

To Be Discontinued

W-LAN+Bluetooth Combo Module Data Sheet

Cypress Chipset
for 802.11a/b/g/n/ac + Bluetooth 4.1

Tentative P/N : LBEE5ZZ1CK-TEMP

The revision history of the product specification

| Revised No. | Date | Note |
|-------------|------------|--|
| - | 2014/03/28 | First Issue |
| B | 2015/02/11 | p4:Adding tolerance p13~20:change output power |
| C | 2016/4/14 | P23 :correction output power setting |
| D | 2017/3/3 | Changed IC Part Number P3:Added Certification information P5:Added Label information P28:Added reference circuit P29:Added Packing information |
| E | 2017/4/12 | Revised BT version P3:1. SCOPE P27:11.10 DC/RF Characteristics for Bluetooth (LE) |

TABLE OF CONTENTS

| | |
|--|----|
| 1. SCOPE..... | 3 |
| 2. Part Number..... | 3 |
| 3. Block Diagram | 3 |
| 4. Certification Information | 3 |
| 4.1. Radio Certification | 3 |
| 5. Dimensions, Marking and Terminal Configuration..... | 4 |
| 6. Rating..... | 8 |
| 7. Operating Condition | 8 |
| 7.1. Operating condition..... | 8 |
| 7.2. Power Up Sequence..... | 8 |
| 7.2.1 Power On Sequence for WLAN ON and BT ON | 8 |
| 7.2.2 Power On Sequence for WLAN ON and BT Off | 9 |
| 7.2.3 Power On Sequence for WLAN OFF and BT ON..... | 9 |
| 7.2.4 Power On Sequence for WLAN OFF and BT OFF | 9 |
| 8 External LPO Signal Requirement | 10 |
| 9. Digital I/O Requirements | 10 |
| 10 Interface timing..... | 11 |
| 10.1 WLAN SDIO Timing | 11 |
| 10.1.1 SDIO Timing(Default Mode)..... | 11 |
| 10.1.2 SDIO Timing(High Speed Mode)..... | 12 |
| 10.1.3 SDIO timing(SDR mode)..... | 12 |
| 10.1.4 SDIO Timing(DDR50 mode) | 15 |
| 10.2 Bluetooth UART Timing | 17 |
| 11 ELECTORICAL CHARACTERISTICS | 18 |
| 11.1 DC/RF Characteristics for IEEE802.11b - 2.4G | 18 |
| 11.2 DC/RF Characteristics for IEEE802.11g - 2.4G | 19 |
| 11.3 DC/RF Characteristics for IEEE802.11n - 2.4GHz..... | 20 |
| 11.4 DC/RF Characteristics for IEEE802.11a - 5GHz | 21 |
| 11.5 DC/RF Characteristics for IEEE802.11n(HT 20MHz) - 5GHz | 22 |
| 11.6 DC/RF Characteristics for IEEE802.11n(HT 40MHz) - 5GHz | 23 |
| 11.7 DC/RF Characteristics for IEEE802.11ac(VHT 40MHz) - 5GHz..... | 24 |
| 11.8 DC/RF Characteristics for IEEE802.11ac(VHT 80MHz)-5GHz | 25 |
| 11.9 DC/RF Characteristics for Bluetooth | 26 |
| 11.10 DC/RF Characteristics for Bluetooth (LE) | 27 |
| 12 REFERENCE CIRCUIT..... | 28 |
| 13 Packing Information..... | 29 |
| NOTICE | 31 |
| 1. Storage Conditions : | 31 |
| 2. Handling Conditions : | 31 |
| 3. Cleaning : | 31 |
| 4. Operational Environment Conditions : | 31 |
| 5. Input Power Capacity : | 31 |
| PRECONDITION TO USE OUR PRODUCTS | 32 |

Please be aware that an important notice concerning availability, standard warranty and use in critical applications of Murata products and disclaimers thereto appears at the end of this specification sheet.

1. SCOPE

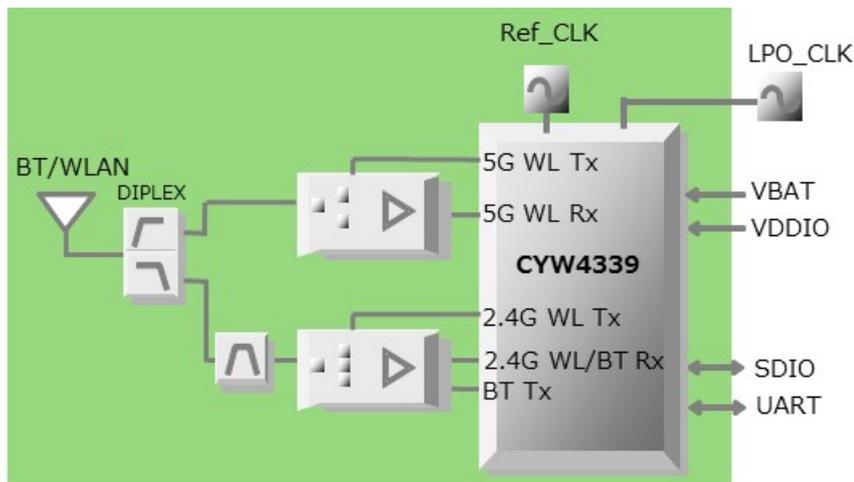
This specification is applied to the IEEE802.11a/b/g/n/ac W-LAN + Bluetooth 4.1 combo module.

- Module size : 33.0 x 18.0 mm typ., t = 7.55 mm max.
- IC/Firmware : Cypress CYW4339
- WLAN Host I/F : SDIO3.0
- Bluetooth Host I/F : UART
- Reference Clock : 37.4MHz Crystal Oscillator embedded
- ROM : Internal OTP
- Weight : 2.47g
- RoHS : This module is compliant with the RoHS directive.

2. Part Number

| |
|--------------------|
| Sample Part Number |
| LBEE5ZZ1CK-TEMP |

3. Block Diagram



4. Certification Information

4.1. Radio Certification

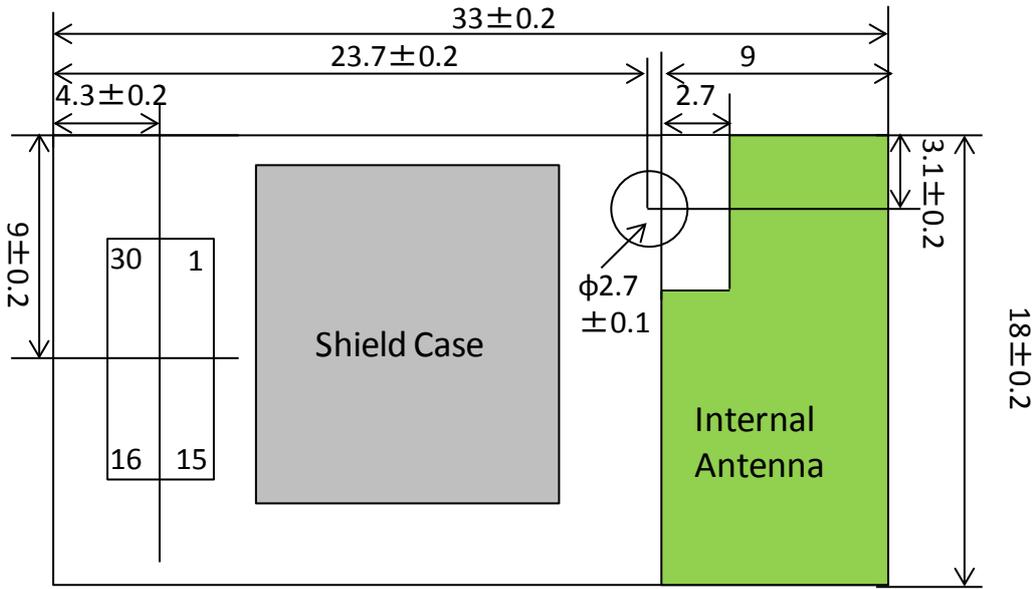
USA/Canada

FCC ID : VPYLB1CK982

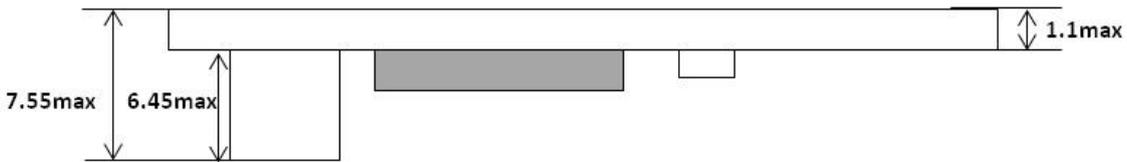
IC : 772C-LB1CK982

5. Dimensions, Marking and Terminal Configuration

Dimensions



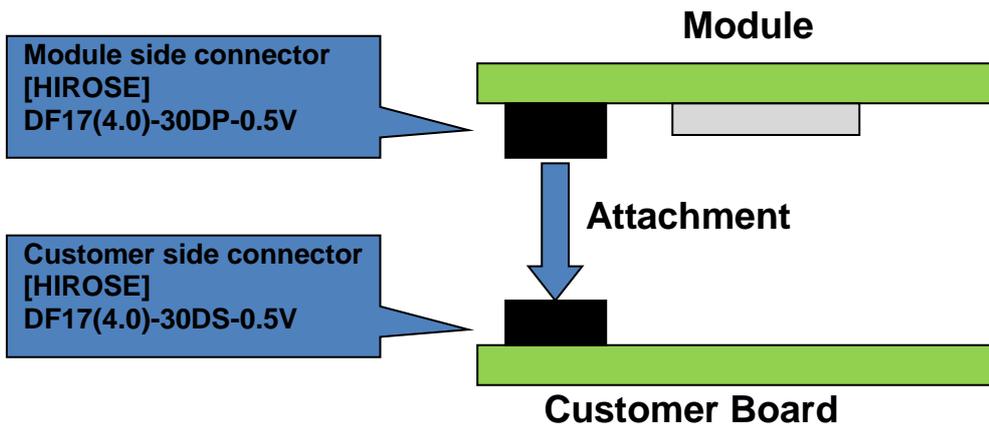
Unit:mm



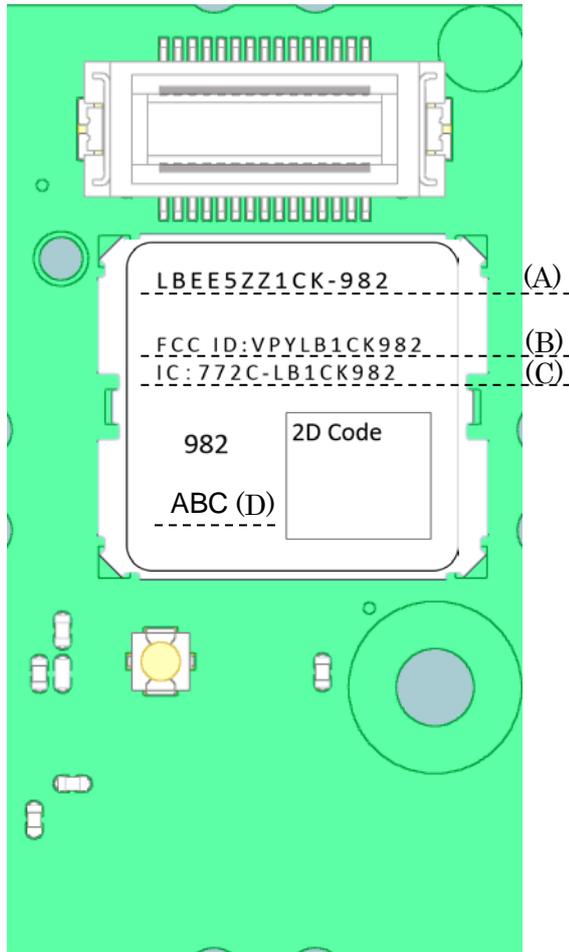
Indication

< connector >

- P/N: DF17(4.0)-30DP-0.5V (mounted on Murata module)
- P/N: DF17(4.0)-30DS-0.5V (need to place on Customer board)
- Maker: HIROSE Electric



