibilities of web browsing, VoIP, Bluetooth headsets applications. With seamless roaming capabilities and advanced security, also could interact with different vendors' 802.11a/b/g/n/ac 2x2 Access Points in the wireless LAN.

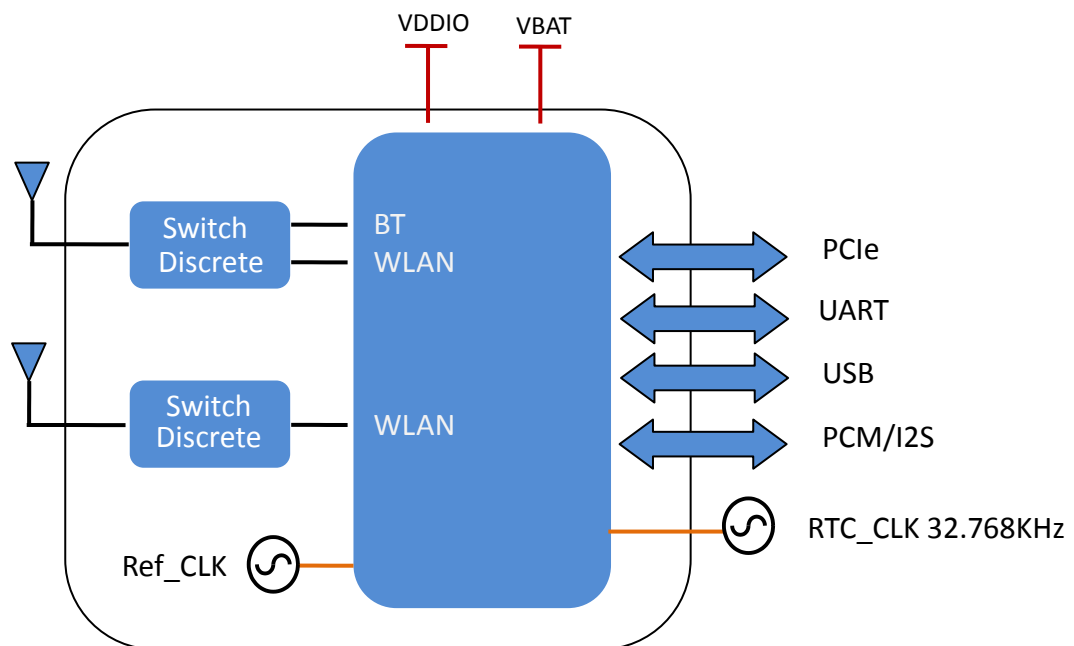
The wireless module complies with IEEE 802.11 a/b/g/n/ac 2x2 MIMO standard and it can achieve up to a speed of 867Mbps with dual stream in 802.11n to connect the wireless LAN. The integrated module provides SDIO/PCIe interface for WiFi, UART / USB/ PCM interface for Bluetooth.

This compact module is a total solution for a combination of WiFi + BT technologies. The module is specifically developed for Smart phones and Portable devices.

## 2. Features

- Lead Free design which is compliant with ROHS requirements.
- 802.11a/b/g/n/ac dual-band radio with virtual-simultaneous dual-band operation
- Dual-stream spatial multiplexing up to 867 Mbps data rate.
- Supports 20, 40, 80 MHz channels with optional SGI(256 QAM modulation)
- Supports IEEE 802.11 ac/n beam forming.
- Supports IEEE 802.15.2 external coexistence interface to optimize bandwidth utilization with other co-located wireless technologies such as LTE, GPS, or WiMAX.
  - Supports standard SDIO/PCIe interfaces.
- BT host digital interface:
  - HCI UART (up to 4 Mbps)
  - PCM for audio data
- Complies with Bluetooth Core Specification Version 4.1 with provisions for supporting future specifications. With Bluetooth Class1 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 below.



## 3. Deliverables

### 3.1 Deliverables

The following products and software will be part of the product.

- Module with packaging
- Evaluation Kits
- Software utility for integration, performance test.
- Product Datasheet.
- Agency certified pre-tested report with the adapter board.

### 3.2 Regulatory certifications

The product delivery is a pre-tested module, without the module level certification. For module approval, the platform's antennas are required for the certification.

## 4. General Specification

### 4.1 General Specification

|                       |                                                                                           |
|-----------------------|-------------------------------------------------------------------------------------------|
| Model Name            | AP6356SDXX                                                                                |
| Product Description   | Support WiFi/Bluetooth functionalities                                                    |
| Dimension             | L x W x H: 16 x 12 x 1.6 (typical) mm                                                     |
| WiFi Interface        | Support PCIe                                                                              |
| BT Interface          | UART / USB / PCM                                                                          |
| Package               | M.2 1216 Solder down                                                                      |
| Total Pin             | 108 Pins                                                                                  |
| Operating temperature | -10°C to 65°C                                                                             |
| Storage temperature   | -40°C to 85°C                                                                             |
| Humidity              | Operating Humidity 10% to 95% Non-Condensing<br>Storage Humidity 5% to 95% Non-Condensing |

### 4.2 Voltages

#### 4.2.1 Absolute Maximum Ratings

| Symbol | Description                         | Min. | Max. | Unit |
|--------|-------------------------------------|------|------|------|
| VBAT   | Input supply Voltage                | -0.5 | 5.5  | V    |
| VDDIO  | Digital/Bluetooth/SDIO/ I/O Voltage | -0.5 | 3.8  | V    |

#### 4.2.2 Recommended Operating Rating

The module requires two power supplies: VBAT and VDDIO.

|                       | Min. | Typ. | Max. | Unit  |
|-----------------------|------|------|------|-------|
| Operating Temperature | -10  | 25   | 65   | deg.C |
| VBAT                  | 3.0  | 3.6  | 4.8  | V     |
| VDDIO                 | 1.7  | -    | 3.6  | V     |

## 5. WiFi RF Specification

### 5.1 2.4GHz RF Specification

Conditions : VBAT=3.6V ; VDDIO=3.3V ; Temp:25°C

| Feature                                       | Description                                                                 |
|-----------------------------------------------|-----------------------------------------------------------------------------|
| WLAN Standard                                 | IEEE 802.11a/b/g/n/ac WiFi compliant                                        |
| Frequency Range                               | 2.400 GHz ~ 2.497 GHz (2.4 GHz ISM Band)                                    |
| Number of Channels                            | 2.4GHz : Ch1 ~ Ch14                                                         |
| Modulation                                    | 802.11b : DQPSK, DBPSK, CCK<br>802.11 g/n : OFDM /64-QAM,16-QAM, QPSK, BPSK |
| Output Power                                  | 802.11b /11Mbps : 16 dBm $\pm$ 1.5 dB @ EVM $\leq$ -9dB                     |
|                                               | 802.11g /54Mbps : 15 dBm $\pm$ 1.5 dB @ EVM $\leq$ -25dB                    |
|                                               | 802.11n /MCS7 : 14 dBm $\pm$ 1.5 dB @ EVM $\leq$ -28dB                      |
| SISO Receive Sensitivity (11b,20MHz) @8% PER  | - 1Mbps PER @ -93 dBm, typical                                              |
|                                               | - 2Mbps PER @ -91 dBm, typical                                              |
|                                               | - 5.5Mbps PER @ -88 dBm, typical                                            |
|                                               | - 11Mbps PER @ -86 dBm, typical                                             |
| SISO Receive Sensitivity (11g,20MHz) @10% PER | - 6Mbps PER @ -90 dBm, typical                                              |
|                                               | - 9Mbps PER @ -89 dBm, typical                                              |
|                                               | - 12Mbps PER @ -88 dBm, typical                                             |
|                                               | - 18Mbps PER @ -85 dBm, typical                                             |
|                                               | - 24Mbps PER @ -82 dBm, typical                                             |
|                                               | - 36Mbps PER @ -79 dBm, typical                                             |
|                                               | - 48Mbps PER @ -74 dBm, typical                                             |
| MIMO Receive Sensitivity (11g,20MHz) @10% PER | - 54Mbps PER @ -72 dBm, typical                                             |
|                                               | - 6Mbps PER @ -91 dBm, typical                                              |
|                                               | - 9Mbps PER @ -91 dBm, typical                                              |
|                                               | - 12Mbps PER @ -90 dBm, typical                                             |
|                                               | - 18Mbps PER @ -88 dBm, typical                                             |
|                                               | - 24Mbps PER @ -85 dBm, typical                                             |
|                                               | - 36Mbps PER @ -82 dBm, typical                                             |
|                                               | - 48Mbps PER @ -77 dBm, typical                                             |
| SISO Receive Sensitivity (11n,20MHz) @10% PER | - 54Mbps PER @ -75 dBm, typical                                             |
|                                               | - MCS=0 PER @ -90 dBm, typical                                              |
|                                               | - MCS=1 PER @ -87 dBm, typical                                              |
|                                               | - MCS=2 PER @ -85 dBm, typical                                              |

|                                                         |                                      |
|---------------------------------------------------------|--------------------------------------|
|                                                         | - MCS=3 PER @ -81 dBm, typical       |
|                                                         | - MCS=4 PER @ -78 dBm, typical       |
|                                                         | - MCS=5 PER @ -73 dBm, typical       |
|                                                         | - MCS=6 PER @ -72 dBm, typical       |
|                                                         | - MCS=7 PER @ -70 dBm, typical       |
| MIMO Receive<br>Sensitivity (11n,20MHz)<br>@10% PER     | - MCS=0 PER @ -91 dBm, typical       |
|                                                         | - MCS=1 PER @ -90 dBm, typical       |
|                                                         | - MCS=2 PER @ -88 dBm, typical       |
|                                                         | - MCS=3 PER @ -85 dBm, typical       |
|                                                         | - MCS=4 PER @ -81 dBm, typical       |
|                                                         | - MCS=5 PER @ -76 dBm, typical       |
|                                                         | - MCS=6 PER @ -74 dBm, typical       |
|                                                         | - MCS=7 PER @ -71 dBm, typical       |
|                                                         | - MCS=8 PER @ -88 dBm, typical       |
|                                                         | - MCS=15 PER @ -69 dBm, typical      |
| SISO Receive<br>Sensitivity (11n,40MHz)<br>@10% PER     | - MCS=0 PER @ -87 dBm, typical       |
|                                                         | - MCS=1 PER @ -83 dBm, typical       |
|                                                         | - MCS=2 PER @ -82 dBm, typical       |
|                                                         | - MCS=3 PER @ -79 dBm, typical       |
|                                                         | - MCS=4 PER @ -75 dBm, typical       |
|                                                         | - MCS=5 PER @ -71 dBm, typical       |
|                                                         | - MCS=6 PER @ -69 dBm, typical       |
| MIMO Receive<br>Sensitivity (11n,40MHz)<br>@10% PER     | - MCS=7 PER @ -68 dBm, typical       |
|                                                         | - MCS=0 PER @ -89 dBm, typical       |
|                                                         | - MCS=1 PER @ -87 dBm, typical       |
|                                                         | - MCS=2 PER @ -85 dBm, typical       |
|                                                         | - MCS=3 PER @ -82 dBm, typical       |
|                                                         | - MCS=4 PER @ -78 dBm, typical       |
|                                                         | - MCS=5 PER @ -74 dBm, typical       |
|                                                         | - MCS=6 PER @ -72 dBm, typical       |
|                                                         | - MCS=7 PER @ -71 dBm, typical       |
|                                                         | - MCS=8 PER @ -87 dBm, typical       |
| SISO Receive<br>Sensitivity<br>(11ac,20MHz) @10%<br>PER | - MCS=15 PER @ -68 dBm, typical      |
|                                                         | - MCS=0, NSS1 PER @ -89 dBm, typical |
|                                                         | - MCS=1, NSS1 PER @ -86 dBm, typical |
|                                                         | - MCS=2, NSS1 PER @ -85 dBm, typical |
|                                                         | - MCS=3, NSS1 PER @ -81 dBm, typical |

