**CUSTOMER : LGE**

**DATE : 2017.09.06.**

# SPECIFICATIONS FOR APPROVAL

**PRODUCT NAME : BT(v4.2) + WLAN(802.11a/b/g/n/ac) 2.4G SISO/5G MIMO**

**MODEL NAME : RBHP-B213B**

**CUSTOMER P/N : EAT63433501**

| APPROVAL | REMARK |
|---|---|
| | |

| APPENDIX |
|---|
| |

| Designed | Checked | Approved | LG Innotek Co., Ltd. | |
|---|---|---|---|---|
| | | | DOCUMENT No. | RBHP-B213B |
| | | | PAGE | 68 |

## 1. Application

⚠ This specification is applied to LGInnotek Bluetooth (v4.2)and 2.4GHz SISO/5GHz MIMO WLAN(802.11a/b/g/n/ac) Module RBHP-B213B which includes BCM88359

## 2. Quality

Quality should meet each condition which mentioned on this specification. However, the items which are not mentioned on this specification follow the inspection agreements and standards which are agreed with both companies.

## 3. Appearance and Characteristics

1) Appearance

Appearance should not be contaminated by harmful materials and should not have cracks etc. Mechanical dimensions should meet the contents of clause 8.

2) Characteristics

Electrical characteristics should meet the contents of clause 10.

## 4. Application of Bluetooth v4.2 and 2.4GHz/5GHz WLAN(IEEE 802.11.a/b/g/n/ac)

1) Automotive

## 5. Maximum Rating

| NO | ITEM | Rating | UNIT |
|---|---|---|---|
| 1 | Operating Temperature Range | -40 ~ +85 | ℃ |
| 2 | Storage Temperature Range | -40 ~ +105 | ℃ |
| 3 | VBAT Voltage Range | -0.5 ~ 6.0 | V |
| 4 | VIO Voltage Range | -0.5 ~ 3.9 | V |
| 5 | VBAT Max. Current | 700(@3.3V) | mA |
| 6 | VIO Max. Current | 50(@1.8V) | mA |

⚠ RBHP-B213B Module assures operating normally at -40 ~ +85 ℃.

## 6. Test

Electrical characteristics are tested for every products. However, if there are any objection in judgments, it should be treated with agreements of companies.

## 7. Labeling Information

**GWANGGAETOH**
①

**RBHP-B213B**
②

**7 04 GJ 27 0059**
③ ④ ⑤ ⑥ ⑦

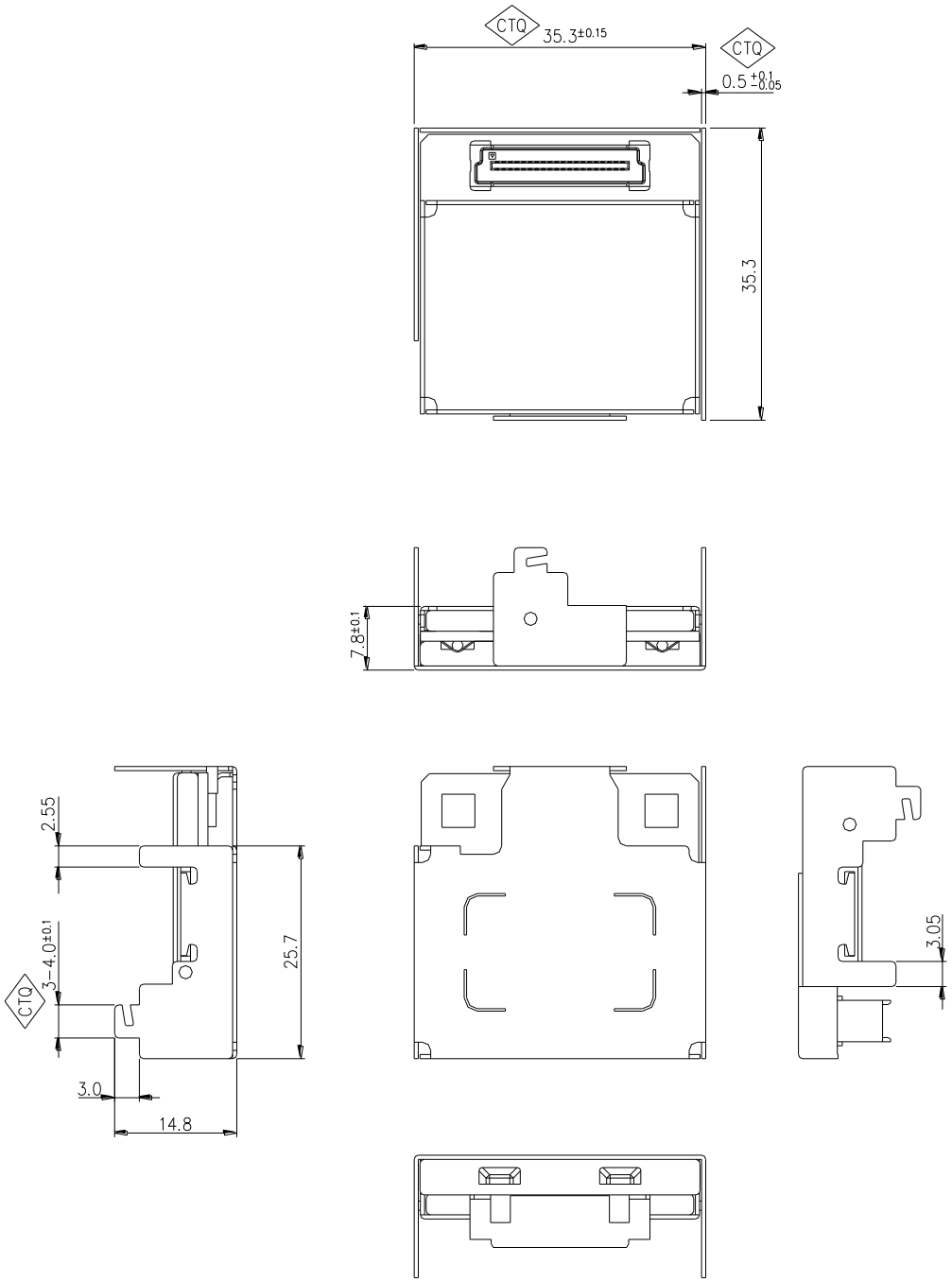
**EAT63433501**
⑧

⑨

| No. | Index |
|---|---|
| ① | PRODUCT |
| ② | MODEL PART NO. |
| ③ | MANUFACTURED YEAR (0~9) |
| ④ | MANUFACTURED MONTH(1,2, …9, A,B,C) |
| ⑤ | GwangJu |
| ⑥ | MANUFACTURED DATE (1~31) |
| ⑦ | MANUFACTURED SERIAL NUMBER(0001~9999) |
| ⑧ | Customer P/N |
| ⑨ | QR CODE INFORMATION<br>: EAT63433501_704GJ270059 |

## 8. Mechanical Dimension

1) Dimension without Antenna Ass'y

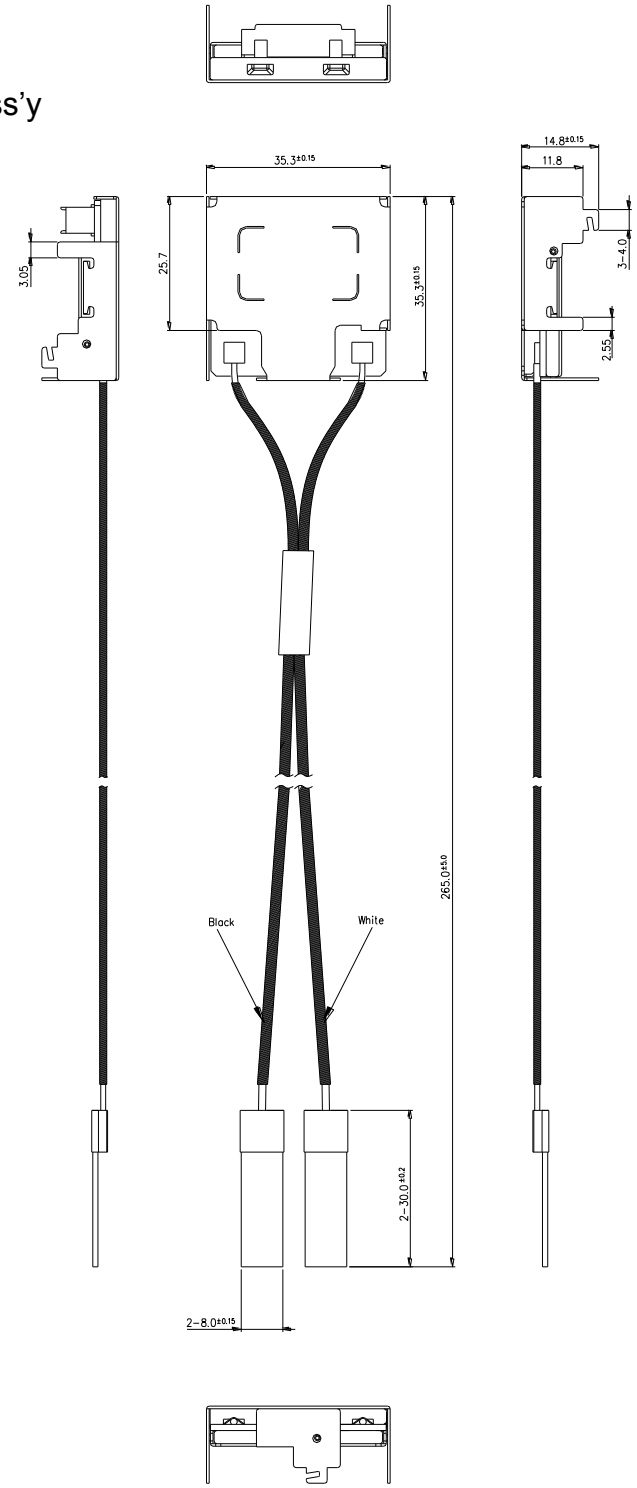



[Unit: mm]

| REV | | | | DSGD | CHKD | APPD | LG Innotek Co., Ltd / RBHP-B213B |
|---|---|---|---|---|---|---|---|
| | 1.2 | 2017. 05.23. | Rev1.2 Released | | | | |
| | 1.3 | 2017. 06.27. | Rev1.3 Released | | | | |
| | 1.4 | 2017. 07.14. | Rev1.4 Released | | | | |
| | 1.5 | 2017. 08.10. | Rev1.5 Released | | | | DOCUMENT NO. 6-3 |
| | 1.6 | 2017. 09.06. | Rev1.6 Released | | | | |

## 8. Mechanical Dimension

2) Dimension with Antenna Ass'y




[Unit: mm]

| REV | | | | LG Innotek Co., Ltd | | | |
|---|---|---|---|---|---|---|---|
| | 1.2 | 2017. 05.23. | Rev1.2 Released | | | | |
| | 1.3 | 2017. 06.27. | Rev1.3 Released | DSGD | CHKD | APPD | RBHP-B213B |
| | 1.4 | 2017. 07.14. | Rev1.4 Released | | | | |
| | 1.5 | 2017. 08.10. | Rev1.5 Released | | | | DOCUMENT NO. |
| | 1.6 | 2017. 09.06. | Rev1.6 Released | | | | 6-3 |

## 9. General Features

### 9.1 BT(v4.2) + 2.4GHz/5GHz WLAN(IEEE 802.11a/b/g/n/ac) 2.4G SISO/5G MIMO

1) Features

- Operation Voltage is 3.3V/1.8V Dual Power Rail
- WiFi Single-stream up to 866 Mbps data rate
- Automotive Module
  : All components are AEC-Q 100/200 qualified
- Support 2 Antenna port
  : ANT0 : Bluetooth/5G WLAN, ANT1 : 2.4G/5G WLAN
- Integrated WLAN PA, RF Switch and LNA
- RoHS Compliant
- Size : 35.3 x 35.3 x 7.8 $mm^3$
- Support bandwidth : HT20 / HT40 / VHT80
- HOST Interface : PCIE/SDIO(WLAN), UART(BT), PCM(I2S)
- Package type : Connector type(B to B)

## 9. General Features

### 9.2 Bluetooth(BT v4.2+EDR compliant)

1) Bluetooth Key Features

- Supports key features of upcoming Bluetooth standards
- Fully supports Bluetooth Core Specification version 4.2 + (Enhanced Data Rate) EDR features:
  - -. Adaptive Frequency Hopping (AFH)
  - -. Quality of Service (QoS)
  - -. Extended Synchronous Connections (eSCO) – Voice Connections
  - -. Fast Connect (interlaced page and inquiry scans)
  - -. Secure simple Pairing (SSP)
  - -. Sniff Sub rating (SSR)
  - -. Encryption Pause Resume (EPR)
  - -. Extended Inquiry Response (EIR)
  - -. Link Supervision Timeout (LST)
- UART baud rates up to 4 Mbps
- Supports all Bluetooth 4.2 packet types
- Supports maximum Bluetooth data rates over HCI UART
- Multipoint operation with up to seven active slaves
  - -. Maximum of seven simultaneous active ACL links
  - -. Maximum of three simultaneous active SCO and eSCO connections with scatternet support
- Narrowband and wideband packet loss concealment
- Scatternet operation with up to four active piconets with background scan and support for scatter mode
- High-speed HCI UART transport support
- Channel quality driven data rate and packet type selection
- Standard Bluetooth test modes
- Extended radio and production test mode features
- Full support for power savings modes
  - -. Bluetooth clock request
  - -. Bluetooth standard sniff
  - -. Deep-sleep modes and software regulator shutdown

## 9. General Features

### 9.3 WLAN

1) WLAN RF band & modulation Features
- Dual-band 2.4GHz and 5GHz 802.11 a/b/g/n/ac(802.11ac compliant)
- Up to 866Mbps data rate
- Supports 20, 40 and 80MHz channels with optional SGI(256 QAM modulation)
- Tx and Rx low-density parity check(LDPC)
- Supports IEEE 802.11ac/n beamforming
- Supports PCIe v3.0-compliant interface running at GEN1 speeds
- Supports two antennas with Bluetooth/5G WLAN and 2.4G/5G WLAN antenna
- Supports standard SDIO V3.0 (up to SDR104 mode at 208MHz, 4-bit and 1-bit)
- Backward compatibility with SDIO v2.0 host interface
- WPA and WPA2(Personal) support for powerful encryption and authentication
- AES and TKIP in hardware for faster data encryption and IEEE 802.11i compatibility
- Reference WLAN subsystem provides Wi-Fi protected Setup(WPS)