Marking
 <Top side>



| Marking | Meaning |
|---------|--------------|
| (A) | Part Number |
| (B) | FCC ID |
| (C) | IC ID |
| (D) | Trace Number |

Terminal Configurations

| No. | Terminal Name | Type | Connection to IC Terminal | Description |
|-----|----------------|------|--------------------------------|---|
| 1 | VBAT | PI | SR_VDDBATP5V LDO_VDDBAT5V | Power VBAT |
| 2 | VBAT | PI | SR_VDDBATP5V LDO_VDDBAT5V | Power VBAT |
| 3 | GND | - | - | - |
| 4 | VIO | PI | PMU_VDDIO VDDIO VDDIO_SD | I/O supply for PMU, WLAN, SDIO |
| 5 | GND | - | - | - |
| 6 | WLAN_REG_ON | I | WL_REG_ON | Used by PMU to power up or power down the internal CYW4339 regulators used by the WLAN section. Also, when deasserted, this pin holds the WLAN section in reset. This pin has an internal 200k ohm pull-down resistor that is enabled by default. It can be disabled through programming. |
| 7 | BT_REG_ON | I | BT_REG_ON | Used by PMU to power up, or power down the internal CYW4339 regulators used by BT section. Also when deasserted, this pin holds the BT/FM section in reset. This pin has an internal 200kohm pull-down resistor that is enabled by default. It can be disabled by programming. |
| 8 | WLAN_HOST_WAKE | I/O | GPIO_0 | This pin can be programmed by S/W to be a GPIO, or WLAN_HOST_WAKE output indicating that host wake-up should be performed. |
| 9 | GND | - | - | - |
| 10 | BT_UART_RTS_N | O | BT_UART_RTS_N | UART request-to-send. Active-low request to send signal for HCI UART I/F |
| 11 | BT_UART_TXD | O | BT_UART_TXD | UART signal output. Serial data output for the HCI UART I/F |
| 12 | BT_UART_RXD | I | BT_UART_RXD | UART signal input. Serial data input for the HCI UART I/F |
| 13 | BT_UART_CTS_N | I | BT_UART_CTS_N | UART clear_to_send. Active low. Clear to send signal for HCI UART I/F |
| 14 | GND | - | - | - |
| 15 | SLEEP_CLK | I | LPO_IN | External Sleep clock input(32.768kHz) |
| 16 | GND | - | - | - |
| 17 | BT_DEV_WAKE | I/O | BT_DEV_WAKE | DEV_WAKE of general purpose I/O signal |
| 18 | BT_HOST_WAKE | I/O | BT_HOST_WAKE | HOST_WAKE of general purpose I/O signal |
| 19 | GND | - | - | - |
| 20 | SDIO_D2 | I/O | SDIO_DATA2 | SDIO Data Line 2 |
| 21 | GND | - | - | - |
| 22 | SDIO_D3 | I/O | SDIO_DATA3 | SDIO Data Line 3 |
| 23 | GND | - | - | - |
| 24 | SDIO_CMD | I/O | SDIO_CMD | SDIO Command Line |
| 25 | GND | - | - | - |
| 26 | SDIO_CLK | I | SDIO_CLK | SDIO Clock Input |
| No. | Terminal Name | Type | Connection to IC Terminal | Description |

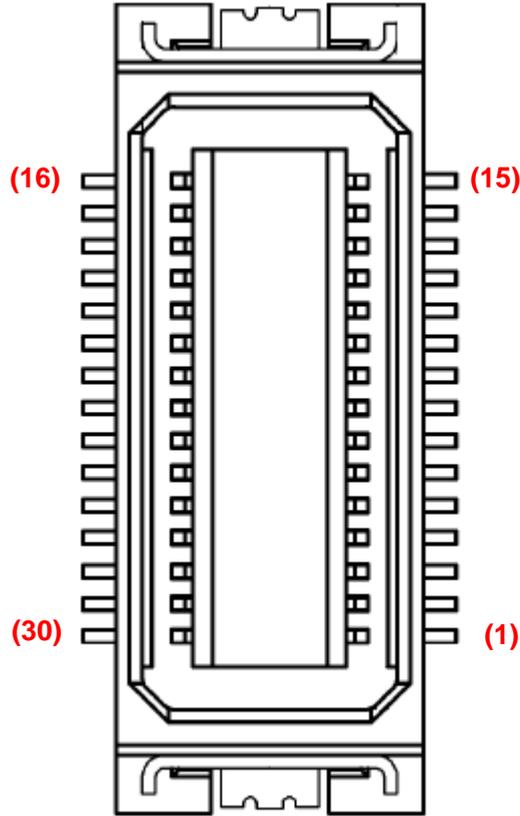
Preliminary

< Specification may be changed by Murata without notice >

Murata Manufacturing Co., Ltd.

| | | | | |
|----|---------|-----|------------|------------------|
| 27 | GND | - | - | - |
| 28 | SDIO_D0 | I/O | SDIO_DATA0 | SDIO Data Line 0 |
| 29 | GND | - | - | - |
| 30 | SDIO_D1 | I/O | SDIO_DATA1 | SDIO Data Line 1 |

Terminal Configuration looked from a board implementation side of the customer



6. Rating

| Parameter | | min. | max. | Unit |
|---------------------|------|------|------|-------|
| Storage Temperature | | -40 | 85 | deg.C |
| Supply Voltage | VBAT | 0 | +5 | V |
| | VIO | 0 | +3.9 | V |

* Stresses in excess of the absolute ratings may cause permanent damage. Functional operation is not implied under these conditions. Exposure to absolute ratings for extended periods of time may adversely affect reliability. No damage assuming only one parameter is set at limit at a time with all other parameters are set within operating condition.

7. Operating Condition

7.1. Operating condition

| Parameter | | min. | typ. | max. | unit |
|-------------------------------------|------|------|------|------|-------|
| Operating Temperature ^{*1} | | -20 | 25 | 80 | deg.C |
| Supply Voltage | VBAT | 3.2 | 3.6 | 4.4 | V |
| | VIO | 1.71 | 1.8 | 1.89 | V |

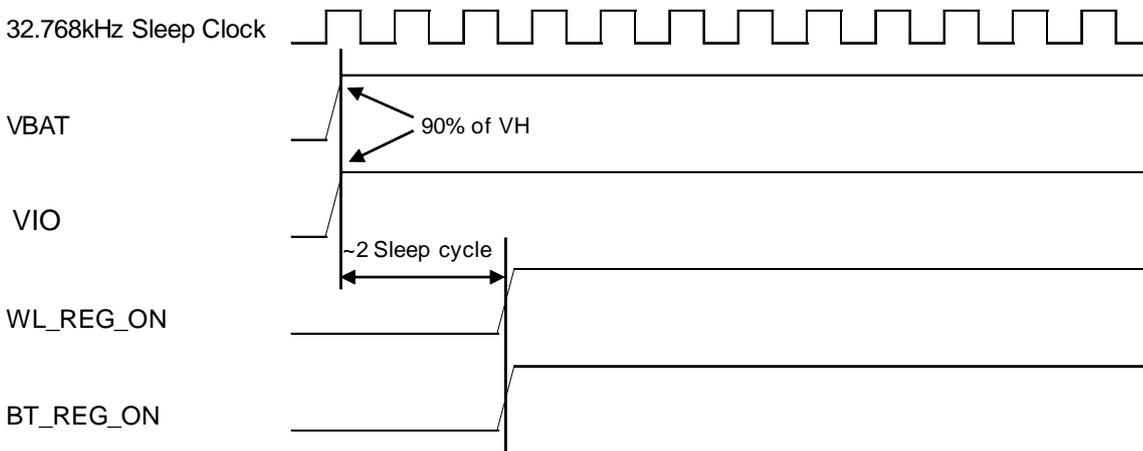
* Surface temperature of shield case

7.2. Power Up Sequence

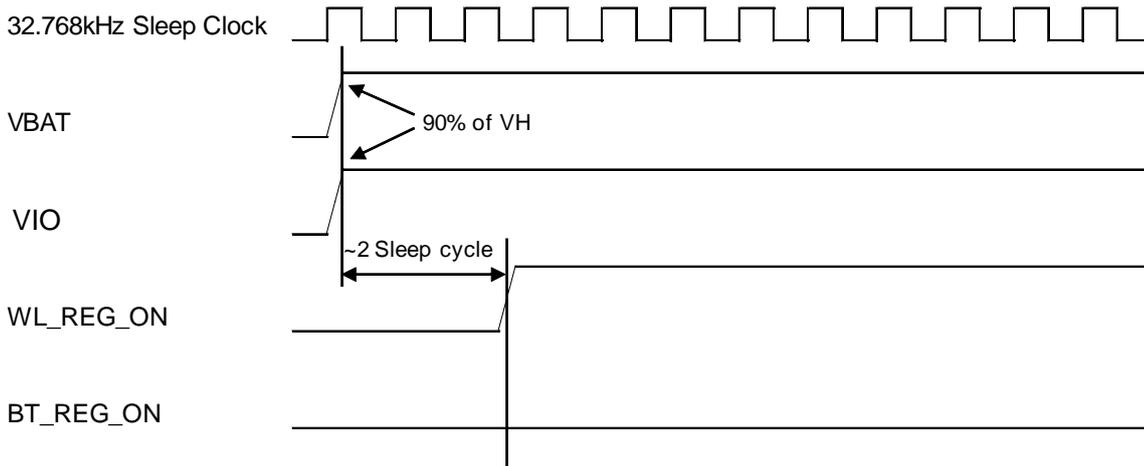
-VBAT should not rise 10%-90% faster than 40 microsecond.