|                                                         |                                      |
|---------------------------------------------------------|--------------------------------------|
|                                                         | - MCS=4, NSS1 PER @ -78 dBm, typical |
|                                                         | - MCS=5, NSS1 PER @ -73 dBm, typical |
|                                                         | - MCS=6, NSS1 PER @ -71 dBm, typical |
|                                                         | - MCS=7, NSS1 PER @ -70 dBm, typical |
|                                                         | - MCS=8, NSS1 PER @ -67 dBm, typical |
| MIMO Receive<br>Sensitivity<br>(11ac,20MHz) @10%<br>PER | - MCS=0, NSS1 PER @ -89 dBm, typical |
|                                                         | - MCS=1, NSS1 PER @ -88 dBm, typical |
|                                                         | - MCS=2, NSS1 PER @ -87 dBm, typical |
|                                                         | - MCS=3, NSS1 PER @ -84 dBm, typical |
|                                                         | - MCS=4, NSS1 PER @ -81 dBm, typical |
|                                                         | - MCS=5, NSS1 PER @ -76 dBm, typical |
|                                                         | - MCS=6, NSS1 PER @ -75 dBm, typical |
|                                                         | - MCS=7, NSS1 PER @ -73 dBm, typical |
|                                                         | - MCS=8, NSS1 PER @ -69 dBm, typical |
|                                                         | - MCS=0, NSS2 PER @ -89 dBm, typical |
|                                                         | - MCS=8, NSS2 PER @ -65 dBm, typical |
| SISO Receive<br>Sensitivity<br>(11ac,40MHz) @10%<br>PER | - MCS=0, NSS1 PER @ -86 dBm, typical |
|                                                         | - MCS=1, NSS1 PER @ -84 dBm, typical |
|                                                         | - MCS=2, NSS1 PER @ -82 dBm, typical |
|                                                         | - MCS=3, NSS1 PER @ -79 dBm, typical |
|                                                         | - MCS=4, NSS1 PER @ -75 dBm, typical |
|                                                         | - MCS=5, NSS1 PER @ -71 dBm, typical |
|                                                         | - MCS=6, NSS1 PER @ -69 dBm, typical |
|                                                         | - MCS=7, NSS1 PER @ -68 dBm, typical |
|                                                         | - MCS=8, NSS1 PER @ -63 dBm, typical |
|                                                         | - MCS=9, NSS1 PER @ -62 dBm, typical |
| MIMO Receive<br>Sensitivity<br>(11ac,40MHz) @10%<br>PER | - MCS=0, NSS1 PER @ -88 dBm, typical |
|                                                         | - MCS=1, NSS1 PER @ -87 dBm, typical |
|                                                         | - MCS=2, NSS1 PER @ -85 dBm, typical |
|                                                         | - MCS=3, NSS1 PER @ -82 dBm, typical |
|                                                         | - MCS=4, NSS1 PER @ -77 dBm, typical |
|                                                         | - MCS=5, NSS1 PER @ -74 dBm, typical |
|                                                         | - MCS=6, NSS1 PER @ -72 dBm, typical |
|                                                         | - MCS=7, NSS1 PER @ -71 dBm, typical |
|                                                         | - MCS=8, NSS1 PER @ -67 dBm, typical |
|                                                         | - MCS=9, NSS1 PER @ -65 dBm, typical |
|                                                         | - MCS=0, NSS2 PER @ -86 dBm, typical |

|                     |                                       |
|---------------------|---------------------------------------|
|                     | - MCS=9, NSS2 PER @ -61 dBm, typical  |
| Maximum Input Level | 802.11b : -10 dBm                     |
|                     | 802.11g/n : -20 dBm                   |
| Antenna Reference   | Small antennas with 0~2 dBi peak gain |

## 5.2 5GHz RF Specification

Conditions : VBAT=3.6V ; VDDIO=3.3V ; Temp:25°C

| Feature                                          | Description                                                                                                        |
|--------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| WLAN Standard                                    | IEEE 802.11a/n 2x2, WiFi compliant                                                                                 |
| Frequency Range                                  | 4.900 GHz ~ 5.845 GHz (5.0 GHz ISM Band)                                                                           |
| Number of Channels                               | 5.0GHz : Please see the table <sup>1</sup>                                                                         |
| 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 |
| Output Power                                     | 802.11a /54Mbps : 13 dBm $\pm$ 1.5 dB @ EVM $\leq$ -25dB                                                           |
|                                                  | 802.11n /MCS7 : 12 dBm $\pm$ 1.5 dB @ EVM $\leq$ -28dB                                                             |
|                                                  | 802.11ac /MCS9 : 10 dBm $\pm$ 1.5 dB @ EVM $\leq$ -32dB                                                            |
| SISO Receive Sensitivity<br>(11a,20MHz) @10% PER | - 6Mbps PER @ -90 dBm, typical                                                                                     |
|                                                  | - 9Mbps PER @ -88 dBm, typical                                                                                     |
|                                                  | - 12Mbps PER @ -87 dBm, typical                                                                                    |
|                                                  | - 18Mbps PER @ -84 dBm, typical                                                                                    |
|                                                  | - 24Mbps PER @ -81 dBm, typical                                                                                    |
|                                                  | - 36Mbps PER @ -78 dBm, typical                                                                                    |
|                                                  | - 48Mbps PER @ -73 dBm, typical                                                                                    |
|                                                  | - 54Mbps PER @ -71 dBm, typical                                                                                    |
| MIMO Receive Sensitivity<br>(11a,20MHz) @10% PER | - 6Mbps PER @ -90 dBm, typical                                                                                     |
|                                                  | - 9Mbps PER @ -90 dBm, typical                                                                                     |
|                                                  | - 12Mbps PER @ -89 dBm, typical                                                                                    |
|                                                  | - 18Mbps PER @ -87 dBm, typical                                                                                    |
|                                                  | - 24Mbps PER @ -84 dBm, typical                                                                                    |
|                                                  | - 36Mbps PER @ -81 dBm, typical                                                                                    |
|                                                  | - 48Mbps PER @ -76 dBm, typical                                                                                    |
|                                                  | - 54Mbps PER @ -72 dBm, typical                                                                                    |
| SISO Receive Sensitivity<br>(11n,20MHz) @10% PER | - MCS=0 PER @ -89 dBm, typical                                                                                     |
|                                                  | - MCS=1 PER @ -86 dBm, typical                                                                                     |

|                                                   |                                      |
|---------------------------------------------------|--------------------------------------|
|                                                   | - MCS=2 PER @ -84 dBm, typical       |
|                                                   | - MCS=3 PER @ -81 dBm, typical       |
|                                                   | - MCS=4 PER @ -77 dBm, typical       |
|                                                   | - MCS=5 PER @ -72 dBm, typical       |
|                                                   | - MCS=6 PER @ -71 dBm, typical       |
|                                                   | - MCS=7 PER @ -69 dBm, typical       |
| MIMO Receive Sensitivity<br>(11n,20MHz) @10% PER  | - MCS=0 PER @ -90 dBm, typical       |
|                                                   | - MCS=1 PER @ -89 dBm, typical       |
|                                                   | - MCS=2 PER @ -87 dBm, typical       |
|                                                   | - MCS=3 PER @ -84 dBm, typical       |
|                                                   | - MCS=4 PER @ -80 dBm, typical       |
|                                                   | - MCS=5 PER @ -75 dBm, typical       |
|                                                   | - MCS=6 PER @ -74 dBm, typical       |
|                                                   | - MCS=7 PER @ -72 dBm, typical       |
|                                                   | - MCS=8 PER @ -89 dBm, typical       |
|                                                   | - MCS=15 PER @ -69 dBm, typical      |
| SISO Receive Sensitivity<br>(11n,40MHz) @10% PER  | - MCS=0 PER @ -86 dBm, typical       |
|                                                   | - MCS=1 PER @ -83 dBm, typical       |
|                                                   | - MCS=2 PER @ -81 dBm, typical       |
|                                                   | - MCS=3 PER @ -78 dBm, typical       |
|                                                   | - MCS=4 PER @ -74 dBm, typical       |
|                                                   | - MCS=5 PER @ -70 dBm, typical       |
|                                                   | - MCS=6 PER @ -68 dBm, typical       |
|                                                   | - MCS=7 PER @ -67 dBm, typical       |
| MIMO Receive Sensitivity<br>(11n,40MHz) @10% PER  | - MCS=0 PER @ -88 dBm, typical       |
|                                                   | - MCS=1 PER @ -86 dBm, typical       |
|                                                   | - MCS=2 PER @ -84 dBm, typical       |
|                                                   | - MCS=3 PER @ -81 dBm, typical       |
|                                                   | - MCS=4 PER @ -77 dBm, typical       |
|                                                   | - MCS=5 PER @ -73 dBm, typical       |
|                                                   | - MCS=6 PER @ -71 dBm, typical       |
|                                                   | - MCS=7 PER @ -70 dBm, typical       |
|                                                   | - MCS=8 PER @ -86 dBm, typical       |
|                                                   | - MCS=15 PER @ -67 dBm, typical      |
| SISO Receive Sensitivity<br>(11ac,20MHz) @10% PER | - MCS=0, NSS1 PER @ -87 dBm, typical |
|                                                   | - MCS=1, NSS1 PER @ -85 dBm, typical |
|                                                   | - MCS=2, NSS1 PER @ -83 dBm, typical |

