

# Datasheet

## AP6181

IEEE 802.11 b/g/n 1x1 WiFi Sip Module

---

## The revision history of the product specification

Version	Purpose	Date	Editor
1.0	Initial Doc	2019/07/17	Aaron
1.1	Add caution for SMT preparation	2019/08/22	Aaron
1.2	Modify Recommended Footprint	2019/09/20	Aaron
1.3	Correcting document content (Page 4)	2020/03/31	Kamoro

# CONTENTS

<b>1. Introduction</b> .....	<b>3</b>
1.1 Product Overview .....	3
1.2 Product Features .....	3
<b>2. Specification</b> .....	<b>4</b>
2.1 General Specification .....	4
2.2 WiFi 2.4GHz RF Specification .....	5
<b>3. Electrical Characteristics</b> .....	<b>6</b>
3.1 Absolute Maximum Ratings .....	6
3.2 Recommended Operating Rating .....	6
3.3 Recommended Operating Conditions and DC Characteristics .....	7
<b>4. Host Interface Timing Diagram</b> .....	<b>8</b>
4.1 Power-up Sequence Timing Diagram .....	8
4.2 SDIO Default Mode Timing Diagram .....	8
4.3 SDIO High Speed Mode Timing Diagram .....	9
<b>5. Power Consumption</b> .....	<b>11</b>
<b>6. Block Diagram</b> .....	<b>12</b>
<b>7. Pin Definition</b> .....	<b>13</b>
7.1 Pin Outline .....	13
7.2 Pin Table.....	14
<b>8. Mechanical Specification</b> .....	<b>16</b>
8.1 Module Dimension .....	16
8.2 PCB Footprint.....	16
<b>9. External Clock Reference</b> .....	<b>18</b>
9.1 SDIO Pin Description .....	19
<b>10. Recommended Reflow Profile</b> .....	<b>20</b>
10.1 Caution for SMT Preparation .....	21
<b>11. Package Information</b> .....	<b>22</b>
11.1 Label .....	22
<b>12. Ordering Information</b> .....	<b>25</b>

# 1. Introduction

## 1.1 Product Overview

AP6181 is a 802.11b/g/n 1T1R low-cost and low-power consumption module which has all of the WiFi functionalities. The highly integrated module makes the possibilities of web browsing, VoIP, headsets and other applications. With seamless roaming capabilities and advanced security, also could interact with different vendors' 802.11b/g/n Access Points in the wireless LAN.

This wireless module complies with IEEE 802.11 b/g/n standard and it can achieve up to a speed of 72.2Mbps with single stream in 802.11n draft, 54Mbps as specified in IEEE 802.11g, or 11Mbps for IEEE 802.11b to connect to the wireless LAN. The integrated module provides SDIO interface for Wi-Fi.

This compact module is a total solution for Wi-Fi technologies. The module is specifically developed for Tablet, Smart phones and Portable devices.

## 1.2 Product Features

- Single-band 2.4GHz IEEE 802.11b/g/n
- Supports standard interfaces SDIO v2.0(50MHz, 4-bit and 1-bit)
- Integrated ARM Cortex-M3™ CPU with on-chip memory enables running IEEE802.11 firmware that can be field-upgraded with future features.
- Security:
  - Hardware WAPI acceleration engine
  - AES and TKIP in hardware for faster data encryption and IEEE 802.11i compatibility
  - WPA™ – and WPA2™ - (Personal) support for powerful encryption and authentication

## 2. Specification

### 2.1 General Specification

Standards	IEEE 802.11 b/g/n 1T1R Wi-Fi Module
Chipset	Broadcom
Operating Frequency	2.412 GHz ~ 2.4835 GHz (2.4 GHz ISM Band)
Modulation	802.11b: DSSS (DBPSK, DQPSK, CCK) 802.11g: OFDM (BPSK, QPSK, 16-QAM, 64-QAM) 802.11gn: OFDM (BPSK, QPSK, 16-QAM, 64-QAM)
Interface	WLAN: SDIO 2.0
Form Factor	Stamp Type
Antenna	External
Dimension	L x W x H: 12mm(± 0.2mm) x 12mm(± 0.2mm) x 1.75mm(Max.)
Operating temperature	-30°C~65°C
Storage temperature	-40°C~85°C
Humidity (Non-Condensing)	10%~95% (Operating) 5%~95% (Storing)
Weight	0.4g
Driver Support	Linux, Android

Note: Optimal RF performance specified in the data sheet, however, is guaranteed only -10°C to 55°C.

## 2.2 WiFi 2.4GHz RF Specification

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

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 /65Mbps : 14 dBm $\pm$ 1.5 dB @ EVM $\leq$ -27dB
Receive Sensitivity (11n,20MHz) @10% PER	- MCS=0 PER @ -86 dBm, $\pm$ 2 dB
	- MCS=1 PER @ -84 dBm, $\pm$ 2 dB
	- MCS=2 PER @ -82 dBm, $\pm$ 2 dB
	- MCS=3 PER @ -80 dBm, $\pm$ 2 dB
	- MCS=4 PER @ -78 dBm, $\pm$ 2 dB
	- MCS=5 PER @ -75 dBm, $\pm$ 2 dB
	- MCS=6 PER @ -72 dBm, $\pm$ 2 dB
	- MCS=7 PER @ -71 dBm, $\pm$ 2 dB
Receive Sensitivity (11g) @10% PER	- 6Mbps PER @ -87 dBm, $\pm$ 2 dB
	- 9Mbps PER @ -86 dBm, $\pm$ 2 dB
	- 12Mbps PER @ -85 dBm, $\pm$ 2 dB
	- 18Mbps PER @ -83 dBm, $\pm$ 2 dB
	- 24Mbps PER @ -82 dBm, $\pm$ 2 dB
	- 36Mbps PER @ -79 dBm, $\pm$ 2 dB
	- 48Mbps PER @ -75 dBm, $\pm$ 2 dB
	- 54Mbps PER @ -74 dBm, $\pm$ 2 dB
Receive Sensitivity (11b) @8% PER	- 1Mbps PER @ -95 dBm, $\pm$ 2 dB
	- 2Mbps PER @ -93 dBm, $\pm$ 2 dB
	- 5.5Mbps PER @ -90 dBm, $\pm$ 2 dB
	- 11Mbps PER @ -87 dBm, $\pm$ 2 dB
Data Rate	802.11b : 1, 2, 5.5, 11Mbps
	802.11g : 6, 9, 12, 18, 24, 36, 48, 54Mbps
Data Rate (20MHz ,Long GI,800ns)	802.11n: 6.5, 13, 19.5, 26, 39, 52, 58.5, 65Mbps
Data Rate (20MHz ,short GI,400ns)	802.11n : 7.2, 14.4, 21.7, 28.9, 43.3, 57.8, 65,72.2Mbps
Maximum Input Level	802.11b : -10 dBm
	802.11g/n : -20 dBm

### 3. Electrical Characteristics

#### 3.1 Absolute Maximum Ratings

Symbol	Description	Min.	Max.	Unit
VBAT	Input supply Voltage	-0.5	6.0	V
VDDIO	Digital/Bluetooth/SDIO/ I/O Voltage	-0.5	4.1	V