-VBAT should be up before or at the same time as VIO. VIO should NOT be present fast or be held high before VBAT is high.

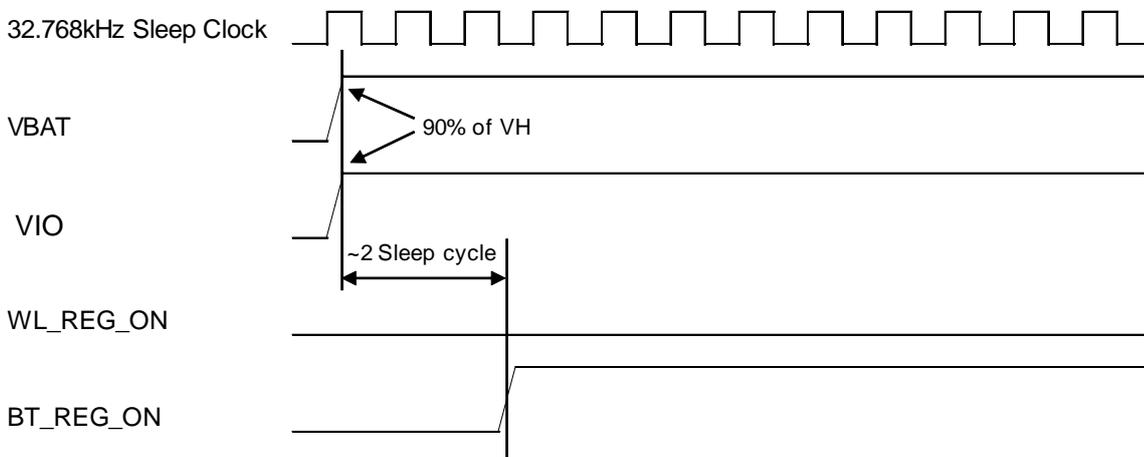
7.2.1 Power On Sequence for WLAN ON and BT ON



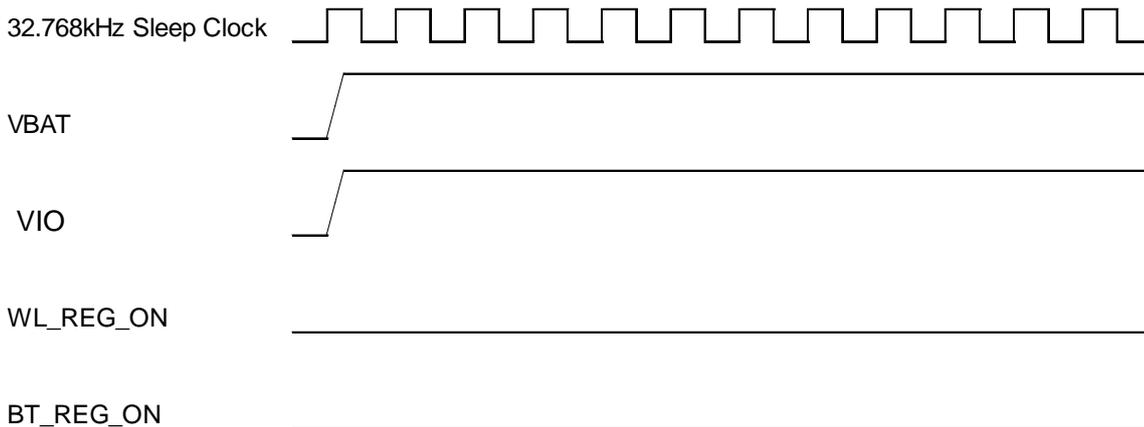
7.2.2 Power On Sequence for WLAN ON and BT OFF



7.2.3 Power On Sequence for WLAN OFF and BT ON



7.2.4 Power On Sequence for WLAN OFF and BT OFF



8 External LPO Signal Requirement

| Parameter | External LPO Clock | Unit |
|--|--------------------------|-----------|
| Nominal input frequency | 32.768 | kHz |
| Frequency accuracy | +/-200 | ppm |
| Duty cycle | 30-70 | % |
| Input signal amplitude | 200 - 1800 | mVp-p |
| Signal type | Square-wave or sine-wave | - |
| Input impedance* ^a | > 100k < 5 | ohm pF |
| Clock jitter (during initial start-up) | <10,000 | ppm |

a)When power is applied or switch off.

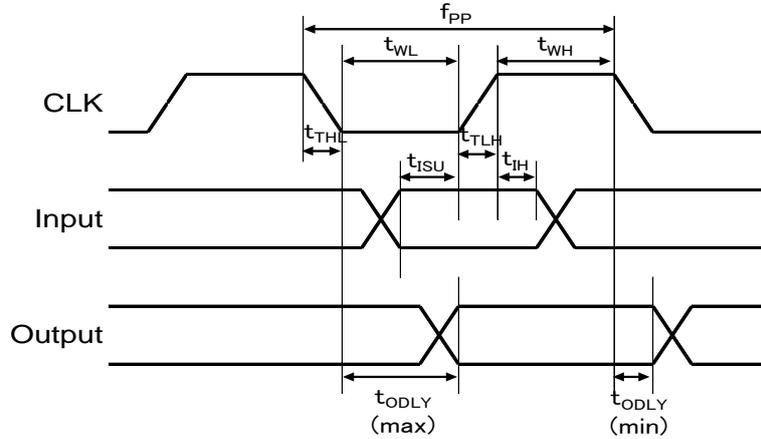
9. Digital I/O Requirements

| Digital I/O Pins | Sym | min. | typ. | max. | unit |
|------------------------------|-----|------------|------|------------|------|
| SDIO Interface I/O Pins@1.8V | | | | | |
| Input high voltage | VIH | 1.27 | - | - | V |
| Input low voltage | VIL | - | - | 0.58 | V |
| Output high voltage@2mA | VOH | 1.40 | - | - | V |
| Output low voltage@2mA | VOL | - | - | 0.45 | V |
| Other Digital I/O Pins@1.8V | | | | | |
| Input high voltage | VIH | 0.65 x VIO | - | - | V |
| Input low voltage | VIL | - | - | 0.35 x VIO | V |
| Output high voltage@2mA | VOH | VIO-0.45 | - | - | V |
| Output low voltage@2mA | VOL | - | - | 0.45 | V |

10 Interface timing

10.1 WLAN SDIO Timing

10.1.1 SDIO Timing(Default Mode)



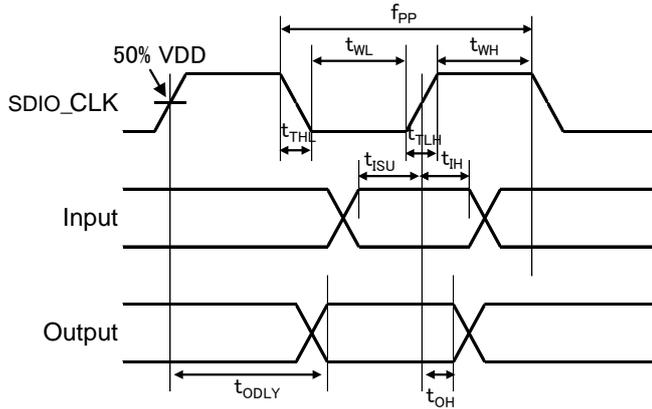
SDIO Bus Timing^(a) parameters (default Mode)

| Parameter | Symbol | Min | Typ | Max | Unit |
|--|--------|-----|-----|-----|------|
| SDIO CLK (All values are referred to minimum VIH and maximum VIL^(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 |
| Inputs: CMD, DAT (referenced to CLK) | | | | | |
| Input Setup Time | tISU | 5 | - | - | ns |
| Input Hold Time | tIH | 5 | - | - | ns |
| Outputs: CMD, DAT (referenced to CLK) | | | | | |
| Output Delay time-Data Transfer Mode | tODLY | 0 | - | 14 | ns |
| Output Delay time-Identification Mode | tODLY | 0 | - | 50 | ns |

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

(b). Min (Vih) = $0.7 \cdot VIO$ and max (Vil) = $0.2 \cdot VIO$.

10.1.2 SDIO Timing(High Speed Mode)



SDIO Bus Timing^(a) parameters (High-Speed Mode)

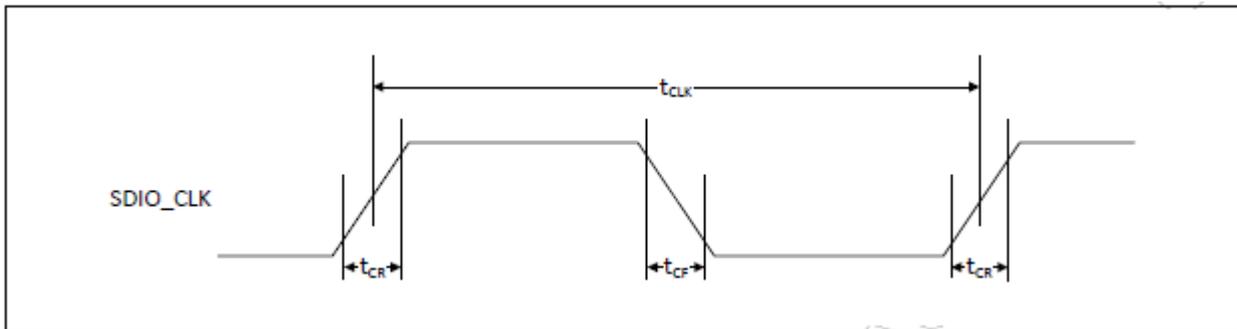
| Parameter | Symbol | Min | Typ | Max | Unit |
|---|-------------------|-----|-----|-----|------|
| SDIO CLK (All values are referred to minimum VIH and maximum VIL ^(b)) | | | | | |
| Frequency-Data Transfer Mode | f _{PP} | 0 | - | 50 | MHz |
| Frequency-Identification Mode | f _{OD} | 0 | - | 400 | kHz |
| Clock Low Time | t _{WL} | 7 | - | - | ns |
| Clock High Time | t _{WH} | 7 | - | - | ns |
| Clock Rise Time | t _{TLH} | - | - | 3 | ns |
| Clock low Time | t _{THL} | - | - | 3 | ns |
| Inputs: CMD, DAT (referenced to CLK) | | | | | |
| Input Setup Time | t _{ISU} | 6 | - | - | ns |
| Input Hold Time | t _{IH} | 2 | - | - | ns |
| Outputs: CMD, DAT (referenced to CLK) | | | | | |
| Output Delay time-Data Transfer Mode | t _{ODLY} | - | - | 14 | ns |
| Output Hold time | t _{OH} | 2.5 | - | - | ns |
| Total System Capacitance (each line) | CL | - | - | 40 | pF |

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

(b). Min (V_{Ih}) = 0.7*V_{IO} and max (V_{Il}) = 0.2*V_{IO}.