|                                                   |                                      |
|---------------------------------------------------|--------------------------------------|
|                                                   | - MCS=3, NSS1 PER @ -80 dBm, typical |
|                                                   | - MCS=4, NSS1 PER @ -76 dBm, typical |
|                                                   | - MCS=5, NSS1 PER @ -71 dBm, typical |
|                                                   | - MCS=6, NSS1 PER @ -70 dBm, typical |
|                                                   | - MCS=7, NSS1 PER @ -69 dBm, typical |
|                                                   | - MCS=8, NSS1 PER @ -65 dBm, typical |
| MIMO Receive Sensitivity<br>(11ac,20MHz) @10% PER | - MCS=0, NSS1 PER @ -89 dBm, typical |
|                                                   | - MCS=1, NSS1 PER @ -88 dBm, typical |
|                                                   | - MCS=2, NSS1 PER @ -86 dBm, typical |
|                                                   | - MCS=3, NSS1 PER @ -83 dBm, typical |
|                                                   | - MCS=4, NSS1 PER @ -79 dBm, typical |
|                                                   | - MCS=5, NSS1 PER @ -74 dBm, typical |
|                                                   | - MCS=6, NSS1 PER @ -73 dBm, typical |
|                                                   | - MCS=7, NSS1 PER @ -72 dBm, typical |
|                                                   | - MCS=8, NSS1 PER @ -68 dBm, typical |
|                                                   | - MCS=0, NSS2 PER @ -88 dBm, typical |
|                                                   | - MCS=8, NSS2 PER @ -64 dBm, typical |
| SISO Receive Sensitivity<br>(11ac,40MHz) @10% PER | - MCS=0, NSS1 PER @ -85 dBm, typical |
|                                                   | - MCS=1, NSS1 PER @ -82 dBm, typical |
|                                                   | - MCS=2, NSS1 PER @ -80 dBm, typical |
|                                                   | - MCS=3, NSS1 PER @ -77 dBm, typical |
|                                                   | - MCS=4, NSS1 PER @ -74 dBm, typical |
|                                                   | - MCS=5, NSS1 PER @ -69 dBm, typical |
|                                                   | - MCS=6, NSS1 PER @ -68 dBm, typical |
|                                                   | - MCS=7, NSS1 PER @ -67 dBm, typical |
|                                                   | - MCS=8, NSS1 PER @ -62 dBm, typical |
|                                                   | - MCS=9, NSS1 PER @ -61 dBm, typical |
| MIMO Receive Sensitivity<br>(11ac,40MHz) @10% PER | - MCS=0, NSS1 PER @ -87 dBm, typical |
|                                                   | - MCS=1, NSS1 PER @ -85 dBm, typical |
|                                                   | - MCS=2, NSS1 PER @ -83 dBm, typical |
|                                                   | - MCS=3, NSS1 PER @ -80 dBm, typical |
|                                                   | - MCS=4, NSS1 PER @ -77 dBm, typical |
|                                                   | - MCS=5, NSS1 PER @ -72 dBm, typical |
|                                                   | - MCS=6, NSS1 PER @ -71 dBm, typical |
|                                                   | - MCS=7, NSS1 PER @ -70 dBm, typical |
|                                                   | - MCS=8, NSS1 PER @ -65 dBm, typical |
|                                                   | - MCS=9, NSS1 PER @ -64 dBm, typical |

|                                                   |                                       |
|---------------------------------------------------|---------------------------------------|
|                                                   | - MCS=0, NSS2 PER @ -85 dBm, typical  |
|                                                   | - MCS=9, NSS2 PER @ -60 dBm, typical  |
| SISO Receive Sensitivity<br>(11ac,80MHz) @10% PER | - MCS=0, NSS1 PER @ -82 dBm, typical  |
|                                                   | - MCS=1, NSS1 PER @ -79 dBm, typical  |
|                                                   | - MCS=2, NSS1 PER @ -77 dBm, typical  |
|                                                   | - MCS=3, NSS1 PER @ -73 dBm, typical  |
|                                                   | - MCS=4, NSS1 PER @ -70 dBm, typical  |
|                                                   | - MCS=5, NSS1 PER @ -67 dBm, typical  |
|                                                   | - MCS=6, NSS1 PER @ -65 dBm, typical  |
|                                                   | - MCS=7, NSS1 PER @ -63 dBm, typical  |
|                                                   | - MCS=9, NSS1 PER @ -59 dBm, typical  |
|                                                   | - MCS=9, NSS1 PER @ -57 dBm, typical  |
| MIMO Receive Sensitivity<br>(11ac,80MHz) @10% PER | - MCS=0, NSS1 PER @ -83 dBm, typical  |
|                                                   | - MCS=1, NSS1 PER @ -82 dBm, typical  |
|                                                   | - MCS=2, NSS1 PER @ -80 dBm, typical  |
|                                                   | - MCS=3, NSS1 PER @ -76 dBm, typical  |
|                                                   | - MCS=4, NSS1 PER @ -73 dBm, typical  |
|                                                   | - MCS=5, NSS1 PER @ -70 dBm, typical  |
|                                                   | - MCS=6, NSS1 PER @ -68 dBm, typical  |
|                                                   | - MCS=7, NSS1 PER @ -66 dBm, typical  |
|                                                   | - MCS=8, NSS1 PER @ -62 dBm, typical  |
|                                                   | - MCS=9, NSS1 PER @ -60 dBm, typical  |
|                                                   | - MCS=0, NSS2 PER @ -81 dBm, typical  |
|                                                   | - MCS=9, NSS2 PER @ -56 dBm, typical  |
| Maximum Input Level                               | 802.11a/n : -30 dBm                   |
| Antenna Reference                                 | Small antennas with 0~2 dBi peak gain |

5GHz(20MHz) Channel table

| Band (GHz)        | Operating Channel Numbers | Channel center frequencies(MHz) |
|-------------------|---------------------------|---------------------------------|
| 5.15GHz~5.25GHz   | 36                        | 5180                            |
|                   | 40                        | 5200                            |
|                   | 44                        | 5220                            |
|                   | 48                        | 5240                            |
| 5.25GHz~5.35GHz   | 52                        | 5260                            |
|                   | 56                        | 5280                            |
|                   | 60                        | 5300                            |
|                   | 64                        | 5320                            |
| 5.5GHz~5.7GHz     | 100                       | 5500                            |
|                   | 104                       | 5520                            |
|                   | 108                       | 5540                            |
|                   | 112                       | 5560                            |
|                   | 116                       | 5580                            |
|                   | 120                       | 5600                            |
|                   | 124                       | 5620                            |
|                   | 128                       | 5640                            |
|                   | 132                       | 5660                            |
|                   | 136                       | 5680                            |
|                   | 140                       | 5700                            |
| 5.725GHz~5.825GHz | 149                       | 5745                            |
|                   | 153                       | 5765                            |
|                   | 157                       | 5785                            |
|                   | 161                       | 5805                            |

## 6. Bluetooth Specification

### 6.1 Bluetooth Specification

Conditions : VBAT=3.6V ; VDDIO=3.3V ; Temp:25°C

| Feature                                               | Description                           |          |      |
|-------------------------------------------------------|---------------------------------------|----------|------|
| <b>General Specification</b>                          |                                       |          |      |
| Bluetooth Standard                                    | Bluetooth V4.1 of 1, 2 and 3 Mbps.    |          |      |
| Antenna Reference                                     | Small antennas with 0~2 dBi peak gain |          |      |
| Frequency Band                                        | 2402 MHz ~ 2480 MHz                   |          |      |
| Number of Channels                                    | 79 channels                           |          |      |
| Modulation                                            | FHSS, GFSK, DPSK, DQPSK               |          |      |
| <b>RF Specification</b>                               |                                       |          |      |
|                                                       | Min.                                  | Typical. | Max. |
| Output Power (Class 1.5)                              |                                       | 7 dBm    |      |
| Output Power (Class 2)                                |                                       | 2 dBm    |      |
| Sensitivity @ BER=0.1%<br>for GFSK (1Mbps)            |                                       | -80 dBm  |      |
| Sensitivity @ BER=0.01%<br>for $\pi/4$ -DQPSK (2Mbps) |                                       | -80 dBm  |      |
| Sensitivity @ BER=0.01%<br>for 8DPSK (3Mbps)          |                                       | -78 dBm  |      |
| Maximum Input Level                                   | GFSK (1Mbps):-20dBm                   |          |      |
|                                                       | $\pi/4$ -DQPSK (2Mbps) :-20dBm        |          |      |
|                                                       | 8DPSK (3Mbps) :-20dBm                 |          |      |



|    |                              |     |                                               |
|----|------------------------------|-----|-----------------------------------------------|
| 4  | NC                           | —   | No connect                                    |
| 5  | 3V3_VBAT                     | I   | VBAT system power supply input                |
| 6  | GND                          | —   | Ground connections                            |
| 7  | JTAG_TDO_GPIO_5              | I/O | GPIO_5                                        |
| 8  | GPIO_8                       | I/O | SDIO and PCIe interface strapping option      |
| 9  | GPIO_9                       | I/O | SDIO and PCIe interface strapping option      |
| 10 | NC                           | —   | No connect                                    |
| 11 | JTAG_TRST_N_COEX0_<br>GPIO_6 | I/O | GPIO_6                                        |
| 12 | JTAG_TCK_COEX1_<br>GPIO_2    | I/O | GPIO_2                                        |
| 13 | JTAG_TMS_COEX2_<br>GPIO_3    | I/O | GPIO_3                                        |
| 14 | NC                           | —   | No connect                                    |
| 15 | NC                           | —   | No connect                                    |
| 16 | NC                           | —   | No connect                                    |
| 17 | GND                          | —   | Ground connections                            |
| 18 | NC                           | —   | No connect                                    |
| 19 | NC                           | —   | No connect                                    |
| 20 | GND                          | —   | Ground connections                            |
| 21 | NC                           | —   | No connect                                    |
| 22 | NC                           | —   | No connect                                    |
| 23 | GND                          | —   | Ground connections                            |
| 24 | BT_DEV_WAKE                  | I/O | Bluetooth DEV_WAKE                            |
| 25 | NC                           | —   | No connect                                    |
| 26 | GND                          | —   | Ground connections                            |
| 27 | SLP_CLK                      | I   | External sleep clock input (32.768KHz)        |
| 28 | WL_RFDISABLE_L_GPIO1         | I/O | WL_DEV_WAKE                                   |
| 29 | PCIE_WAKEn                   | O   | PCIe wake signal                              |
| 30 | PCIE_CLKREQn                 | I/O | PCIe clock request                            |
| 31 | PCIE_PERSTn                  | I   | PCIe host indication to reset the device      |
| 32 | GND                          | —   | Ground connections                            |
| 33 | PCIE_RCLK_N                  | I   | PCI Express differential clock input-Negative |
| 34 | PCIE_RCLK_P                  | I   | PCI Express differential clock input-Positive |
| 35 | GND                          | —   | Ground connections                            |
| 36 | PCIE_TX_N                    | O   | PCI Express transmit data-Negative            |
| 37 | PCIE_TX_P                    | O   | PCI Express transmit data-Positive            |