#### 3.2 Recommended Operating Rating

Test conditions: At room temperature 25°C		Min.	Typ.	Max.	Unit
VBAT		3.0	3.3	3.8	V
VDDIO		1.71	-	3.6	V

Note: The voltage of VDDIO is depended on system I/O voltage

Test conditions: At operating temperature -10°C ~65°C		Min.	Typ.	Max.	Unit
VBAT		3.0	3.3	3.8	V
VDDIO		1.71	-	3.6	V

Note: VDDIO operating voltage range from 1.71V to 3.63V at operating temperature is guaranteed

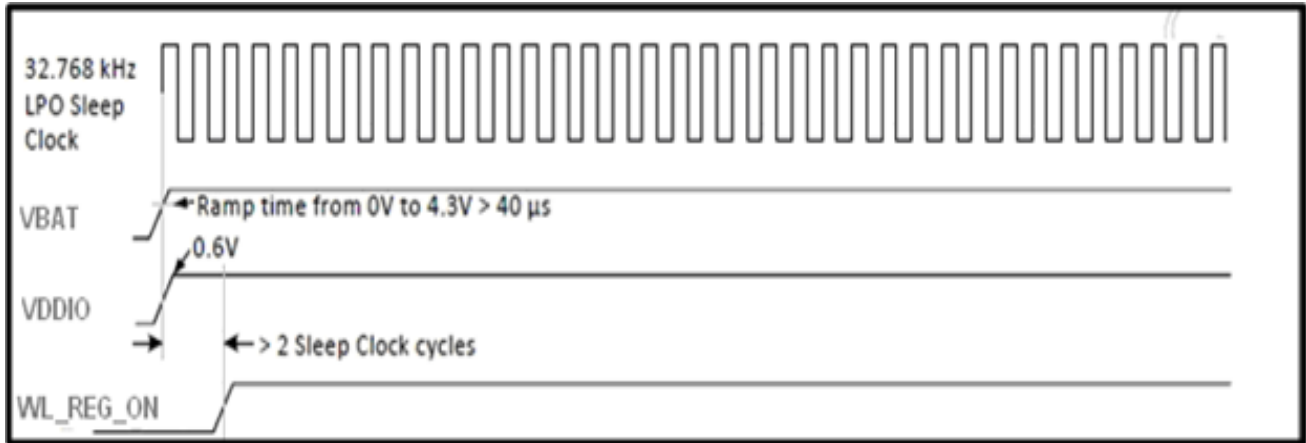
### 3.3 Recommended Operating Conditions and DC Characteristics

Parameter	Symbol	Value			Unit
		Minimum	Typical	Maximum	
DC supply voltage for VBAT	VBAT	2.3	-	4.8 <sup>a</sup>	V
DC supply for WLAN power amplifier	VDDPA	2.3	3.3	4.8 <sup>a</sup>	
DC supply voltage for core	VDD	1.14	1.2	1.26	V
DC supply voltage for RF blocks in chip	VDDRF	1.14	1.2	1.26	V
DC supply voltage for digital I/O	VDDIO VDDIO_SD	1.71	-	3.63	V
DC supply voltage for RF I/Os	VDDIO_RF	3.13	3.3	3.46	V
WRF_VCD_LDO_IN_VDD1P8	-	1.4	1.8	1.9	V
WRF_TCXO_VDD3P3 (I <sub>cc</sub> =500 uA max) <sup>b,c</sup>	-	1.7	1.8	3.3	
Input high voltage (WL_RST_N, EXT_SMPS_REQ, EXT_PWM_REQ)	V <sub>IH</sub>	1.08	-	3.6	
Input low voltage (WL_RST_N, EXT_SMPS_REQ, EXT_PWM_REQ)	V <sub>IL</sub>	-	-	0.4	
Input high voltage (VDDIO = 1.8V) <sup>d</sup>	V <sub>IH</sub>	1.1	-	VDDIO	V
Input low voltage (VDDIO = 1.8V) <sup>c</sup>	V <sub>IL</sub>	-	-	0.7	V
Input high voltage (VDDIO = 2.5V) <sup>c</sup>	V <sub>IH</sub>	1.7	--	VDDIO	V
Input low voltage (VDDIO = 2.5V) <sup>c</sup>	V <sub>IL</sub>	-	-	0.8	V
Input high voltage (VDDIO = 3.3V) <sup>c</sup>	V <sub>IH</sub>	2.0	-	VDDIO	V
Input low voltage (VDDIO = 3.3V) <sup>c</sup>	V <sub>IL</sub>	-	-	0.8	V
SDIO Input high voltage (VDDIO = 1.8V)	V <sub>IH</sub>	1.17	-	VDDIO_SD	V
SDIO Input low voltage (VDDIO = 1.8V)	V <sub>IL</sub>	-	-	0.63	V
SDIO Input high voltage (VDDIO = 2.5V)	V <sub>IH</sub>	2.0	--	VDDIO_SD	V
SDIO Input low voltage (VDDIO = 2.5V)	V <sub>IL</sub>	-	-	0.8	V
Output Low Voltage <sup>e</sup>	V <sub>OL</sub>	-	-	0.40	V
Output high Voltage <sup>d</sup>	V <sub>OH</sub>	VDDIO-0.4V	-	TBD	V
Input low current	I <sub>IL</sub>	-	0.3	-	μA
Input high current	I <sub>IH</sub>	-	0.3	-	μA