10.1.3 SDIO timing(SDR mode)

Clock Timing



SDIO Bus Clock Timing Parameters(SDR Modes)

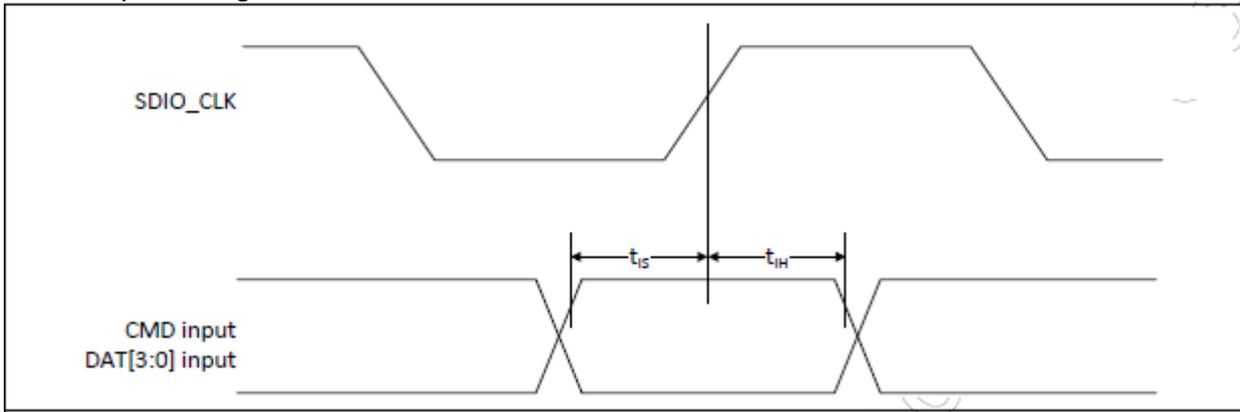
| Parameter | Symbol | Min | Max | Unit | Comments |
|------------------|-----------------------------------|-----|----------------------|------|--|
| - | t _{clk} | 40 | - | ns | SDR12 mode |
| | | 20 | - | ns | SDR25 mode |
| | | 10 | - | ns | SDR50 mode |
| | | 4.8 | - | ns | SDR104 mode |
| - | t _{cr} , t _{cf} | - | 0.2xt _{clk} | ns | t _{cr} , t _{cf} < 2.00ns(max) @ 100MHz, C _{card} = 10pF t _{cr} , t _{cf} < 0.96ns(max) @ 208MHz, C _{card} = 10pF |
| Clock duty cycle | - | 30 | 70 | % | ns |

Preliminary

< Specification may be changed by Murata without notice >

Murata Manufacturing Co., Ltd.

Device Input Timing

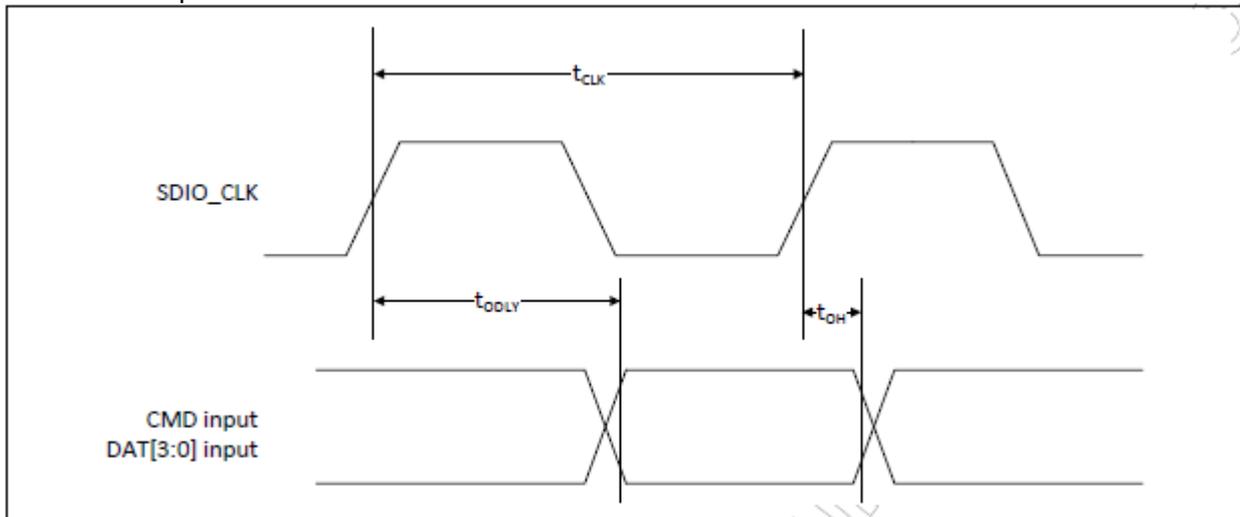


SDIO Bus Input Timing Parameters(SDR Modes)

| Symbol | Min | Max | Unit | CommentsUnit |
|--------------------|-----|-----|------|------------------------|
| SDR104 Mode | | | | |
| t_{IS} | 1.4 | - | ns | Ccard=10pF, VCT=0.975V |
| t_{IH} | 0.8 | - | ns | Ccard=5pF, VCT=0.975v |
| SDR50 Mode | | | | |
| t_{IS} | 3.0 | - | ns | Ccard=10pF, VCT=0.975V |
| t_{IH} | 0.8 | - | ns | Ccard=5pF, VCT=0.975V |

Device Output Timing

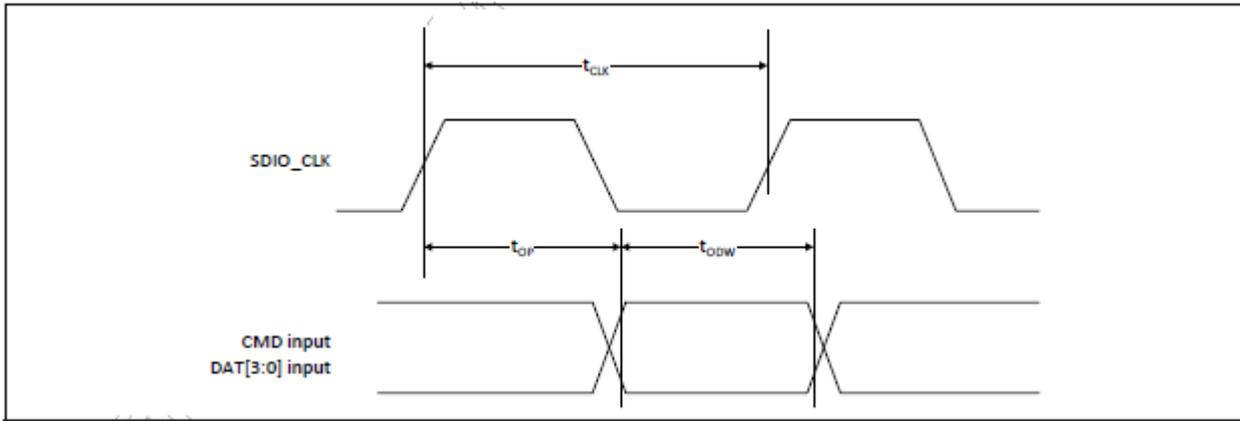
SDR Modes up to 100MHz



SDIO Bus Output Timing Parameters(SDR Modes up to 100MHz)

| Symbol | Min | Max | Unit | CommentsUnit |
|------------|-----|------|------|--|
| t_{odly} | - | 7.5 | ns | $t_{clk} > 10ns$ CI=30pF using driver tyoe B for SDR50 |
| t_{odly} | - | 14.0 | ns | $t_{clk} > 20ns$ CI=40pF using for SDR12, SDR25 |
| t_{oh} | 1.5 | - | ns | Hold time at the $t_{odly}(\min)$ CI=15pF |

SDR Modes 100MHz to 208MHz



SDIO Bus Output Timing Parameters(SDR Modes 100MHz up to 208MHz)

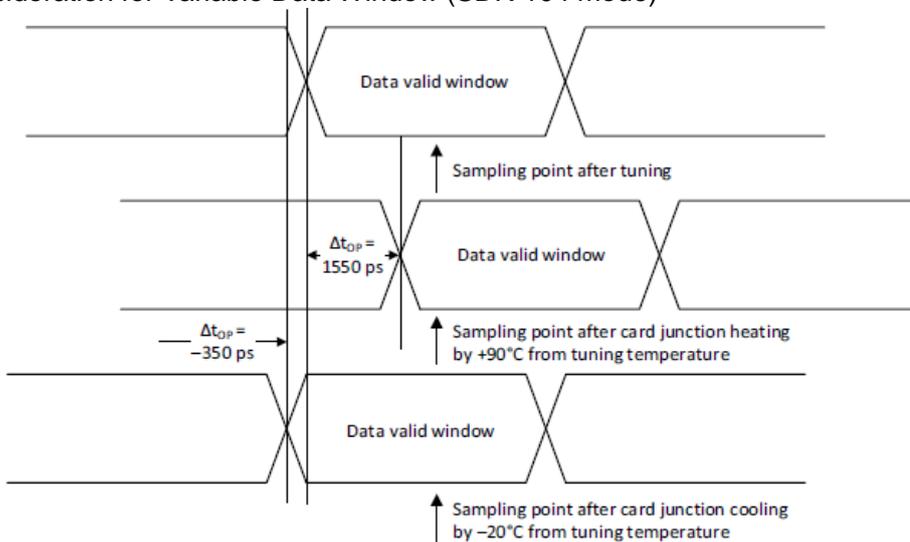
| Symbol | Min | Max | Unit | Comments |
|-----------------|------|-------|------|---|
| t_{op} | 0 | 2 | UI | Card output phase |
| Δt_{op} | -350 | +1550 | ps | Delay variation due to temp change after tuning |
| t_{odw} | 0.60 | - | UI | $t_{odw}=2.88ns@208MHz$ |