|    |                            |     |                                                                                                     |
|----|----------------------------|-----|-----------------------------------------------------------------------------------------------------|
| 38 | GND                        | —   | Ground connections                                                                                  |
| 39 | PCIE_RX_N                  | I   | PCI Express receive data-Negative                                                                   |
| 40 | PCIE_RX_P                  | I   | PCI Express receive data-Positive                                                                   |
| 41 | GND                        | —   | Ground connections                                                                                  |
| 42 | NC                         | —   | No connect                                                                                          |
| 43 | BT_I2S_WS                  | I/O | I2S data command line                                                                               |
| 44 | VIO_SD                     | I   | Digital I/O SDIO power supply                                                                       |
| 45 | SDIO_RESET_L_<br>WL_REG_ON | I   | Used by PMU to power up or power down the internal module regulators used by the WLAN section.      |
| 46 | SDIO_WAKE_L_GPIO_0         | I   | WL_HOST_WAKE                                                                                        |
| 47 | SDIO_DATA3                 | I/O | SDIO data line bit3                                                                                 |
| 48 | SDIO_DATA2                 | I/O | SDIO data line bit2                                                                                 |
| 49 | SDIO_DATA1                 | I/O | SDIO data line bit1                                                                                 |
| 50 | SDIO_DATA0                 | I/O | SDIO data line bit0                                                                                 |
| 51 | SDIO_CMD                   | I/O | SDIO command/response                                                                               |
| 52 | SDIO_CLK                   | I   | SDIO clock input                                                                                    |
| 53 | BT_HOST_WAKE               | O   | Bluetooth HOST_WAKE                                                                                 |
| 54 | UART_CTS                   | I   | UART_CTS                                                                                            |
| 55 | UART_SOUT                  | O   | UART_SOUT                                                                                           |
| 56 | UART_SIN                   | I   | UART_SIN                                                                                            |
| 57 | UART_RTS                   | O   | UART_RTS                                                                                            |
| 58 | PCM_SYNC                   | I/O | PCM sync                                                                                            |
| 59 | PCM_IN                     | I   | PCM data in                                                                                         |
| 60 | PCM_OUT                    | O   | PCM data out                                                                                        |
| 61 | PCM_CLK                    | I/O | PCM bus clock                                                                                       |
| 62 | GND                        | —   | Ground connections                                                                                  |
| 63 | BT_ENABLE                  | I   | Used by PMU to power up or power down the internal module regulators used by the Bluetooth section. |
| 64 | BT_I2S_DO_<br>BT_LED       | O   | I2S data line output<br>It can be used as BT_LED                                                    |
| 65 | WL_LED_GPIO_7              | O   | It can be used as WL_LED                                                                            |
| 66 | BT_I2S_DI                  | I   | I2S data line input                                                                                 |
| 67 | BT_I2S_CLK                 | I/O | I2S data line clock                                                                                 |
| 68 | GND                        | —   | Ground connections                                                                                  |
| 69 | USB_DM                     | I/O | USB serial differential data Negative                                                               |
| 70 | USB_DP                     | I/O | USB serial differential dataPositive                                                                |
| 71 | GND                        | —   | Ground connections                                                                                  |

|     |         |   |                          |
|-----|---------|---|--------------------------|
| 72  | 3V3_USB | I | 3.3V power supply        |
| 73  | VIO     | I | Digital I/O power supply |
| 74  | GND     | — | Ground connections       |
| 75  | GND     | — | Ground connections       |
| 76  | GND     | — | Ground connections       |
| 77  | GND     | — | Ground connections       |
| 78  | GND     | — | Ground connections       |
| 79  | GND     | — | Ground connections       |
| 80  | GND     | — | Ground connections       |
| 81  | GND     | — | Ground connections       |
| 82  | GND     | — | Ground connections       |
| 83  | GND     | — | Ground connections       |
| 84  | GND     | — | Ground connections       |
| 85  | GND     | — | Ground connections       |
| 86  | GND     | — | Ground connections       |
| 87  | GND     | — | Ground connections       |
| 88  | GND     | — | Ground connections       |
| 89  | GND     | — | Ground connections       |
| 90  | GND     | — | Ground connections       |
| 91  | GND     | — | Ground connections       |
| 92  | GND     | — | Ground connections       |
| 93  | GND     | — | Ground connections       |
| 94  | GND     | — | Ground connections       |
| 95  | GND     | — | Ground connections       |
| 96  | GND     | — | Ground connections       |
| G1  | GND     | — | Ground connections       |
| G2  | GND     | — | Ground connections       |
| G3  | GND     | — | Ground connections       |
| G4  | GND     | — | Ground connections       |
| G5  | GND     | — | Ground connections       |
| G6  | GND     | — | Ground connections       |
| G7  | GND     | — | Ground connections       |
| G8  | GND     | — | Ground connections       |
| G9  | GND     | — | Ground connections       |
| G10 | GND     | — | Ground connections       |
| G11 | GND     | — | Ground connections       |
| G12 | GND     | — | Ground connections       |





## 9. External clock reference

External LPO signal characteristics

| Parameter                                    | Specification                        | Units    |
|----------------------------------------------|--------------------------------------|----------|
| Nominal input frequency                      | 32.768                               | kHz      |
| Frequency accuracy                           | $\pm 30$                             | ppm      |
| Duty cycle                                   | 30 - 70                              | %        |
| Input signal amplitude                       | 1600 to 3300                         | mV, p-p  |
| Signal type                                  | Square-wave or sine-wave             | -        |
| Input impedance                              | >100k                                | $\Omega$ |
|                                              | <5                                   | pF       |
| Clock jitter (integrated over 300Hz – 15KHz) | <1                                   | Hz       |
| Output high voltage                          | 0.7V <sub>io</sub> - V <sub>io</sub> | V        |

### 9.1 SDIO Pin Description

The module supports SDIO version 3.0 for all 1.8V 4-bit UHSI speeds: SDR50(100 Mbps),SDR104(208MHz) and DDR50(50MHz, dual rates) in addition to the 3.3V default speed(25MHz) and high speed (50 MHz). It has the ability to stop the SDIO clock and map the interrupt signal into a GPIO pin. This 'out-of-band' interrupt signal notifies the host when the WLAN device wants to turn on the SDIO interface. The ability to force the control of the gated clocks from within the WLAN chip is also provided.

- ❖ Function 0 Standard SDIO function (Max BlockSize / ByteCount = 32B)
- ❖ Function 1 Backplane Function to access the internal System On Chip (SOC) address space (Max BlockSize / ByteCount = 64B)
- ❖ Function 2 WLAN Function for efficient WLAN packet transfer through DMA (Max BlockSize/ByteCount=512B)

SDIO Pin Description

| SD 4-Bit Mode |                          |
|---------------|--------------------------|
| DATA0         | Data Line 0              |
| DATA1         | Data Line 1 or Interrupt |
| DATA2         | Data Line 2 or Read Wait |
| DATA3         | Data Line 3              |
| CLK           | Clock                    |
| CMD           | Command Line             |

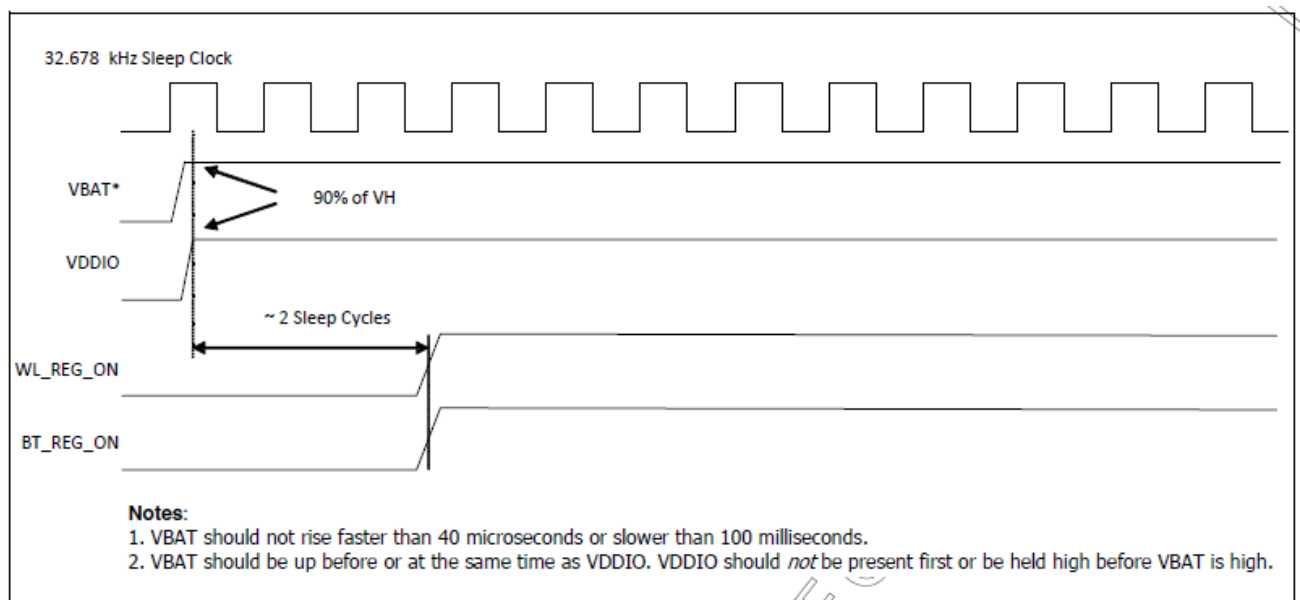
# 10. Host Interface Timing Diagram

## 10.1 Power-up Sequence Timing Diagram

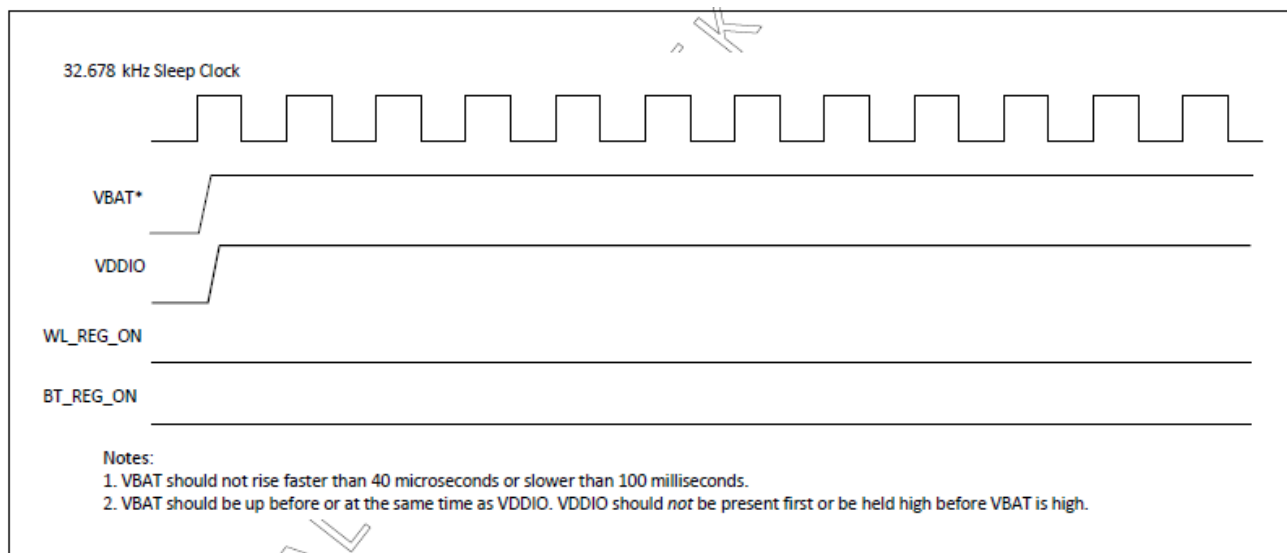
The module has signals that allow the host to control power consumption by enabling or disabling the Bluetooth, WLAN and internal regulator blocks. These signals are described below.

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.

