

# Datasheet

## AP6398S

IEEE 802.11ac/a/b/g/n 2x2 WiFi with Bluetooth5.2

Combo Sip Module

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## The revision history of the product specification

Version	Purpose	Date	Editor
1.0	Initial Doc	2019/07/19	Aaron
1.1	Add Caution for SMT preparation	2019/08/22	Aaron
1.2	Correcting document content	2020/03/31	Kamoro
1.3	Correcting document content	2021/04/20	Kamoro

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# 1. Introduction

## 1.1 Product Overview

AP6398S is a fully Wi-Fi and Bluetooth functionalities module with seamless roaming capabilities and advance security, also it could interact with different vendors' 802.11a/b/g/n/ac 2x2 Access Points with MIMO standard and can accomplish up to speed of 867Mbps with dual stream in 802.11n to connect the wireless LAN. Furthermore AP6398S included SDIO interface for Wi-Fi, UART/ PCM interface for Bluetooth.

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

## 1.2 Product Feature

### 1.2.1 WLAN

- TX and RX low-density parity check (LDPC) support for improved range and power efficiency.
- Dual-stream spatial multiplexing up to 867 Mbps data rate.
- 20, 40, 80 MHz channels with optional SGI (256 QAM modulation)
- Real simultaneous dual-band (RSDB)
- Supports 2 antennas with one for WLAN & Bluetooth shared port and one WLAN port. Also, shared Bluetooth and WLAN receive signal path eliminates the need for an external power splitter while maintaining excellent sensitivity for both Bluetooth and WLAN.
  - Supports standard SDIO v3.0, compatible with SDIO v2.0 HOST interfaces.

### 1.2.2 Bluetooth

- BT host digital interface:
  - HCI UART (up to 4 Mbps)
  - PCM for audio data
- Complies with Bluetooth Core Specification Version 5.2 with provisions for supporting future specifications. With Bluetooth Class 1 or Class2 transmitter operation.
- Supports extended synchronous connections (eSCO), for enhanced voice quality by allowing for retransmission of dropped packets.

## 2. Specification

### 2.1 General Specification

Standards	IEEE 802.11 ac/a/b/g/n 2T2R Wi-Fi + BT 5.2 Module Bluetooth V5.2, V5.0, V4.2, V4.1, V4.0 LE, V3.0+HS, V2.1+EDR
Chipset	Synaptics
Operating Frequency	2.400 GHz ~ 2.4835 GHz (2.4GHz ISM Band) 5.150~5.850GHz (5GHz UNII Band) Bluetooth: 2.402 GHz ~ 2.480 GHz
Modulation	WiFi: 802.11b: DSSS (DBPSK, DQPSK, CCK) 802.11g: OFDM (BPSK, QPSK, 16-QAM, 64-QAM) 802.11gn: OFDM (BPSK, QPSK, 16-QAM, 64-QAM) 802.11a: OFDM (BPSK, QPSK, 16-QAM, 64-QAM) 802.11an: OFDM (BPSK, QPSK, 16-QAM, 64-QAM) 802.11ac: OFDM (BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM)  BT: Header: GFSK Payload 2M: $\pi/4$ -DQPSK Payload 3M: 8-DPSK
Interface	WLAN: SDIO 3.0 / 2.0 Bluetooth: UART / PCM
Form Factor	Stamp Type
Antenna	External
Dimension	L x W x H: 15mm( $\pm$ 0.2mm) x 13 mm( $\pm$ 0.2mm) x 1.85mm(Max.)
Operating temperature	-30°C~75°C
Storage temperature	-40°C~85°C
Humidity (Non-Condensing)	10% ~95% (Operating)
Weight	0.6g
Driver Support	Linux, Android

Note: The optimal RF performance specified in the data sheet, however, is guaranteed only -10 °C to +55 °C and 3.2V < VBAT < 3.8V without derating performance.

## 2.2 WiFi 2.4GHz RF Specification

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

<b>Output Power , tolerance <math>\pm 1.5</math> dB</b>					
<b>The transmit EVM quality &amp; spectrum mask are compliant with IEEE 802.11 standard</b>					
802.11b	1Mbps	2Mbps	5.5Mbps	11Mbps	
	17.5	17.5	17.5	17.5	
802.11g	6 、 9Mbps	12 、 18Mbps	24Mbps	36Mbps	48Mbps
	17.5	17.5	17	17	16.5
	54Mbps				
802.11n 20MHz	MCS0~2	MCS3	MCS4	MCS5	MCS6
	17.5	16.5	16.5	16	16
	MCS7				
	15.5				

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

<b>Sensitivity, tolerance <math>\pm 2</math> dB</b>				
<b>CCK modulation PER <math>\leq 8\%</math> 、 OFDM modulation PER <math>\leq 10\%</math></b>				
802.11b	Data Rate	Spec.(dBm)		
	1Mbps	-96		
	2Mbps	-93		
	5.5Mbps	-91		
	11Mbps	-88		
802.11g SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	6Mbps	-92	24Mbps	-84
	9Mbps	-91	36Mbps	-81
	12Mbps	-90	48Mbps	-78
	18Mbps	-87	54Mbps	-76
802.11g MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	6Mbps	-95	24Mbps	-87
	9Mbps	-94	36Mbps	-84
	12Mbps	-93	48Mbps	-81
	18Mbps	-90	54Mbps	-78
802.11n_20MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0	-91	MCS4	-80
	MCS1	-89	MCS4	-78
	MCS2	-87	MCS6	-76
	MCS3	-78	MCS7	-74

802.11n_20MHz MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0	-93	MCS5	-80
MCS1	-92	MCS6	-78	
MCS2	-90	MCS7	-76	
MCS3	-87	MCS8	-92	
MCS4	-83	MCS15	-73	
Maximum Input Level	802.11b : -10 dBm			
	802.11g/n : -20 dBm			

## 2.3 WiFi 5GHz RF Specification

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

Output Power , tolerance $\pm 1.5$ dB					
The transmit EVM quality & spectrum mask are compliant with IEEE 802.11 standard					
802.11a	Frequency (MHz)	6~9Mbps	12~18Mbps	24Mbps	36Mbps
	5150~5350	16.5	16.5	16	16
	5470~5720	16.5	16.5	16	16
	5725~5845	16.5	16.5	16	16
	Frequency (MHz)	48Mbps	54Mbps		
	5150~5350	15.5	15.5		
	5470~5720	15.5	15.5		
802.11n 20MHz	Frequency (MHz)	MCS0~2	MCS3	MCS4	MCS5
	5150~5350	16	16	15.5	15.5
	5470~5720	16	16	15.5	15.5
	5725~5845	16	16	15.5	15.5
	Frequency (MHz)	MCS6	MCS7		
	5150~5350	14.5	14.5		
	5470~5720	14.5	14.5		
802.11n 40MHz	Frequency (MHz)	MCS0~2	MCS3	MCS4	MCS5
	5150~5350	16	16	15.5	15.5
	5470~5720	16	16	15.5	15.5
	5725~5845	16	16	15.5	15.5
	Frequency (MHz)	MCS6	MCS7		
	5150~5350	14.5	14.5		
	5470~5720	14.5	14.5		
5725~5845	14.5	14.5			

802.11ac 20MHz	Frequency (MHz)	MCS0~2	MCS3	MCS4	MCS5
	5150~5350	16	16	15.5	15.5
	5470~5720	16	16	15.5	15.5
	5725~5845	16	16	15.5	15.5
	Frequency (MHz)	MCS6	MCS7	MCS8	
	5150~5350	14.5	14.5	12	
	5470~5720	14.5	14.5	12	
5725~5845	14.5	14.5	12		
802.11ac 40MHz	Frequency (MHz)	MCS0~2	MCS3	MCS4	MCS5
	5150~5350	16	16	15.5	15.5
	5470~5720	16	16	15.5	15.5
	5725~5845	16	16	15.5	15.5
	Frequency (MHz)	MCS6	MCS7	MCS8	MCS9
	5150~5350	14.5	14.5	12	10
	5470~5720	14.5	14.5	12	10
5725~5845	14.5	14.5	12	10	
802.11ac 80MHz	Frequency (MHz)	MCS0~2	MCS3	MCS4	MCS5
	5150~5350	15	15	14	14
	5470~5720	15	15	14	14
	5725~5845	15	15	14	14
	Frequency (MHz)	MCS6	MCS7	MCS8	MCS9
	5150~5350	13	13	12	10
	5470~5720	13	13	12	10
5725~5845	13	13	12	10	

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

**Sensitivity, tolerance  $\pm 1.5$  dB**

**CCK modulation PER  $\leq 8\%$  、 OFDM modulation PER  $\leq 10\%$**

802.11a SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	6Mbps	-91	24Mbps	-83
	9Mbps	-90	36Mbps	-80
	12Mbps	-88	48Mbps	-76
	18Mbps	-86	54Mbps	-74
802.11a MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	6Mbps	-92	24Mbps	-86
	9Mbps	-91	36Mbps	-83
	12Mbps	-90	48Mbps	-78
	18Mbps	-89	54Mbps	-77



802.11n_20MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0	-90	MCS4	-79
	MCS1	-88	MCS5	-76
	MCS2	-86	MCS6	-73
	MCS3	-83	MCS7	-72
802.11n_20MHz MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0	-92	MCS5	-78
	MCS1	-91	MCS6	-76
	MCS2	-89	MCS7	-75
	MCS3	-86	MCS8	-89
802.11n_40MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0	-88	MCS4	-77
	MCS1	-86	MCS5	-72
	MCS2	-83	MCS6	-70
	MCS3	-80	MCS7	-69
802.11n_40MHz MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0	-88	MCS5	-75
	MCS1	-88	MCS6	-73
	MCS2	-86	MCS7	-72
	MCS3	-83	MCS8	-86
802.11ac_20MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0	-90	MCS5	-75
	MCS1	-88	MCS6	-73
	MCS2	-86	MCS7	-70
	MCS3	-83	MCS8	-67
802.11ac_20MHz MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0,NSS=1	-92	MCS6,NSS=1	-76
	MCS1,NSS=1	-91	MCS7,NSS=1	-75
	MCS2,NSS=1	-88	MCS8,NSS=1	-72
	MCS3,NSS=1	-85	MCS0,NSS=2	-88
	MCS4,NSS=1	-82	MCS8,NSS=2	-65
802.11ac_40MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0	-88	MCS5	-72
	MCS1	-86	MCS6	-70
	MCS2	-83	MCS7	-69
	MCS3	-80	MCS8	-65
	MCS4	-76	MCS9	-63