$\Delta t_{op}=+1550$ ps for junction temperature of $\Delta t_{op}=90$ degrees during operation

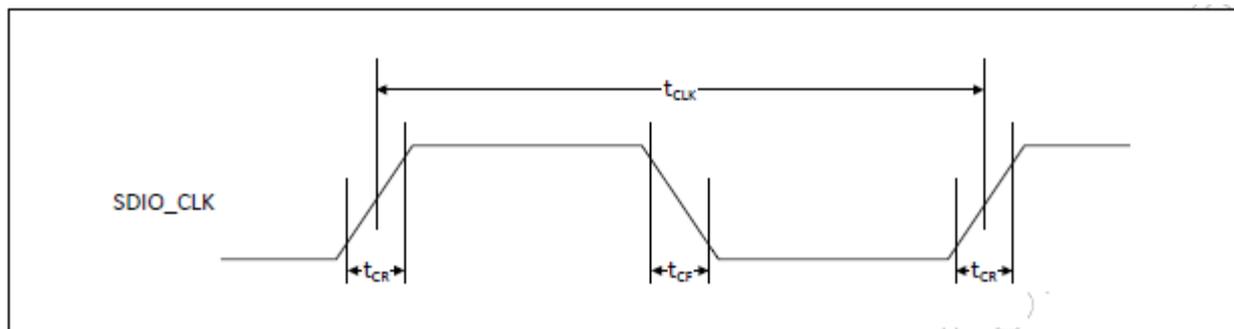
$\Delta t_{op}=-350$ ps for junction temperature of $\Delta t_{op}=-20$ degrees during operation

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

Δt_{op} Consideration for Variable Data Window (SDR 104 mode)



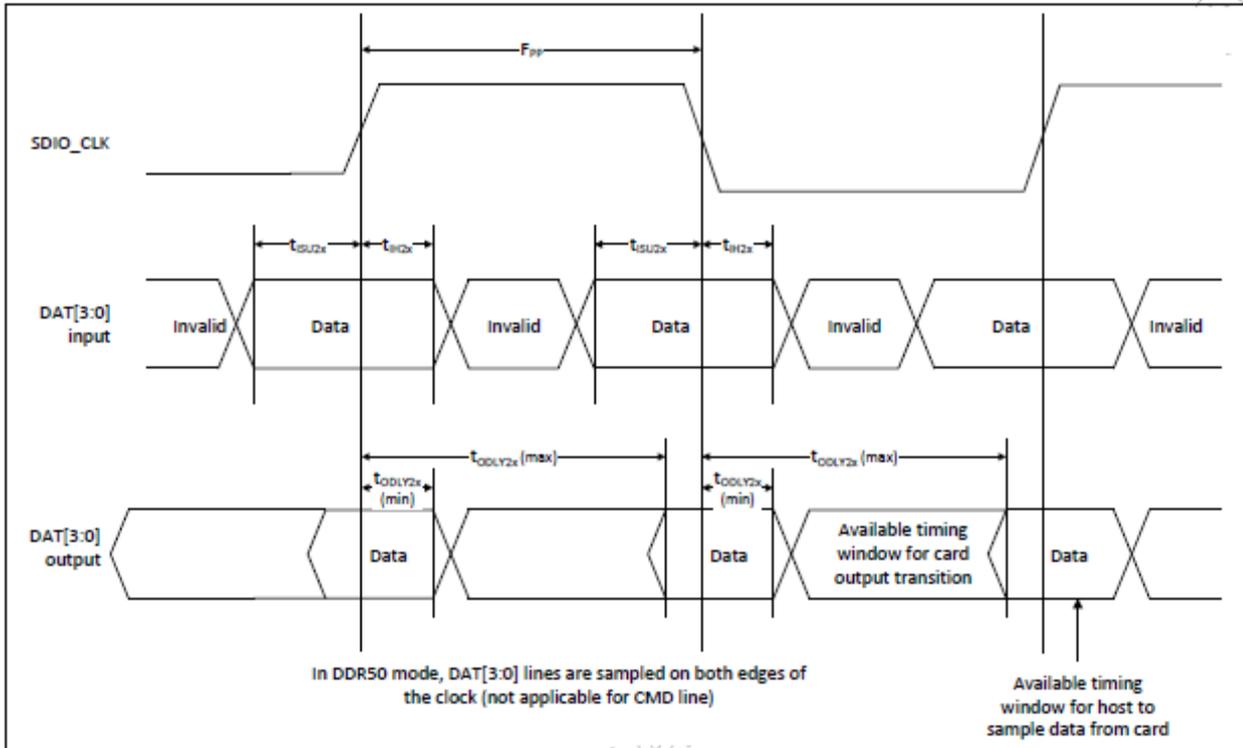
10.1.4 SDIO Timing(DDR50 mode)



SDIO Bus Clock Timing Parameters(DDR50 Mode)

| parameter | Symbol | Min | Max | Unit | Comments |
|------------------|----------|-----|----------|------|---|
| - | tclk | 20 | - | ns | DDR50 mode |
| - | tcr, tcf | - | 0.2xtclk | ns | tcr, tcf<4.00ns(max)@50MHz, Ccard=10pF |
| Clock duty cycle | - | 45 | 55 | % | - |

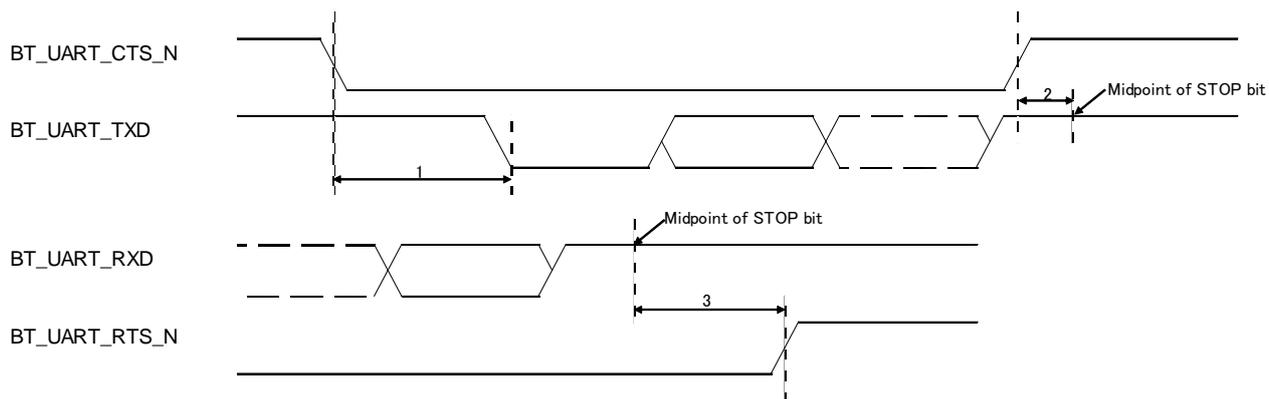
Data Timing, DDR50 Mode



SDIO Bus Timing Parameters(DDR50 Mode)

| parameter | Symbol | Min | Max | unit | Comments |
|-------------------|---------|-----|------|------|--------------------|
| Input CMD | | | | | |
| Input setup time | tisu | 6 | - | ns | Ccard<10pF(1 Card) |
| Input hold time | tih | 0.8 | - | ns | Ccard<10pF(1 Card) |
| Output CMD | | | | | |
| Output delay time | todly | - | 13.7 | ns | Ccard<30pF(1 Card) |
| Output hold time | toh | 1.5 | - | ns | Ccard<15pF(1 Card) |
| Input DAT | | | | | |
| Input setup time | tisu2x | 3 | - | ns | Ccard<10pF(1 Card) |
| Input hold time | tih2x | 0.8 | - | ns | Ccard<10pF(1 Card) |
| Output DAT | | | | | |
| Output delay time | todly2x | - | 7.0 | ns | Ccard<25pF(1 Card) |
| Output hold time | todly2x | 1.5 | - | ns | Ccard<15pF(1 Card) |

10.2 Bluetooth UART Timing



| Reference | Description | Min | Typ | Max | Unit |
|-----------|---|-----|-----|-----|-------------|
| 1 | Delay time, UART_CTS low to UART_TXD valid | - | - | 1.5 | Bit periods |
| 2 | Setup time, UART_CTS high before midpoint of stop bit | - | - | 0.5 | Bit periods |
| 3 | Delay time, midpoint of stop bit to UART_RTS high | - | - | 0.5 | Bit periods |

11 ELECTORICAL CHARACTERISTICS

11.1 DC/RF Characteristics for IEEE802.11b - 2.4G

Normal Condition : 25deg.C, VBAT=3.6V.

11Mbps mode unless otherwise specified.

| Items | Contents | | | |
|--|--------------------|-------------|-------------|-------------|
| Specification | IEEE802.11b-2.4GHz | | | |
| Mode | DSSS / CCK | | | |
| Channel frequency | 2412 to 2472 MHz | | | |
| Data rate | 1, 2, 5.5, 11Mbps | | | |
| Power setting (Tx power, in dBm) | 17 | | | |
| Current Consumption | Min. | Typ. | Max. | unit |
| (a) Tx mode (99% Tx mode) | - | - | 350 | mA |
| (b) Rx mode | - | - | 100 | mA |
| Transmitter | Min. | Typ. | Max. | Unit |
| Power Levels | 15 | 17 | 19 | dBm |
| Spectrum Mask | | | | |
| (a) 1st side lobes | - | - | -30 | dBr |
| (b) 2nd side lobes | - | - | -50 | dBr |
| Power-on/off ramp | - | - | 2.0 | Usec |
| RF Carrier Suppression | 15 | - | - | dB |
| Modulation Accuracy | - | - | 35 | % |
| Spurious Emissions (BW=100kHz) | | | | |
| (a) $10\text{MHz} \leq f < 2387\text{MHz}$ | - | - | -36 | dBm |
| (b) $2387\text{MHz} \leq f < 2400\text{MHz}$ | - | - | -30 | dBm |
| (c) $2483.5\text{MHz} < f \leq 2496.5\text{MHz}$ | - | - | -47 | dBm |
| (d) $2496.5\text{MHz} < f \leq 8\text{GHz}$ | - | - | -47 | dBm |
| Receiver | Min. | Typ. | Max. | Unit |
| Minimum Input Level (FER \leq 8%) | - | - | -76 | dBm |
| Maximum Input Level (FER \leq 8%) | -10 | - | - | dBm |
| Adjacent Channel Rejection (FER \leq 8%) | 35 | - | - | dB |

11.2 DC/RF Characteristics for IEEE802.11g - 2.4G

Normal Condition : 25deg.C, VBAT =3.6V.