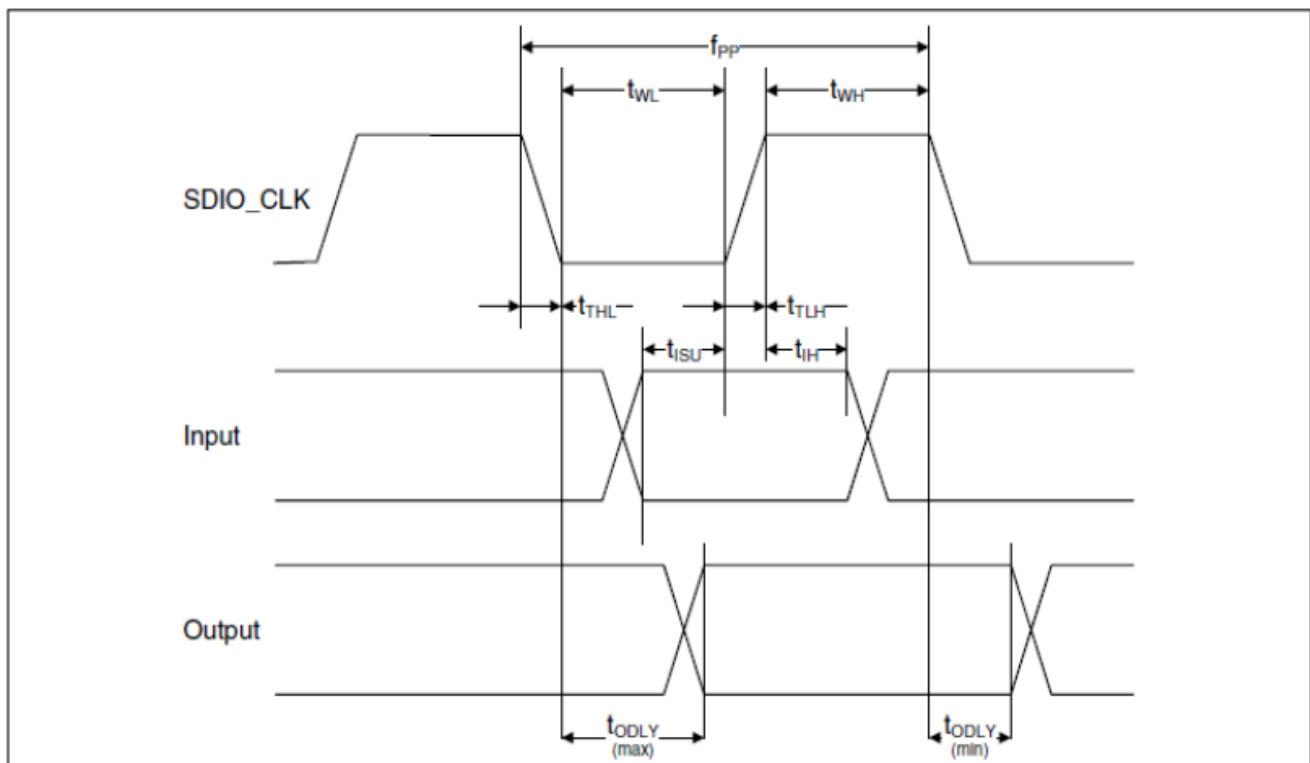
## 4. Host Interface Timing Diagram

### 4.1 Power-up Sequence Timing Diagram



- ※ WL\_REG\_ON: Internal regulators power enable/disable.  
This pin must be driven high or low (not left floating)

### 4.2 SDIO Default Mode Timing Diagram

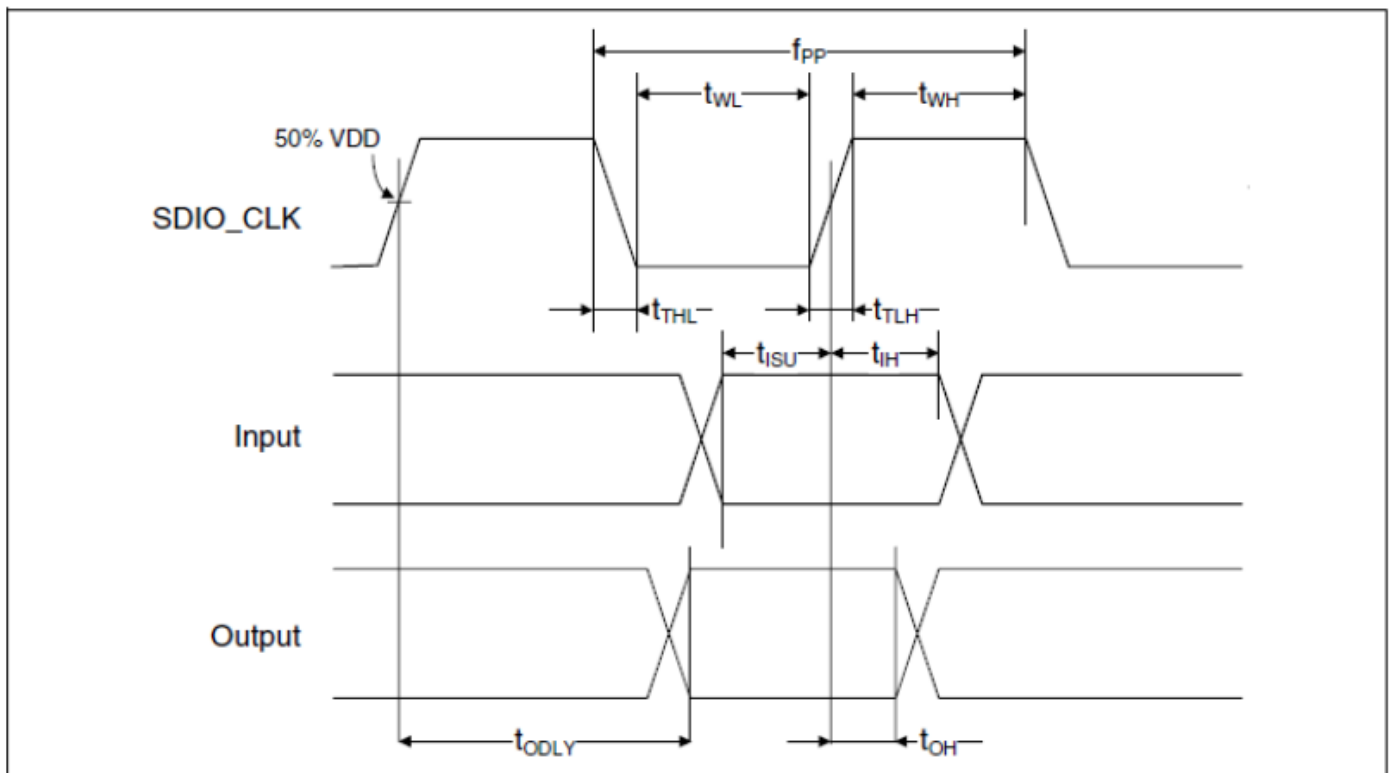


Parameter	Symbol	Minimum	Typical	Maximum	Unit
<b>SDIO CLK (ALL values are referred to minimum VIH and maximum VIL b)</b>					
Frequency – Data Transfer mode	fPP	0	-	25	MHz
Frequency – Identification mode	fOD	0	-	400	kHz
Clock low time	tWL	10	-	-	ns
Clock high time	tWH	10	-	-	ns
Clock rise time	tTLH	-	-	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  $CL \leq 40$  pF load on CMD and Data.

b. Min. (Vih) =  $0.7 \times VDDIO$  and max. (Vil) =  $0.2 \times VDDIO$

### 4.3 SDIO High Speed 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	-	50	MHz
Frequency – Identification mode	fOD	0	-	400	kHz
Clock low time	tWL	7	-	-	ns
Clock high time	tWH	7	-	-	ns
Clock rise time	tTLH	-	-	3	ns
Clock low time	tTHL	-	-	3	ns
<b>Inputs : CMD, DAT(referenced to CLK)</b>					
Input setup time	tISU	6	-	-	ns
Input hold time	tIH	2	-	-	ns
<b>Outputs : CMD, DAT(referenced to CLK)</b>					
Output delay time - Data Transfer mode	tODLY	-	-	14	ns
Output hold time	tOH	2.5	-	-	ns
Total system capacitance(each line)	CL			40	