2) WLAN MAC features
- Enhanced MAC for supporting IEEE 802.11ac features
- Transmission and reception of aggregated MPDUs(A-MPDU) for high throughput(HT)
- Support for power management schemes, including WMM power-save multi-poll(PSMP) and multiphase PSMP operation
- Support for immediate ACK and block-ACK policies
- Inter-frame space timing support, including RIFS
- Back-off counters in hardware for supporting multiple priorities as specified in the WMM specification
- Timing synchronization function(TSF), network allocation vector(NAV) maintenance, and target beacon transmission time(TBTT) generation in hardware
- Hardware offload for AES-CCMP, legacy WPA TKIP, legacy WEP ciphers, WAPI, and support for key management
- Programmable independent basic service set(IBSS) or infrastructure basic service set functionality

## 9. General Features

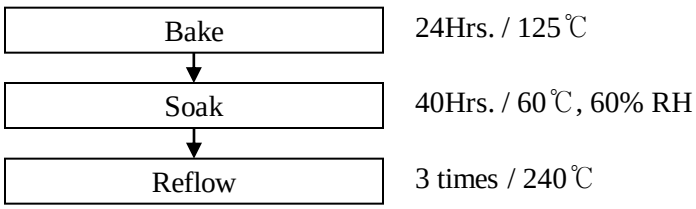
### 9.3 WLAN

3) WLAN PHY features

- Programmable data rates from MCS0-9 in 20MHz, 40MHz, and 80MHz channels, as specified in IEEE 802.11ac
- Improved performance with channel smoothing and spur canceller support
- Supports Optional short GI and Green field modes in Tx and Rx
- Tx and Rx LDPC for improved range and power efficiency
- Beamforming support
- Supports IEEE 802.11h/k for worldwide operation
- Advanced algorithms for low power, enhanced sensitivity, range, and reliability
- IEEE 802.11a, 11b, 11g, 11n, 11ac single stream PHY standards
- Designed to meet FCC and other worldwide regulatory requirements

### 9.4 JEDEC MSL (Moisture Sensitivity Level) Test

- MSL 3 Level (Floor Life Time : 168Hrs. / Condition : ≤30℃, 60% RH)
- Standard : IPC / JEDEC J-STD-020C



## 10. Electrical Specification

### 10.3 I/O characteristics

1) SDIO Interface I/O pins and PCIe out of band signals(PERST_N/PME_L/CLKREQ_N)

*VIO_SD= 1.8V

| Item | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Input high voltage | $V_{IH}$ | 1.27 | - | - | V |
| Input low voltage | $V_{IL}$ | - | - | 0.58 | V |
| Output high voltage@2mA | $V_{OH}$ | 1.40 | - | - | V |
| Output low voltage@2mA | $V_{OL}$ | - | - | 0.45 | V |

*VIO_SD = 3.3V

| Item | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Input high voltage | $V_{IH}$ | 0.625xVIO | - | - | V |
| Input low voltage | $V_{IL}$ | - | - | 0.25xVIO | V |
| Output high voltage@2mA | $V_{OH}$ | 0.75xVIO | - | - | V |
| Output low voltage@2mA | $V_{OL}$ | - | - | 1.25xVIO | V |

2) Other Digital I/O Pins(UART/PCM/WAKE/REG_ON/STRAP and GPIOs)

*VIO = 1.8V

| Item | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Input high voltage | $V_{IH}$ | 0.625xVIO | - | VIO+0.1 | V |
| Input low voltage | $V_{IL}$ | - | - | 0.35xVIO | V |
| Output high voltage@2mA | $V_{OH}$ | 0.45xVIO | - | - | V |
| Output low voltage@2mA | $V_{OL}$ | - | - | 0.45 | V |

## 10. Electrical Specification

### 10.3 I/O characteristics

*VIO = 3.3V

| Item | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Input high voltage | $V_{IH}$ | 2.00 | - | VIO+0.1 | V |
| Input low voltage | $V_{IL}$ | - | - | 0.8 | V |
| Output high voltage@2mA | $V_{OH}$ | VIO-0.4 | - | - | V |
| Output low voltage@2mA | $V_{OL}$ | - | - | 0.4 | V |

3) WLAN host interface strap selection

- PCIE_EN, SDIO_DIS, SDIO_PAD

| PCIE_EN | SDIO_DIS | SDIO_PAD | Mode |
|---|---|---|---|
| High | High | High | PCIe |
| Low | Low | High | 1.8V SDIO |
| Low | Low | low | 3.3V SDIO |

4) Sequencing of reset and regulator control signals

- Description of control signals

*WL_REG_ON
: Used by the PMU to power up the WLAN section. It is also OR-gated with the BT_REG_ON input to control the internal BCM88359 regulators. When this pin is high, the regulators are enabled and the WLAN section is out of reset. When this pin is low, the WLAN section is in reset. If both the BT_REG_ON and WL_REG_ON pins are low, the regulators are disabled

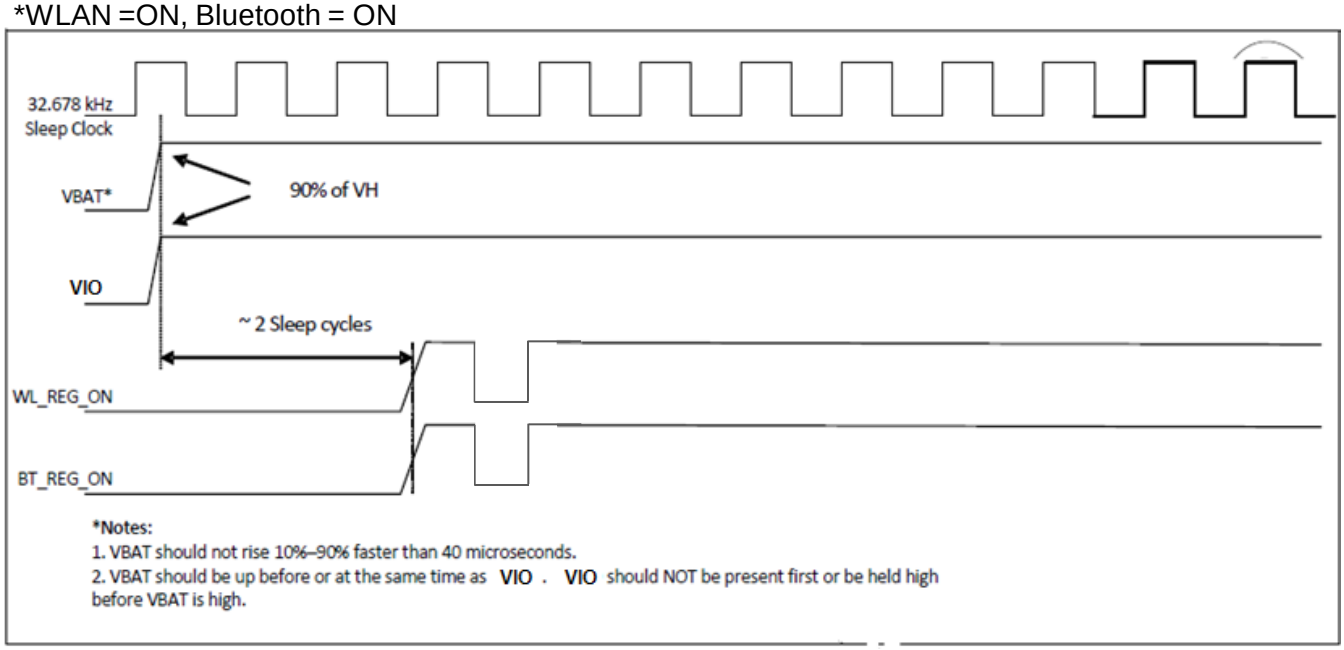
*BT_REG_ON
: Used by the PMU(OR-gated with the WL_REG_ON)to power up the internal BCM88359 regulators. If both the BT_REG_ON and WL_REG_ON pins are low, the regulators are disabled. When this pin is low and WL_REG_ON is high, the BT section is in reset