802.11ac_40MHz MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0,NSS=1	-90	MCS6,NSS=1	-73
	MCS1,NSS=1	-88	MCS7,NSS=1	-72
	MCS2,NSS=1	-86	MCS8,NSS=1	-68
	MCS3,NSS=1	-82	MCS9,NSS=1	-66
	MCS4,NSS=1	-79	MCS0,NSS=2	-86
	MCS5,NSS=1	-77	MCS9,NSS=2	-60
802.11ac_80MHz SISO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0	-85	MCS5	-68
	MCS1	-82	MCS6	-67
	MCS2	-79	MCS7	-65
	MCS3	-76	MCS8	-62
	MCS4	-73	MCS9	-60
802.11ac_80MHz MIMO	Data Rate	Spec.(dBm)	Data Rate	Spec.(dBm)
	MCS0,NSS=1	-87	MCS6,NSS=1	-70
	MCS1,NSS=1	-85	MCS7,NSS=1	-68
	MCS2,NSS=1	-82	MCS8,NSS=1	-66
	MCS3,NSS=1	-79	MCS9,NSS=1	-63
	MCS4,NSS=1	-76	MCS0,NSS=2	-83
MCS5,NSS=1	-71	MCS9,NSS=2	-58	
Maximum Input Level	802.11a/n/ac : -30 dBm			

## 2.4 Bluetooth RF Specification

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

RF Specification			
	Min.	Typical.	Max.
Output Power*	0	7	10
Sensitivity @ BER=0.1% for GFSK (1Mbps)		-86 dBm	
Sensitivity @ BER=0.01% for $\pi/4$ -DQPSK (2Mbps)		-88 dBm	
Sensitivity @ BER=0.01% for 8DPSK (3Mbps)		-84 dBm	
Sensitivity @ BER=0.01% for LE (1Mbps)		-89 dBm	
Sensitivity @ BER=0.01% for 2LE (2Mbps)		TBD	
Maximum Input Level	GFSK (1Mbps):-20dBm		
	$\pi/4$ -DQPSK (2Mbps) :-20dBm		
	8DPSK (3Mbps) :-20dBm		

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

## 3 Electrical Characteristics

### 3.1 Absolute Maximum Ratings

Symbol	Description	Min.	Max.	Unit
VBAT	Input supply Voltage	-0.5	4.5	V
VDDIO	Digital/Bluetooth/SDIO/ I/O Voltage	-0.5	3.8	V

### 3.2 Recommended Operating Rating

The module requires two power supplies: VBAT and VDDIO.

Voltage rails	Min.	Typ.	Max.	Unit
VBAT	3.0	3.3	3.8	V
VDDIO	1.7	1.8,3.3	3.6	V

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

### 3.3 Recommended Operating Conditions and DC Characteristics

Parameter	Symbol	Value			Unit
		Minimum	Typical	Maximum	
DC supply voltage for VBAT	VBAT	3.0 <sup>a</sup>	-	5.25	V
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 TCXO input buffer	WRF_TCXO_VDD	1.62	1.8	1.98	V
DC supply voltage for Digital I/O	VDDIO VDDIO_SD	1.62	-	3.63	V
DC supply voltage for RF switch I/Os	VDDIO_RF	3.13	3.3	3.46	V
External TSSI input	TSSI	0.15	-	0.95	V
Internal POR threshold	Vth_POR	0.4	-	0.7	V
DC supply voltage for WCC I/O	WCC_VDDIO	1.62	-	3.63	V
<b>SDIO Interface I/O pins and PCIe Out-of Band Signals (PCIE_PERST_L, PCIE_PME_L, and PCIE_CLKREQ_L)</b>					
For VDDIO = 1.8V					
Input high voltage	VIH	1.27	--	-	V
Input low voltage	VIL	-	-	0.58	V
Output high Voltage @ 2 mA	VOH	1.40	-	-	V
Output Low Voltage @ 2 mA	VOL	-	-	0.45	V
For VDDIO_SD = 3.3V					
Input high Voltage	VIH	0.625 x VDDIO	-	-	V
Input low Voltage	VIL	-	-	0.25 x VDDIO	V

Output high voltage @2mA	VOH	0.75 x VDDIO	-	-	V
Output Low Voltage @2mA	VOL	-	-	0.125 x VDDIO	V
<b>Other Digital I/O Pins</b>					
For VDDIO=1.8V					
Input high voltage	VIH	0.65 x VDDIO	-	-	V
Input low voltage	VIL	-	-	0.35 x VDDIO	V
Output high voltage @2mA	VOH	VDDIO-0.45	-	-	V
Output low voltage @2mA	VOL	-	-	0.45	V
For VDDIO=3.3V					
Input high voltage	VIH	2.00	-	-	V
Input low voltage	VIL	-	-	0.80	V
Output high voltage@2mA	VOH	VDDIO-0.4	-	-	V
Output low voltage@2mA	VOL	-	-	0.4	V
<b>RF Switch Control Output Pins<sup>b</sup></b>					
For VDDIO_RF=3.3V					
Output high voltage@2mA	VOH	VDDIO-0.4	-	-	V
Output low voltage@2mA	VOL	-	-	0.4	V
Input capacitance	C <sub>IN</sub>	-	-	5	pF

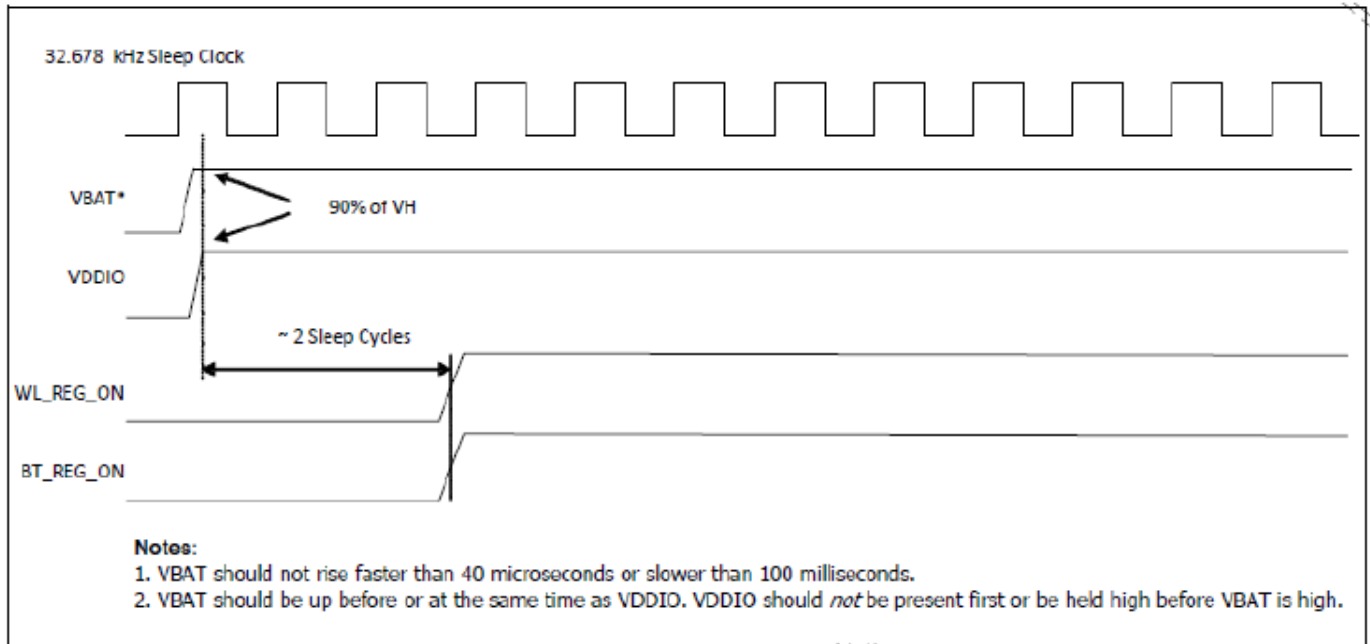
## 4. Host Interface Timing Diagram

### 4.1 Power-up Sequence Timing Diagram

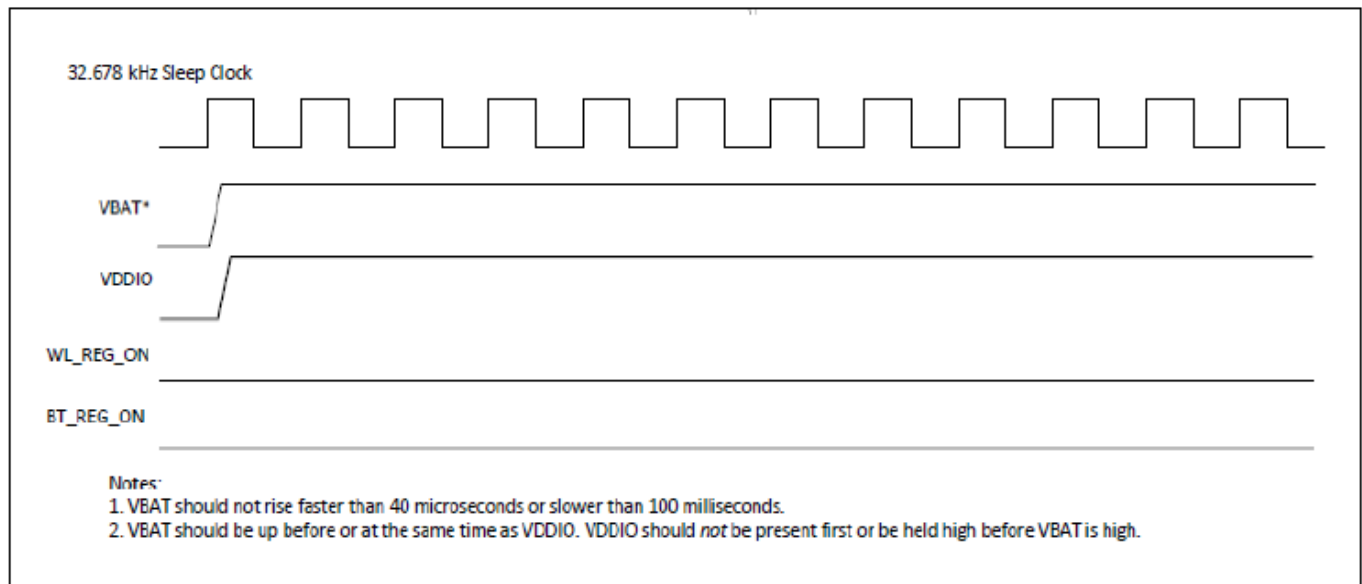
The module has signals that allow the host to control power consumption by enabling or disabling the Bluetooth, WLAN and internal regulator blocks. These signals are described below.

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.