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

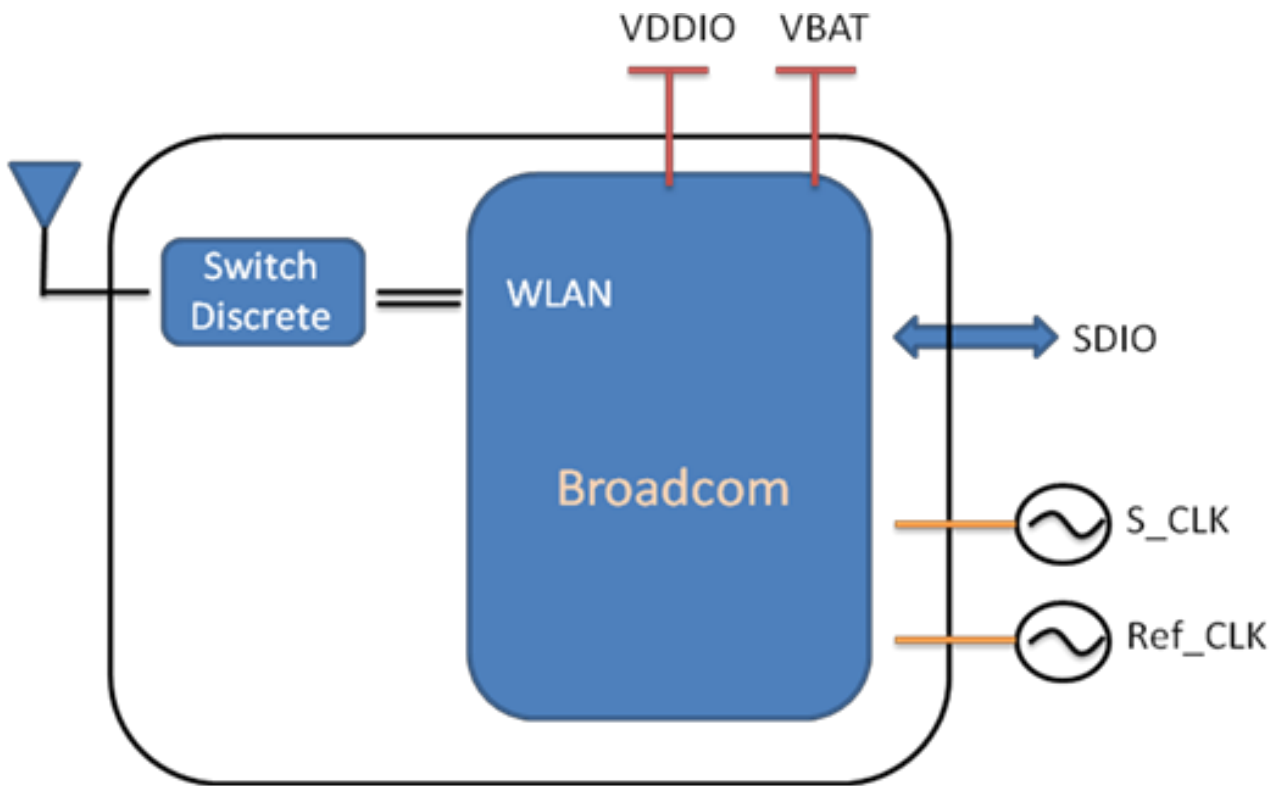
b. Min. (Vih) = 0.7 x VDDIO and max. (Vil) = 0.2 x VDDIO

## 5. Power Consumption

### ■ 2.4GHz:

Test Mode	DUT Status	Supply Voltage	Supply Voltage (VBAT)	Supply Voltage (VIO)
802.11b mode	Continue TX	Vbat	205mA	180uA
	Continue RX	Vbat	58mA	182uA
802.11g mode	Continue TX	Vbat	158mA	181uA
	Continue RX	Vbat	55mA	182uA
802.11n mode	Continue TX	Vbat	151mA	183uA
	Continue RX	Vbat	54mA	182uA