## 10. Electrical Specification

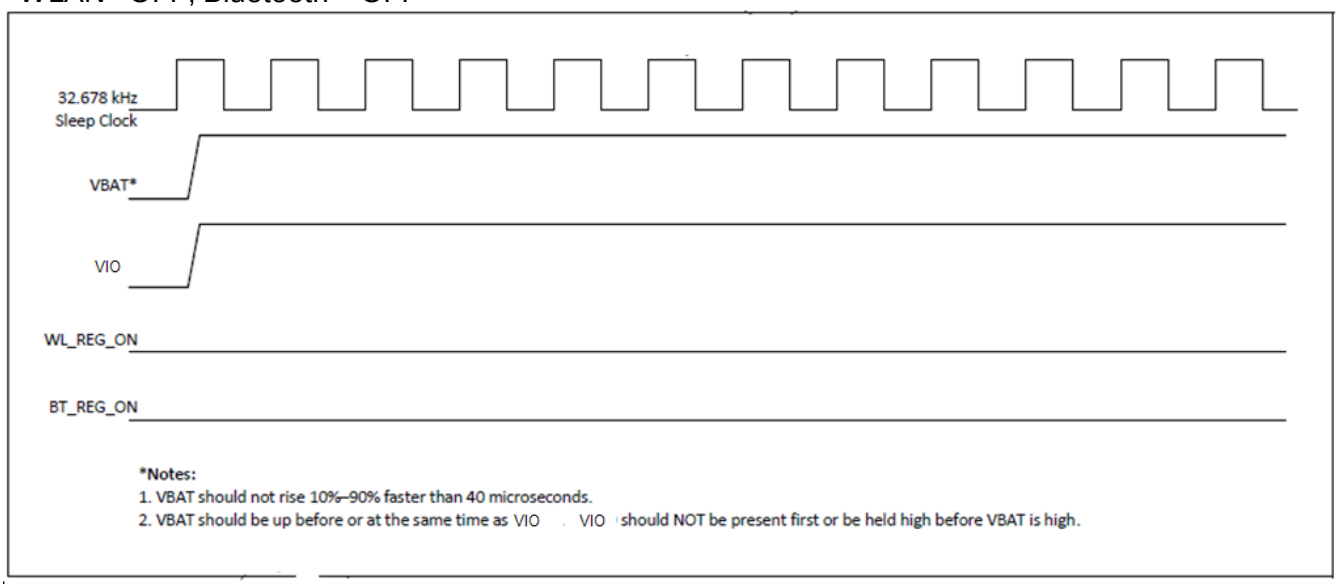
### 10.3 I/O characteristics

- Control signal timing diagrams

*WLAN =ON, Bluetooth = ON




*WLAN =OFF, Bluetooth = OFF

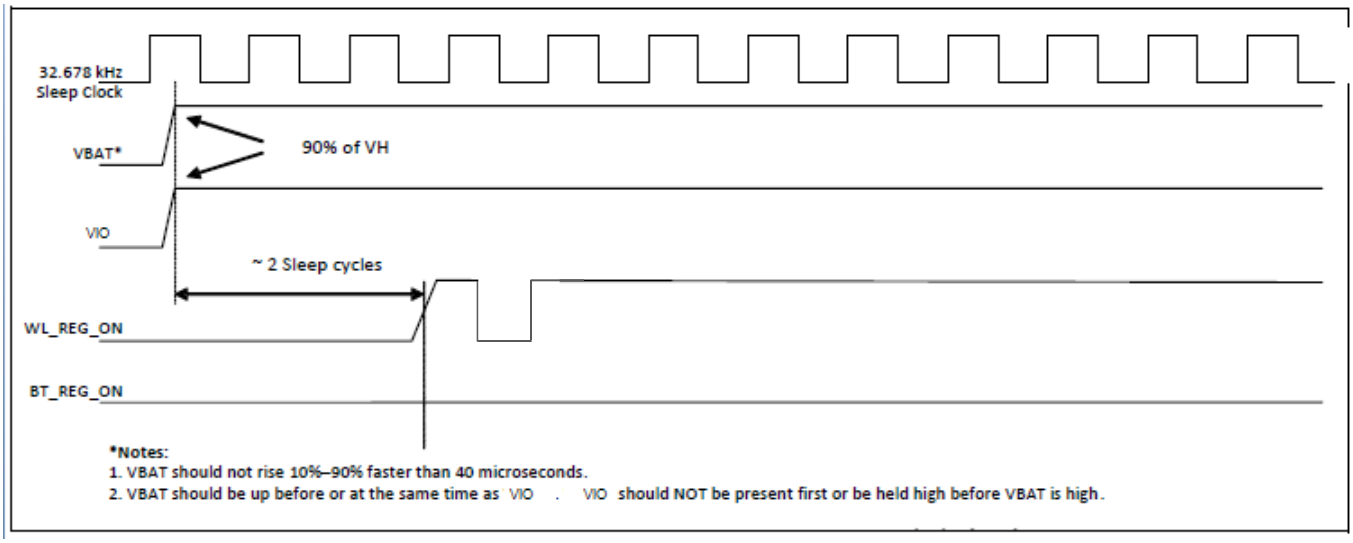


## 10. Electrical Specification

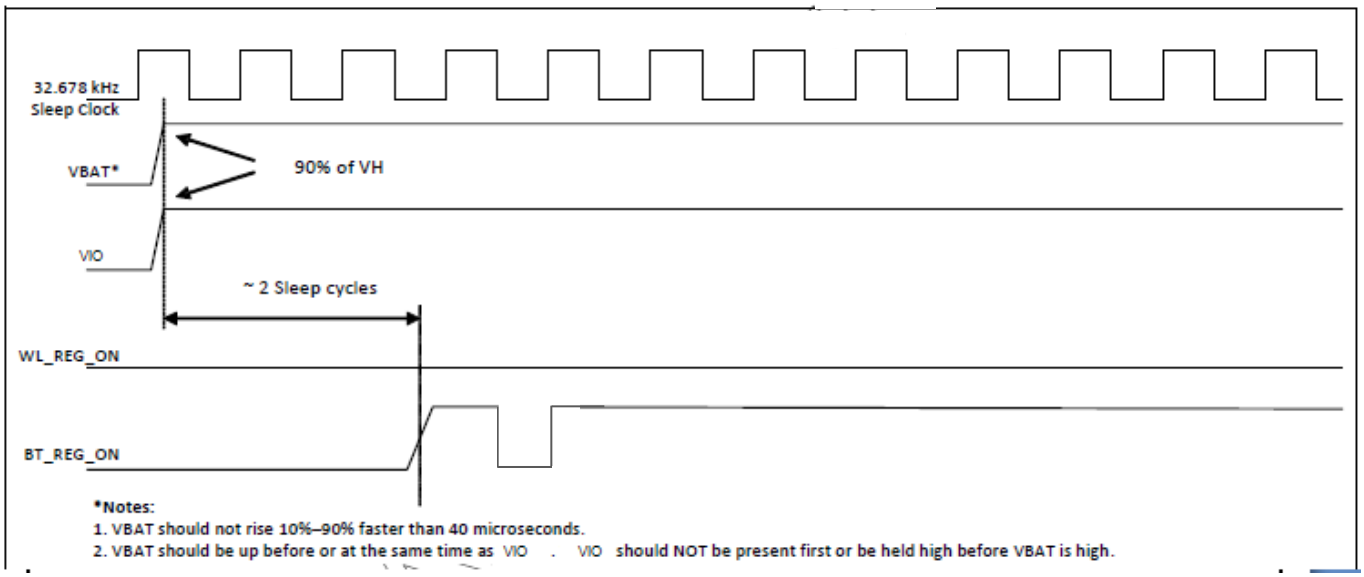
### 10.3 I/O characteristics

- Control signal timing diagrams

*WLAN =ON, Bluetooth = OFF



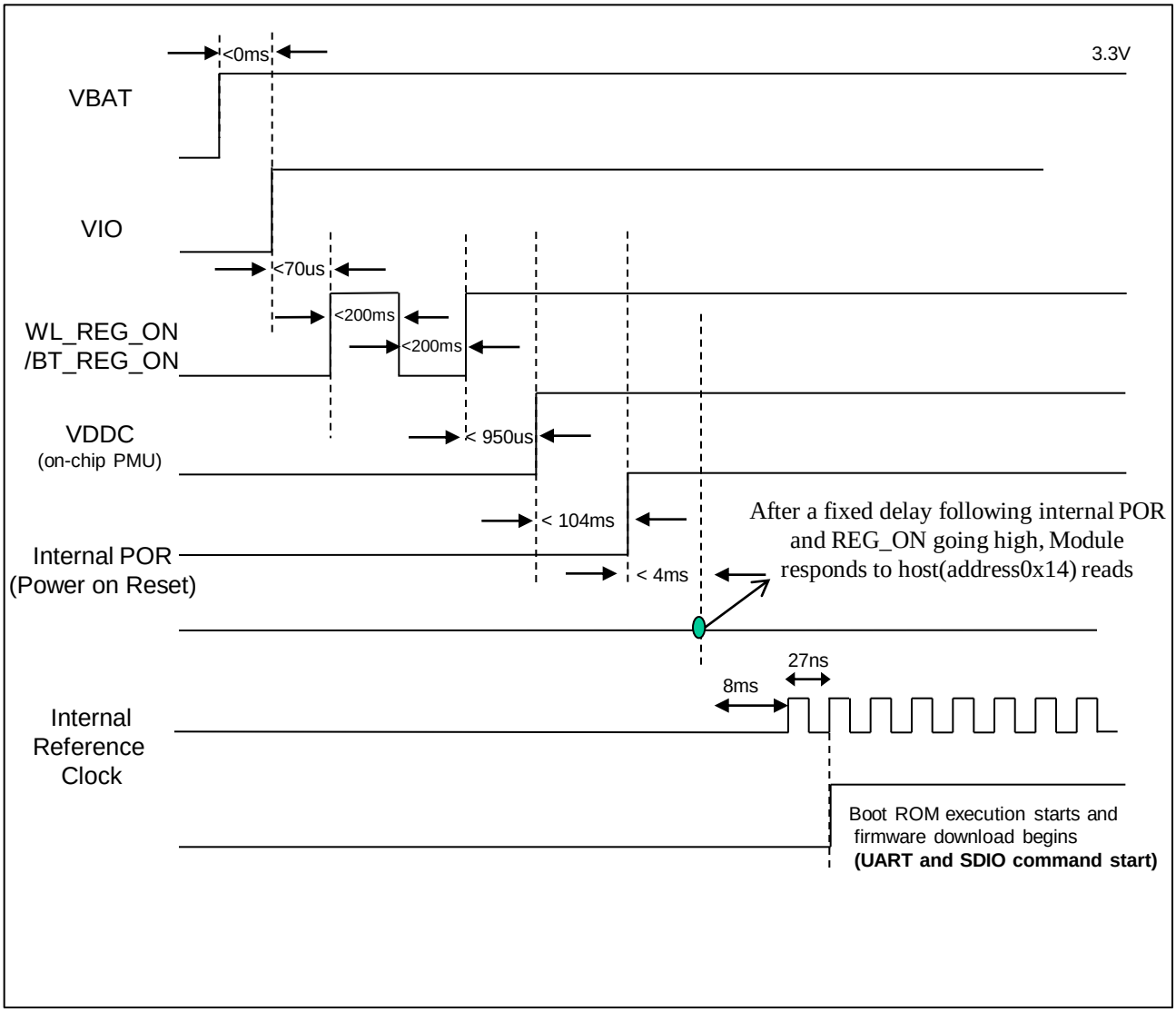

*WLAN =OFF, Bluetooth = ON



## 10. Electrical Specification

### 10.3 I/O characteristics

- Boot-Up Sequence and Reset timing

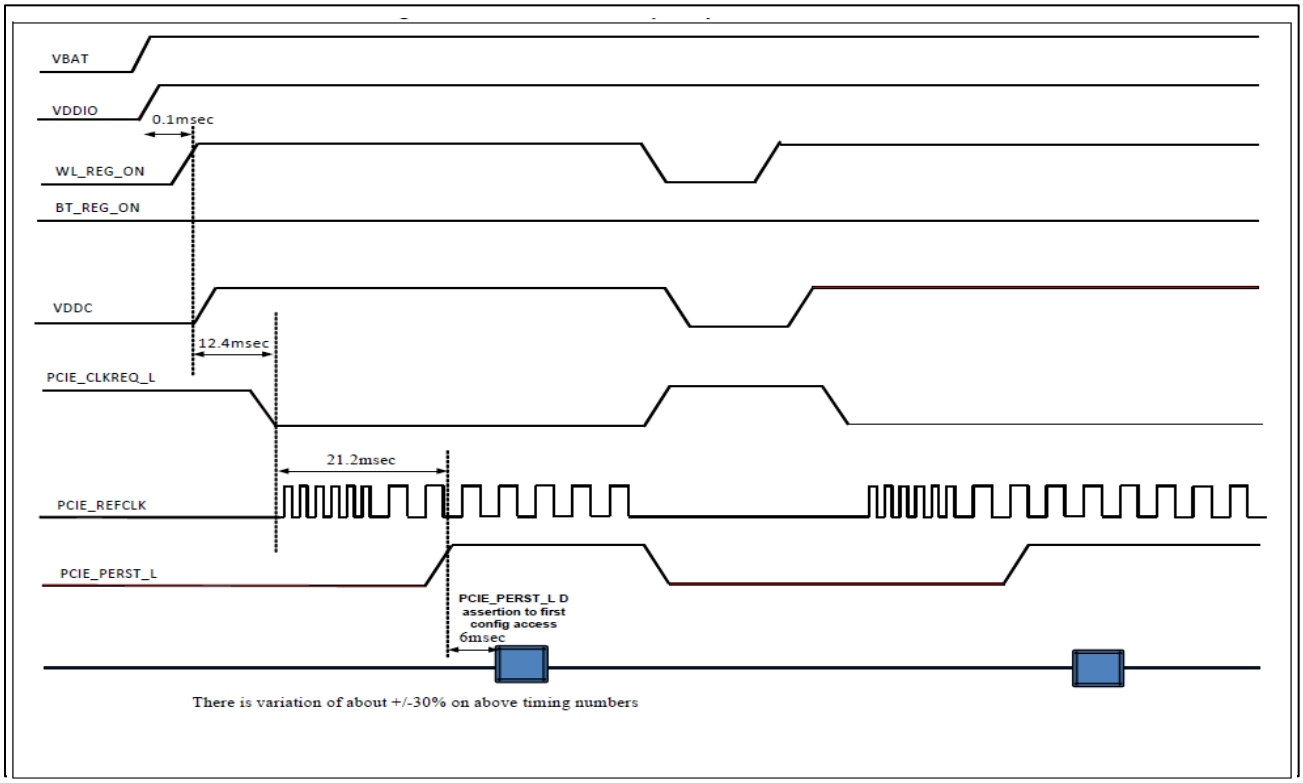


## 10. Electrical Specification

### 10.3 I/O characteristics

⚠r - PCIe Power-on Timing

*Timing Parameter WL_REG_ON)Perst# Deassertion – First Config Access)



## 10. Electrical Specification

### 10.3 I/O characteristics

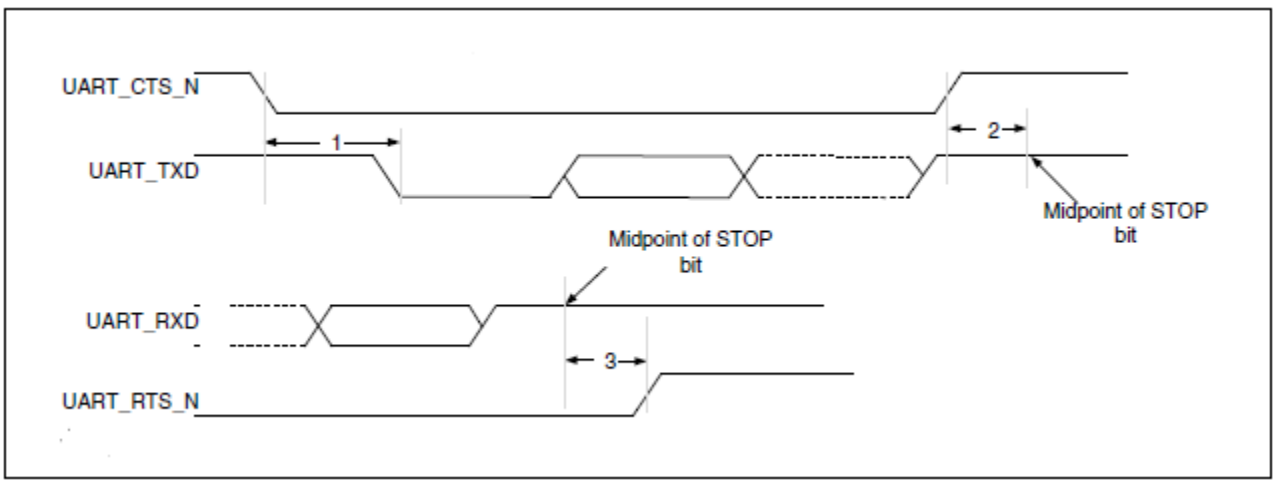
5) UART characteristics

-. UART physical interface is a standard, 4-wire interface(Rx, Tx, RTS, CTS) with adjustable baud rates from 9600 bps to 4Mbps. Normally the UART baud rate is set by a configuration record downloaded after reset or by automatic baud rate detection. LGIT Module supports HCI 3-wire transport(UART H5)

-. UART bus timing specifications

| Item | Min | Typ | Max | Unit |
|---|---|---|---|---|
| Delay time, UART_CTS_N low to UART_TXD valid | - | - | 1.5 | Bit periods |
| Setup time, UART_CTS_N high before midpoint of stop bit | - | - | 0.5 | Bit periods |
| Delay time, midpoint of stop bit to UART RTS_N high | - | - | 0.5 | Bit periods |
| Baud rates range(default rate : 115200bps) | 9600 | - | 4M | bps |

-. UART bus timing



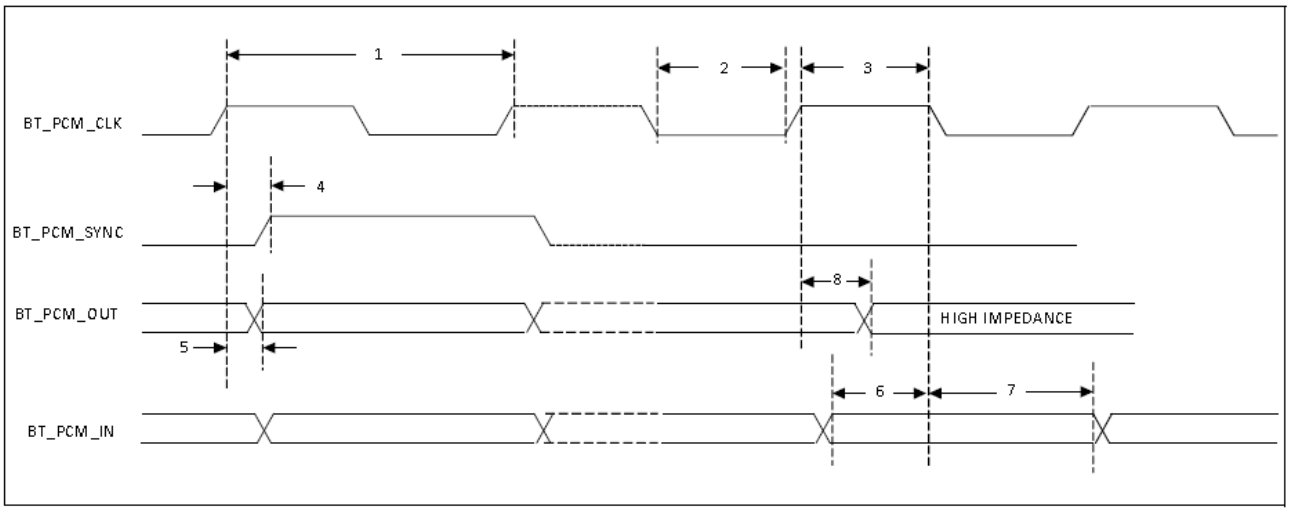
## 10. Electrical Specification

### 10.3 I/O characteristics

6) PCM characteristics

-. LGIT Module PCM interface can connect to linear PCM codec devices in master or slave mode. In master mode, the device generates the PCM_CLK and PCM_SYNC signals. In slave mode, these signals are provided by another master on the PCM interfaces as inputs to the devices

-. Short frame sync, master mode timing diagram




-. Short frame sync, master mode interface timing specifications

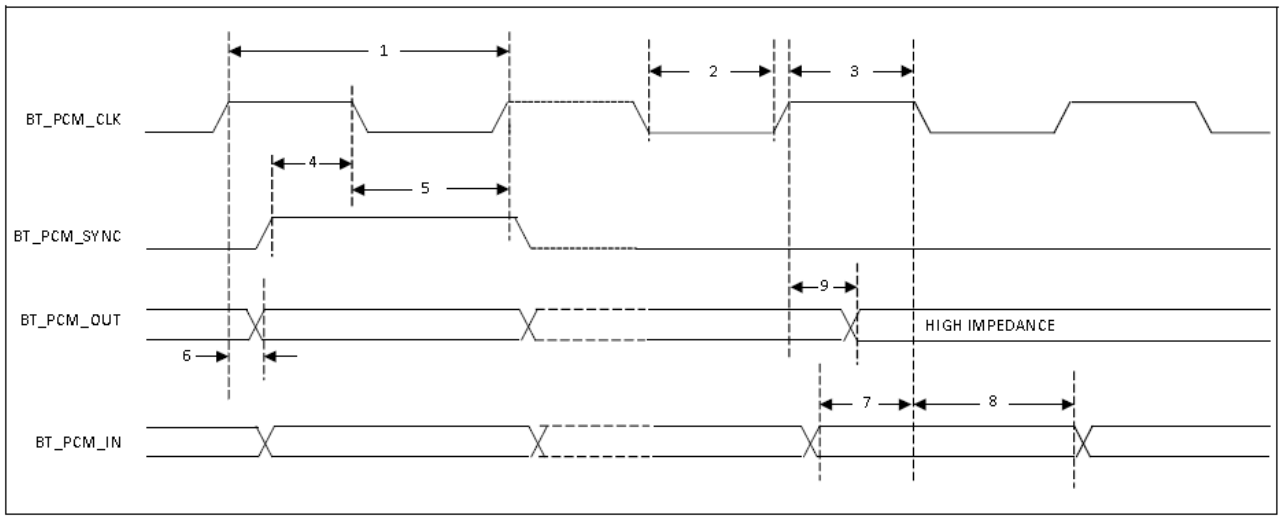
| Item | Min | Typ | Max | Unit |
|---|---|---|---|---|
| PCM bit clock frequency | - | - | 12 | MHz |
| PCM bit clock LOW | 41 | - | - | ns |
| PCM bit clock HIGH | 41 | - | - | ns |
| PCM_SYNC delay | 0 | - | 25 | ns |
| PCM_OUT delay | - | - | 25 | ns |
| PCM_IN setup | 8 | - | - | ns |
| PCM_IN hold | 8 | - | - | ns |
| Delay from rising edge of PCM_BCLK during last bit period to PCM_OUT becoming high impedance | - | - | 25 | ns |