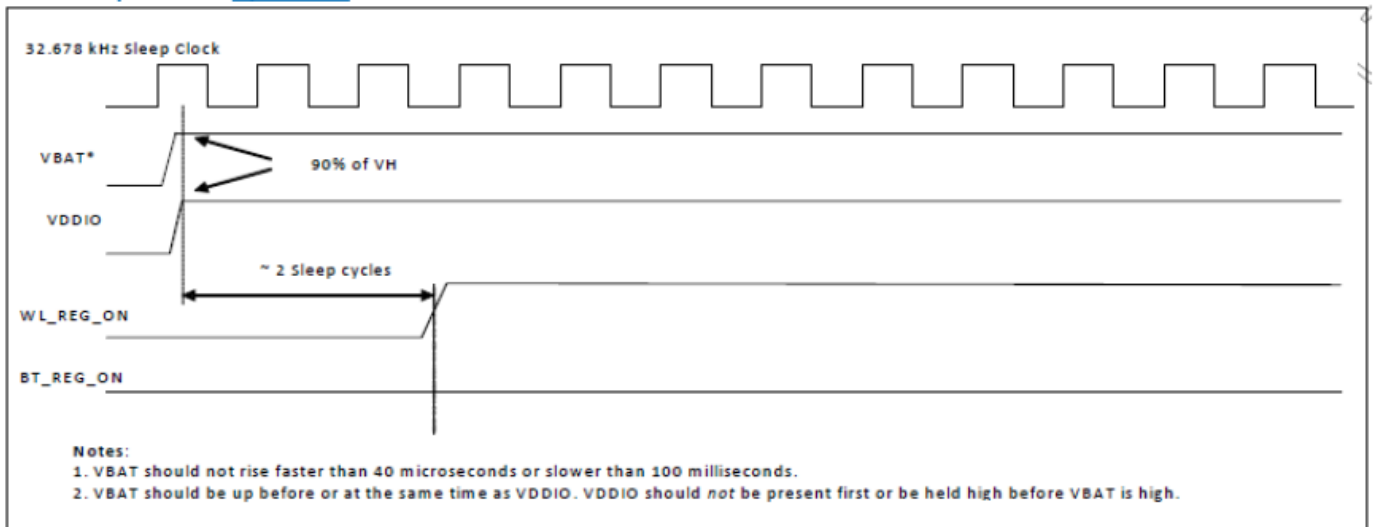
- **WL\_REG\_ON:** Used by the PMU to power up or power down the internal regulators used by the WLAN section. When this pin is high, the regulators are enabled and the WLAN section is out of reset. When this pin is low the WLAN section is in reset.
- **BT\_REG\_ON:** Used by the PMU to power up or power 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).



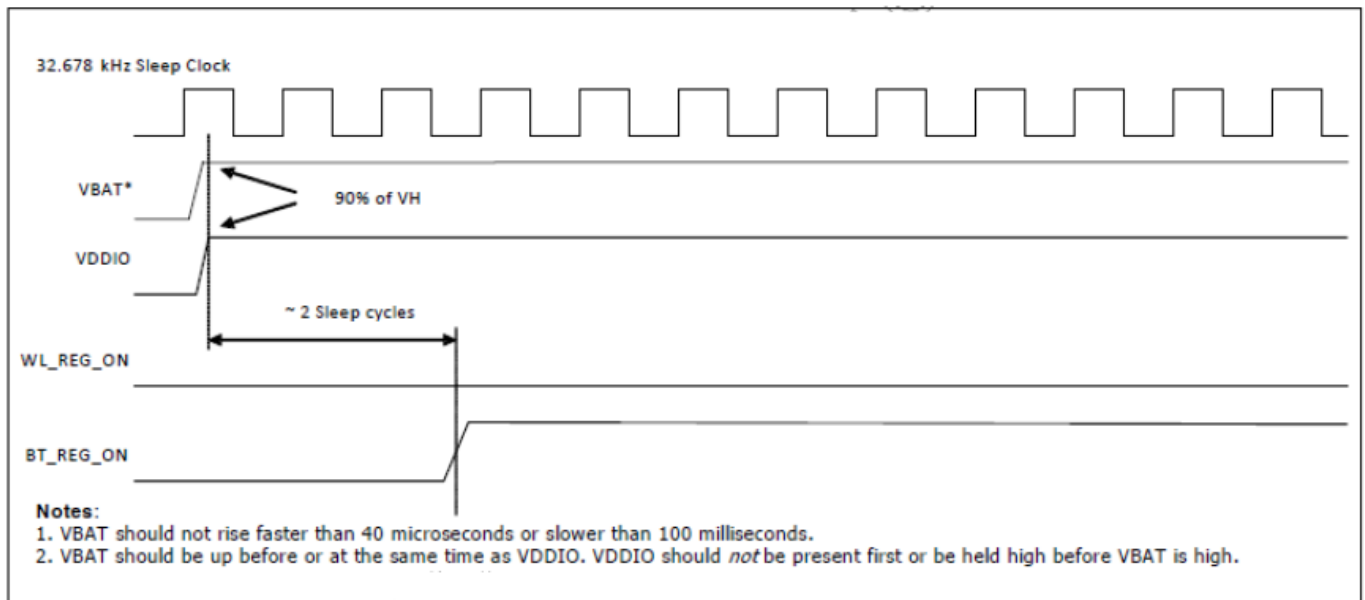
WLAN=ON, Bluetooth=ON



WLAN=OFF, Bluetooth=OFF

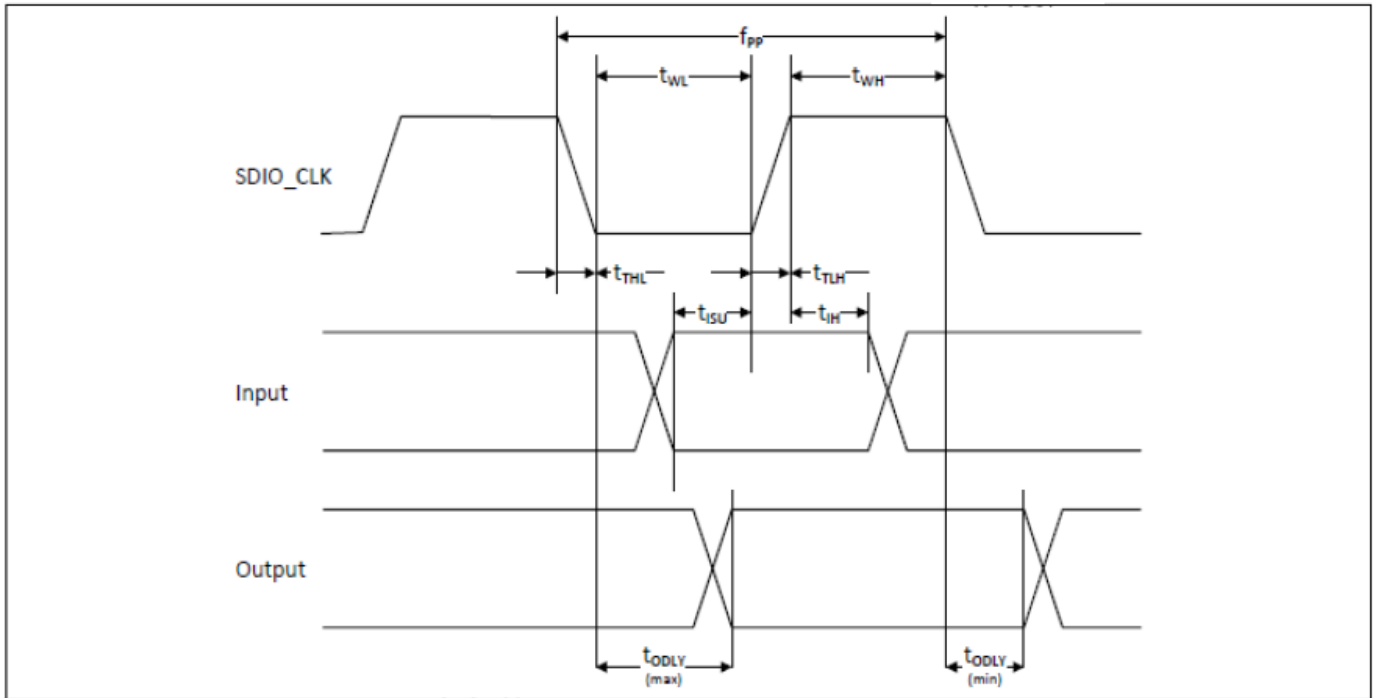


WLAN=ON, Bluetooth=OFF



WLAN=OFF, Bluetooth=ON

## 4.2 SDIO Default Mode Timing Diagram

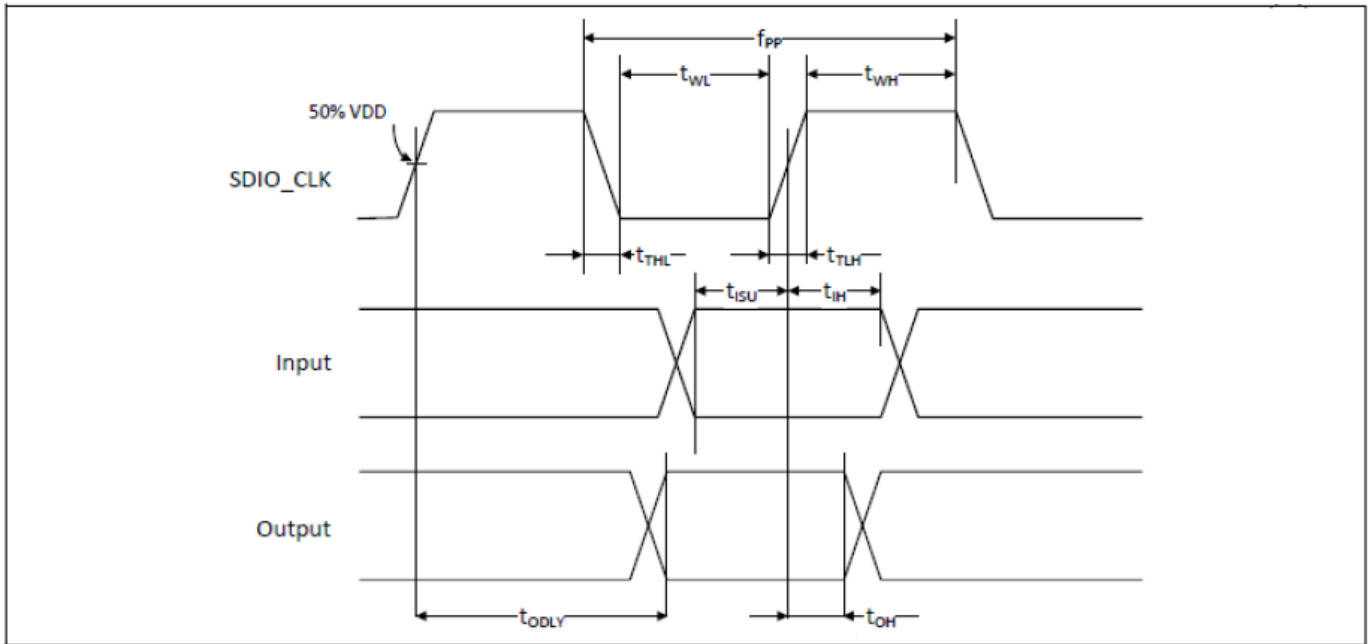


Parameter	Symbol	Minimum	Typical	Maximum	Unit
<b>SDIO CLK (ALL values are referred to minimum VIH and maximum VIL <sup>b</sup>)</b>					
Frequency – Data Transfer mode	f <sub>PP</sub>	0	-	25	MHz
Frequency – Identification mode	f <sub>OD</sub>	0	-	400	kHz
Clock low time	t <sub>WL</sub>	10	-	-	ns
Clock high time	t <sub>WH</sub>	10	-	-	ns
Clock rise time	t <sub>TLH</sub>	-	-	10	ns
Clock low time	t <sub>THL</sub>	-	-	10	ns
<b>Inputs : CMD, DAT(referenced to CLK)</b>					
Input setup time	t <sub>ISU</sub>	5	-	-	ns
Input hold time	t <sub>IH</sub>	5	-	-	ns
<b>Outputs : CMD, DAT(referenced to CLK)</b>					
Output delay time - Data Transfer mode	t <sub>ODLY</sub>	0	-	14	ns
Output delay time,- Identification mode	t <sub>ODLY</sub>	0	-	50	ns