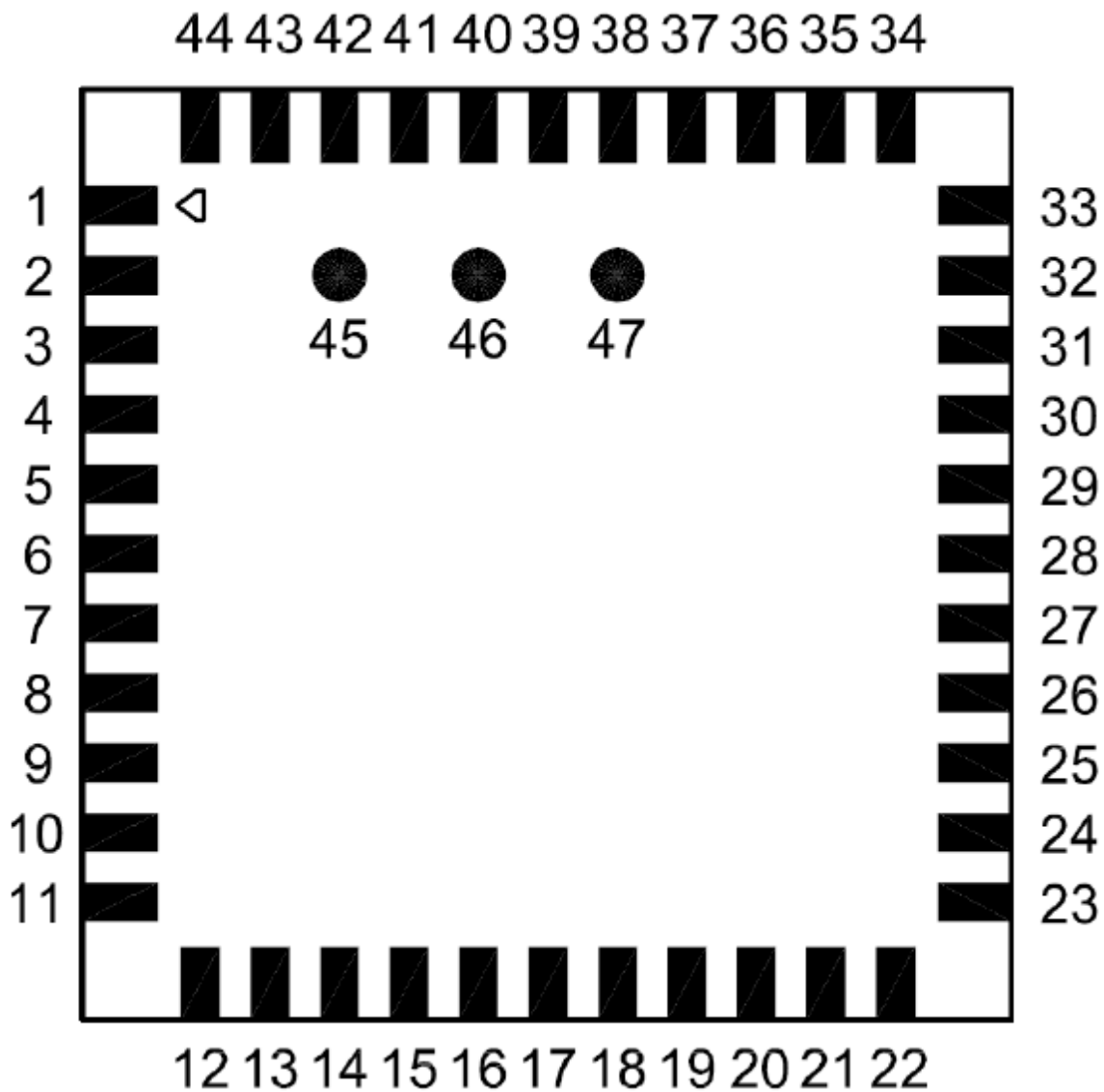
## 6. Block Diagram



## 7. Pin Definition

### 7.1 Pin Outline

< Top View >



## 7.2 Pin Table

NO	Name	Type	Description
1	GND	—	Ground connections
2	WL_BT_ANT	I/O	RF I/O port
3	GND	—	Ground connections
4	NC	—	Floating (Don't connected to ground)
5	NC	—	Floating (Don't connected to ground)
6	NC	—	Floating (Don't connected to ground)
7	NC	—	Floating (Don't connected to ground)
8	NC	—	Floating (Don't connected to ground)
9	VBAT	P	Main power voltage source input
10	XTAL_IN	I	XTAL oscillator input
11	XTAL_OUT	O	XTAL oscillator output
12	WL_REG_ON	I	Internal regulators power enable/disable
13	WL_HOST_WAKE	O	WLAN wake-up HOST
14	SDIO_DATA_2	I/O	SDIO data line 2
15	SDIO_DATA_3	I/O	SDIO data line3
16	SDIO_DATA_CMD	I/O	SDIO command line
17	SDIO_DATA_CLK	I/O	SDIO CLK line
18	SDIO_DATA_0	I/O	SDIO data line 0
19	SDIO_DATA_1	I/O	SDIO data line 1
20	GND	—	Ground connections
21	VIN_LDO_OUT	P	Internal Buck voltage generation pin
22	VDDIO	P	I/O Voltage supply input
23	VIN_LDO	P	Internal Buck voltage generation pin
24	LPO	I	External Low Power Clock input (32.768KHz)
25	NC	—	Floating (Don't connected to ground)
26	NC	—	Floating (Don't connected to ground)
27	NC	—	Floating (Don't connected to ground)
28	NC	—	Floating (Don't connected to ground)
29	NC	—	Floating (Don't connected to ground)
30	NC	—	Floating (Don't connected to ground)
31	GND	—	Ground connections
32	NC	—	Floating (Don't connected to ground)
33	GND	—	Ground connections

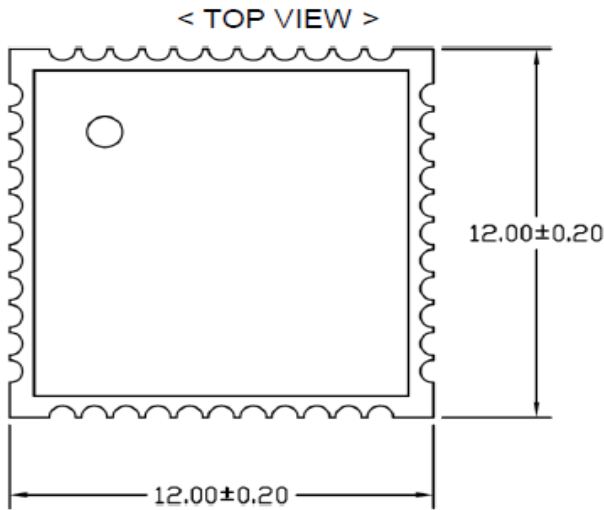
34	NC	—	Floating (Don't connected to ground)
35	NC	—	Floating (Don't connected to ground)
36	GND	—	Ground connections
37	NC	—	Floating (Don't connected to ground)
38	NC	—	Floating (Don't connected to ground)
39	NC	—	Floating (Don't connected to ground)
40	NC	—	Floating (Don't connected to ground)
41	NC	—	Floating (Don't connected to ground)
42	NC	—	Floating (Don't connected to ground)
43	NC	—	Floating (Don't connected to ground)
44	NC	—	Floating (Don't connected to ground)
45	TP1 (NC)	—	Floating (Don't connected to ground)
46	TP2 (NC)	—	Floating (Don't connected to ground)
47	TP3 (NC)	—	Floating (Don't connected to ground)



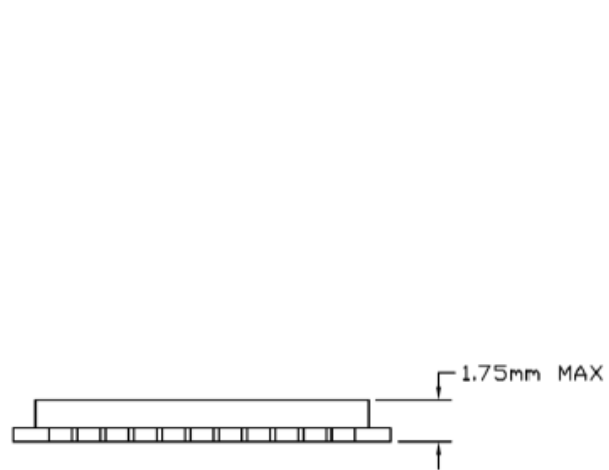
## 8. Mechanical Specification

### 8.1 Module Dimension

(Unit: mm)

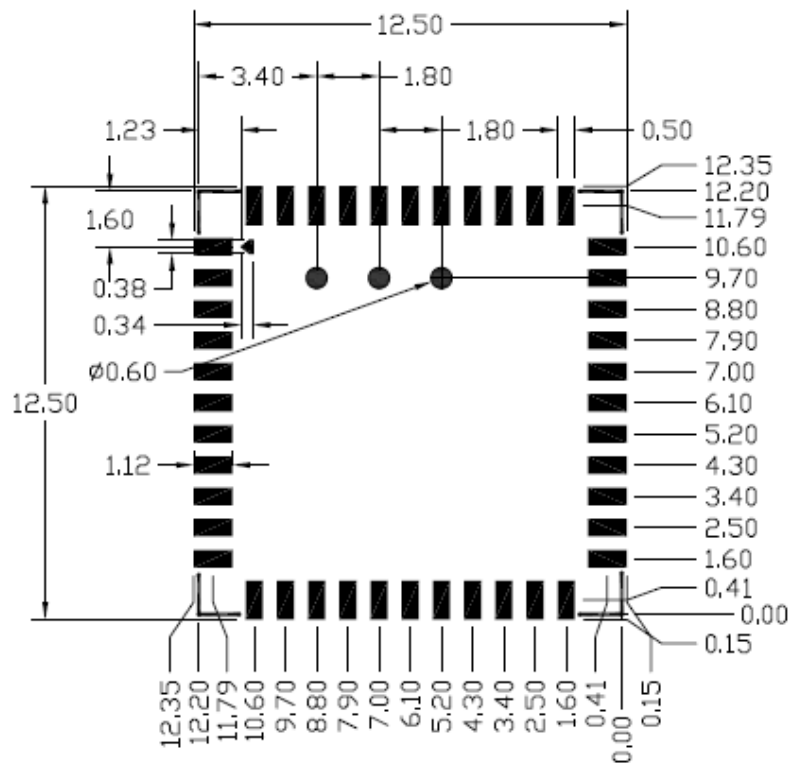
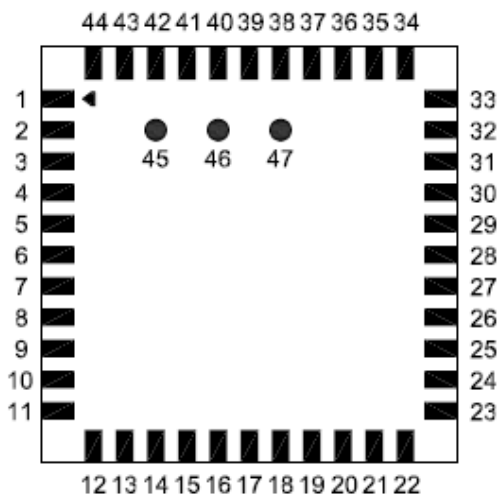