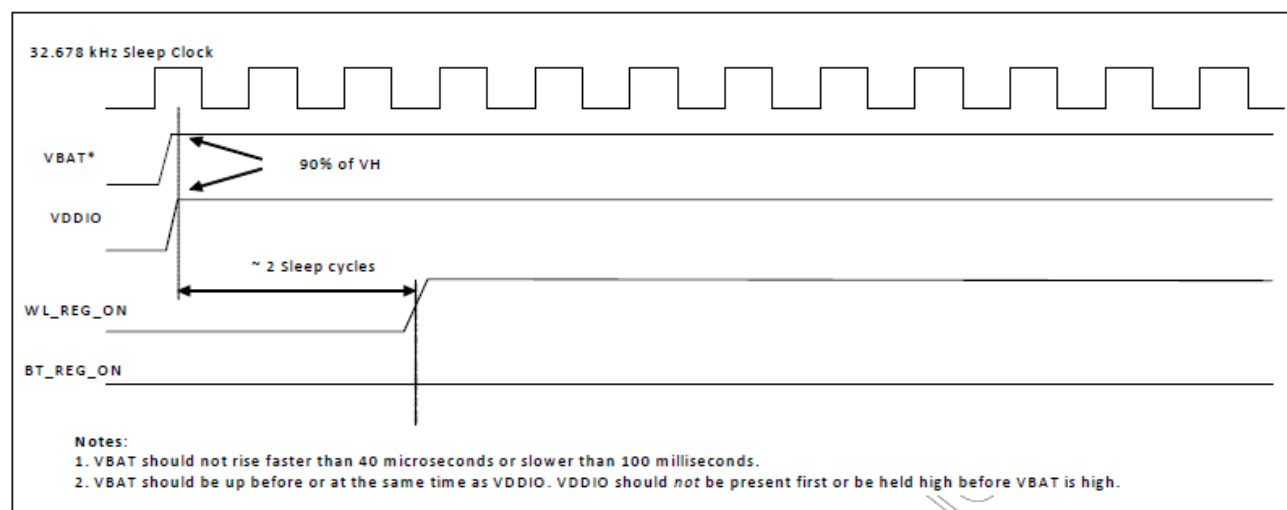
- ※ WL\_REG\_ON: Used by the PMU to power up or power down the internal regulators used by the WLAN section. When this pin is high, the regulators are enabled and the WLAN section is out of reset. When this pin is low the WLAN section is in reset.
- ※ BT\_REG\_ON: Used by the PMU to power up or power down the internal regulators used by the BT section. Low asserting reset for Bluetooth. This pin has no effect on WLAN and does not control any PMU functions. This pin must be driven high or low (not left floating).



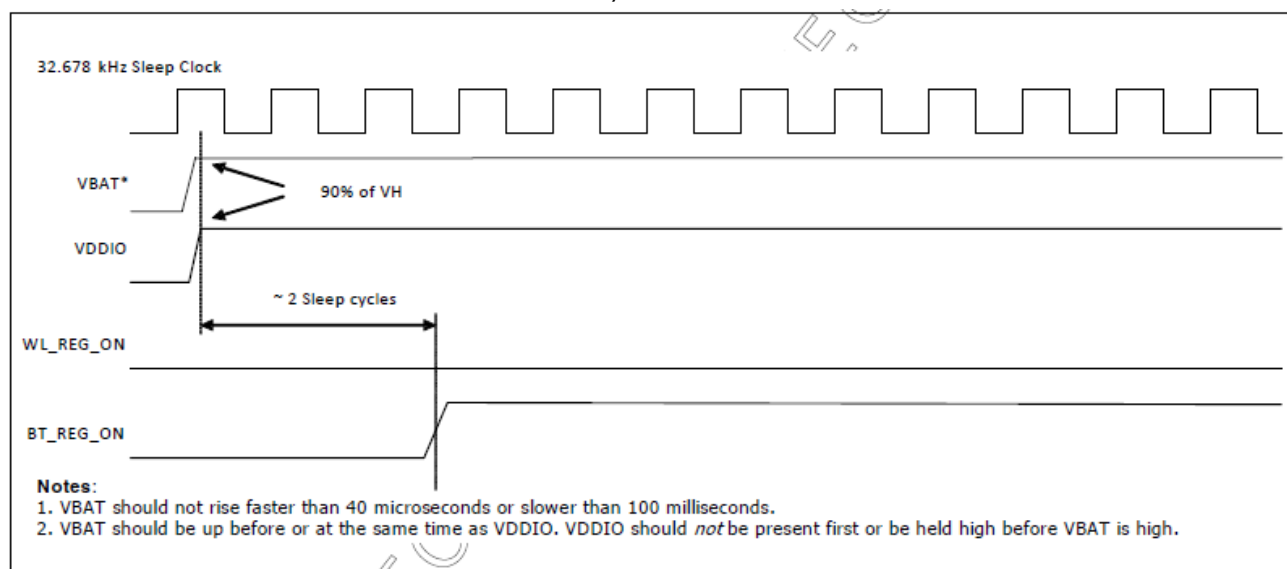
WLAN=ON, Bluetooth=ON



WLAN=OFF, Bluetooth=OFF

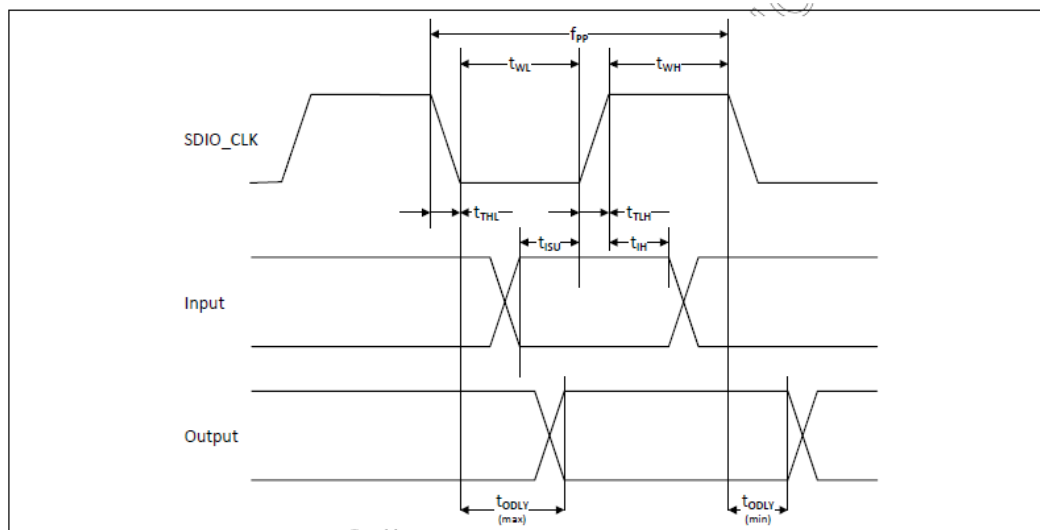


WLAN=ON, Bluetooth=OFF



WLAN=OFF, Bluetooth=ON

## 10.2 SDIO Default Mode Timing Diagram

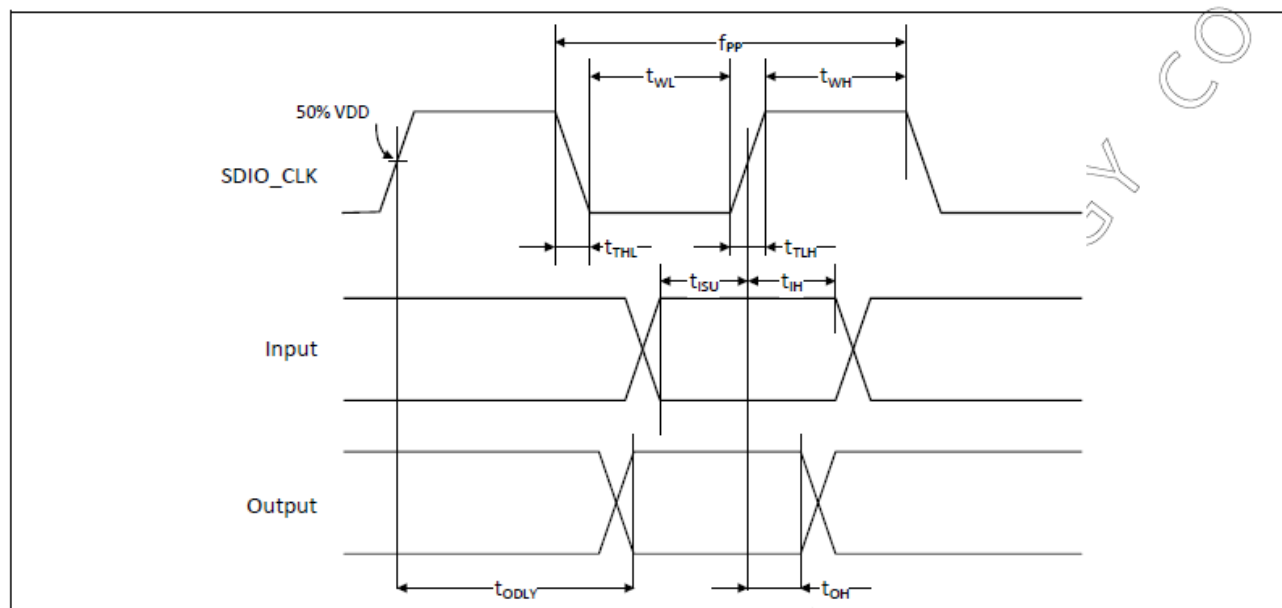


| Parameter                                                                            | Symbol | Minimum | Typical | Maximum | Unit |
|--------------------------------------------------------------------------------------|--------|---------|---------|---------|------|
| <b>SDIO CLK (All values are referred to minimum VIH and maximum VIL<sup>b</sup>)</b> |        |         |         |         |      |
| Frequency – Data Transfer mode                                                       | fPP    | 0       | –       | 25      | MHz  |
| Frequency – Identification mode                                                      | fOD    | 0       | –       | 400     | kHz  |
| Clock low time                                                                       | tWL    | 10      | –       | –       | ns   |
| Clock high time                                                                      | tWH    | 10      | –       | –       | ns   |
| Clock rise time                                                                      | tTLH   | –       | –       | 10      | ns   |
| Clock low time                                                                       | tTHL   | –       | –       | 10      | ns   |
| <b>Inputs: CMD, DAT (referenced to CLK)</b>                                          |        |         |         |         |      |
| Input setup time                                                                     | tISU   | 5       | –       | –       | ns   |
| Input hold time                                                                      | tIH    | 5       | –       | –       | ns   |
| <b>Outputs: CMD, DAT (referenced to CLK)</b>                                         |        |         |         |         |      |
| Output delay time – Data Transfer mode                                               | tODLY  | 0       | –       | 14      | ns   |
| Output delay time – Identification mode                                              | tODLY  | 0       | –       | 50      | ns   |

a. Timing is based on  $CL \leq 40pF$  load on CMD and Data.

b.  $\min(V_{ih}) = 0.7 \times V_{DDIO}$  and  $\max(V_{il}) = 0.2 \times V_{DDIO}$ .