54Mbps mode unless otherwise specified.

| Items | Contents | | | |
|--|----------------------------------|-------------|-------------|-------------|
| Specification | IEEE802.11g-2.4GHz | | | |
| Mode | OFDM | | | |
| Channel frequency | 2412 to 2472 MHz | | | |
| Data rate | 6, 9, 12, 18, 24, 36, 48, 54Mbps | | | |
| Power setting (Tx power, in dBm) | 14 | | | |
| Current Consumption | Min. | Typ. | Max. | Unit |
| (a) Tx mode (99% Tx mode) | - | - | 300 | mA |
| (b) Rx mode | - | - | 100 | mA |
| Transmitter | Min. | Typ. | Max. | Unit |
| Power Levels | 12 | 14 | 16 | dBm |
| Spectrum Mask | | | | |
| (a) at $f_c \pm 11\text{MHz}$ | - | - | -20 | dBr |
| (b) at $f_c \pm 20\text{MHz}$ | - | - | -28 | dBr |
| (c) at $f_c \geq \pm 30\text{MHz}$ | - | - | -40 | dBr |
| Constellation Error | - | - | -25 | dB |
| Spurious Emissions (BW=100kHz) | | | | |
| (a) $10\text{MHz} \leq f < 2387\text{MHz}$ | - | - | -36 | dBm |
| (b) $2387\text{MHz} \leq f < 2400\text{MHz}$ | - | - | -30 | dBm |
| (c) $2483.5\text{MHz} < f \leq 2496.5\text{MHz}$ | - | - | -47 | dBm |
| (d) $2496.5\text{MHz} < f \leq 8\text{GHz}$ | - | - | -47 | dBm |
| Receiver | Min. | Typ. | Max. | Unit |
| Minimum Input Level (PER $\leq 10\%$) | - | - | -65 | dBm |
| Maximum Input Level (PER $\leq 10\%$) | -20 | - | - | dBm |
| Adjacent Channel Rejection (FER $\leq 10\%$) | -1 | - | - | dB |

11.3 DC/RF Characteristics for IEEE802.11n - 2.4GHz

Normal Condition : 25deg.C, VBAT =3.6V.

65Mbps (MCS7) mode unless otherwise specified.

| Items | Contents | | | |
|--|---|-------------|-------------|-------------|
| Specification | IEEE802.11n-2.4GHz | | | |
| Mode | OFDM | | | |
| Channel frequency | 2412 to 2472 MHz | | | |
| Data rate | 6.5, 13, 19.5, 26, 39, 52, 58.5, 65Mbps | | | |
| Power setting (Tx power, in dBm) | 13 | | | |
| Current Consumption | Min. | Typ. | Max. | Unit |
| (a) Tx mode (99% Tx mode) | - | - | 300 | mA |
| (b) Rx mode | - | - | 100 | mA |
| Transmitter | Min. | Typ. | Max. | Unit |
| Power Levels | 11 | 13 | 15 | dBm |
| Spectrum Mask | | | | |
| (a) at $f_c \pm 11\text{MHz}$ | - | - | -20 | dBr |
| (b) at $f_c \pm 20\text{MHz}$ | - | - | -28 | dBr |
| (c) at $f_c \geq \pm 30\text{MHz}$ | - | - | -45 | dBr |
| Constellation Error | - | - | -27 | dB |
| Spurious Emissions (BW=100kHz) | | | | |
| (a) $10\text{MHz} \leq f < 2387\text{MHz}$ | - | - | -36 | dBm |
| (b) $2387\text{MHz} \leq f < 2400\text{MHz}$ | - | - | -30 | dBm |
| (c) $2483.5\text{MHz} < f \leq 2496.5\text{MHz}$ | - | - | -47 | dBm |
| (d) $2496.5\text{MHz} < f \leq 8\text{GHz}$ | - | - | -47 | dBm |
| Receiver | Min. | Typ. | Max. | Unit |
| Minimum Input Level (PER $\leq 10\%$) | - | - | -64 | dBm |
| Adjacent Channel Rejection (FER $\leq 10\%$) | -1 | - | - | dB |

11.4 DC/RF Characteristics for IEEE802.11a - 5GHz

Normal Condition : 25deg.C, VBAT =3.6V.

54Mbps mode unless otherwise specified.

| Items | Contents | | | |
|--|----------------------------------|-------------|-------------|-------------|
| Specification | IEEE802.11a-5GHz | | | |
| Mode | OFDM | | | |
| Channel frequency | 5180 - 5825MHz | | | |
| Data rate | 6, 9, 12, 18, 24, 36, 48, 54Mbps | | | |
| Power setting (Tx power, in dBm) | 12 | | | |
| Current Consumption | min. | Typ. | Max. | Unit |
| (a) Tx mode (99% Tx mode) | - | - | 350 | mA |
| (b) Rx mode | - | - | 110 | mA |
| Transmitter | min. | Typ. | Max. | Unit |
| Power Levels | 10 | 12 | 14 | dBm |
| Spectrum Mask | | | | |
| (a) at $f_c \pm 11\text{MHz}$ | - | - | -20 | dBr |
| (b) at $f_c \pm 20\text{MHz}$ | - | - | -28 | dBr |
| (c) at $f_c \geq \pm 30\text{MHz}$ | - | - | -40 | dBr |
| Constellation Error | - | - | -25 | dB |
| Spurious Emissions (BW=100kHz) | | | | |
| (a) $10\text{MHz} \leq f < 2387\text{MHz}$ | - | - | -36 | dBm |
| (b) $2387\text{MHz} \leq f < 2400\text{MHz}$ | - | - | -30 | dBm |
| (c) $2483.5\text{MHz} < f \leq 2496.5\text{MHz}$ | - | - | -47 | dBm |
| (d) $2496.5\text{MHz} < f \leq 8\text{GHz}$ | - | - | -47 | dBm |
| Receiver | min. | Typ. | Max. | Unit |
| Minimum Input Level (PER $\leq 10\%$) | - | - | -65 | dBm |
| Adjacent Channel Rejection (FER $\leq 10\%$) | -1 | - | - | dB |

11.5 DC/RF Characteristics for IEEE802.11n(HT 20MHz) - 5GHz

Normal Condition : 25deg.C, VBAT =3.6V.

65Mbps (MCS7 – HT 20MHz) mode unless otherwise specified.

| Items | Contents | | | |
|---|---|-------------|-------------|-------------|
| Specification | IEEE802.11n-5GHz | | | |
| Mode | OFDM | | | |
| Channel frequency | 5180 - 5825MHz | | | |
| Data rate | 6.5, 13, 19.5, 26, 39, 52, 58.5, 65Mbps | | | |
| Power setting (Tx power, in dBm) | 12 | | | |
| Current Consumption | min. | Typ. | Max. | Unit |
| (a) Tx mode (99% Tx mode) | - | - | 350 | mA |
| (b) Rx mode | - | - | 110 | mA |
| Transmitter | min. | Typ. | Max. | Unit |
| Power Levels | 10 | 12 | 14 | dBm |
| Spectrum Mask | | | | |
| (a) at fc +/- 11MHz | - | - | -20 | dBr |
| (b) at fc +/- 20MHz | - | - | -28 | dBr |
| (c) at fc ≥ +/-30MHz | - | - | -40 | dBr |
| Constellation Error (measured at enhanced mode) | - | - | -27 | dB |
| Spurious Emissions (BW=100kHz) | | | | |
| (a) 10MHz ≤ f < 2387MHz | - | - | -36 | dBm |
| (b) 2387MHz ≤ f < 2400MHz | - | - | -30 | dBm |
| (c) 2483.5MHz < f ≤ 2496.5MHz | - | - | -47 | dBm |
| (d) 2496.5MHz < f ≤ 8GHz | - | - | -47 | dBm |
| Receiver | min. | Typ. | Max. | Unit |
| Minimum Input Level (PER ≤ 10%) | - | - | -64 | dBm |
| Adjacent Channel Rejection (FER ≤ 10%) | -1 | - | - | dB |

11.6 DC/RF Characteristics for IEEE802.11n(HT 40MHz) - 5GHz

Normal Condition : 25deg.C, VBAT =3.6V.

135Mbps (MCS7 – HT 40MHz) mode unless otherwise specified.

| Items | Contents | | | |
|--|---|-------------|-------------|-------------|
| Specification | IEEE802.11n-5GHz | | | |
| Mode | OFDM | | | |
| Channel frequency | 5190 - 5795MHz | | | |
| Data rate | 13.5, 27, 40.5, 54, 81, 108, 121.5, 135Mbps | | | |
| Power setting (Tx power, in dBm) | 11.5 | | | |
| Current Consumption | min. | Typ. | Max. | Unit |
| (a) Tx mode (99% Tx mode) | - | - | 350 | mA |
| (b) Rx mode | - | - | 110 | mA |
| Transmitter | min. | Typ. | Max. | Unit |
| Power Levels | 9.5 | 11.5 | 13.5 | dBm |
| Spectrum Mask | | | | |
| (a) at $f_c \pm 11\text{MHz}$ | - | - | -20 | dBr |
| (b) at $f_c \pm 20\text{MHz}$ | - | - | -28 | dBr |
| (c) at $f_c \geq \pm 30\text{MHz}$ | - | - | -40 | dBr |
| Constellation Error (measured at enhanced mode) | - | - | -27 | dB |
| Spurious Emissions (BW=100kHz) | | | | |
| (a) $10\text{MHz} \leq f < 2387\text{MHz}$ | - | - | -36 | dBm |
| (b) $2387\text{MHz} \leq f < 2400\text{MHz}$ | - | - | -30 | dBm |
| (c) $2483.5\text{MHz} < f \leq 2496.5\text{MHz}$ | - | - | -47 | dBm |
| (d) $2496.5\text{MHz} < f \leq 8\text{GHz}$ | - | - | -47 | dBm |
| Receiver | min. | Typ. | Max. | Unit |
| Minimum Input Level (PER $\leq 10\%$) | - | - | -61 | dBm |
| Adjacent Channel Rejection (FER $\leq 10\%$) | -1 | - | - | dB |

11.7 DC/RF Characteristics for IEEE802.11ac(VHT 40MHz) - 5GHz

Normal Condition : 25deg.C, VBAT =3.6V.