< Side View >



### 8.2 PCB Footprint

<TOP VIEW>



Unit: mm

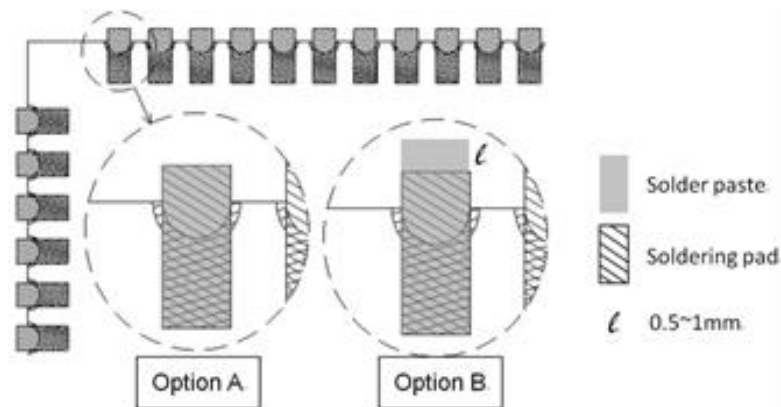
- Solder paste layer design is generally the same as recommended footprint.

(錫膏層設計通常建議和焊墊尺寸相同)

- If soldering quality with good wetting on upright side is essential for PQC, how to optimize the aperture design in the stencil to adjust the amount of solder paste would be crucial.

In addition, a kind of stencil design with stepped thickness in partial area would be considered if the thickness of stencil is about 0.1mm or thinner. Please optimize the stencil design by manufacture engineer or contact SparkLAN FAE for assistance.

(如果模組吃錫品質考量側面爬錫，如何優化鋼網開孔設計以調整適當的錫膏量是非常重要的。尤其鋼網的厚度大約是 0.1mm或更薄時，可考慮局部加厚鋼網的設計。請諮詢製程工程師以優化鋼網的設計,或是聯絡速連通訊技術支持團隊)。



## 9. External Clock Reference

External LPO signal characteristics

Parameter	Specification	Units
Nominal input frequency	32.768	kHz
Frequency accuracy	+/-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 <5	$\Omega$ pF
Clock jitter (integrated over 300Hz – 15KHz)	<1	Hz
Output high voltage	0.7V <sub>io</sub> - V <sub>io</sub>	V

External Ref\_CLK signal characteristics

NO	Item	Symb.	Electrical Specification				Remark
			Min	Type	Max	Units	
1	Nominal Frequency	F0	26.00000			MHz	
2	Mode of Vibration		Fundamental				
3	Frequency Tolerance	$\Delta F/F0$	-10	-	10	ppm	At 25°C ± 3°C
4	Operating Temperature Range	T <sub>OPR</sub>	-30	-	85	°C	
5	Frequency Stability	TC	-10	-	10	ppm	
6	Storage Temperature	T <sub>STG</sub>	-55	-	125	°C	
7	Load capacitance	CL	-	16		pF	
8	Equivalent Series Resistance	ESR	-	-	50	$\Omega$	
9	Drive Level	DL	-	100	200	uW	
10	Insulation Resistance	IR	500	-	-	M $\Omega$	AT 100V <sub>DC</sub>
11	Shunt Capacitance	C0	-	-	3	pF	
12	Aging Per Year	Fa	-2	-	2	ppm	First Year

## 9.1 SDIO Pin Description

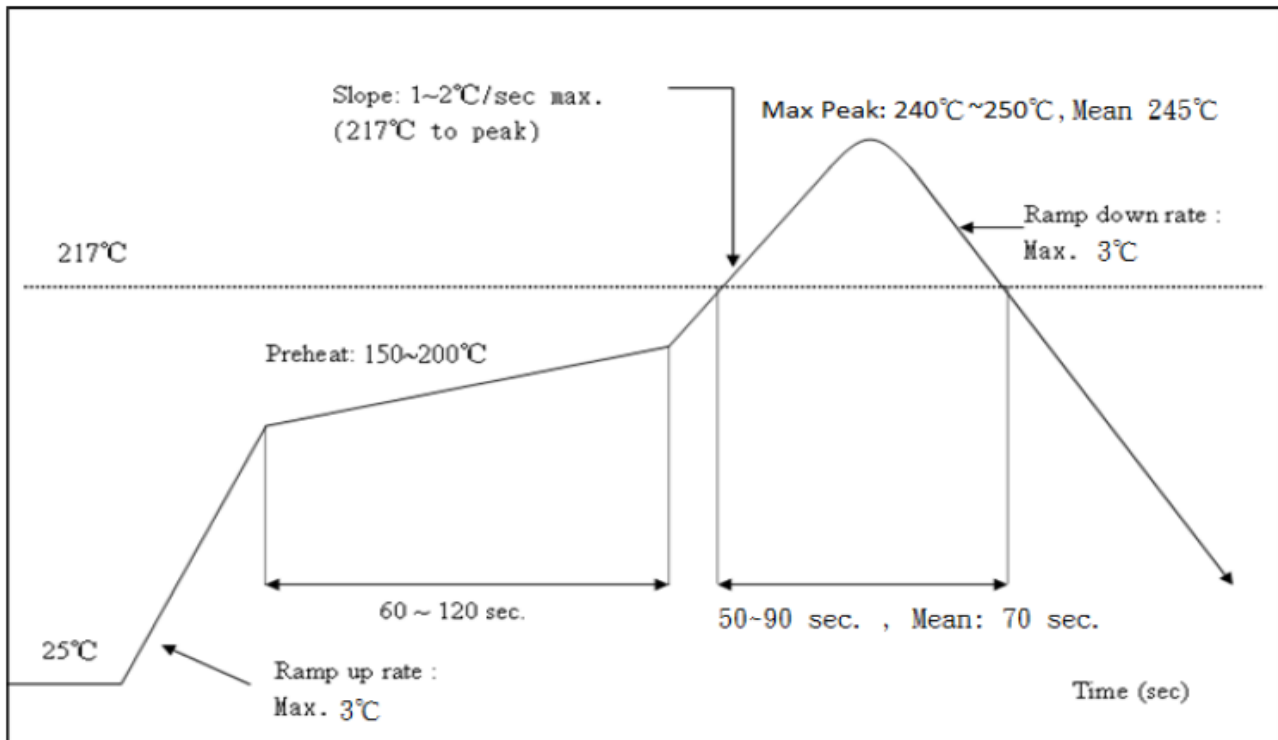
The module supports SDIO version 2.0 for 4-bit modes. It has the ability to stop the SDIO clock and map the interrupt signal into a GPIO pin. This 'out-of-band' interrupt signal notifies the host when the WLAN device wants to turn on the SDIO interface. The ability to force the control of the gated clocks 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. Recommended Reflow Profile



- Referred to IPC/JEDEC standard.
- Peak Temperature: <250°C
- Number of Times: < 2 times
- The notification of the WiFi module before mounting
- The aperture of stencil should be larger than the footprint of the module, and the stencil thickness should be not less than 0.12mm.
- It must use N2 for reflow and suggest the concentration of oxygen less than 5000 ppm .