a. Timing is base on  $CL \leq 40\text{pF}$  load on CMD and Data

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

### 4.3 SDIO High Speed Mode Timing Diagram



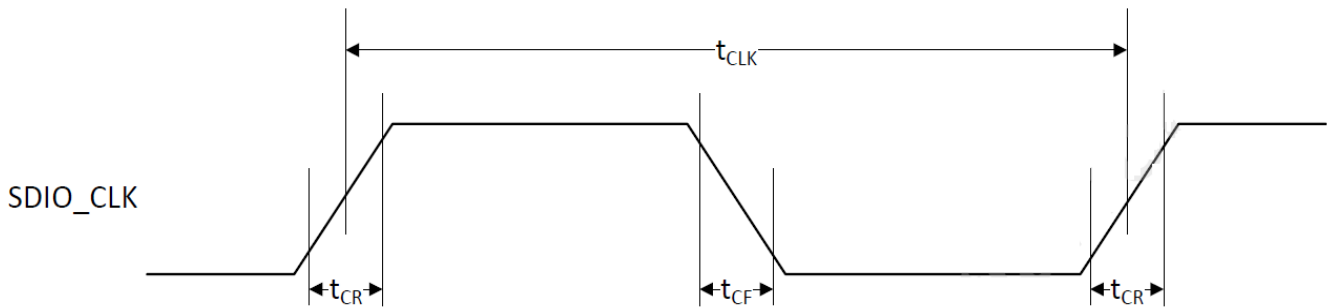
Parameter	Symbol	Minimum	Typical	Maximum	Unit
<b>SDIO CLK (ALL values are referred to minimum VIH and maximum VIL <sup>b)</sup>)</b>					
Frequency – Data Transfer mode	f <sub>PP</sub>	0	-	50	MHz
Frequency – Identification mode	f <sub>OD</sub>	0	-	400	kHz
Clock low time	t <sub>WL</sub>	7	-	-	ns
Clock 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 delay time,- Identification mode	t <sub>ODH</sub>	2.5	-	-	ns
Total system capacitance (each line)	CL	-	-	40	pF

a. Timing is base on  $CL \leq 40\text{pF}$  load on CMD and Data

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

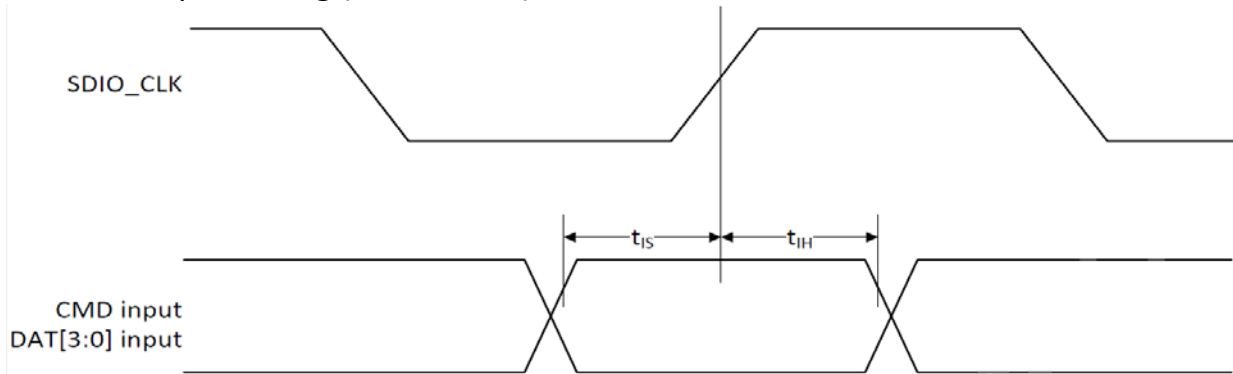


## 4.4 SDIO Bus Timing Specifications in SDR Modes



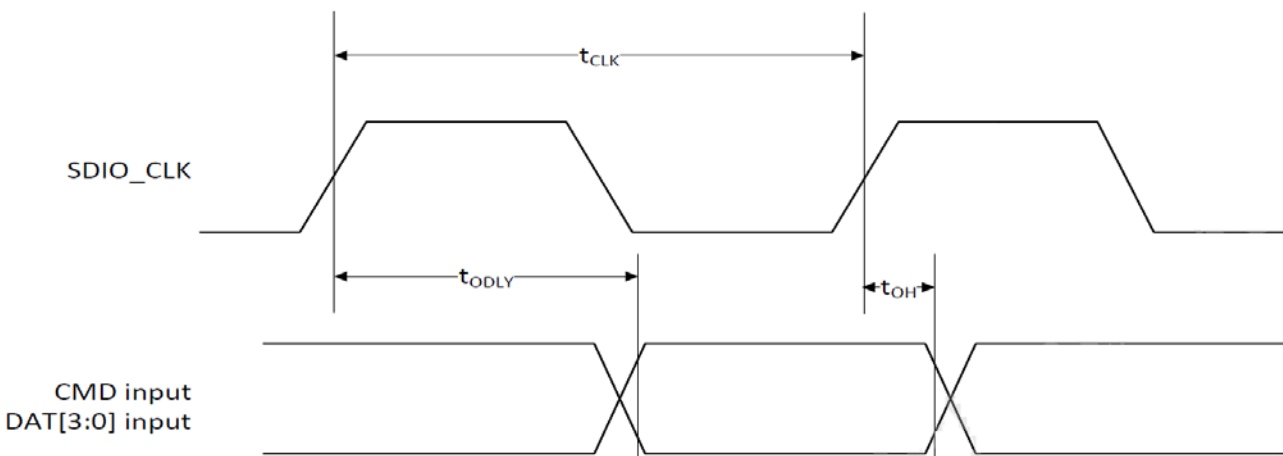
Parameter	Symbol	Minimum	Maximum	Unit	Comments
-	$t_{CLK}$	40	-	ns	SDR12 mode
-		20	-	ns	SDR25mode
-		10	-	ns	SDR50 mode
-		4.8	-	ns	SDR104 mode
-	$t_{CR}, t_{CF}$	-	$0.2 \times t_{CLK}$	ns	$t_{CR}, t_{CF} < 2.00$ ns (max) @100MHz, $C_{CARD} = 10$ pF $t_{CR}, t_{CF} < 0.96$ ns (max) @208MHz, $C_{CARD} = 10$ pF
Clock duty	-	30	70	%	-

### SDIO Bus Input timing (SDR Modes)



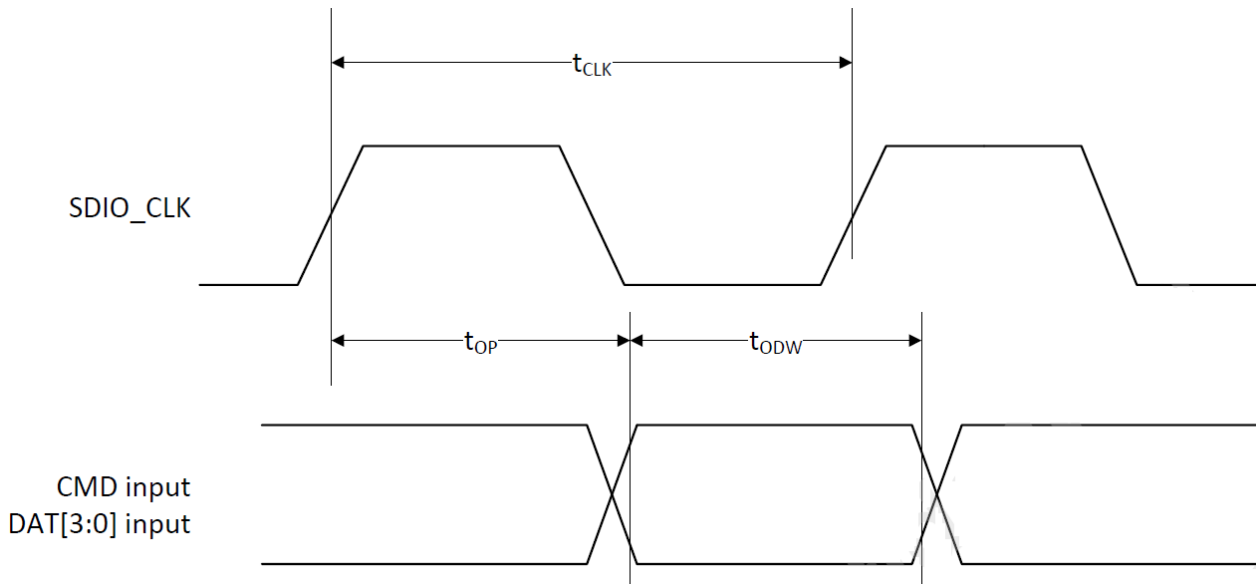
Symbol	Minimum	Maximum	Unit	Comments
<b>SDR104 Mode</b>				
$t_{IS}$	1.4	-	ns	$C_{CARD} = 10 \text{ pF}$ , $V_{CT} = 0.975V$
$t_{IH}$	0.80	-	ns	$C_{CARD} = 5 \text{ pF}$ , $V_{CT} = 0.975V$
<b>SDR50 Mode</b>				
$t_{IS}$	3.00	-	ns	$C_{CARD} = 10 \text{ pF}$ , $V_{CT} = 0.975V$
$t_{IH}$	0.80	-	ns	$C_{CARD} = 5 \text{ pF}$ , $V_{CT} = 0.975V$

### SDIO Bus output timing (SDR Modes up to 100MHz)



Symbol	Minimum	Maximum	Unit	Comments
$t_{ODLY}$	-	7.5	ns	$t_{CLK} \geq 10 \text{ ns}$ $C_L = 30 \text{ pF}$ using driver type B for SDR25
$t_{ODLY}$	-	14.0	ns	$t_{CLK} \geq 20 \text{ ns}$ $C_L = 40 \text{ pF}$ using for SR12, SDR25
$t_{OH}$	1.5	-	ns	Hold time at the $t_{ODLY}$ (min) $C_L = 15 \text{ pF}$