## 10.3 SDIO High Speed Mode Timing Diagram



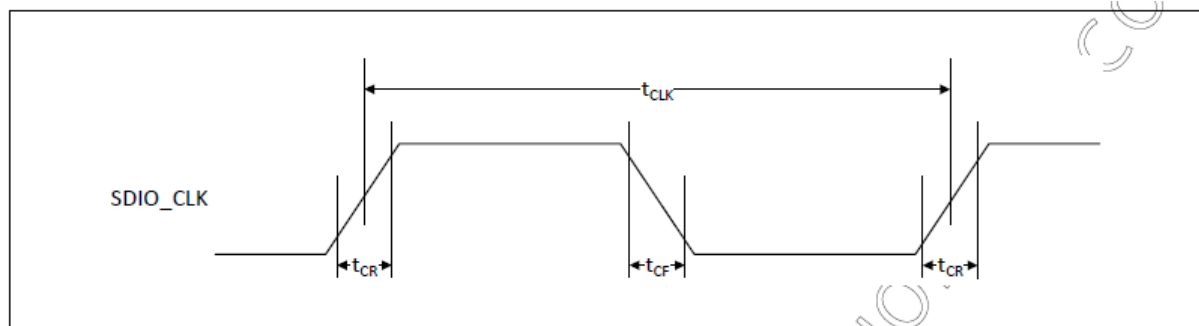
| Parameter                                                                                                  | Symbol            | Minimum | Typical | Maximum | Unit |
|------------------------------------------------------------------------------------------------------------|-------------------|---------|---------|---------|------|
| <b>SDIO CLK (all values are referred to minimum <math>V_{IH}</math> and maximum <math>V_{IL}^b</math>)</b> |                   |         |         |         |      |
| Frequency – Data Transfer Mode                                                                             | f <sub>PP</sub>   | 0       | –       | 50      | MHz  |
| Frequency – Identification Mode                                                                            | f <sub>OD</sub>   | 0       | –       | 400     | kHz  |
| Clock low time                                                                                             | t <sub>WL</sub>   | 7       | –       | –       | ns   |
| Clock high time                                                                                            | t <sub>WH</sub>   | 7       | –       | –       | ns   |
| Clock rise time                                                                                            | t <sub>TLH</sub>  | –       | –       | 3       | ns   |
| Clock low time                                                                                             | t <sub>THL</sub>  | –       | –       | 3       | ns   |
| <b>Inputs: CMD, DAT (referenced to CLK)</b>                                                                |                   |         |         |         |      |
| Input setup Time                                                                                           | t <sub>ISU</sub>  | 6       | –       | –       | ns   |
| Input hold Time                                                                                            | t <sub>IH</sub>   | 2       | –       | –       | ns   |
| <b>Outputs: CMD, DAT (referenced to CLK)</b>                                                               |                   |         |         |         |      |
| Output delay time – Data Transfer Mode                                                                     | t <sub>ODLY</sub> | –       | –       | 14      | ns   |
| Output hold time                                                                                           | t <sub>OH</sub>   | 2.5     | –       | –       | ns   |
| Total system capacitance (each line)                                                                       | CL                | –       | –       | 40      | pF   |

a. Timing is based on CL ≤ 40 pF load on CMD and Data.

b. min( $V_{ih}$ ) = 0.7 × VDDIO and max( $V_{il}$ ) = 0.2 × VDDIO.

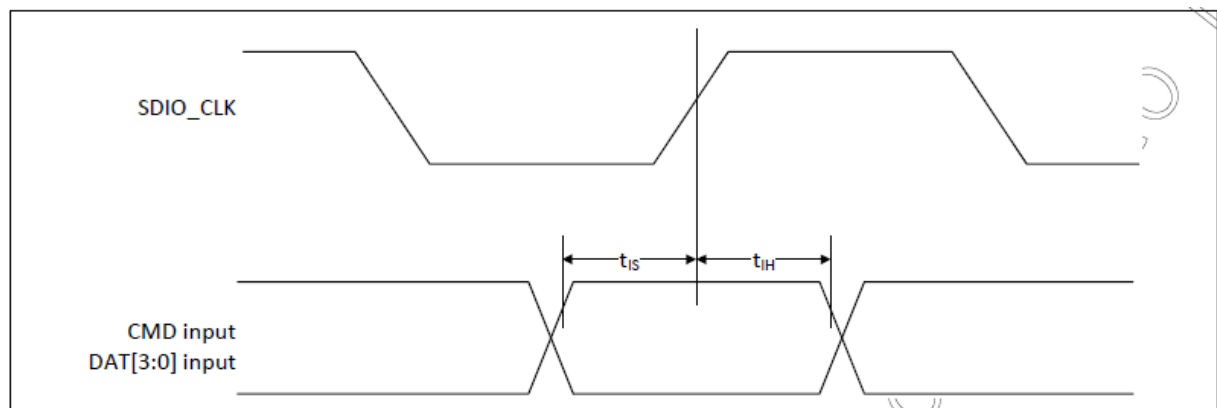
## 10.4 SDIO Bus Timing Specifications in SDR Modes

### Clock timing(SDR Modes)



| Parameter  | Symbol           | Minimum | Maximum              | Unit | Comments                                                                                                                             |
|------------|------------------|---------|----------------------|------|--------------------------------------------------------------------------------------------------------------------------------------|
| –          | $t_{CLK}$        | 40      | –                    | ns   | SDR12 mode                                                                                                                           |
|            |                  | 20      | –                    | ns   | SDR25 mode                                                                                                                           |
|            |                  | 10      | –                    | ns   | SDR50 mode                                                                                                                           |
|            |                  | 4.8     | –                    | ns   | SDR104 mode                                                                                                                          |
| –          | $t_{CR}, t_{CF}$ | –       | $0.2 \times t_{CLK}$ | ns   | $t_{CR}, t_{CF} < 2.00$ ns (max) @100 MHz,<br>$C_{CARD} = 10$ pF<br>$t_{CR}, t_{CF} < 0.96$ ns (max) @208 MHz,<br>$C_{CARD} = 10$ pF |
| Clock duty | –                | 30      | 70                   | %    | –                                                                                                                                    |

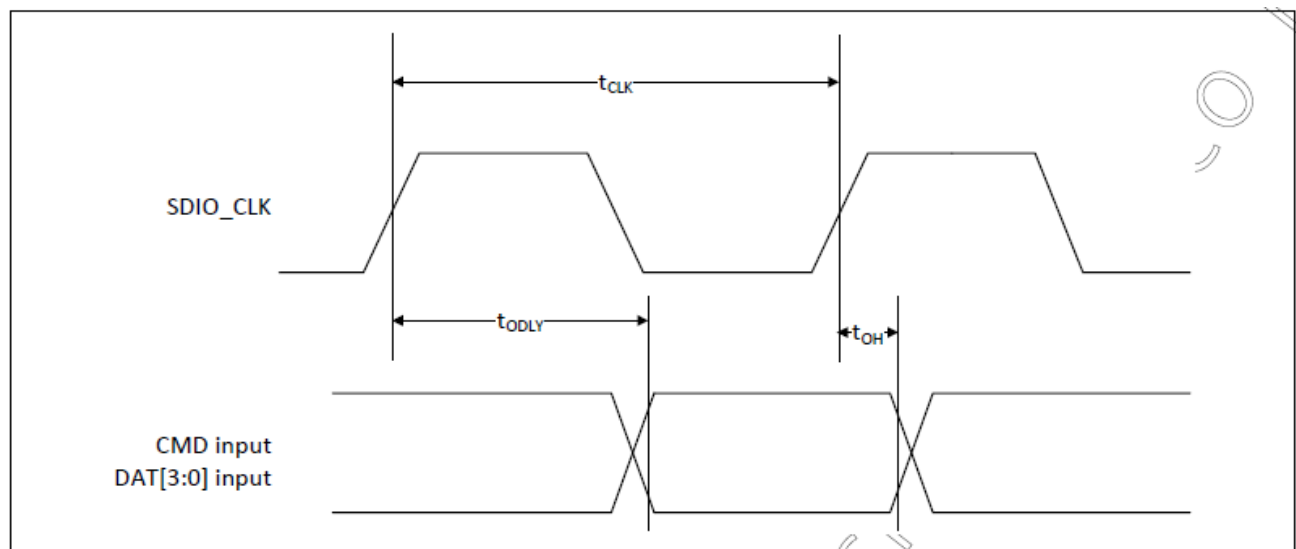
### Card Input timing (SDR Modes)



| Symbol             | Minimum           | Maximum | Unit | Comments                         |
|--------------------|-------------------|---------|------|----------------------------------|
| <b>SDR104 Mode</b> |                   |         |      |                                  |
| $t_{IS}$           | 1.70 <sup>a</sup> | –       | ns   | $C_{CARD} = 10$ pF, VCT = 0.975V |
| $t_{IH}$           | 0.80              | –       | ns   | $C_{CARD} = 5$ pF, VCT = 0.975V  |
| <b>SDR50 Mode</b>  |                   |         |      |                                  |
| $t_{IS}$           | 3.00              | –       | ns   | $C_{CARD} = 10$ pF, VCT = 0.975V |
| $t_{IH}$           | 0.80              | –       | ns   | $C_{CARD} = 5$ pF, VCT = 0.975V  |

a. SDIO 3.0 specification value is 1.40 ns.

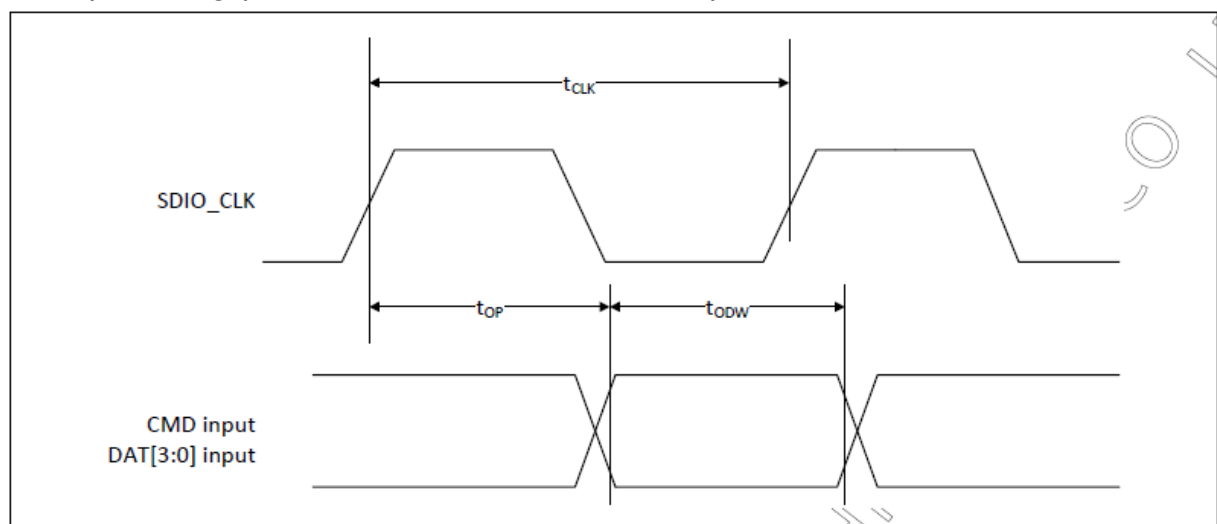
## Card output timing (SDR Modes up to 100MHz)



| Symbol     | Minimum | Maximum           | Unit | Comments                                                         |
|------------|---------|-------------------|------|------------------------------------------------------------------|
| $t_{ODLY}$ | –       | 7.85 <sup>a</sup> | ns   | $t_{CLK} \geq 10$ ns $C_L = 30$ pF using driver type B for SDR50 |
| $t_{ODLY}$ | –       | 14.0              | ns   | $t_{CLK} \geq 20$ ns $C_L = 40$ pF using for SDR12, SDR25        |
| $t_{OH}$   | 1.5     | –                 | ns   | Hold time at the $t_{ODLY}$ (min) $C_L = 15$ pF                  |

a. SDIO 3.0 specification value is 7.5 ns.