## 10. Electrical Specification

### 10.3 I/O characteristics

6) PCM characteristics

-. Short frame sync, slave mode timing diagram




-. Short frame sync, slave mode interface timing specifications

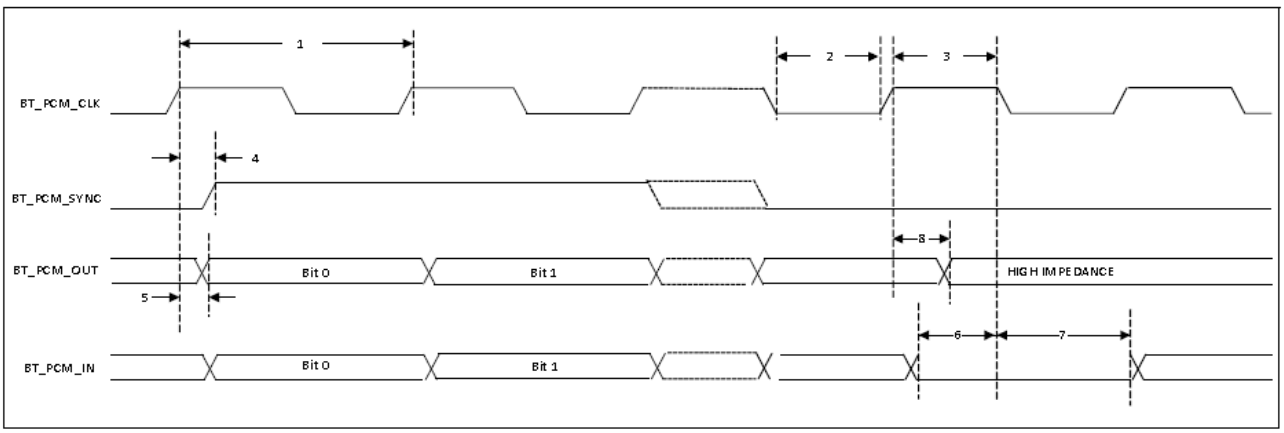
| Item | Min | Typ | Max | Unit |
|---|---|---|---|---|
| PCM bit clock frequency | - | - | 12 | MHz |
| PCM bit clock LOW | 41 | - | - | ns |
| PCM bit clock HIGH | 41 | - | - | ns |
| PCM_SYNC setup | 8 | - | - | ns |
| PCM_SYNC hold | 8 | - | - | ns |
| PCM_OUT delay | - | - | 25 | ns |
| PCM_IN setup | 8 | - | - | ns |
| PCM_IN hold | 8 | - | - | ns |
| Delay from rising edge of PCM_CLK during last bit period to PCM_OUT becoming high impedance | 0 | - | 25 | ns |

## 10. Electrical Specification

### 10.3 I/O characteristics

6) PCM characteristics

-. Long frame sync, master mode timing diagram




-. Long frame sync, master mode interface timing specifications

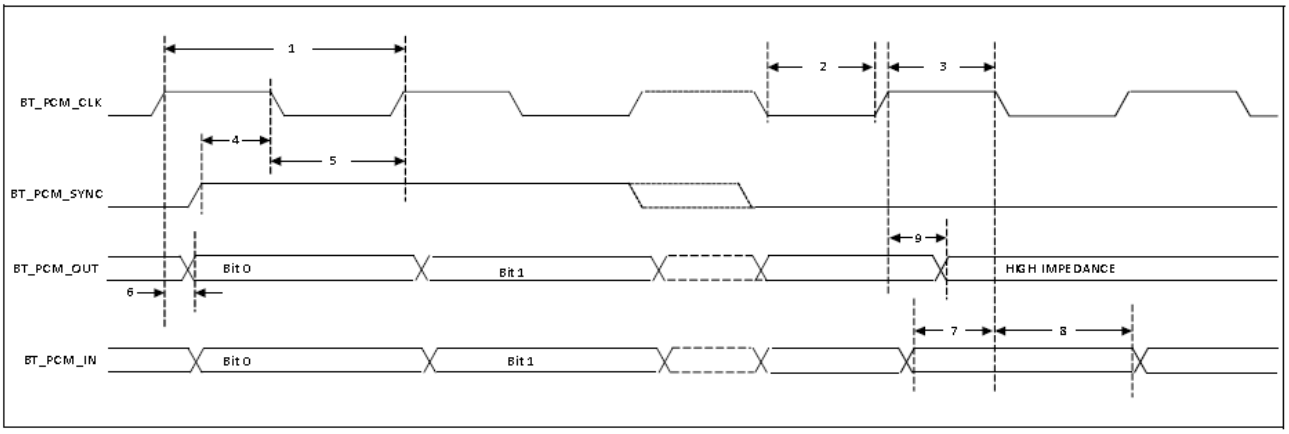
| Item | Min | Typ | Max | Unit |
|---|---|---|---|---|
| PCM bit clock frequency | - | - | 12 | MHz |
| PCM bit clock LOW | 41 | - | - | ns |
| PCM bit clock HIGH | 41 | - | - | ns |
| PCM_SYNC delay | 0 | - | 25 | ns |
| PCM_OUT delay | 0 | - | 25 | ns |
| PCM_IN setup | 8 | - | - | ns |
| PCM_IN hold | 8 | - | - | ns |
| Delay from rising edge of PCM_BCLK during last bit period to PCM_OUT becoming high impedance | 0 | - | 25 | ns |

## 10. Electrical Specification

### 10.3 I/O characteristics

6) PCM characteristics

-. Long frame sync, slave mode timing diagram




-. Long frame sync, slave mode interface timing specifications

| Item | Min | Typ | Max | Unit |
|---|---|---|---|---|
| PCM bit clock frequency | - | - | 12 | MHz |
| PCM bit clock LOW | 41 | - | - | ns |
| PCM bit clock HIGH | 41 | - | - | ns |
| PCM_SYNC setup | 8 | - | - | ns |
| PCM_SYNC hold | 8 | - | - | ns |
| PCM_OUT Delay | 0 | - | 25 | ns |
| PCM_IN setup | 8 | - | - | ns |
| PCM_IN hold | 8 | - | - | ns |
| Delay from falling edge of PCM_BCLK or PCM_SYNC during last bit period to PCM_OUT becoming high impedance | 0 | - | 25 | ns |

## 10. Electrical Specification

### 10.3 I/O characteristics

7) SDIO characteristics

-. RBHP-B213B support up to SDIO 3.0 specification

· DS : Default speed(DS) up to 25MHz(3.3V signaling)

· SDR12 : SDR up to 25MHz(1.8V signaling)

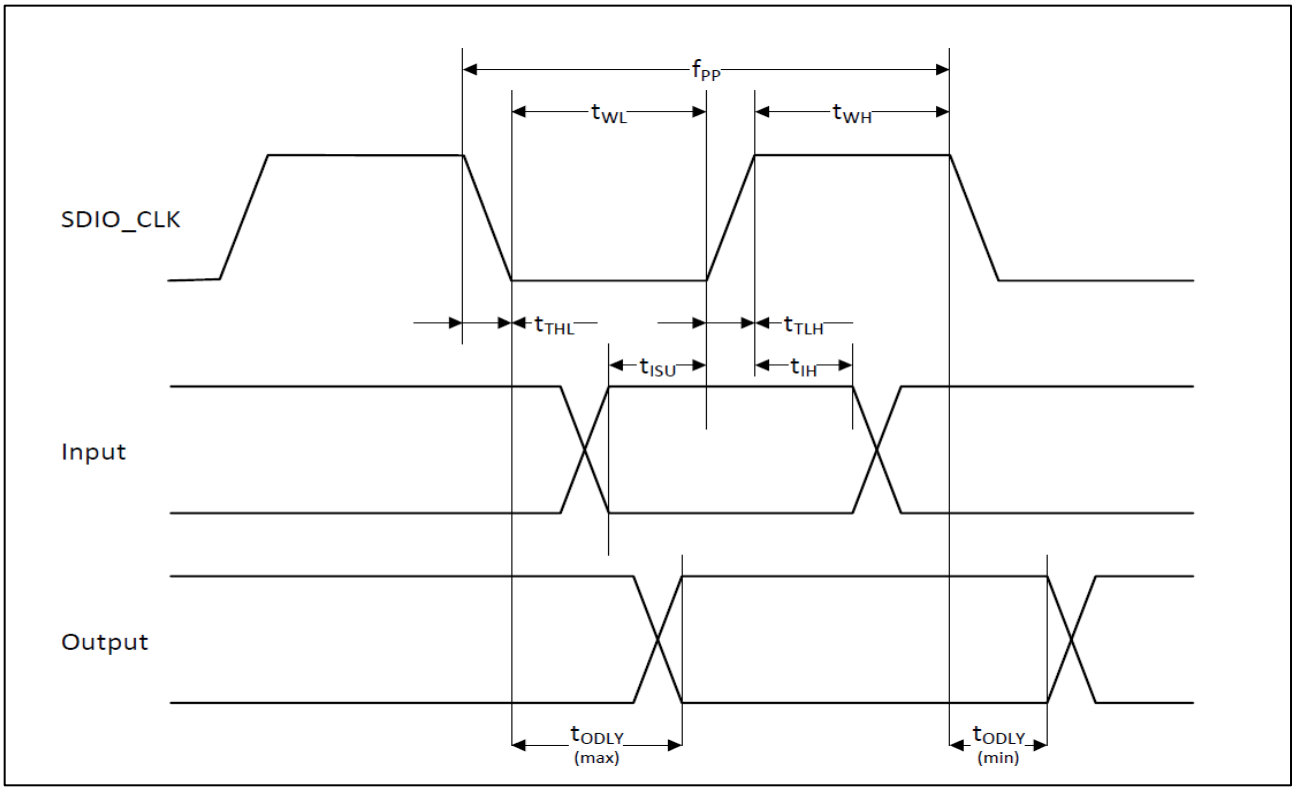
· SDR25 : SDR up to 50MHz(1.8V signaling)

· SDR50 : SDR up to 100MHz(1.8V signaling)

· SDR104 : SDR up to 208MHz(1.8V signaling)

· DDR50 : DDR up to 50MHz(1.8V signaling)

-. SDIO default mode timing(min.Vih = 0.7 X VIO, max.Vil = 0.2 x VIO)



## 10. Electrical Specification

### 10.3 I/O characteristics

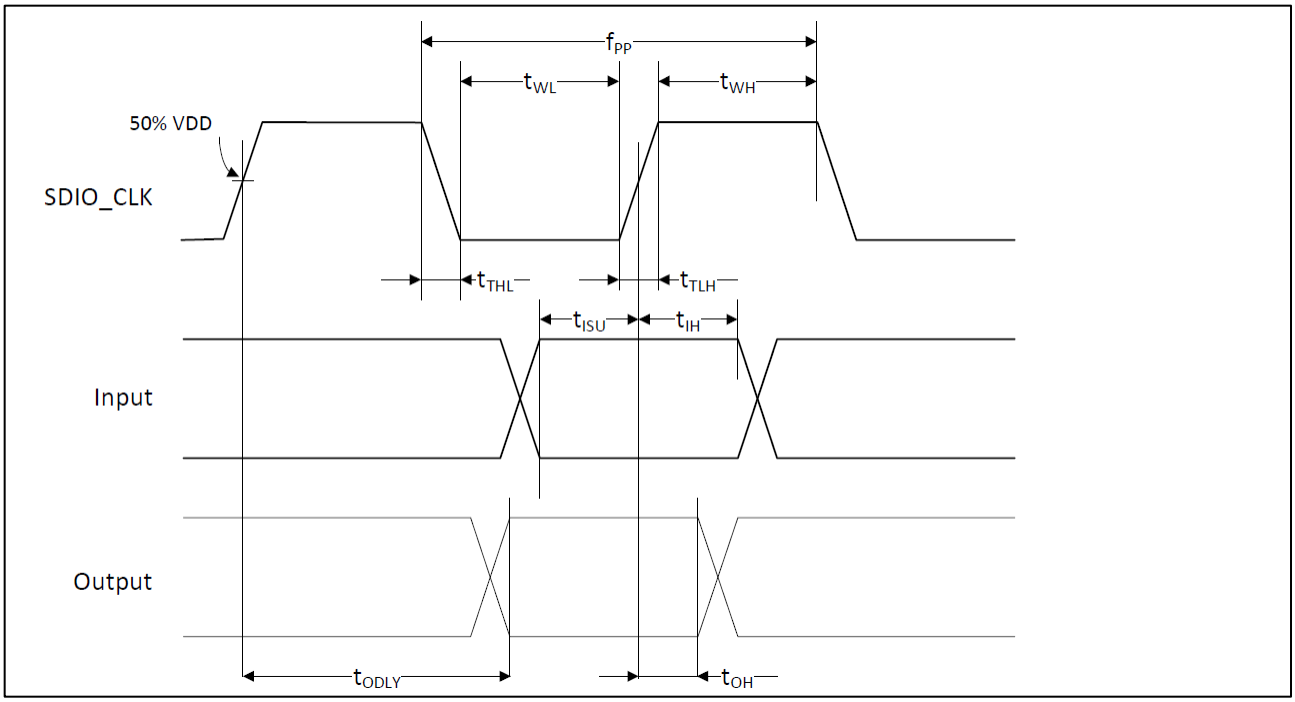
-. SDIO default mode bus timing parameters

| Item | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| SDIO CLK | | | | | |
| Freq.(data transfer mode) | fPP | 0 | - | 25 | MHz |
| Freq.(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 |
| Input : CMD, DAT(referenced to CLK) | | | | | |
| Input setup time | tISU | 5 | - | - | ns |
| Input hold time | tIH | 5 | - | - | ns |
| Output : CMD, DAT(referenced to CLK) | | | | | |
| Output delay time-data transfer mode | tODLY | 0 | - | 14 | ns |
| Output delay time-data identification mode | tODLY | 0 | - | 50 | ns |