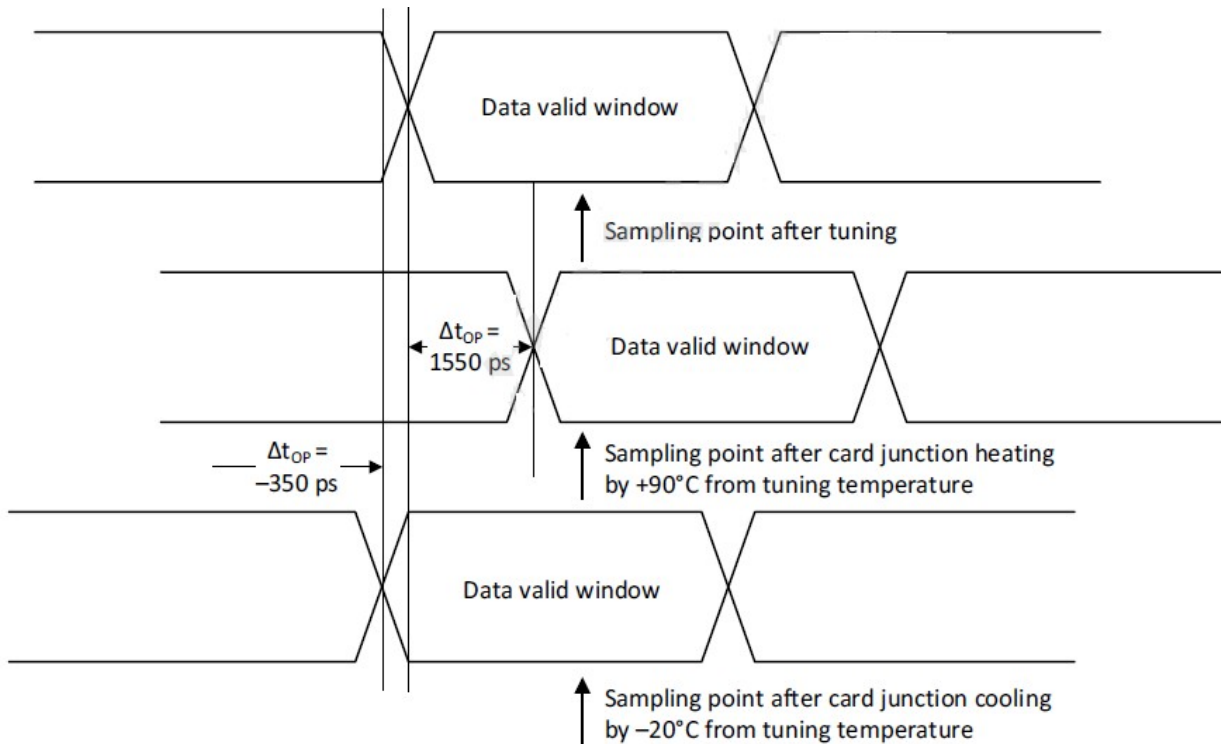
Card output timing (SDR Modes 100MHz to 208MHz)



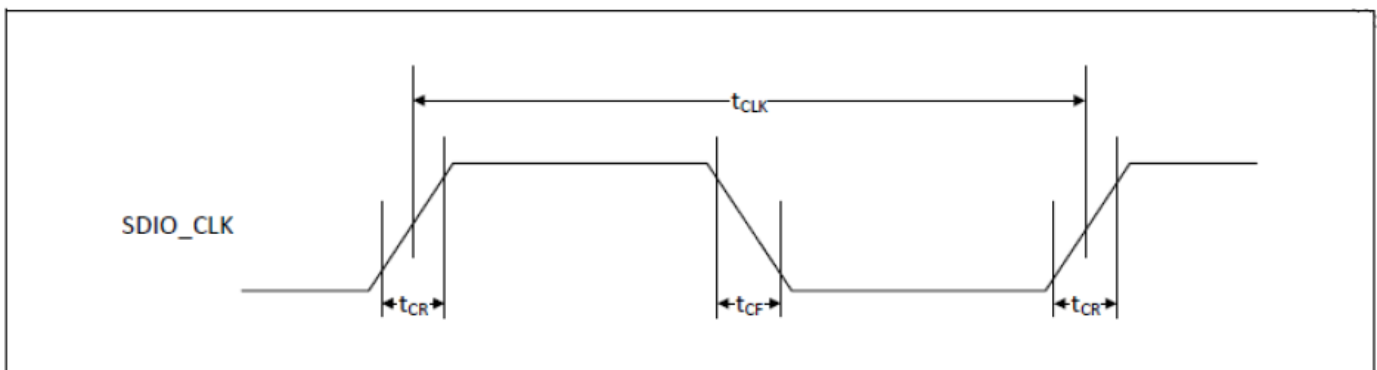
Symbol	Minimum	Maximum	Unit	Comments
$t_{OP}$	0	2	UI	Card output phase
$\Delta t_{OP}$	-350	+1550	ps	Delay variation due to tempo. change after tuning
$\Delta t_{ODW}$	0.60	-	UI	$t_{ODW} = 2.88 \text{ ns @ } 208\text{MHz}$

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

## $\Delta t_{OP}$ Consideration for Variable Data Window (SDR 104 Mode)

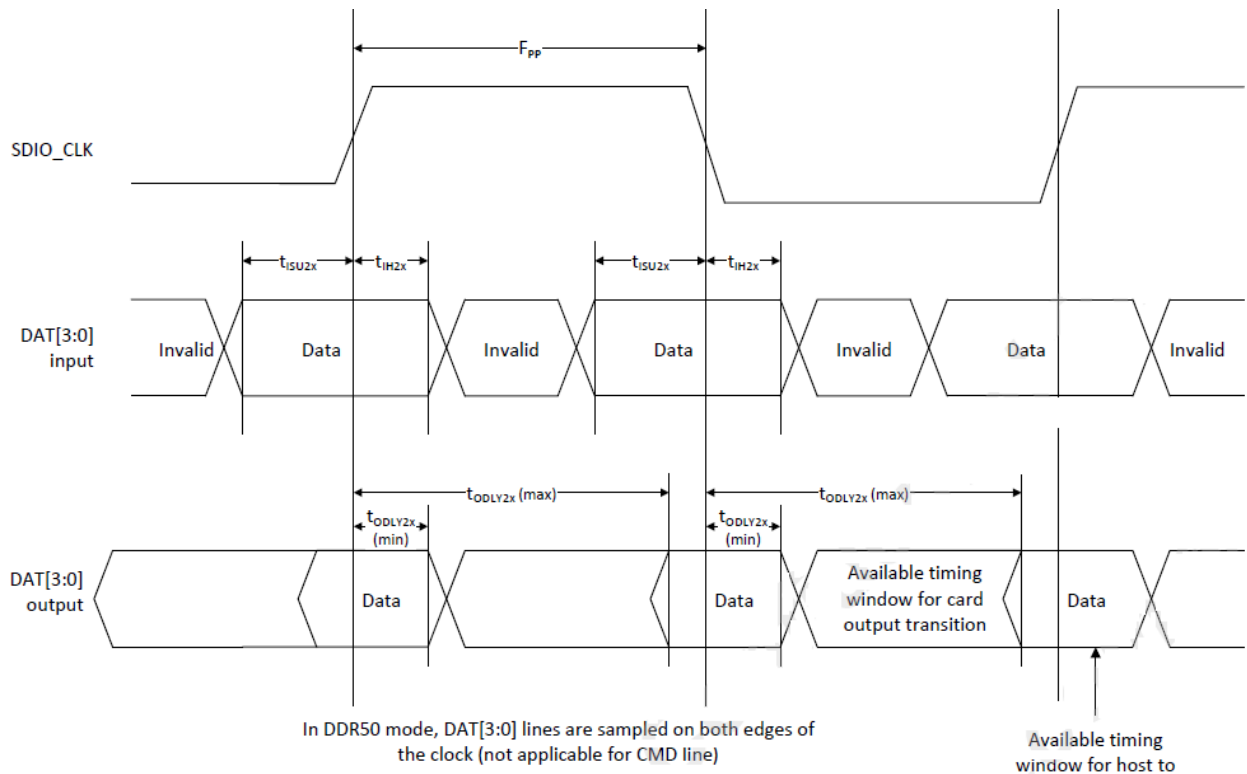


## 4.5 SDIO Bus Timing Specifications in DDR50 Mode



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

## Data Timing



Parameter	Symbol	Minimum	Maximum	Unit	Comments
<b>Input CMD</b>					
Input setup time	$t_{ISU}$	6	-	ns	$C_{CARD} < 10 \text{ pF}$ (1 Card)
Input hold time	$t_{IH}$	0.8	-	ns	$C_{CARD} < 10 \text{ pF}$ (1 Card)
<b>Output CMD</b>					
Output delay time	$t_{ODLY}$	-	13.7	ns	$C_{CARD} < 30 \text{ pF}$ (1 Card)
Output hold time	$t_{OH}$	1.5	-	ns	$C_{CARD} < 15 \text{ pF}$ (1 Card)
<b>Input DAT</b>					
Input setup time	$t_{ISU2x}$	3	-	ns	$C_{CARD} < 10 \text{ pF}$ (1 Card)
Input hold time	$t_{IH2x}$	0.8	-	ns	$C_{CARD} < 10 \text{ pF}$ (1 Card)
<b>Output DAT</b>					
Output delay time	$t_{ODLY2x}$	-	7.5	ns	$C_{CARD} < 25 \text{ pF}$ (1 Card)
Output hold time	$t_{ODLY2x}$	1.5	-	ns	$C_{CARD} < 15 \text{ pF}$ (1 Card)

## 5. Power Consumption

### ■ 2.4 GHz

Test Mode	DUT Status	Supply Voltage (VDDIO 3.3V )	Supply Voltage (VBAT 3.3V )
802.11b 11Mbps	Continue TX(SISO)	0.8mA	270 mA
	Continue RX(SISO)	0.8mA	75 mA
802.11b 11Mbps	Continue TX(CDD)	0.8 mA	510 mA
	Continue RX(CDD)	0.8 mA	110 mA
802.11g 54Mbps	Continue TX (SISO)	0.8 mA	220 mA
	Continue RX(SISO)	0.8 mA	75 mA
	Continue TX (CDD)	0.8 mA	410 mA
	Continue RX(CDD)	0.8 mA	110 mA
802.11n MCS7	Continue TX HT20(SISO)	0.8 mA	200 mA
	Continue RX HT20 (SISO)	0.8 mA	75 mA
	Continue TX HT20 (CDD)	0.8 mA	380 mA
	Continue RX HT20 (CDD)	0.8 mA	110 mA
Bluetooth	Continue TX	0.21 mA	13 mA
	Continue RX	0.21 mA	12 mA