180Mbps (MCS9 – VHT 40MHz) mode unless otherwise specified.

| Items | Contents | | | |
|--|--|-------------|-------------|-------------|
| Specification | IEEE802.11ac-5GHz | | | |
| Mode | OFDM | | | |
| Channel frequency | 5190 - 5795MHz | | | |
| Data rate | 13.5,27,40.5,54,81,108,121.5,135,160,180Mbps | | | |
| Power setting (Tx power, in dBm) | 11.5 | | | |
| Current Consumption | min. | Typ. | Max. | Unit |
| (a) Tx mode (99% Tx mode) | - | - | 350 | mA |
| (b) Rx mode | - | - | 130 | mA |
| Transmitter | min. | Typ. | Max. | Unit |
| Power Levels | 9.5 | 11.5 | 13.5 | dBm |
| Spectrum Mask | | | | |
| (a) at $f_c \pm 21\text{MHz}$ | - | - | -20 | dBr |
| (b) at $f_c \pm 40\text{MHz}$ | - | - | -28 | dBr |
| (c) at $f_c \geq \pm 60\text{MHz}$ | - | - | -40 | dBr |
| Constellation Error (measured at enhanced mode) | - | - | -32 | dB |
| Spurious Emissions (BW=100kHz) | | | | |
| (a) $10\text{MHz} \leq f < 2387\text{MHz}$ | - | - | -36 | dBm |
| (b) $2387\text{MHz} \leq f < 2400\text{MHz}$ | - | - | -30 | dBm |
| (c) $2483.5\text{MHz} < f \leq 2496.5\text{MHz}$ | - | - | -47 | dBm |
| (d) $2496.5\text{MHz} < f \leq 8\text{GHz}$ | - | - | -47 | dBm |
| Receiver | min. | Typ. | Max. | Unit |
| Minimum Input Level (PER $\leq 10\%$) | - | - | -54 | dBm |
| Adjacent Channel Rejection (FER $\leq 10\%$) | -1 | - | - | dB |

11.8 DC/RF Characteristics for IEEE802.11ac(VHT 80MHz)-5GHz

Normal Condition : 25deg.C, VBAT =3.6V.

390Mbps (MCS9 – VHT 80MHz) mode unless otherwise specified.

| Items | Contents | | | |
|--|--|-------------|-------------|-------------|
| Specification | IEEE802.11ac-5GHz | | | |
| Mode | OFDM | | | |
| Channel frequency | 5210 - 5775MHz | | | |
| Data rate | 29.3,58.5,87.8,117,175.5,234,263.3,292.5,351,390Mbps | | | |
| Power setting (Tx power, in dBm) | 11 | | | |
| Current Consumption | min. | Typ. | Max. | Unit |
| (a) Tx mode (99% Tx mode) | - | - | 350 | mA |
| (b) Rx mode | - | - | 160 | mA |
| Transmitter | min. | Typ. | Max. | Unit |
| Power Levels | 9 | 11 | 13 | dBm |
| Spectrum Mask | | | | |
| (a) at $f_c \pm 41\text{MHz}$ | - | - | -20 | dBr |
| (b) at $f_c \pm 80\text{MHz}$ | - | - | -28 | dBr |
| (c) at $f_c \geq \pm 120\text{MHz}$ | - | - | -40 | dBr |
| Constellation Error (measured at enhanced mode) | - | - | -32 | dB |
| Spurious Emissions (BW=100kHz) | | | | |
| (a) $10\text{MHz} \leq f < 2387\text{MHz}$ | - | - | -36 | dBm |
| (b) $2387\text{MHz} \leq f < 2400\text{MHz}$ | - | - | -30 | dBm |
| (c) $2483.5\text{MHz} < f \leq 2496.5\text{MHz}$ | - | - | -47 | dBm |
| (d) $2496.5\text{MHz} < f \leq 8\text{GHz}$ | - | - | -47 | dBm |
| Receiver | min. | Typ. | Max. | Unit |
| Minimum Input Level (PER $\leq 10\%$) | - | - | -51 | dBm |
| Adjacent Channel Rejection (FER $\leq 10\%$) | -1 | - | - | dB |

11.9 DC/RF Characteristics for Bluetooth

Normal conditions : 25 deg.C, VBAT = 3.6V

| Items | Contents | | | |
|---|--------------------------|-------------|-------------|-------------|
| Bluetooth specification (power class) | Version 2.1+EDR (Class1) | | | |
| Channel frequency (spacing) | 2402 to 2480 MHz (1MHz) | | | |
| Current Consumption | Min. | Typ. | Max. | Unit |
| (a) DH5 Packet 50% Rx/Tx slot duty cycle | - | - | 90 | mA |
| (b) 2DH5 Packet 50% Rx/Tx slot duty cycle | - | - | 80 | mA |
| (c) 3DH5 Packet 50% Rx/Tx slot duty cycle | - | - | 80 | mA |
| Transmitter | Min. | Typ. | Max. | Unit |
| Output Power *1 | 7 | 11 | 15 | dBm |
| Frequency range | 2400 | - | 2483.5 | MHz |
| 20dB bandwidth | - | - | 1 | MHz |
| Adjacent Channel Power *2 | | | | |
| (a) [M-N] =2 | - | - | -20 | dBm |
| (b) [M-N] ≥3 | - | - | -40 | dBm |
| Modulation characteristics | | | | |
| (a) Modulation Δf1avg | 140 | - | 175 | kHz |
| (b) Modulation Δf2max | 115 | - | - | kHz |
| (c) Modulation Δf2avg / Δf1avg | 0.8 | - | - | |
| Carrier Frequency Drift | | | | |
| (a) 1slot | -25 | - | +25 | kHz |
| (b) 3slot / 5slot | -40 | - | +40 | kHz |
| (c) Maximum drift rate | -20 | - | +20 | kHz/50us |
| EDR Relative Power | -4 | - | +1 | dB |
| EDR Carrier Frequency Stability and Modulation Accuracy | | | | |
| (a) ωi | -75 | - | +75 | kHz |
| (b) ωi+ωo | -75 | - | +75 | kHz |
| (c) ωo | -10 | - | +10 | kHz |
| (d) RMS DEVM (DQPSK) | - | - | 20 | % |
| (e) Peak DEVM (DQPSK) | - | - | 35 | % |
| (f) 99% DEVM (DQPSK) | - | - | 30 | % |
| (g) RMS DEVM (8DPSK) | - | - | 13 | % |
| (h) Peak DEVM (8DPSK) | - | - | 25 | % |
| (i) 99% DEVM (8DPSK) | - | - | 20 | % |
| Spurious Emissions (BW=100kHz) | | | | |
| (a) 10MHz ≤ f < 2387MHz | - | - | -36 | dBm |
| (b) 2387MHz ≤ f < 2400MHz | - | - | -30 | dBm |
| (c) 2483.5MHz < f ≤ 2496.5MHz | - | - | -47 | dBm |
| (d) 2496.5MHz < f ≤ 8GHz | - | - | -47 | dBm |
| Receiver | Min. | Typ. | Max. | Unit |
| Sensitivity (BER≤0.1%) | - | - | -80 | dBm |
| C/I Performance (BER≤0.1%) *3 | | | | |
| (a) co-channel | - | - | 11 | dB |
| (b) 1MHz | - | - | 0 | dB |
| (c) 2MHz | - | - | -30 | dB |
| (d) 3MHz | - | - | -40 | dB |
| (e) image (+4MHz) | - | - | -9 | dB |
| (f) image +/- 1MHz | - | - | -20 | dB |
| Maximum Input Level (BER≤0.1%) | -20 | - | - | dBm |
| EDR Sensitivity (BER≤0.007%) | | | | |
| (a) 8DPSK | - | - | -77 | dBm |

*1: Up to three spurious responses within Bluetooth limits are allowed.

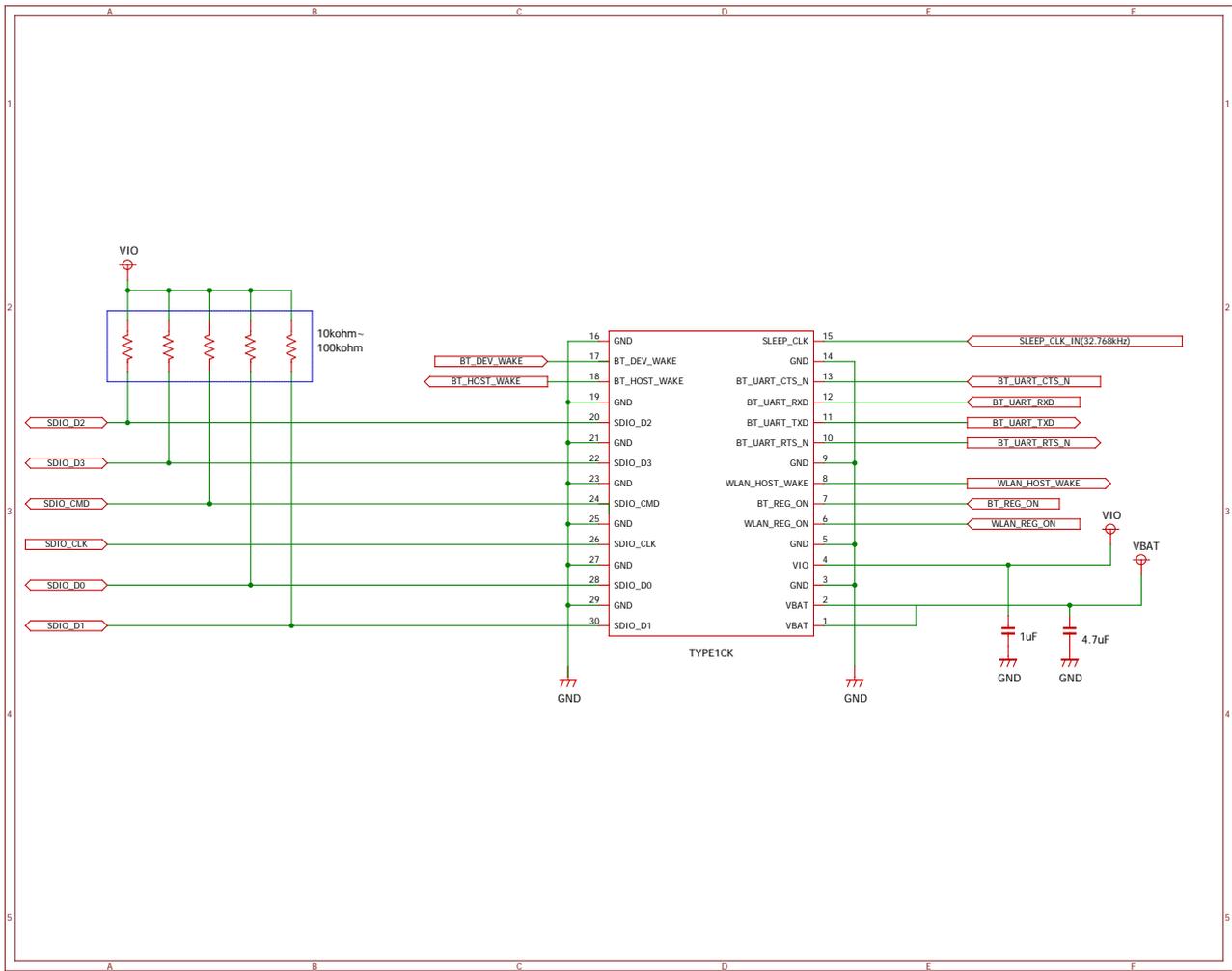
*2: Up to five spurious responses within Bluetooth limits are allowed.