Reflow 時需使用N2, 含氧量建議5000 ppm以下

## 10.1 Caution for SMT Preparation

### Moisture Sensitivity Level: 4

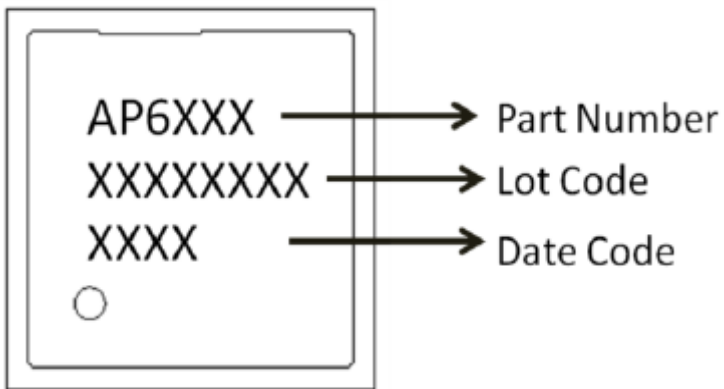
1. Calculated shelf life in sealed bag: 12 months at  $<40^{\circ}\text{C}$  and  $<90\%$  relative humidity (RH).
2. Peak package body temperature:  $250^{\circ}\text{C}$ .
3. After bag was opened, devices that will be subjected to reflow solder or other high temperature process must be
  - a) Mounted within: 72 hours of factory conditions  $\leq 30^{\circ}\text{C}/60\%RH$  or
  - b) Stored per J-STD-033
4. Devices require bake before mounting, if:
  - a) Humidity Indicator Card reads  $> 10\%$  for level 2a - 5a devices or  $>60\%$  for level 2 devices when read at  $23\pm 5^{\circ}\text{C}$
  - b) 3a or 3b are not met.
5. If baking is required, refer to IPC/JEDEC J-STD-033 for bake procedure.

## 11. Package Information

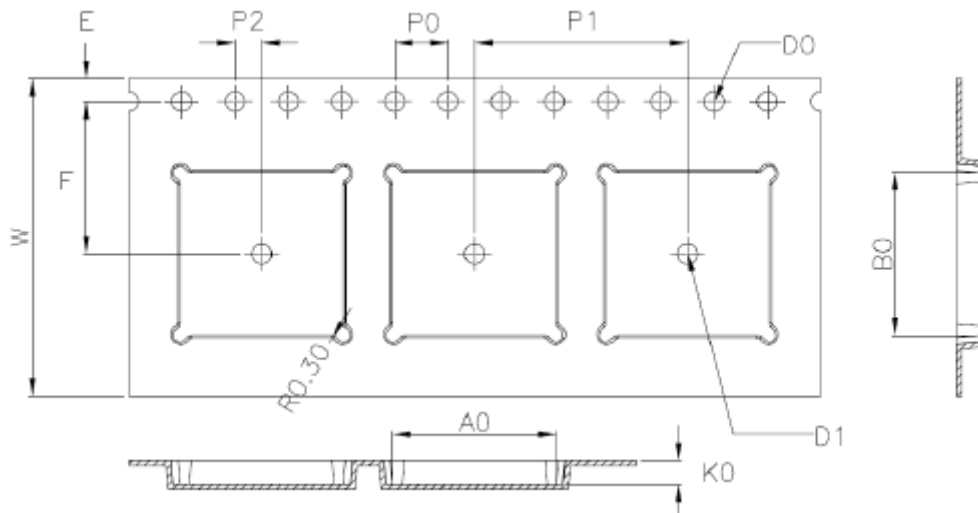
### 11.1 Label

Label A → Anti-static and humidity notice

Label B → MSL caution / Storage Condition

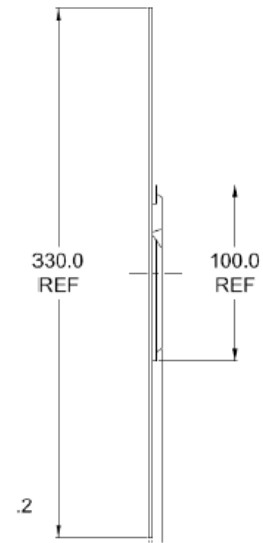
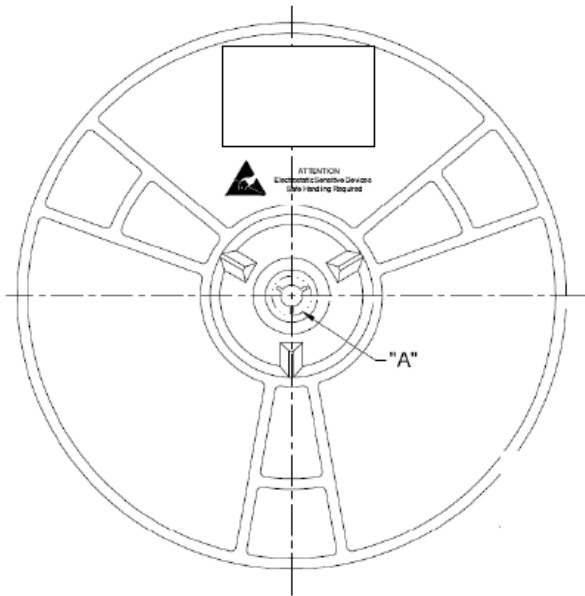


W	24.00±0.30
A0	12.30±0.10
B0	12.30±0.10
K0	1.8±0.10
E	1.75±0.10
F	11.50±0.10
P0	4.00±0.10
P1	16.00±0.10
P2	2.00±0.10
D0	1.50 <sup>+0.10</sup> <sub>-0.00</sub>
D1	∅ 1.50MIN