(Unit: mA)

### ■ 5GHz

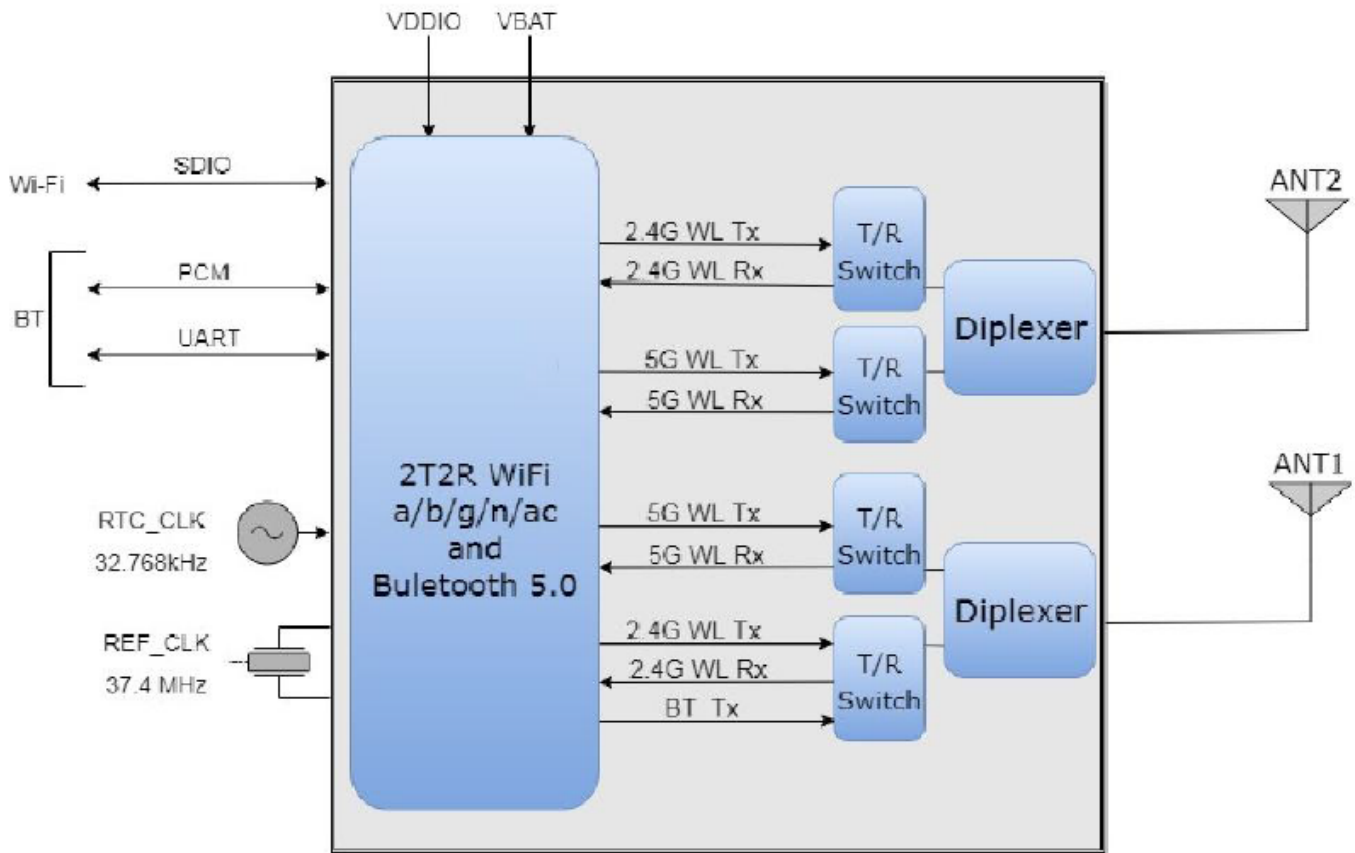
Test Mode	DUT Status	Supply Voltage (VDDIO 3.3V )	Supply Voltage (VBAT 3.3V )
802.11a 54Mbps	Continue TX (SISO)	0.8 mA	250 mA
	Continue RX(SISO)	0.8 mA	110 mA
	Continue TX (CDD)	0.8 mA	466 mA
	Continue RX(CDD)	0.8 mA	140 mA
802.11n MCS7	Continue TX HT20(SISO)	0.8 mA	240 mA
	Continue RX HT20 (SISO)	0.8 mA	110 mA
	Continue TX HT20 (CDD)	0.8 mA	440 mA
	Continue RX HT20 (CDD)	0.8 mA	140 mA
	Continue TX HT40(SISO)	0.8 mA	253 mA
	Continue RX HT40 (SISO)	0.8 mA	130 mA
	Continue TX HT40 (CDD)	0.8 mA	410 mA
	Continue RX HT40 (CDD)	0.8 mA	160 mA

(Unit: mA)

802.11n MCS15	Continue TX HT20(MIMO)	0.8 mA	385 mA
	Continue RX HT20 (MIMO)	0.8 mA	150 mA
	Continue TX HT40 (MIMO)	0.8 mA	370 mA
	Continue RX HT40 (MIMO)	0.8 mA	170 mA
802.11ac MCS9	Continue TX HT80(SISO)	0.8 mA	215 mA
	Continue RX HT80 (SISO)	0.8 mA	170 mA
	Continue TX HT80 (MIMO)	0.8 mA	420 mA
	Continue RX HT80 (MIMO)	0.8 mA	240 mA

(Unit: mA)

## 6. Block Diagram

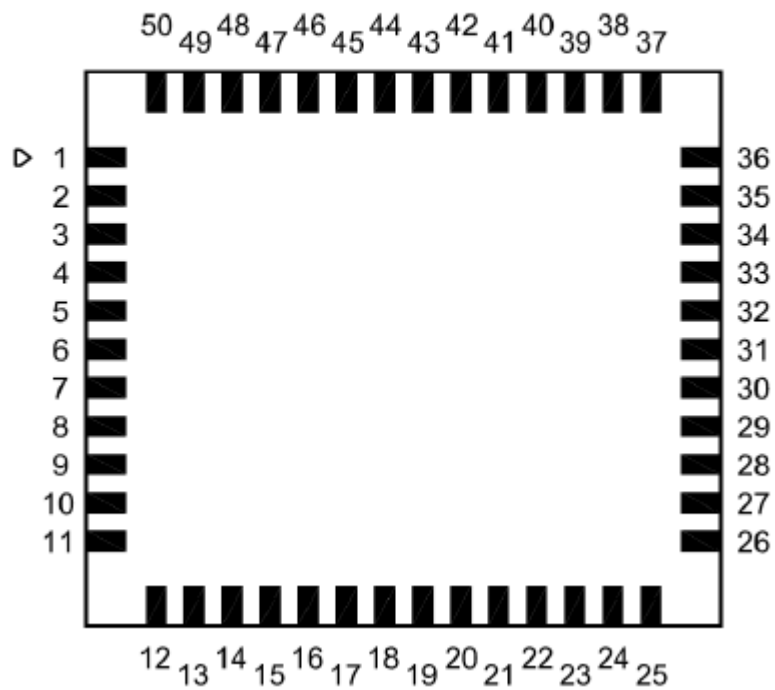




## 7. Pin Definition

### 7.1 Pin Outline

<TOP VIEW>



## 7.2 Pin Table

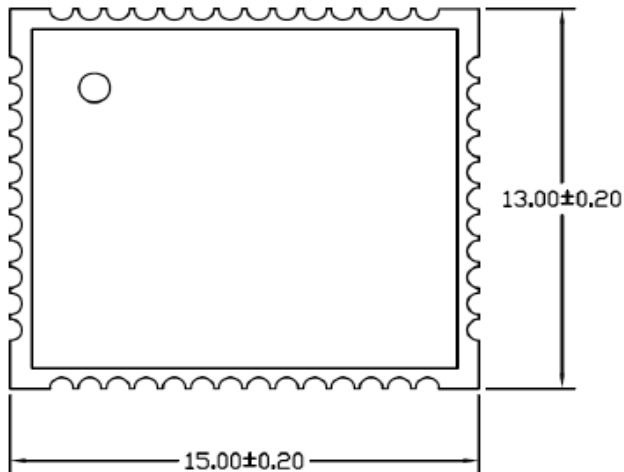
NO	Name	Type	Description
1	GND	—	Ground connections
2	WL_ANT0	I/O	RF(BT&WIFI) I/O port0
3	GND	—	Ground connections
4	GND	—	Ground connections
5	GND	—	Ground connections
6	GND	—	Ground connections
7	GND	—	Ground connections
8	GND	—	Ground connections
9	WL_ANT1	I/O	RF(WIFI) I/O port1
10	GND	—	Ground connections
11	GND	—	Ground connections
12	NC	—	Floating (Don't connected to ground)
13	XTAL_OUT	O	External Crystal out
14	XTAL_IN	I	External Crystal in/ Single clock source in
15	WL_REG_ON	I	Low asserting reset for WiFi core
16	WL_HOST_WAKE	O	WLAN to wake-up HOST
17	SDIO_DATA_CMD	I/O	SDIO command line
18	SDIO_DATA_CLK	I/O	SDIO clock line
19	SDIO_DATA_3	I/O	SDIO data line 3
20	SDIO_DATA_2	I/O	SDIO data line 2
21	SDIO_DATA_0	I/O	SDIO data line 0
22	SDIO_DATA_1	I/O	SDIO data line 1
23	GND	—	Ground connections
24	SDIO_VSEL	I	SDIO voltage select: 0: 3.3V 1:1.8V
25	VIN_LDO	P	Internal Buck voltage generation pin
26	VIN_LDO_OUT	P	Internal Buck voltage generation pin
27	PCM_SYNC	I/O	PCM sync signal
28	PCM_IN	I	PCM data input
29	PCM_OUT	O	PCM Data output
30	PCM_CLK	I/O	PCM clock
31	LPO	I	External Low Power Clock input (32.768KHz)
32	GND	—	Ground connections
33	NC	—	Floating (Don't connected to ground)
34	VDDIO	P	I/O Voltage supply input
35	NC	—	Floating (Don't connected to ground)
36	VBAT	P	Main power voltage source input
37	NC	—	Floating (Don't connected to ground)
38	BT_REG_ON	I	Low asserting reset for Bluetooth core
39	GND	—	Ground connections

40	UART_TXD	O	Bluetooth UART interface
41	UART_RXD	I	Bluetooth UART interface
42	UART_RTS_N	O	Bluetooth UART interface
43	UART_CTS_N	I	Bluetooth UART interface
44	WL_UART_TX	O	WL_UART_TX
45	WL_UART_RX	I	WL_UART_RX
46	NC	—	Floating (Don't connected to ground)
47	GND	—	Ground connections
48	NC	—	Floating (Don't connected to ground)
49	BT_WAKE	I	HOST wake-up Bluetooth device
50	BT_HOST_WAKE	O	Bluetooth device to wake-up HOST