## 10. Electrical Specification

### 10.3 I/O characteristics

-. SDIO high speed mode bus timing(min.Vih = 0.7 X VIO, max.Vil = 0.2 x VIO)




-. SDIO high speed mode bus timing parameters

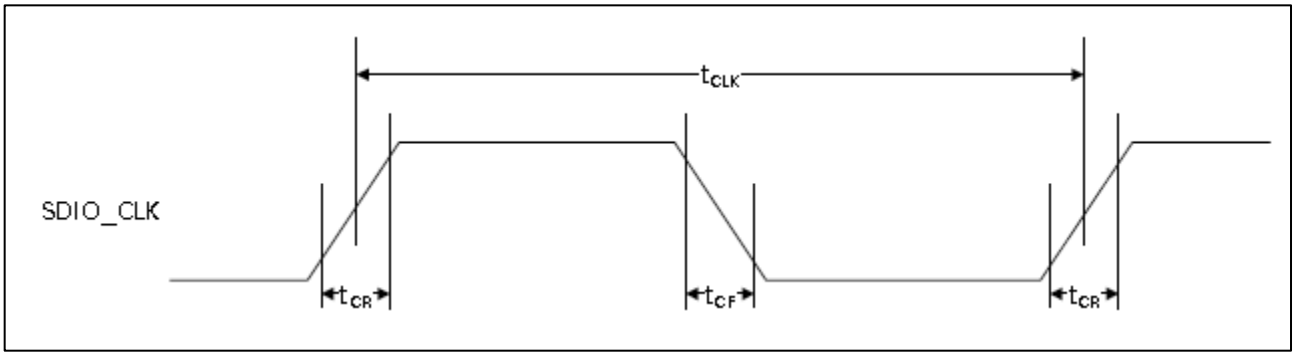
| Item | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| SDIO CLK | | | | | |
| Freq.(data transfer mode) | fPP | 0 | - | 50 | MHz |
| Freq.(identification mode) | fOD | 0 | - | 400 | KHz |
| Clock low time | tWL | 7 | - | - | ns |
| Clock high time | tWH | 7 | - | - | ns |
| Clock rise time | tTLH | - | - | 3 | ns |
| Clock low time | tTHL | - | - | 3 | ns |

## 10. Electrical Specification

### 10.3 I/O characteristics

| Item | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Input : CMD, DAT(referenced to CLK) | | | | | |
| Input setup time | tISU | 6 | - | - | ns |
| Input hold time | tIH | 2 | - | - | ns |
| Output : CMD, DAT(referenced to CLK) | | | | | |
| Output delay time-data transfer mode | tODLY | - | - | 14 | ns |
| Output delay time-data identification mode | tODLY | 2.5 | - | - | ns |
| Total system capacitance(each line) | CL | - | - | 40 | pF |

-. SDIO SDR mode clock timing

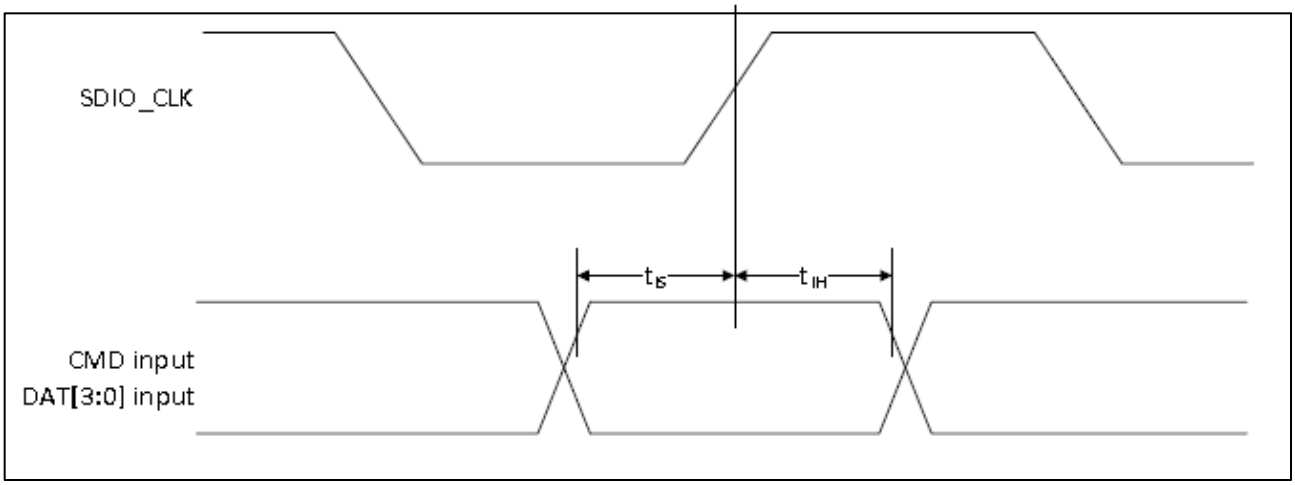



| Item | Symbol | Min | Max | Unit | Comments |
|---|---|---|---|---|---|
| - | $t_{CLK}$ | 40 | 50 | ns | SDR12 mode |
| | | 20 | 400 | ns | SDR25 mode |
| | | 10 | - | ns | SDR50 mode |
| | | 4.8 | - | ns | SDR104 mode |
| - | $t_{CR}$, $t_{CF}$ | - | 0.2 X $t_{CLK}$ | ns | $t_{CR}$, $t_{CF}$ < 2.0ns(max)@100MHz $C_{CARD}$ = 10pF $t_{CR}$, $t_{CF}$ < 0.96ns(max)@208MHz $C_{CARD}$ = 10pF |
| Clock duty | - | 30 | 70 | % | - |

## 10. Electrical Specification

### 10.3 I/O characteristics

-. SDIO SDR mode Device input timing

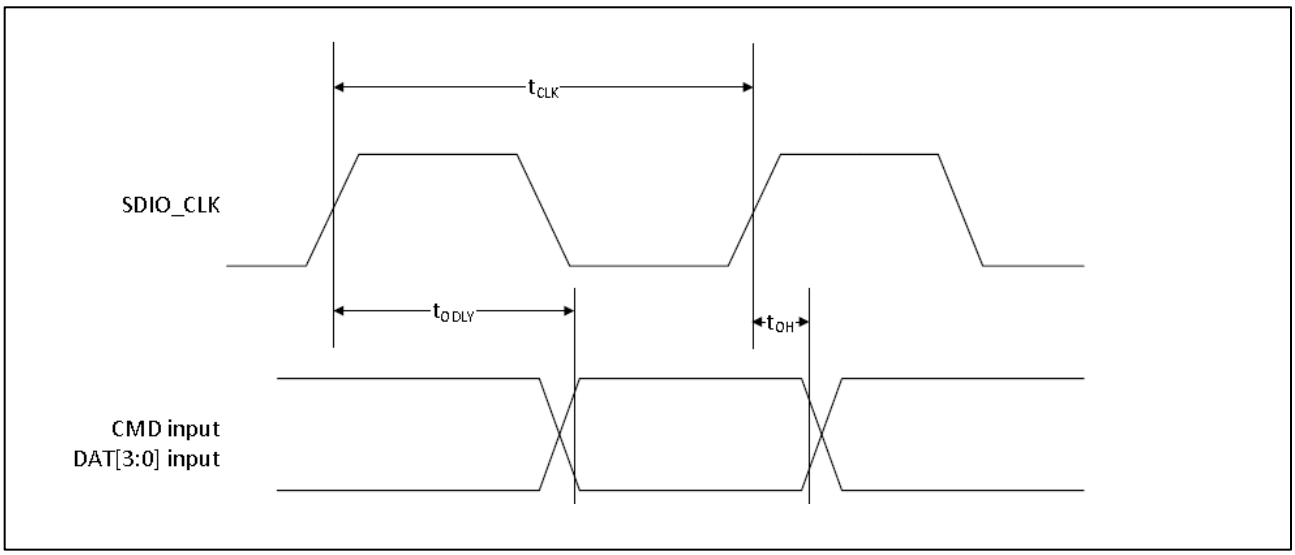



| Item | Symbol | Min | Max | Unit | Comments |
|---|---|---|---|---|---|
| SDR104 Mode | $t_{IS}$ | 1.4 | - | ns | $C_{CARD}$ = 10pF, VCT=0.975V |
| | $t_{IH}$ | 0.8 | - | ns | $C_{CARD}$ = 5pF, VCT=0.975V |
| SDR50 Mode | $t_{IS}$ | 3 | - | ns | $C_{CARD}$ = 10pF, VCT=0.975V |
| | $t_{IH}$ | 0.8 | - | ns | $C_{CARD}$ = 10pF, VCT=0.975V |

## 10. Electrical Specification

### 10.3 I/O characteristics

-. SDIO SDR mode Device output timing(SDR modes up to 100MHz)

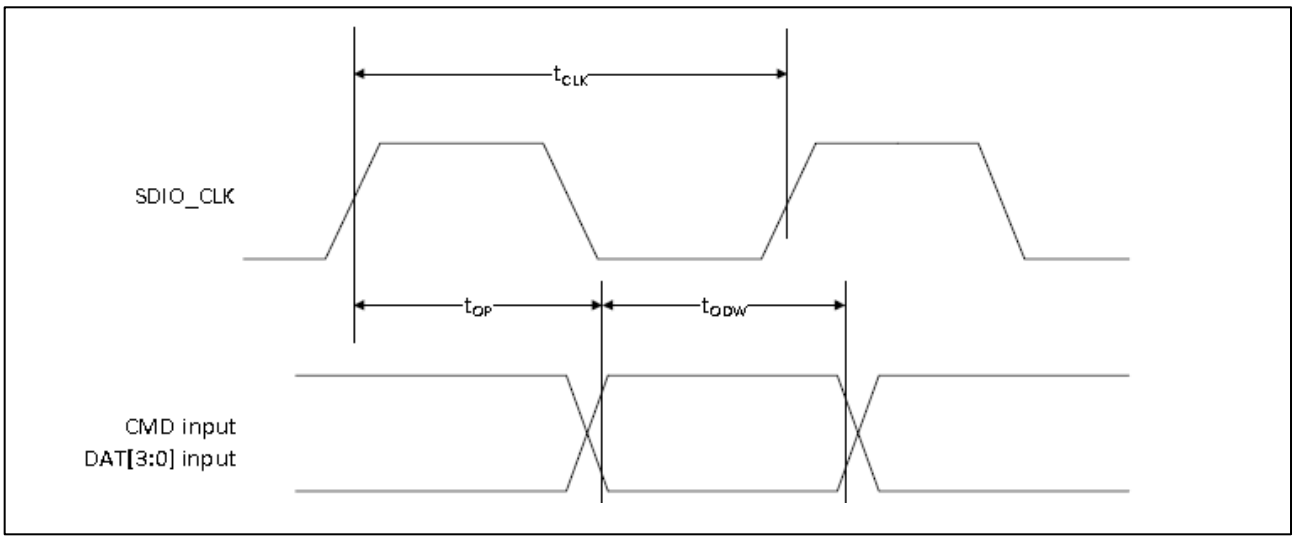



| Symbol | Min | Max | Unit | Comments |
|---|---|---|---|---|
| $t_{ODLY}$ | - | 7.5 | ns | $t_{CLK}$ > 10ns, CL = 30pF using driver type B for SDR50 |
| $t_{ODLY}$ | - | 14.0 | ns | $t_{CLK}$ > 20ns, $C_L$ = 40pF using for SDR12, SDR25 |
| $t_{OH}$ | 1.5 | - | ns | Hold time at the $t_{ODLY}$ (min) $C_L$ = 15pF |

## 10. Electrical Specification

### 10.3 I/O characteristics

-. SDIO SDR mode Device output timing(SDR modes 100MHz to 208MHz)

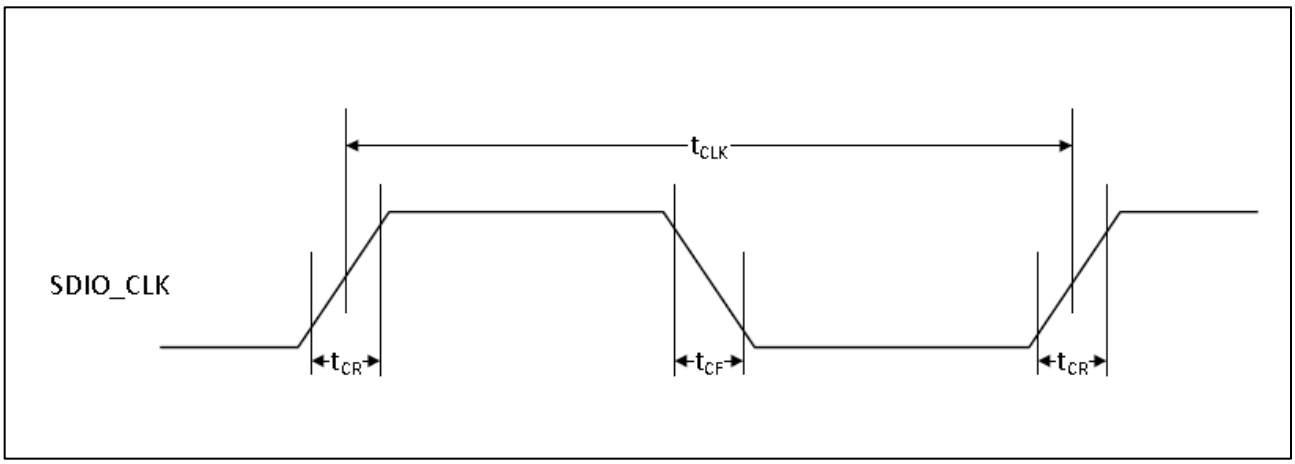



| Symbol | Min | Max | Unit | Comments |
|---|---|---|---|---|
| $t_{OP}$ | 0 | 2 | UI | Card output phase |
| $\Delta t_{OP}$ | -350 | +1550 | Ps | Delay variation due to temp. change after tuning |
| $\Delta t_{ODW}$ | 0.60 | - | UI | $\Delta t_{ODW}$ = 2.88ns @208MHz |