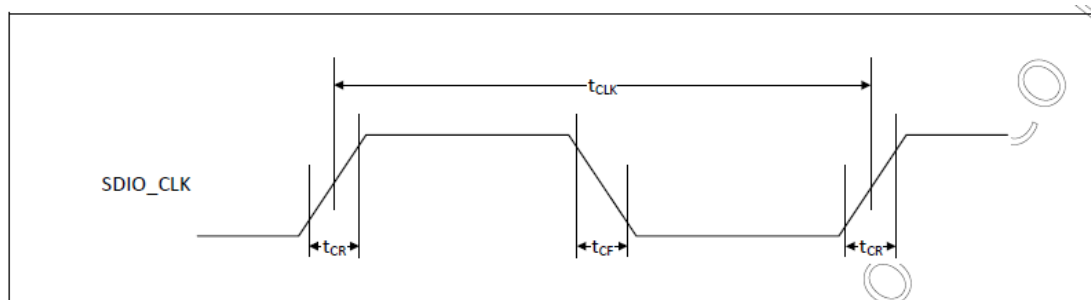
## Card output timing (SDR Modes 100MHz to 208MHz)



| Symbol          | Minimum | Maximum | Unit | Comments                                        |
|-----------------|---------|---------|------|-------------------------------------------------|
| $t_{OP}$        | 0       | 2       | UI   | Card output phase                               |
| $\Delta t_{OP}$ | –350    | +1550   | ps   | Delay variation due to temp change after tuning |
| $t_{ODW}$       | 0.60    | –       | UI   | $t_{ODW} = 2.88$ ns @ 208 MHz                   |

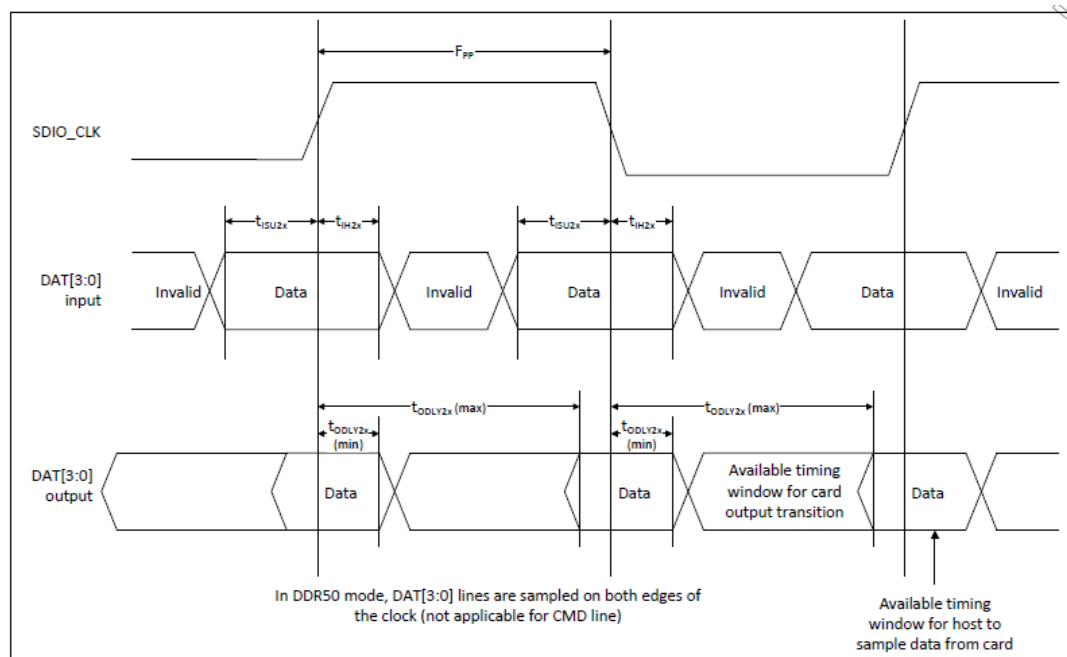
- $\Delta t_{OP} = +1550$  ps for junction temperature of  $\Delta t_{OP} = 90$  degrees during operation
- $\Delta t_{OP} = -350$  ps for junction temperature of  $\Delta t_{OP} = -20$  degrees during operation
- $\Delta t_{OP} = +2600$  ps for junction temperature of  $\Delta t_{OP} = -20$  to  $+125$  degrees during operation

## 10.5 SDIO Bus Timing Specifications in DDR50 Mode



| Parameter  | Symbol           | Minimum | Maximum              | Unit | Comments                                                        |
|------------|------------------|---------|----------------------|------|-----------------------------------------------------------------|
| –          | $t_{CLK}$        | 20      | –                    | ns   | DDR50 mode                                                      |
| –          | $t_{CR}, t_{CF}$ | –       | $0.2 \times t_{CLK}$ | ns   | $t_{CR}, t_{CF} < 4.00$ ns (max) @50 MHz,<br>$C_{CARD} = 10$ pF |
| Clock duty | –                | 45      | 55                   | %    | –                                                               |

### Data Timing



| Parameter         | Symbol       | Minimum | Maximum           | Unit | Comments                    |
|-------------------|--------------|---------|-------------------|------|-----------------------------|
| <b>Input CMD</b>  |              |         |                   |      |                             |
| Input setup time  | $t_{ISU}$    | 6       | –                 | ns   | $C_{CARD} < 10$ pF (1 Card) |
| Input hold time   | $t_{IH}$     | 0.8     | –                 | ns   | $C_{CARD} < 10$ pF (1 Card) |
| <b>Output CMD</b> |              |         |                   |      |                             |
| Output delay time | $t_{ODLY}$   | –       | 13.7              | ns   | $C_{CARD} < 30$ pF (1 Card) |
| Output hold time  | $t_{OH}$     | 1.5     | –                 | ns   | $C_{CARD} < 15$ pF (1 Card) |
| <b>Input DAT</b>  |              |         |                   |      |                             |
| Input setup time  | $t_{ISU2x}$  | 3       | –                 | ns   | $C_{CARD} < 10$ pF (1 Card) |
| Input hold time   | $t_{IH2x}$   | 0.8     | –                 | ns   | $C_{CARD} < 10$ pF (1 Card) |
| <b>Output DAT</b> |              |         |                   |      |                             |
| Output delay time | $t_{ODLY2x}$ | –       | 7.85 <sup>a</sup> | ns   | $C_{CARD} < 25$ pF (1 Card) |
| Output hold time  | $t_{ODLY2x}$ | 1.5     | –                 | ns   | $C_{CARD} < 15$ pF (1 Card) |

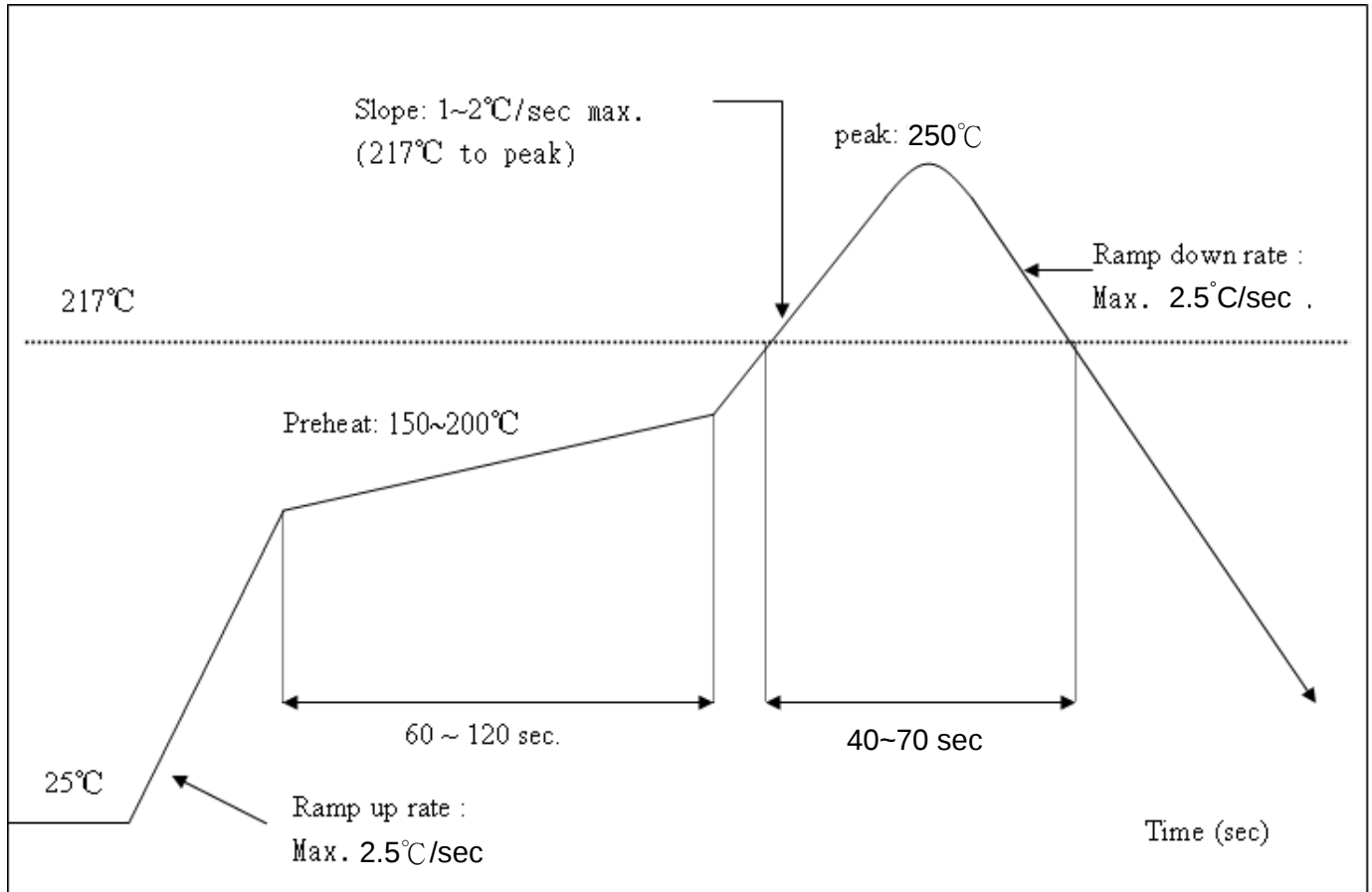
<sup>a</sup> SDIO 3.0 specification value is 7.0 ns.

# 11. Recommended Reflow Profile

Referred to IPC/JEDEC standard.