## 8. Mechanical Specification

### 8.1 Module Dimension

<TOP VIEW>

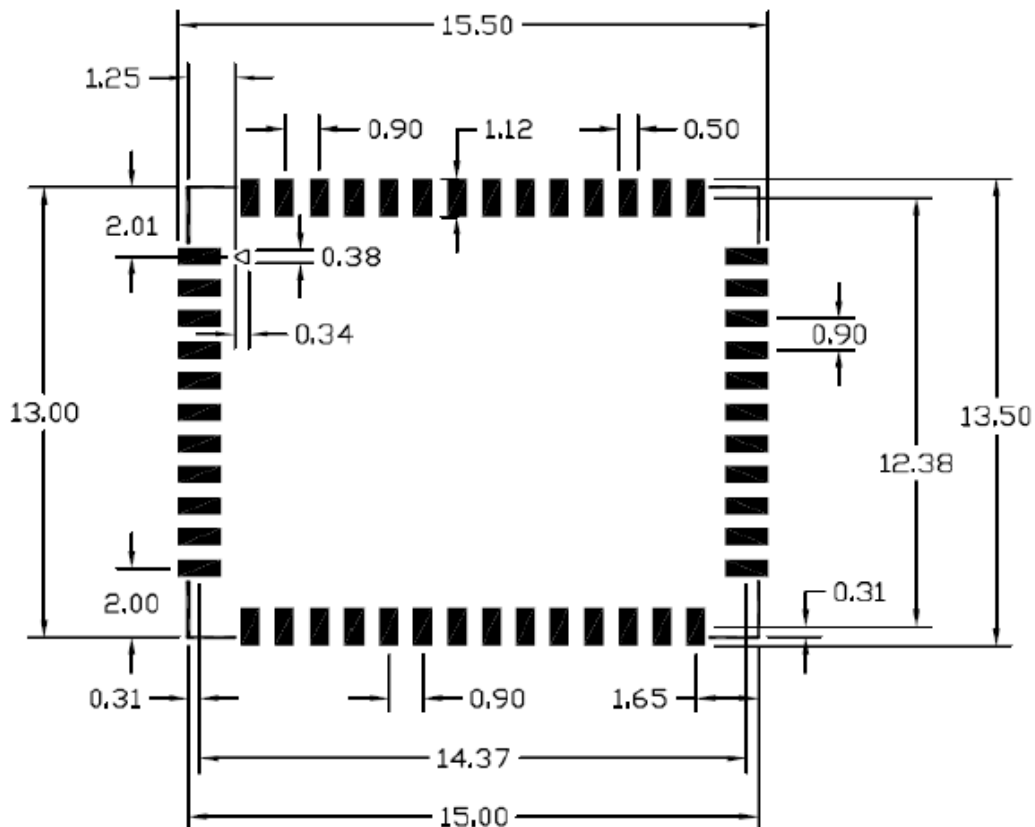


<SIDE VIEW>



unit : mm

### 8.1 PCB Footprint



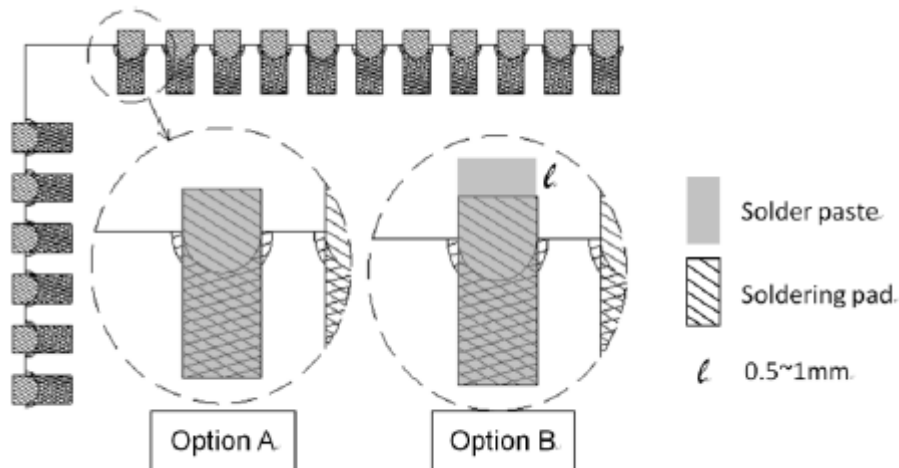
- Solder paste layer design is generally the same as recommended footprint.

(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

### 9.1 SDIO Interface Description

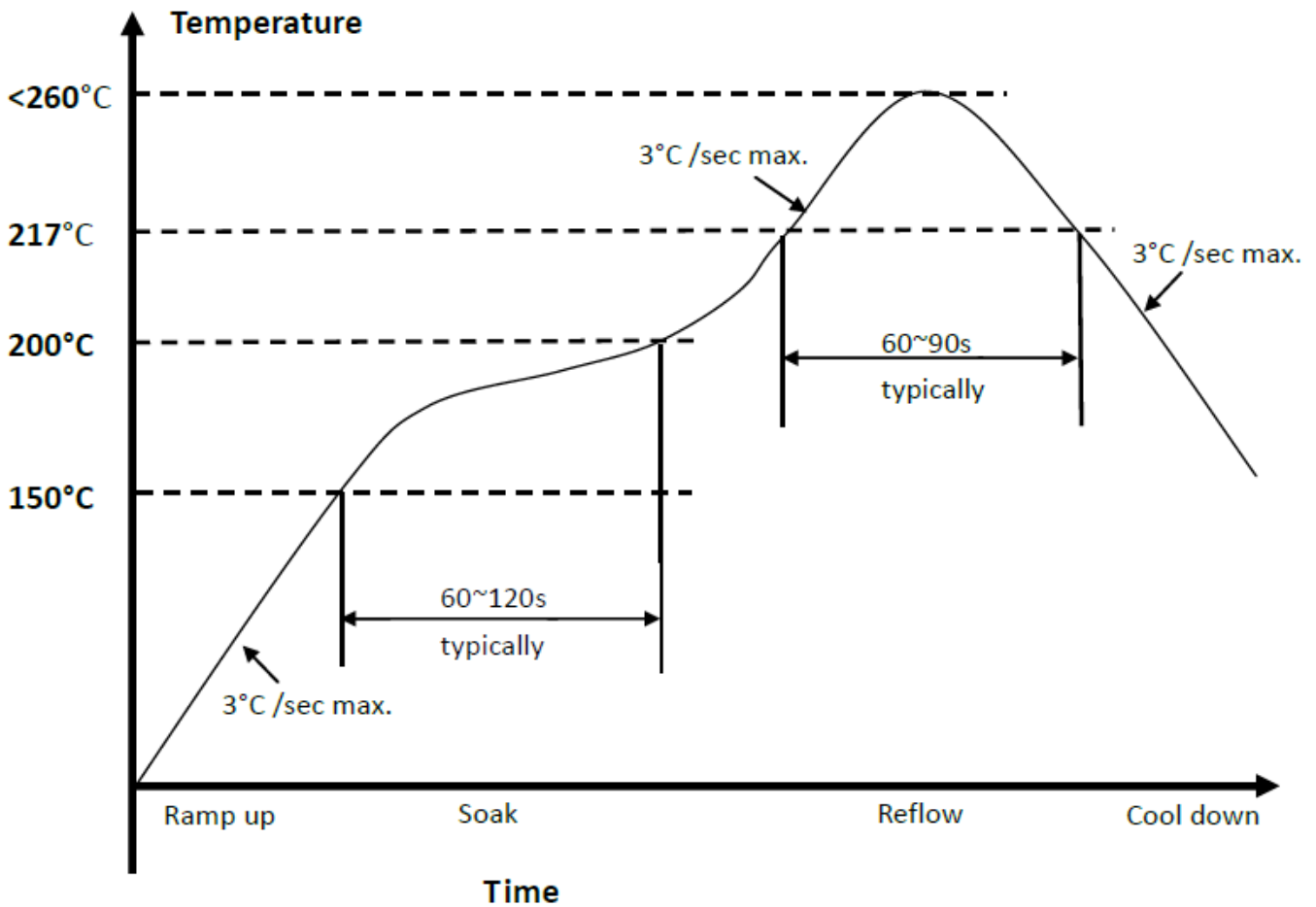
The module supports SDIO version 3.0 for all 1.8V 4-bit UHSI speeds: SDR50 (100 Mbps), SDR104 (208MHz) and DDR50 (50MHz, dual rates) in addition to the 3.3V default speed (25MHz) and high speed (50 MHz). It has the ability to stop the SDIO clock and map the interrupt signal into a GPIO pin. This 'out-of-band' 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. Recommended Reflow Profile



- Referred to IPC/JEDEC standard
- Peak Temperature : <260°C
- Cycle of Reflow : 2 times max.
- Adding Nitrogen (N<sub>2</sub>) to implement 2000ppm or less of oxygen concentration during reflow process is recommended.
- If the shelf time is exceeded, be sure baking step to remove the moisture from the component

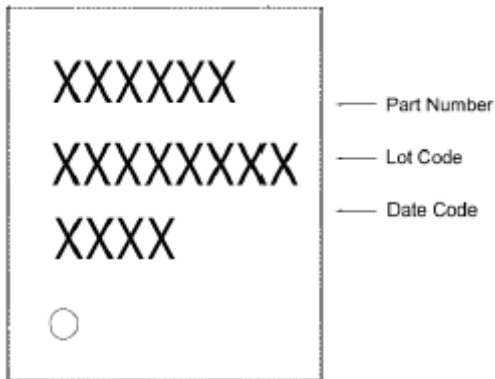
## 10.1 Caution for SMT Preparation

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  $\leq 30^{\circ}\text{C}/60\%\text{RH}$  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.