## 10. Electrical Specification

### 10.3 I/O characteristics

-. SDIO DDR50 mode Clock timing

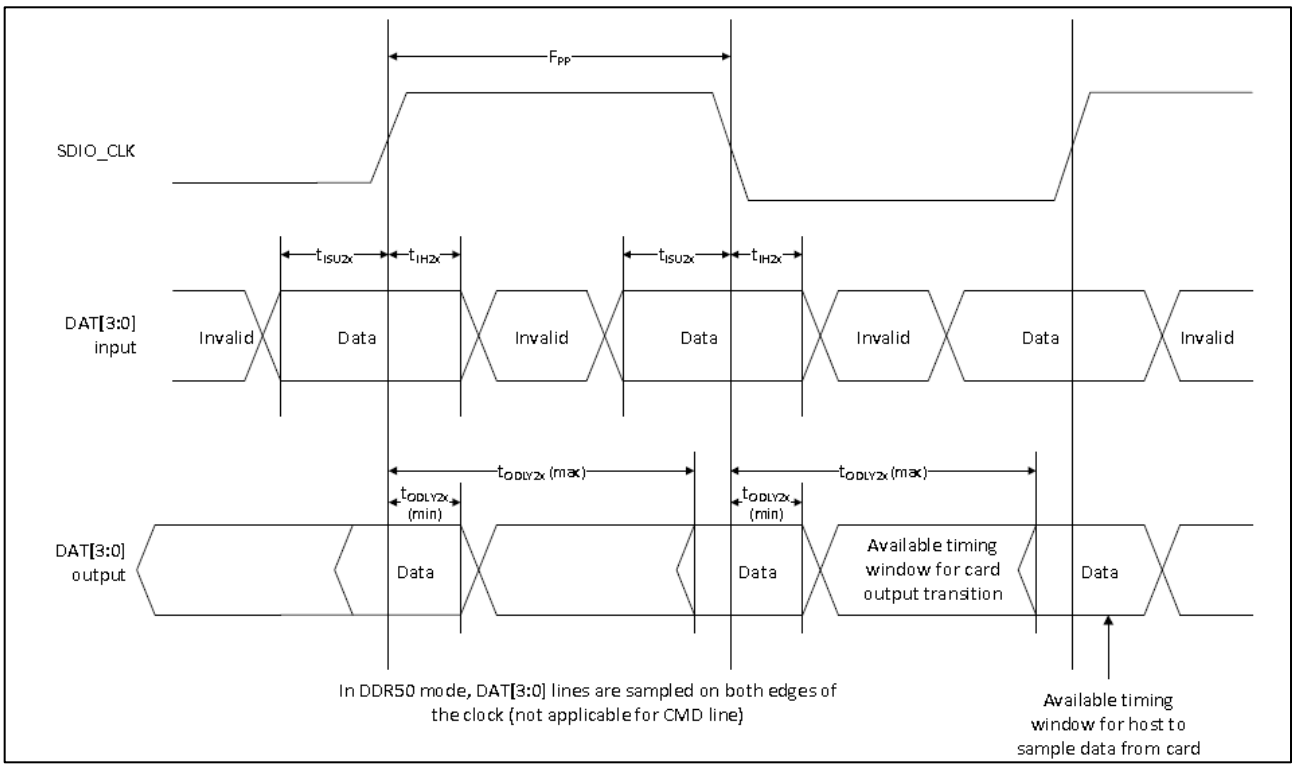



| Item | Symbol | Min | Max | Unit | Comments |
|---|---|---|---|---|---|
| - | $t_{CLK}$ | 20 | - | ns | DDR50 mode |
| - | $t_{CR}$, $t_{CK}$ | - | 0.2x $t_{CLK}$ | ns | $t_{CR}$, $t_{CF}$ < 4.0ns(max)@50MHz<br>$C_{CARD}$ = 10pF |
| Clock duty | - | 45 | 55 | % | - |

## 10. Electrical Specification

### 10.3 I/O characteristics

-. SDIO DDR50 mode Data timing




| | Item | Symbol | Min | Max | Unit | Comments |
|---|---|---|---|---|---|---|
| Input CMD | Input Setup time | $t_{ISU}$ | 6 | - | ns | $C_{CARD}$ < 10pF(1CARD) |
| | Input Hold time | $t_{IH}$ | 0.8 | - | ns | $C_{CARD}$ < 10pF(1CARD) |
| Output CMD | Output delay time | $t_{ODLY}$ | - | 13.7 | ns | $C_{CARD}$ < 30pF(1CARD) |
| | Output hold time | $t_{OH}$ | 1.5 | - | Ns | $C_{CARD}$ < 15pF(1CARD) |
| Input DAT | Input Setup time | $t_{ISU2X}$ | 3 | - | ns | $C_{CARD}$ < 10pF(1CARD) |
| | Input Hold time | $t_{IH2X}$ | 0.8 | - | ns | $C_{CARD}$ < 10pF(1CARD) |
| Output DAT | Output delay time | $t_{ODLY2X}$ | | 7.5 | ns | $C_{CARD}$ < 25pF(1CARD) |
| | Output holdtime | $t_{ODLY2X}$ | 1.5 | - | Ns | $C_{CARD}$ < 15pF(1CARD) |

## 10. Electrical Specification

### 10.3 I/O characteristics

8) PCI Express characteristics

⚠ -. PCI Express Reference CLK

| Parameters | Symbol | Comments | Min. | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Baud rate | BPS | - | - | 2.5 | - | Gbaud |
| Reference clock amplitude | Vref | LVPECL, AC coupled | 1.0 | - | - | V |

-. PCI Express Receiver

| Parameters | Symbol | Comments | Min. | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Differential termination | ZRX-DIFF-DC | Differential termination | 80 | 100 | 120 | Ω |
| DC impedance | ZRX-DC | DC common-mode impedance | 40 | 50 | 60 | Ω |
| Powered down termination(POS) | ZRX-HIGH-IMP-DC-POS | Power-down or RESET high Impedance | 100k | - | - | Ω |
| Powered down termination(NEG) | ZRX-HIGH-IMP-DC-NEG | Power-down or RESET high Impedance | 1k | - | - | Ω |
| Input voltage | VRX-DIFFp-p | AC coupled, differential(p-p) | 175 | - | - | mV |
| Jitter tolerance | TRX-EYE | Minimum receiver eye width | 0.4 | - | - | UI |
| Differential return loss | RLRX-DIFF | Differential return loss | 10.0 | - | - | dB |
| Common-mode return loss | RLRX-CM | Common-mode return loss | 6 | - | - | dB |
| Unexpected electrical idle enter detect threshold integration time | RX-IDEL-DET-DIFFENTERTIME | An unexpected electrical idle must be recognized no longer than this time to signal an unexpected idle condition. | - | - | 10.0 | ms |
| Signal detect threshold | VRX-IDLE-DET-DIFFpp | Electrical idle detect threshold | 65.0 | - | 175 | mV |

## 10. Electrical Specification

### 10.3 I/O characteristics

8) PCI Express characteristics

-. PCI Express Transmitter

| Parameters | Symbol | Comments | Min. | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Output voltage | VTX-DIFFp-p | Differential p-p, programmable in 16 steps | 0.8 | - | 1200 | mV |
| Output voltage rise time | VTX-RISE | 20% to 80% | 0.125 (2.5 GT/s) 0.15 (5 GT/s) | - | - | UI |
| Output voltage fall time | VTX-FALL | 80% to 20% | 0.125 (2.5 GT/s) 0.15 (5 GT/s) | - | - | UI |
| RX detection voltage swing | VTX-RCV-DETECT | The amount of voltage change allowed during receiver detection. | - | - | 600 | mV |
| TX AC peak common-mode voltage(5 GT/s) | VTX-CM-AC-PP | TX AC common mode voltage (5 GT/s) | - | - | 100 | mV |
| TX AC peak commonmode voltage(2.5 GT/s) | VTX-CM-AC-P | TX AC common mode voltage (2.5 GT/s) | - | - | 20.0 | mV |
| Absolute delta of DC common-model voltage during L0 and electrical idle | VTX-CM-DC-ACTIVE-IDLE-DELTA | Absolute delta of DC common-model voltage during L0 and electrical idle. | 0 | - | 100 | mV |
| Absolute delta of DC common-model voltage between D+ and D- | VTX-CM-DC-LINE-DELTA | DC offset between D+ and D- | 0 | - | 25.0 | mV |
| Electrical idle differential peak output voltage | VTX-IDLE-DIFF-AC-p | Peak-to-peak voltage | 0 | - | 20.0 | mV |

## 10. Electrical Specification

### 10.3 I/O characteristics

8) PCI Express characteristics

| Parameters | Symbol | Comments | Min. | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| TX short circuit current | ITX-SHORT | Current limit when TX output is shorted to ground. | - | - | 90.0 | mA |
| DC differential TX termination | ZTX-DIFF-DC | Low impedance defined during signaling (parameter is captured for 5.0 GHz by RLTX-DIFF) | 80.0 | - | 120 | Ω |
| Differential return loss | RLTX-DIFF | Differential return loss | 10 (min) for 0.05: 1.25 GHz | - | - | dB |
| Common-mode return loss | RLTX-CM | Common-mode return loss | 6.0 | - | - | dB |
| TX eye width | TTX-EYE | Minimum TX eye width | 0.75 | - | - | UI |

## 10. Electrical Specification

### 10.4 Operating Conditions

1) **Recommended operation conditions**

| Parameter | Min | Max | Unit |
|---|---|---|---|
| Operating Temperature Range | -40 | +85 | ℃ |
| Supply Voltage : VBATT (3.3V) | 3.0[1)] | 3.6 | V |
| Supply Voltage : VIO (1.8V) | 1.62 | 1.98 | V |

2) **Current consumption**

| Parameter | Average | Unit |
|---|---|---|
| Stand-by (BT & WLAN) | 10 | mA |
| WLAN Continuous Rx | 180 | mA |
| WLAN Continuous Tx[2)] | 420 | mA |
| Bluetooth Connection | 20 | mA |

3) **ESD Precautions**

RBHP-B213B is classified as a JESD22-A114(HBM) class 1C(1kV) product. Apply ESD static handling precautions during manufacturing.

4) **External 32.768KHz low-power oscillator(LPO)**

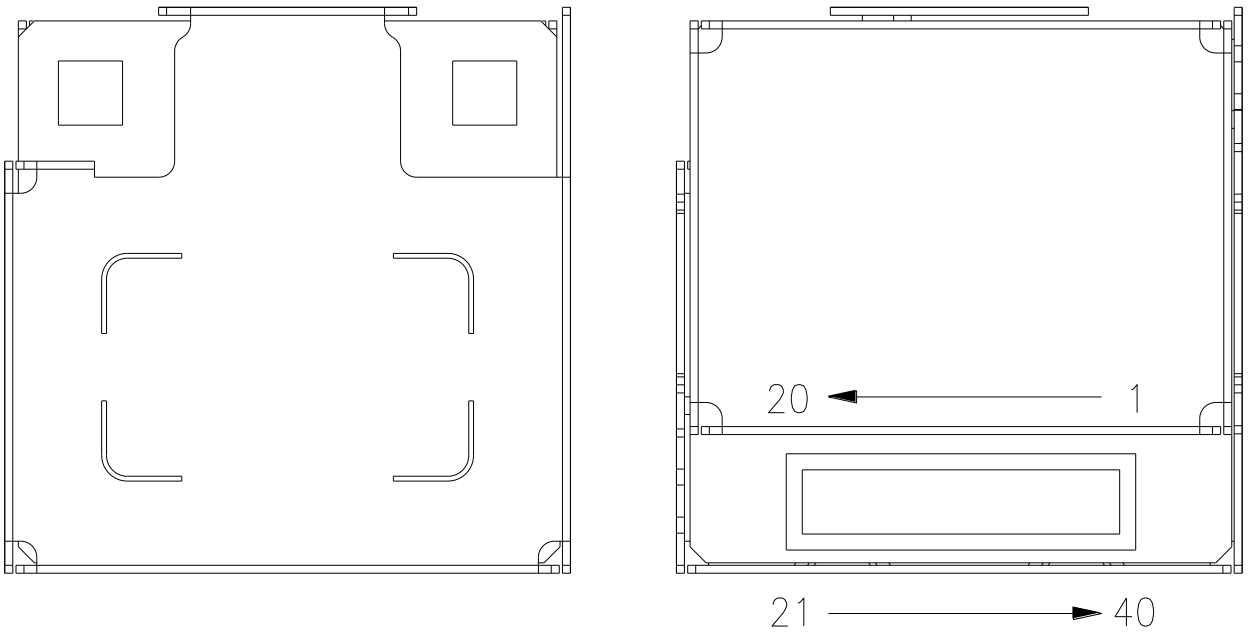
External 32.768KHz precision oscillator is required.

| Parameter | LPO clock | Unit |
|---|---|---|
| Nominal input frequency | 32.768 | KHz |
| Frequency accuracy | ±200 | ppm |
| Single input amplitude | 200 ~ 1800 | mV, p-p |
| Signal type | Square-wave or sine-wave | |

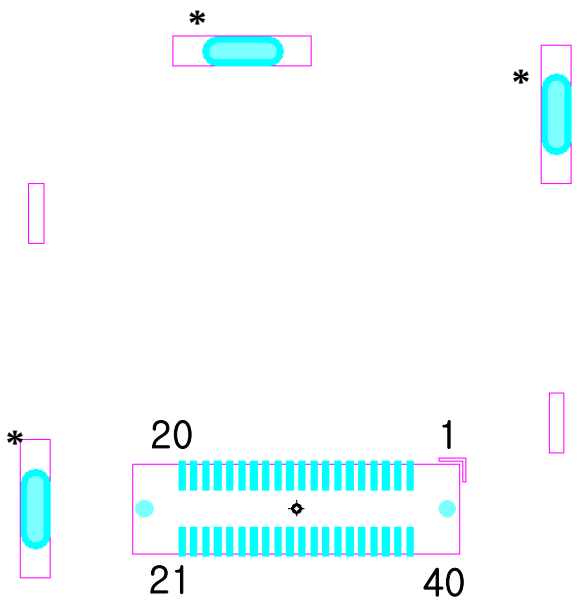
[1)] The BCM88359 is functional across this range of voltages.
Optimal RF performance specified in the RBHP-B213B approval sheet, however , is guaranteed only for min. 3.2V including VBAT ripple