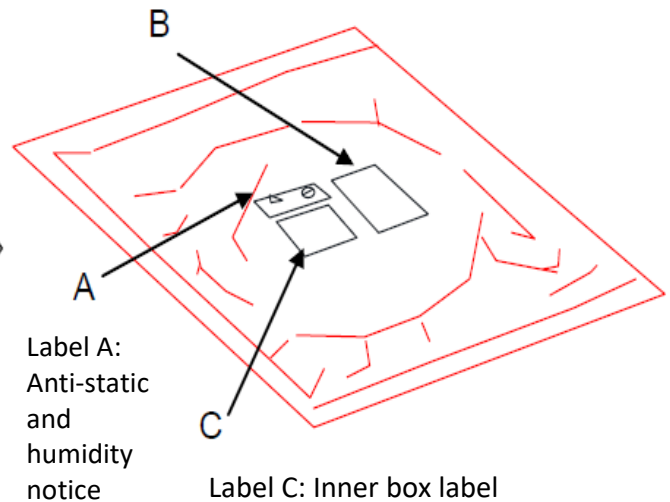
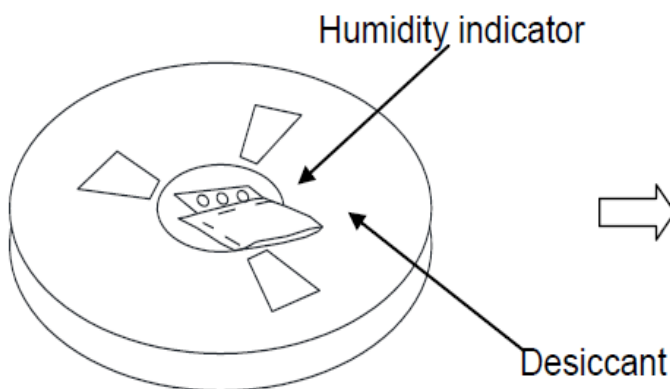


- 10 sprocket hole pitch cumulative tolerance ±0.20.
- Carrier camber is within 1 mm in 250 mm.
- Material : Black Conductive Polystyrene Alloy.
- All dimensions meet EIA-481-D requirements.

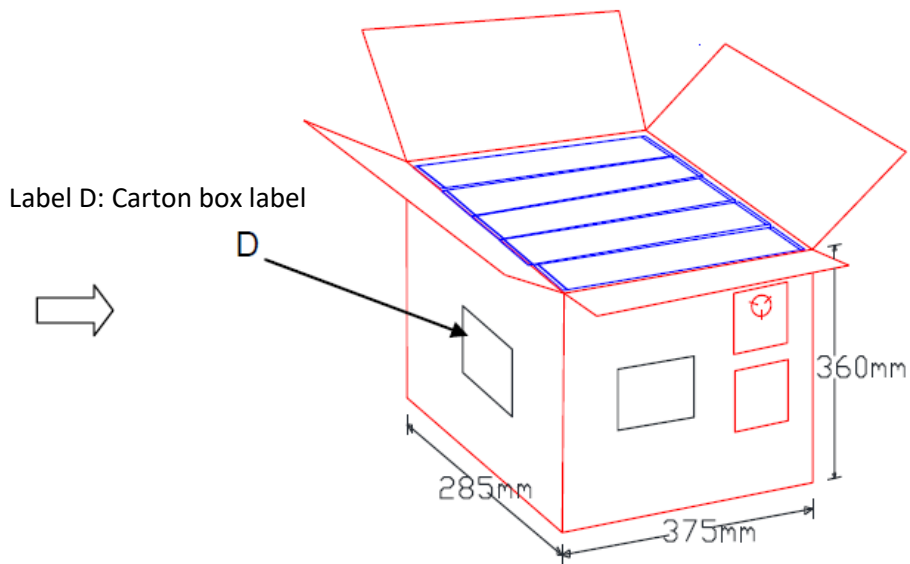
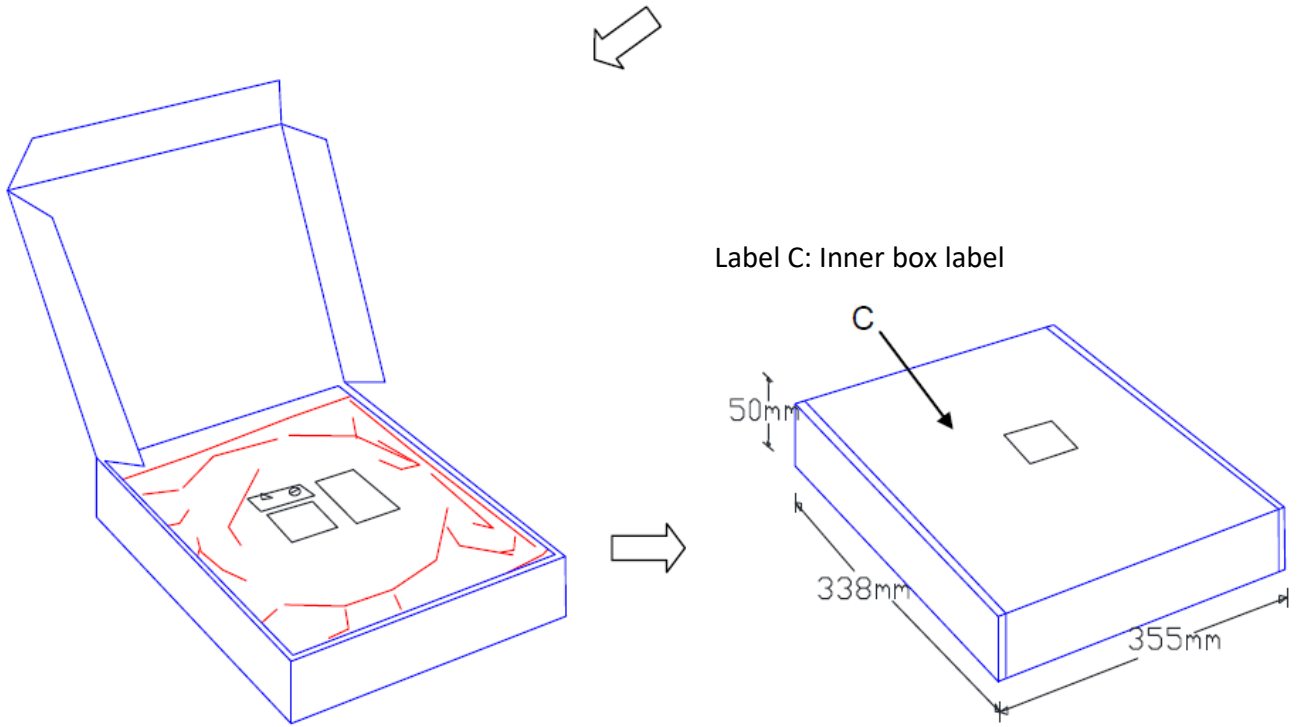
- Thickness: 0.30±0.05mm.
- Packing length per 22" reel : 98.5 Meters.(1:3)
- Component load per 13" reel : 1500 pcs



Label B: MSL caution / Storage Condition







Note: 1 tape reel = 1 box = 1,500pcs  
1 carton = 5 boxes = 5 \* 1,500pcs=7,500pcs

## 12. Ordering Information

Product Name	Part Number	Description
AP6181	R9701920005	11b/g/n 1T1R WiFi Sip Module