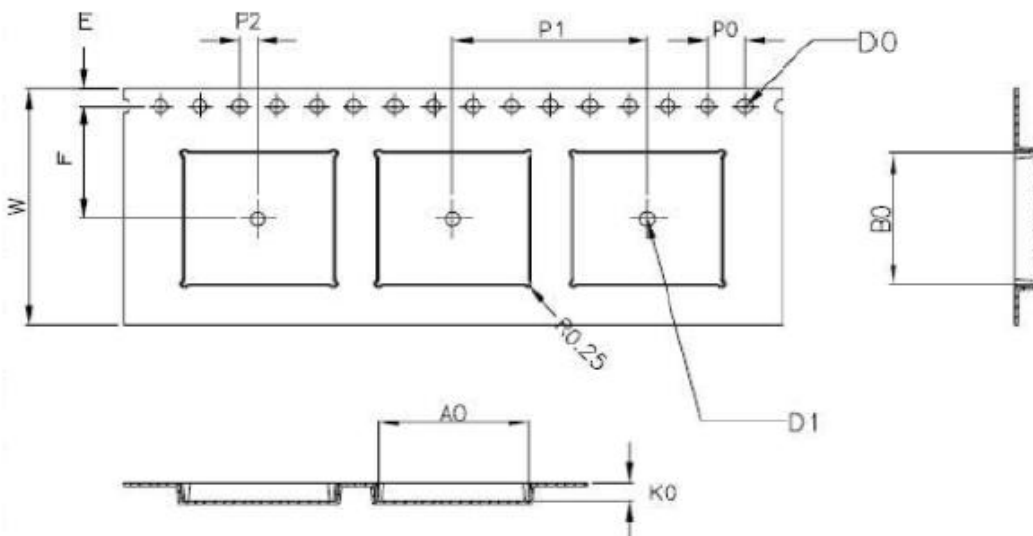


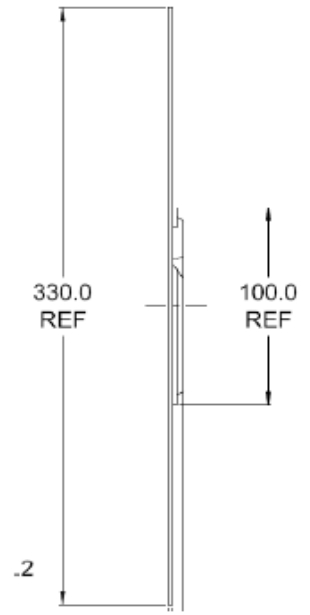
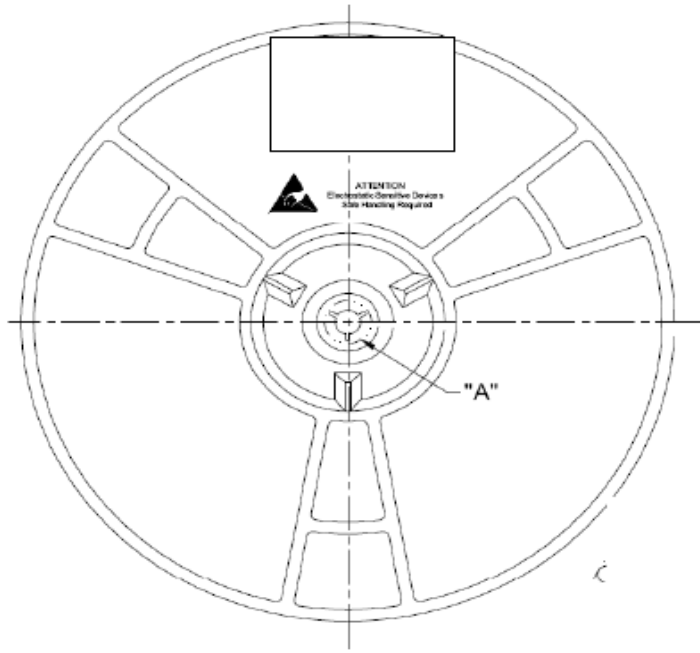
## 11. Package Information



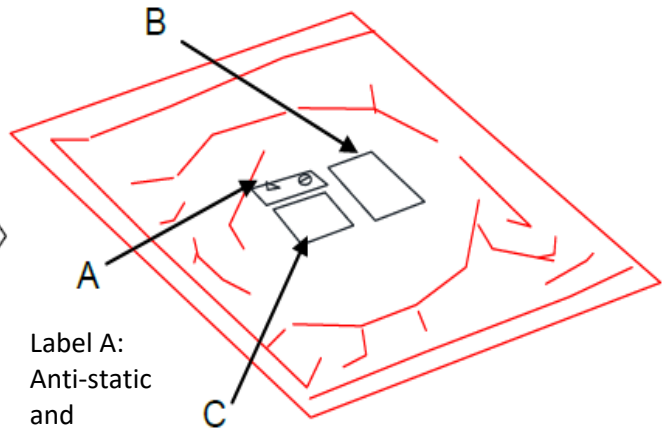
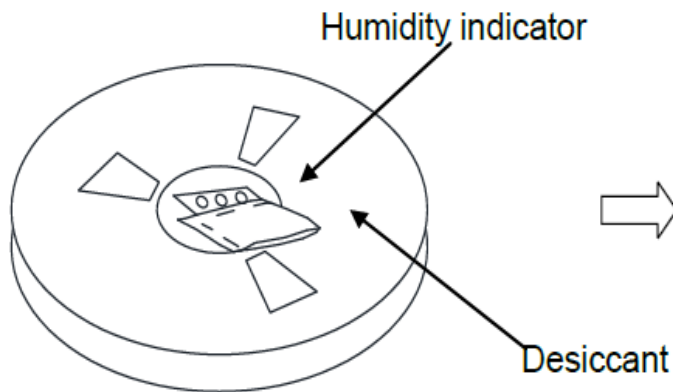
W	24.00±0.30
A0	15.30±0.10
B0	13.30±0.10
K0	2.00±0.10
E	1.75±0.10
F	11.50±0.10
P0	4.00±0.10
P1	20.00±0.10
P2	2.00±0.10
D0	1.50 <sup>+0.10</sup> <sub>-0.00</sub>
D1	∅ 1.50MIN

- 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.
- Component load per 13" reel : 1000 pcs



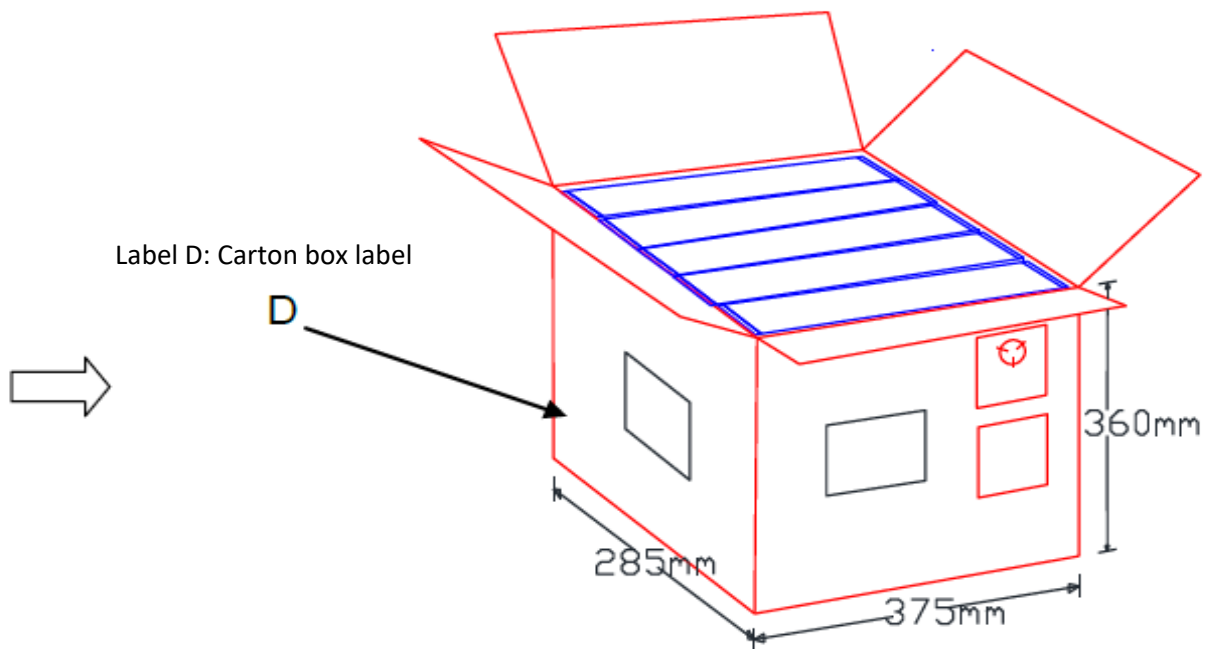
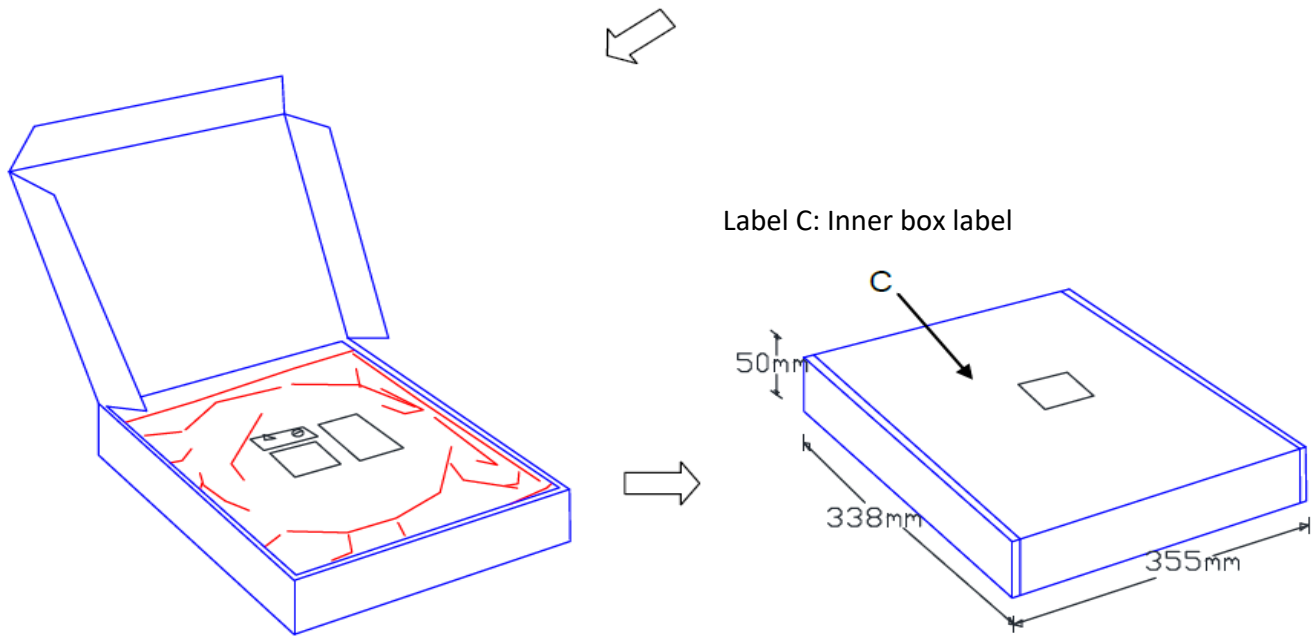


Label B: MSL caution / Storage Condition



Label A:  
Anti-static  
and  
humidity  
notice

Label C: Inner box label



Note: 1 tape reel = 1 box = 1,000pcs  
1 Carton = 5 box = 5,000pcs

## 12. Order Information

Product Name	Part Number	Description
AP6398S	R9701820002	11ac/a/b/g/n 2T2R WiFi + BT5.2 Combo Sip Module