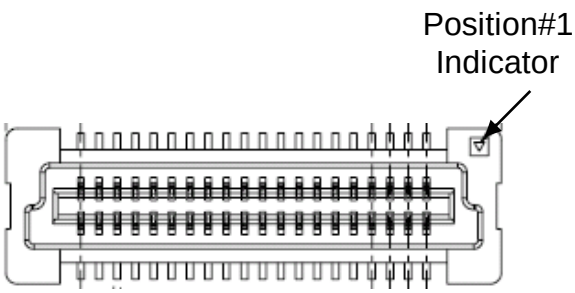
[2)] MIMO condition

## 11. Pin Configuration




**< Opposite (Host) Pin Map (Top View) >**

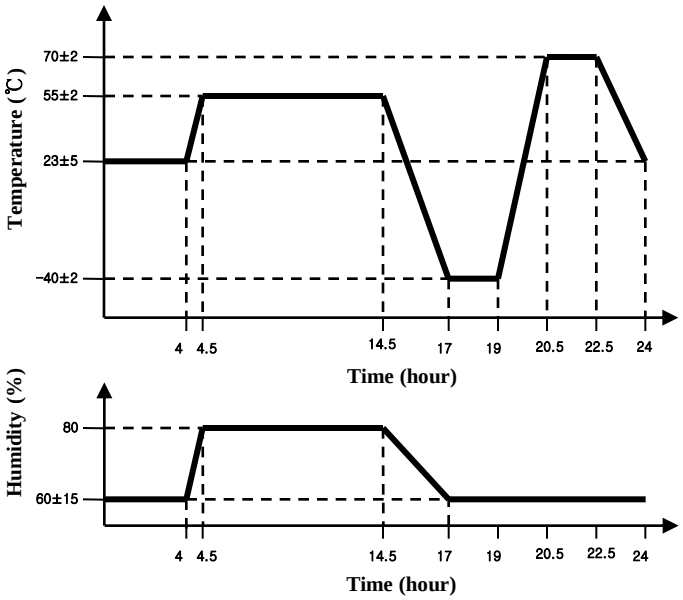



**<FCI 61082-041 >**

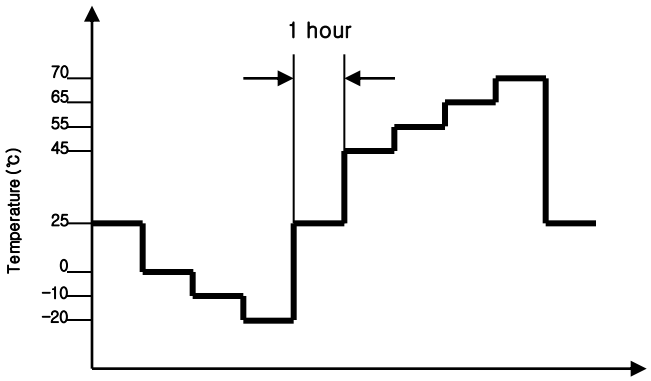
## 12. Reliability Test Conditions

### 12.1 Items related with Non-Solderability(ES96100-02)

| NO | ITEM | Condition | Characteristics |
|---|---|---|---|
| 9 | Against flux | Initial value measured at standard test condition.<br>**Test Conditions**<br>-Soak 5 seconds in a I.P.A and let waiting condition for 35 seconds. After then test. | - No electrical problem |
| 10 | Temperature and Humidity Cycling | Initial value measured at standard test condition.<br>**Test Conditions:** 3 cycle condition.<br>  <br>In standard test condition, take measurements 2hr after. | - No electrical problem |
| 11 | Dew Condensation test | Initial value measured at standard test condition.<br>**Test Conditions:** 3 cycle condition.<br>-30℃ (1 Hr)<br>-30℃ → 25℃, 90%RH (within 1 min)<br>25℃, 90%RH (1 Hr) - On : 15 min / Off : 15 min<br>In standard test condition, take measurements 2hr after. | - No electrical problem |
| 12 | High humidity and Temp. load test | IInitial value measured at standard test condition.<br>**Test Conditions:** 60℃, 80%, 48hr<br>In standard test condition, take measurements within 3hr. | - No electrical problem |
| 13 | Dust | IInitial value measured at standard test condition.<br>**Test Conditions:** JIS Z 8901, 5kg<br>In standard test condition, take measurements within 3hr. | - No electrical problem |

## 12. Reliability Test Conditions

### 12.1 Items related with Non-Solderability(ES96100-02)

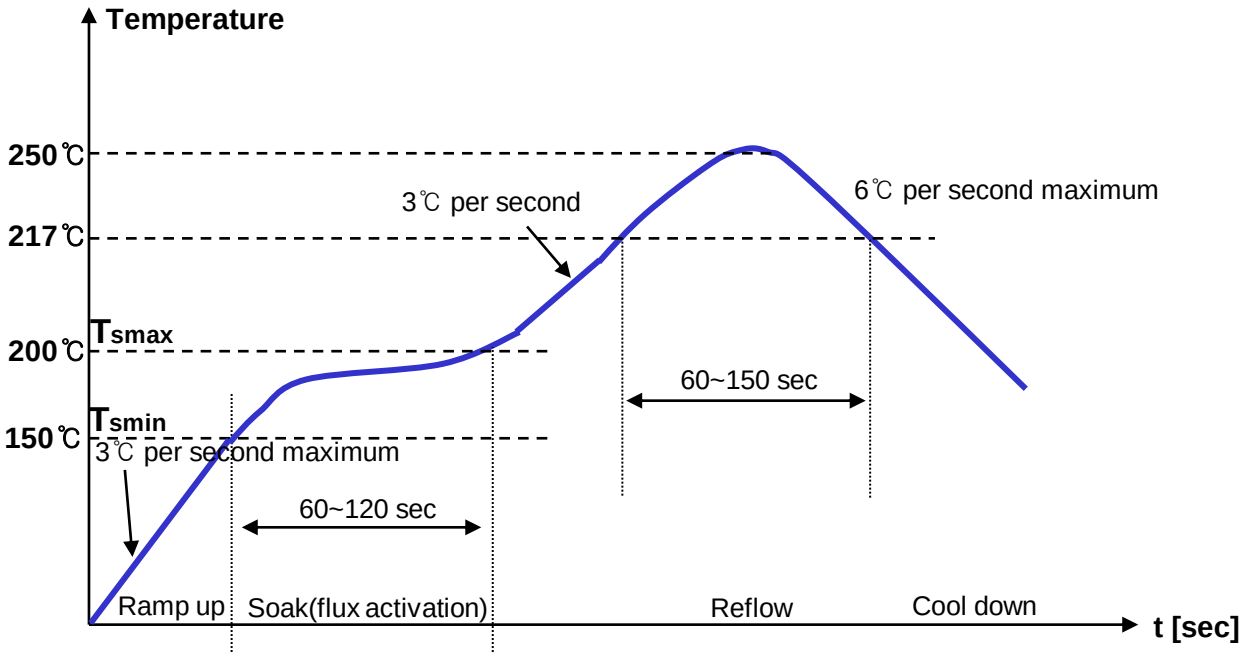
| NO | ITEM | Condition | Characteristics |
|---|---|---|---|
| 14 | Temperature Drift Test | Initial value measured at standard test condition.<br>**Test Conditions:**<br>  <br><br>Take measurements sustaining each temperature. | - No electrical problem |
| 15 | Dust | IInitial value measured at standard test condition.<br>**Test Conditions:** JIS Z 8901, 5kg<br>In standard test condition, take measurements within 3hr. | - No electrical problem |
| 16 | Complex Environment | IInitial value measured at standard test condition.<br>**Test Conditions:** -20℃~60℃, 10~50Hz, 1G<br>In standard test condition, take measurements within 3hr. | - No electrical problem |
| 17 | Operation Durability | IInitial value measured at standard test condition.<br>**Test Conditions:** 25±5℃ 60±20%, 1500Hrs<br>In standard test condition, take measurements within 3hr. | - No electrical problem |
| 18 | ESD | IInitial value measured at standard test condition.<br>**Test Conditions:** ±1KV 5time 150pF/330Ω<br>In standard test condition, take measurements within 3hr. | - No electrical problem |

## 12. Reliability Test Conditions

### 12.2 Items related with Solderability(ES90000-04)

| NO | ITEM | Condition | Characteristics |
|---|---|---|---|
| 1 | High Temperature and Humidity Load Test | Initial value measured at standard test condition.<br>**Test Conditions**: 85±3℃, 85±5%RH, 1000hr<br>In standard test condition, take measurements within 3hr. | - Whisker, No electrical problem |
| 2 | Thermal Shock | Initial value measured at standard test condition.<br>**Test Conditions:**<br>-40℃ ( 10 min)<br>-40℃ → 85℃, (within 10 min)<br>85℃ ( 10 min)<br>85℃ → -40℃, (within 10 min)<br>- Test cycle : 1000 cycles<br>- Test Times : 667 Hr<br>In standard test condition, take measurements within 3Hr. | - No Whisker, Bond strength, section inspection, electrical problem |
| 3 | Power and Temperature Cycling | Initial value measured at standard test condition.<br>**Test Conditions:** 100 cycle condition<br>- Test Times : 100 Hr<br>**Supply Voltage Condition:** standard ± 5%<br>**Power Condition:**<br>-35℃ ( 10 min)<br>-35℃ → 75℃, (Temp. variation velocity : over 6℃/min)<br>75℃ ( 10 min)<br>75℃ → -35℃, (Temp. variation velocity : over 6℃/min)<br>- On: 300 sec , Off: 300 sec<br>In standard test condition, take measurements within 3Hr | |
| 4 | Random Vibration test With operation | Initial value measured at standard test condition.<br>**Test Conditions:**<br>- Frequency : 10 ~ 1000Hz<br>- Power spectrum density : 0.0296 ~ 9.63 $(m/s^3)^2/Hz$<br>- Direction : X/Y/Z, 8hr/Axis<br>In standard test condition, take measurements 2hr after. | |

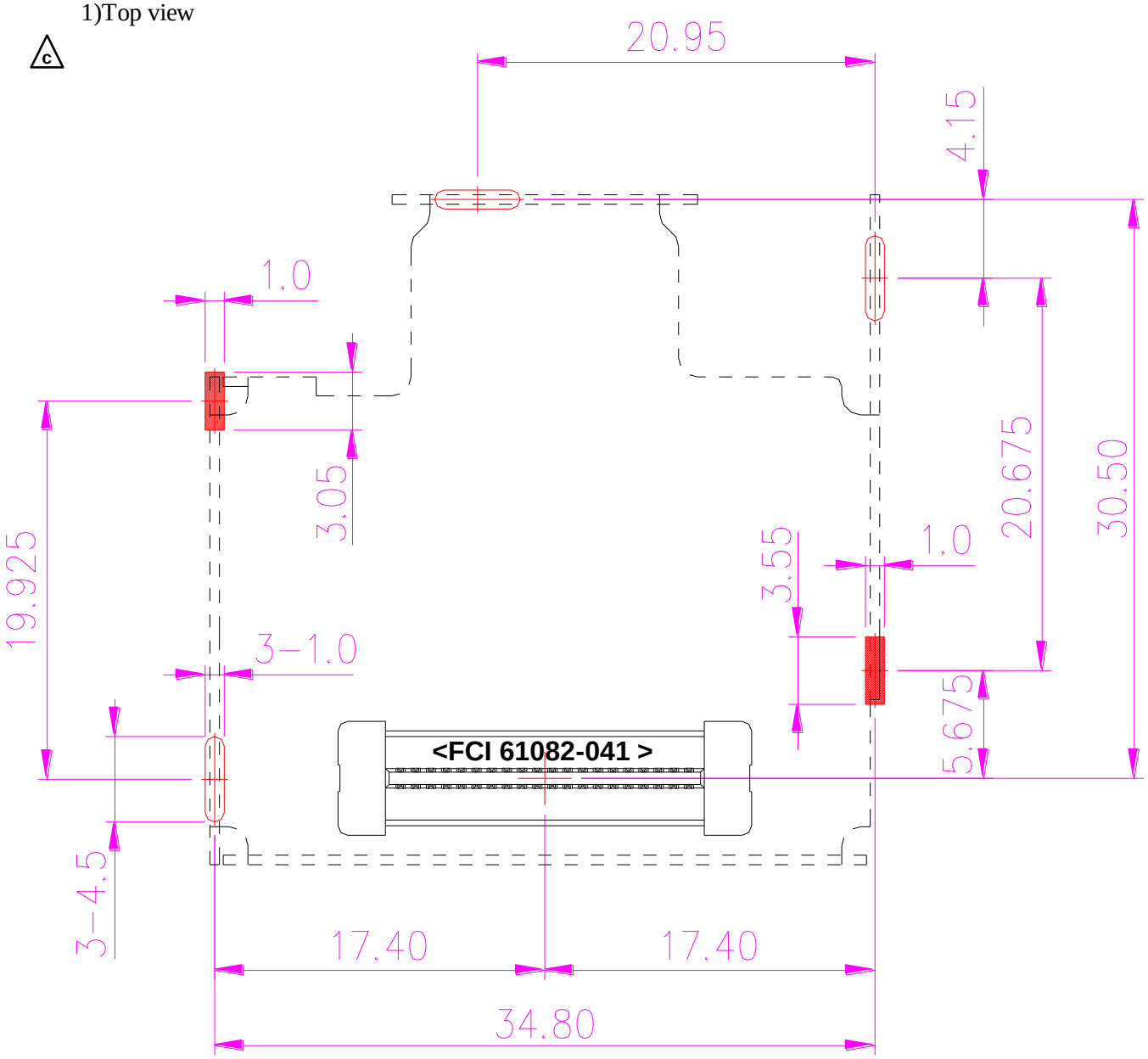
## 15. Reflow Profile




| Profile Feature | Pb-free Assembly |
|---|---|
| Initial ramp-up rate | 3℃ per second maximum |
| Preheat<br>Temperature minimum(Tsmin)<br>Temperature maximum(Tsmax)<br>Time(minimum to maximum) | <br>150℃<br>200℃<br>60-120s |
| Ramp-up rate Tsmax to $T_L$ | 3℃ per second maximum |
| Liquidus Temperature($T_L$) | 217℃ |
| Time above $T_L$ | 60-150s |
| Peak temperature | 250℃ maximum |
| Time within 5℃ of actual peak | 10s |
| Ramp-down rate | 6℃ per second maximum |