Peak Temperature :  $<250^{\circ}\text{C}$

Number of Times :  $\leq 2$  times



# 12. Package Information

## 12.1 Label

Label A → Anti-static and humidity notice



Label B → MSL caution / Storage Condition

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                          |                                                                                                                                                           |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Caution</b><br>This bag contains<br><b>MOISTURE-SENSITIVE DEVICES</b> | <b>LEVEL</b><br><br><small>If blank, see adjacent bar code label</small> |
| 1. Calculated shelf life in sealed bag: 12 months at <40°C and <90% relative humidity (RH)<br>2. Peak package body temperature: _____ °C<br><small>If blank, see adjacent bar code label</small><br>3. After bag is opened, devices that will be subjected to reflow solder or other high temperature process must be<br>a) Mounted within: _____ hours of factory conditions<br><small>If blank, see adjacent bar code label</small><br>≤30°C/60% RH, or<br>b) Stored per J-STD-033<br>4. Devices require bake, before mounting, if:<br>a) Humidity Indicator Card reads >10% for level 2a - 5a devices or >60% for level 2 devices when read at 23 ± 5°C<br>b) 3a or 3b are not met<br>5. If baking is required, refer to IPC/JEDEC J-STD-033 for bake procedure<br>Bag Seal Date: _____<br><small>If blank, see adjacent bar code label</small><br><small>Note: Level and body temperature defined by IPC/JEDEC J-STD-020</small> |                                                                          |                                                                                                                                                           |

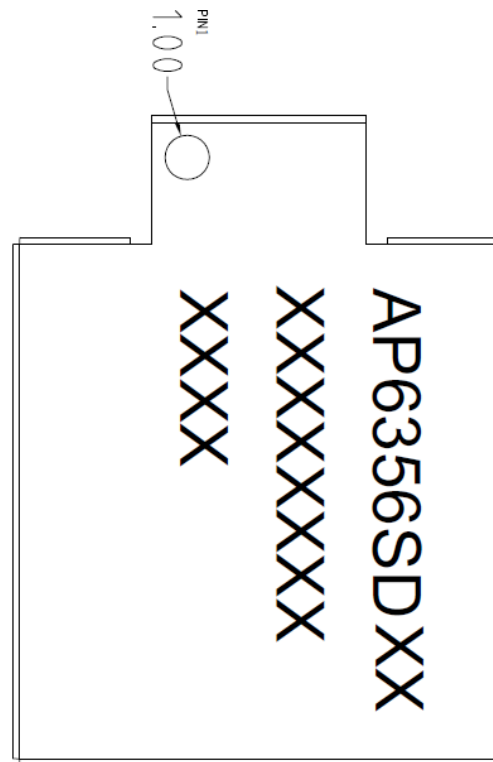
Label C → Inner box label .

|             |                                                                                                        |
|-------------|--------------------------------------------------------------------------------------------------------|
| PO:         |                     |
| AMK DEVICE: |                     |
| PKG S/N:    | <br>9PKG13031600001 |
| Model :     | <br>AP6356SDXX(HF)  |
| P/N:        | <br>99P-W01-0XXXR   |
| Qty :       | <br>1000            |
| Date Code : | <br>XXXX            |
| Lot Code :  | <br>TXXXXXXX        |

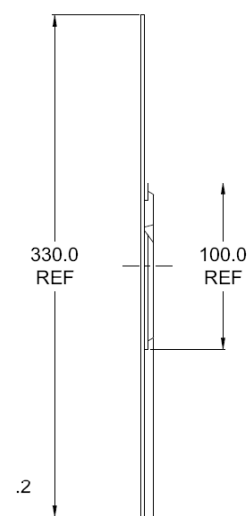
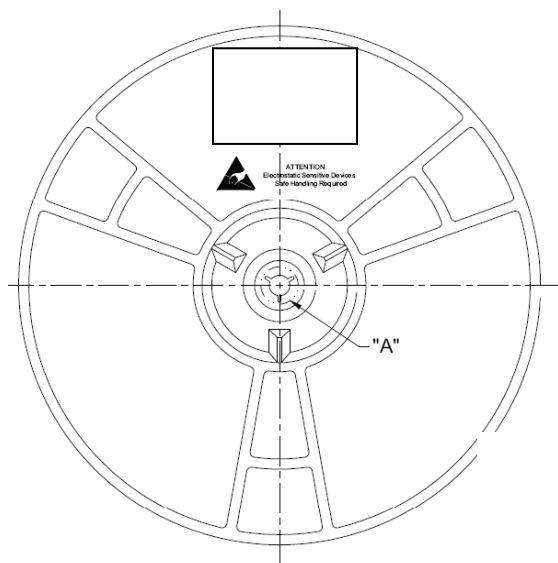
Label D → Carton box label .

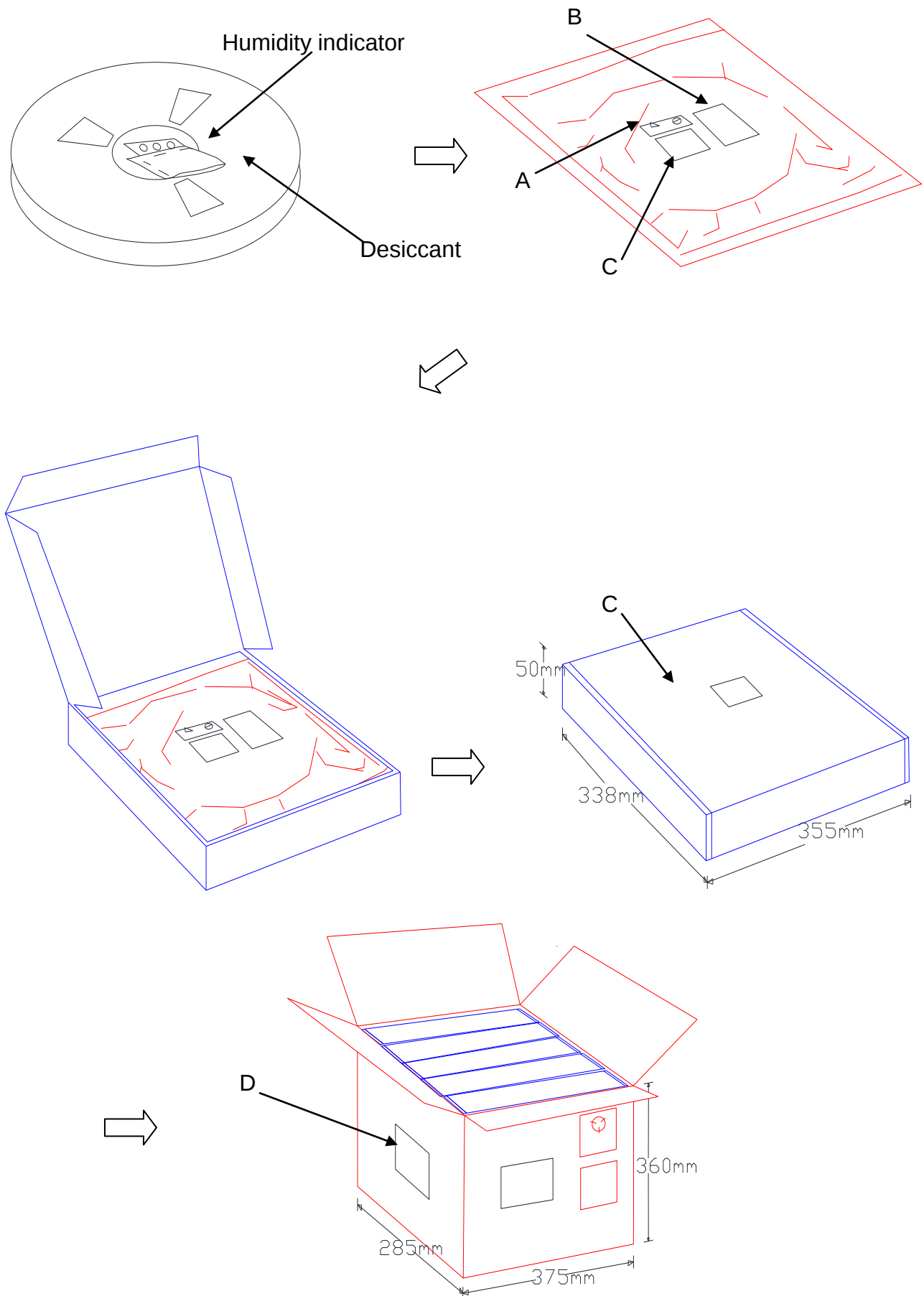
|                       |                                                                                                       |
|-----------------------|-------------------------------------------------------------------------------------------------------|
| AMPAK Technology Inc. |                                                                                                       |
| PO :                  |                    |
| AMK DEVICE:           |                    |
| Model Name :          | <br>AP6356SDXX(HF) |
| Part No.:             | <br>99P-W01-0XXXR  |
| Quantity :            | <br>5000           |
| Lot D/C:              | <br>TXXXXXXX XXXX |
| Manufacture:          | <br>2015/XX/XX     |

## 12.2 Dimension



1. 10 sprocket hole pitch cumulative tolerance  $\pm 0.20$ .
2. Carrier camber is within 1 mm in 250 mm.
3. Material : Black Conductive Polystyrene Alloy.
4. All dimensions meet EIA-481-D requirements.
5. Thickness :  $0.30 \pm 0.05$  mm.
6. Component load per 13" reel





## 12.3 MSL Level / Storage Condition

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                       |                                                                                                                                                                                                                                                               |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <h3 style="margin: 0;">Caution</h3> <p style="margin: 0;">This bag contains<br/><b>MOISTURE-SENSITIVE DEVICES</b></p> | <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;"> <p style="margin: 0;">LEVEL</p> <p style="font-size: 2em; margin: 0;">4</p> </div> <p style="font-size: 0.8em; margin: 0;">If blank, see adjacent bar code label</p> |
| <ol style="list-style-type: none"> <li>1. Calculated shelf life in sealed bag: 12 months at <math>&lt;40^{\circ}\text{C}</math> and <math>&lt;90\%</math> relative humidity (RH)</li> <li>2. Peak package body temperature: <u>250</u> <math>^{\circ}\text{C}</math><br/><span style="font-size: 0.8em; display: block; text-align: right;">If blank, see adjacent bar code label</span></li> <li>3. After bag is opened, devices that will be subjected to reflow solder or other high temperature process must be               <ol style="list-style-type: none"> <li>a) Mounted within: <u>72</u> hours of factory conditions<br/><span style="font-size: 0.8em; display: block; text-align: right;">If blank, see adjacent bar code label</span><br/><math>\leq 30^{\circ}\text{C} / 60\% \text{ RH}</math>, or</li> <li>b) Stored per J-STD-033</li> </ol> </li> <li>4. Devices require bake, before mounting, if:               <ol style="list-style-type: none"> <li>a) Humidity Indicator Card reads <math>&gt;10\%</math> for level 2a-5a devices or <math>&gt;60\%</math> for level 2 devices when read at <math>23 \pm 5^{\circ}\text{C}</math></li> <li>b) 3a or 3b are not met.</li> </ol> </li> <li>5. If baking is required, refer to IPC/JEDEC J-STD-033 for bake procedure.</li> </ol> <p>Bag Seal Date: _____<br/><span style="font-size: 0.8em; display: block; text-align: right;">If blank, see adjacent bar code label</span></p> <p style="font-size: 0.8em; margin-top: 10px;">Note: Level and body temperature defined by IPC/JEDEC J-STD-020</p> |                                                                                                                       |                                                                                                                                                                                                                                                               |

**※NOTE : Accumulated baking time should not exceed 96hrs**