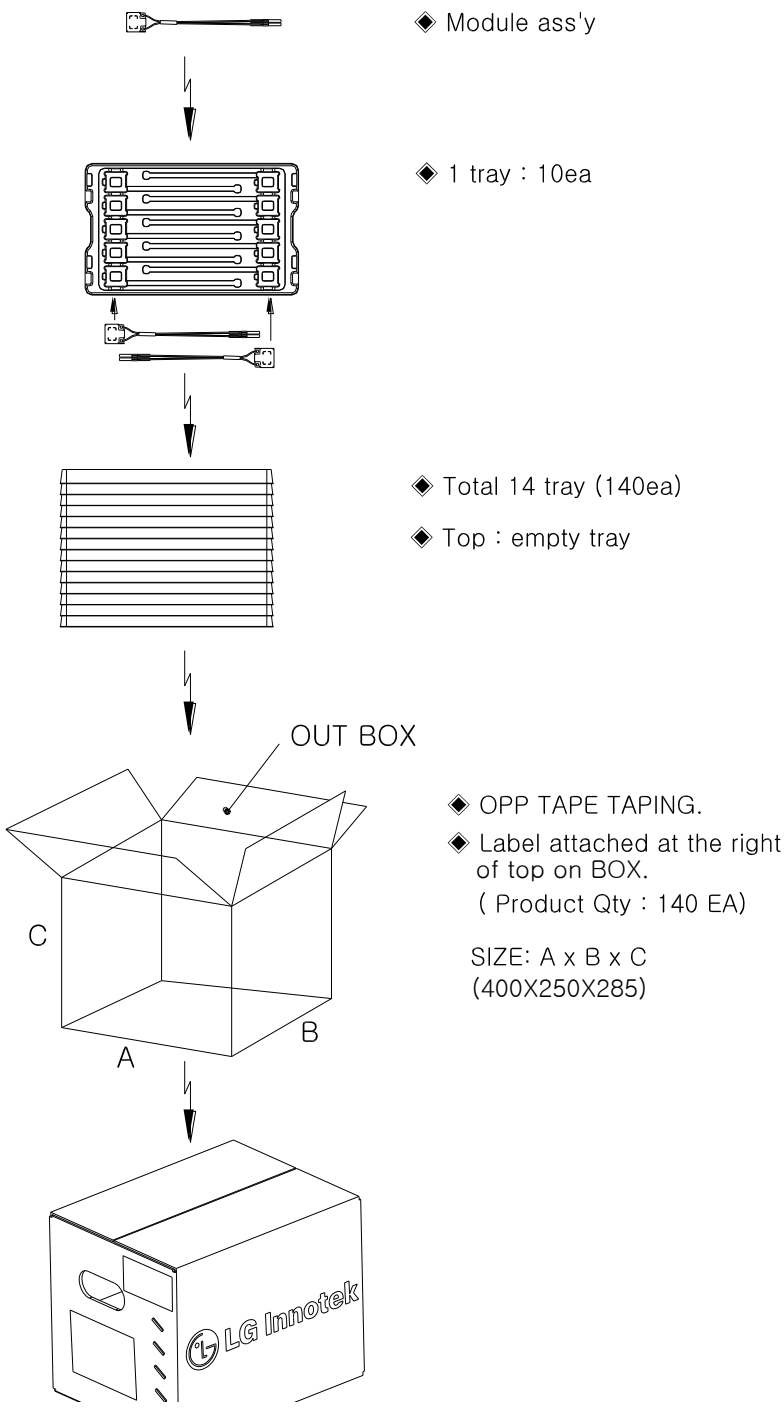
## 16. Recommended Land Pattern

1)Top view




<Unit : mm>

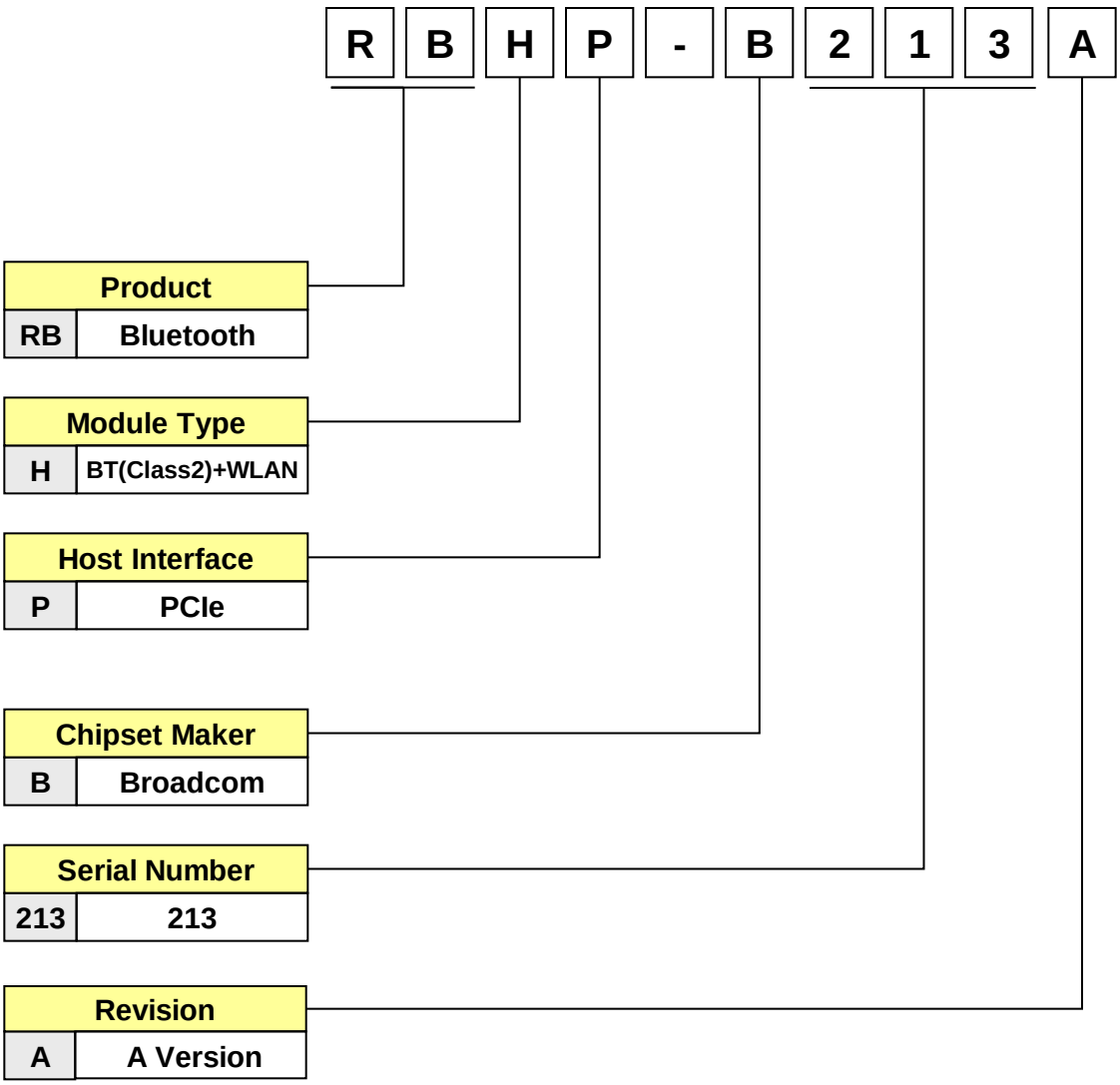
## 17. Packing Information



## 17. Packing Information

| No. | Index |
|---|---|
| ① | POSITION (ITEM / OUTBOX) |
| ② | CUSTOMER |
| ③ | FIRMWARE VERSION (vX.X) |
| ④ | SHIPPING DATE (YYYY.MM.DD) |
| ⑤ | BARCODE (Customer P/N, Quantity)<br>Ex) EAT63433501 130 |
| ⑥ | CUSTOMER P/N |
| ⑦ | QUANTITY |
| ⑧ | MODEL P/N |
| ⑨ | LOT NUMBER |
| ⑩ | BARCODE (Lot No.)<br>Ex) 6530-001 |
| ⑪ | BARCODE (Model P/N, Lot No.1)<br>Ex) RBHP-B213B.6530-001.1 |

## 18. Ordering Information



## FCC Information

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

Note: This equipment has been tested and found to comply with the limits for CLASS B digital device, pursuant to Part 15 of FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment 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 correct the interference by one or more of the following measures:

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

## WARNING

Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.

"CAUTION : Exposure to Radio Frequency Radiation.
Antenna shall be mounted in such a manner to minimize the potential for human contact during normal operation. The antenna should not be contacted during operation to avoid the possibility of exceeding the FCC radio frequency exposure limit.

## IC Information

This device complies with Industry Canada license-exempt RSS standard(s). Operation in subject to The following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Cet appareil est conforme avec Industrie Canada RSS standard exempts de licence(s), Son utilisation est soumise à Les deux conditions suivantes: (1) cet appareil ne peut pas provoquer d'interférences et (2) cet appareil doit accepter Toute interférence, y compris les interférences qui peuvent causer un mauvais fonctionnement du dispositif.

## Information for OEM Integrator

This device is intended only for OEM integrators under the following conditions:
1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and
2) The transmitter module may not be co-located with any other transmitter or antenna.

End product labelling
The label for end product must include
"Contains FCC ID: BEJRBHP-B213B, Contains IC: 2703H-RBHPB213B".

" CAUTION: Exposure to Radio Frequency Radiation.
This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance of 20cm between the radiator and your body. This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users."

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**2.2 List of applicable FCC rules**

List the FCC rules that are applicable to the modular transmitter. These are the rules that specifically establish the bands of operation, the power, spurious emissions, and operating fundamental frequencies. DO NOT list compliance to unintentional-radiator rules (Part 15 Subpart B) since that is not a condition of a module grant that is extended to a host manufacturer. See also Section 2.10 below concerning the need to notify host manufacturers that further testing is required.3

**Explanation:** This module meets the requirements of FCC part 15C(15.247).

**2.3 Summarize the specific operational use conditions**

Describe use conditions that are applicable to the modular transmitter, including for example any limits on antennas, etc. For example, if point-to-point antennas are used that require reduction in power or compensation for cable loss, then this information must be in the instructions. If the use condition limitations extend to professional users, then instructions must state that this information also extends to the host manufacturer's instruction manual. In addition, certain information may also be needed, such as peak gain per frequency band and minimum gain, specifically for master devices in
5 GHz DFS bands.

**Explanation:** The EUT has a PCB Antenna, , and the antenna use a permanently attached antenna which is not replaceable.

**2.4 Limited module procedures**

If a modular transmitter is approved as a "limited module," then the module manufacturer is responsible for approving the host environment that the limited module is used with. The manufacturer of a limited module must describe, both in the filing and in the installation instructions, the alternative means that the limited module manufacturer uses to verify that the host meets the necessary requirements to satisfy the module limiting conditions.

A limited module manufacturer has the flexibility to define its alternative method to address the conditions that limit the initial approval, such as: shielding, minimum signaling amplitude, buffered modulation/data inputs, or power supply regulation. The alternative method could include that the limited module manufacturer reviews detailed test data or host designs prior to giving the host manufacturer approval.

This limited module procedure is also applicable for RF exposure evaluation when it is necessary to demonstrate compliance in a specific host. The module manufacturer must state how control of the product into which the modular transmitter will be installed will be maintained such that full compliance of the product is always ensured. For additional hosts other than the specific host originally granted with a limited module, a Class II permissive change is required on the module grant to register the additional host as a specific host also approved with the module.

**Explanation:** The module is not a limited module.

**2.5 Trace antenna designs**

For a modular transmitter with trace antenna designs, see the guidance in Question 11 of KDB Publication 996369 D02 FAQ – Modules for Micro-Strip Antennas and traces. The integration information shall include for the TCB review the integration instructions for the following aspects:
layout of trace design, parts list (BOM), antenna, connectors, and isolation requirements.

a) Information that includes permitted variances (e.g., trace boundary limits, thickness, length, width, shape(s), dielectric constant, and impedance as applicable for each type of antenna);
b) Each design shall be considered a different type (e.g., antenna length in multiple(s) of frequency, the wavelength, and antenna shape (traces in phase) can affect antenna gain and must be considered);
c) The parameters shall be provided in a manner permitting host manufacturers to design the printed circuit (PC) board layout;
d) Appropriate parts by manufacturer and specifications;
e) Test procedures for design verification; and
f) Production test procedures for ensuring compliance.

The module grantee shall provide a notice that any deviation(s) from the defined parameters of the antenna trace, as described by the instructions, require that the host product manufacturer must notify the module grantee that they wish to change the antenna trace design. In this case, a Class II permissive change application is required to be filed by the grantee, or the host manufacturer can take responsibility through the change in FCC ID (new application) procedure followed by a Class II permissive change application.

**Explanation:** Yes, The module with trace antenna designs, and This manual has been shown the layout of trace design,, antenna, connectors, and isolation requirements.

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**2.6 RF exposure considerations**

It is essential for module grantees to clearly and explicitly state the RF exposure conditions that permit a host product manufacturer to use the module. Two types of instructions are required for RF exposure information: (1) to the host product manufacturer, to define the application conditions (mobile, portable – xx cm from a person's body); and (2) additional text needed for the host product manufacturer to provide to end users in their end-product manuals. If RF exposure statements and use conditions are not provided, then the host product manufacturer is required to take responsibility of the module through a change in FCC ID (new application).

**Explanation:** This module complies with FCC RF radiation exposure limits set forth for an uncontrolled environment, This equipment should be installed and operated with a minimum distance of 20 centimeters between the radiator and your body." This module is designed to comply with the FCC statement, FCC ID is: BEJRBHP-B213B.

**2.7 Antennas**

A list of antennas included in the application for certification must be provided in the instructions. For modular transmitters approved as limited modules, all applicable professional installer instructions must be included as part of the information to the host product manufacturer. The antenna list shall also identify the antenna types (monopole, PIFA, dipole, etc. (note that for example an "omni-directional antenna" is not considered to be a specific "antenna type")).

For situations where the host product manufacturer is responsible for an external connector, for example with an RF pin and antenna trace design, the integration instructions shall inform the installer that unique antenna connector must be used on the Part 15 authorized transmitters used in the host product. The module manufacturers shall provide a list of acceptable unique connectors.

**Explanation:** The EUT has a PCB Antenna, , and the antenna use a permanently attached antenna which is unique.

**2.8 Label and compliance information**

Grantees are responsible for the continued compliance of their modules to the FCC rules. This includes advising host product manufacturers that they need to provide a physical or e-label stating "Contains FCC ID" with their finished product. See Guidelines for Labeling and User Information for RF Devices – KDB Publication 784748.

**Explanation:**The host system using this module, should have label in a visible area indicated the following texts: "Contains FCC ID: BEJRBHP-B213B

**2.9 Information on test modes and additional testing requirements5**

Additional guidance for testing host products is given in KDB Publication 996369 D04 Module Integration Guide. Test modes should take into consideration different operational conditions for a stand-alone modular transmitter in a host, as well as for multiple simultaneously transmitting modules or other transmitters in a host product.

The grantee should provide information on how to configure test modes for host product evaluation for different operational conditions for a stand-alone modular transmitter in a host, versus with multiple, simultaneously transmitting modules or other transmitters in a host.

Grantees can increase the utility of their modular transmitters by providing special means, modes, or instructions that simulates or characterizes a connection by enabling a transmitter. This can greatly simplify a host manufacturer's determination that a module as installed in a host complies with FCC requirements.

**Explanation:** Topband can increase the utility of our modular transmitters by providing instructions that simulates or characterizes a connection by enabling a transmitter.

**2.10 Additional testing, Part 15 Subpart B disclaimer**

The grantee should include a statement that the modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. If the grantee markets their product as being Part 15 Subpart B compliant (when it also contains unintentional-radiator digital circuity), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

**Explanation:** The module without unintentional-radiator digital circuity, so the module does not require an evaluation by FCC Part 15 Subpart B. The host shoule be evaluated by the FCC Subpart B.

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