11.10 DC/RF Characteristics for Bluetooth (LE)

Normal conditions : 25 deg.C, VBAT = 3.6V

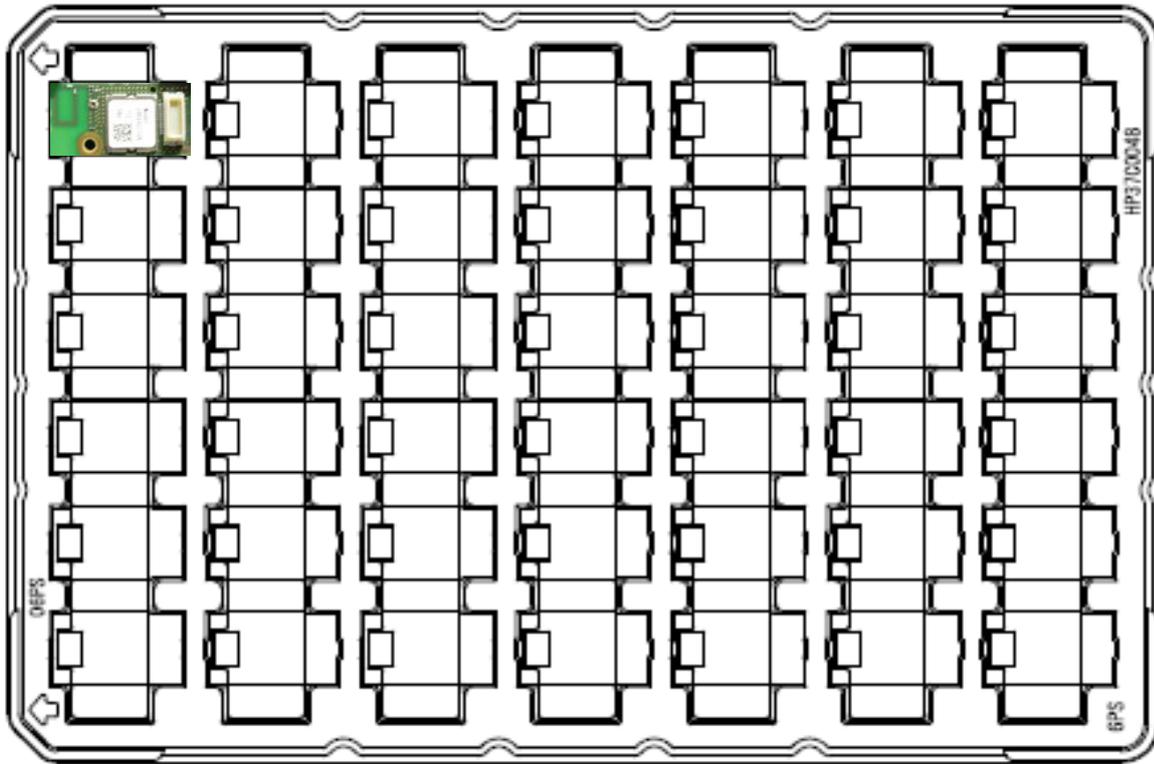
| Items | Contents | | | |
|--|-------------------------|------|------|------|
| Bluetooth specification (power class) | Version 4.1(LE) | | | |
| Channel frequency (spacing) | 2402 to 2480 MHz (2MHz) | | | |
| Number of RF Channel | 40 | | | |
| Item / Condition | Min. | Typ. | Max. | Unit |
| Center Frequency | 2402 | - | 2480 | MHz |
| Channel Spacing | - | 2 | - | MHz |
| Number of RF channel | - | 40 | - | - |
| Output power *1 | - | - | 10 | dBm |
| Modulation Characteristics | | | | |
| 1) $\Delta f_{1\text{avg}}$ | 225 | - | 275 | kHz |
| 2) $\Delta f_{2\text{max}}$ (at 99.9%) | 185 | - | - | kHz |
| 3) $\Delta f_{2\text{avg}} / \Delta f_{1\text{avg}}$ | 0.8 | - | - | - |
| Carrier frequency offset and drift | | | | |
| 1) Frequency offset | - | - | 150 | kHz |
| 2) Frequency drift | - | - | 50 | kHz |
| 3) Drift rate | - | - | 20 | kHz |
| Receiver sensitivity (PER < 30.8%) | - | - | -70 | dBm |
| Maximum input signal level (PER < 30.8%) | -10 | - | - | dBm |
| PER Report Integrity (-30dBm input) | 50 | - | 65.4 | % |

12 REFERENCE CIRCUIT



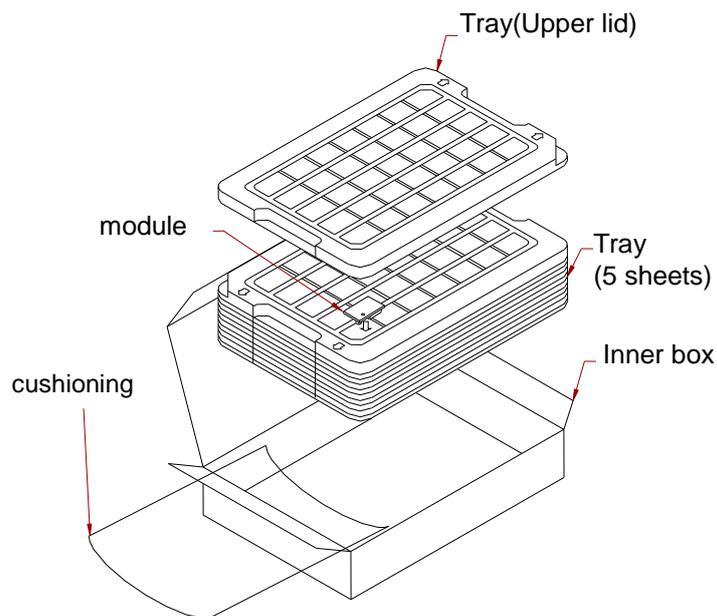
13 Packing Information

The products shall be packed in the below tray.

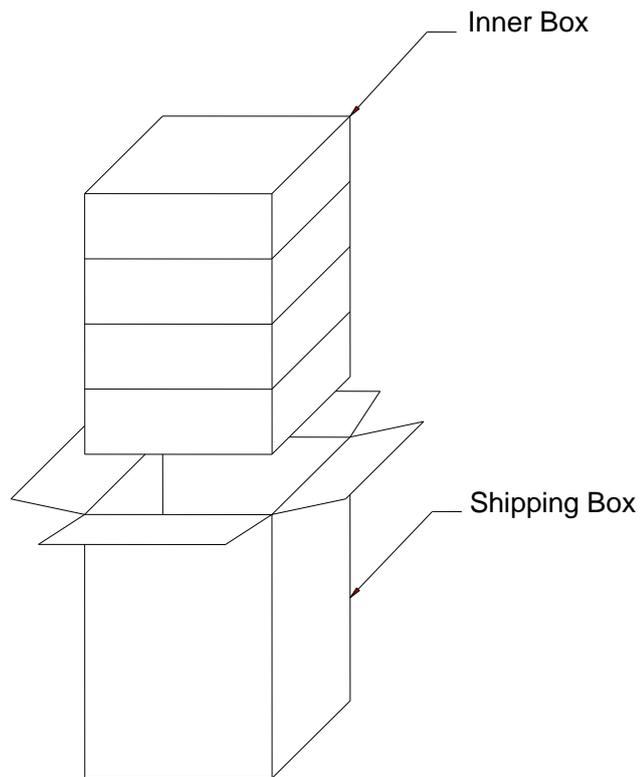


Number of the products in the carton is 210pcs.
There is the 42pcs per tray and 5pile number of the tray which stored the product.
Finally, a dummy tray is put on the topmost part of trays.

Packing in a inner box



Shipping box



- Please keep any packaging below 40 deg.C until using it up, because a tray is potentially deformed with storage over the temperature.
- Please don't stack the shipping box over 1.5m height to avoid any physical problem.
- Four inner boxes is general number in a shipping box, but it may be dummy for some of inner boxes.
- One inner box has 210pcs as standard q'ty.
- MOQ is 840pcs, which are constructed two inner boxes.

NOTICE

1. Storage Conditions :

Please use this product within 6month after receipt.

- The product shall be stored without opening the packing under the ambient temperature from 5 to 35deg.C and humidity from 20 to 70%RH.

(Packing materials, in particular, may be deformed at the temperature over 40deg.C.)

- The product left more than 6months after reception, it needs to be confirmed the solderbility before used.

- The product shall be stored in non corrosive gas (Cl₂, NH₃, SO₂, NO_x, etc.).

- Any excess mechanical shock including, but not limited to, sticking the packing materials by sharp object and dropping the product, shall not be applied in order not to damage the packing materials.

2. Handling Conditions :

Be careful in handling or transporting products because excessive stress or mechanical shock may break products.

Handle with care if products may have cracks or damages on their terminals, the characteristics of products may change. Do not touch products with bear hands that may destroy by static electrical charge.

3. Cleaning :

Since this Product is Moisture Sensitive, any cleaning is not permitted.

4. Operational Environment Conditions :

Products are designed to work for electronic products under normal environmental conditions (ambient temperature, humidity and pressure). Therefore, products have no problems to be used under the similar conditions to the above-mentioned. However, if products are used under the following circumstances, it may damage products and leakage of electricity and abnormal temperature may occur.

- In an atmosphere containing corrosive gas (Cl₂, NH₃, SO_x, NO_x etc.).
- In an atmosphere containing combustible and volatile gases.
- Dusty place.
- Direct sunlight place.
- Water splashing place.
- Humid place where water condenses.
- Freezing place.

If there are possibilities for products to be used under the preceding clause, consult with Murata before actual use.

As it might be a cause of degradation or destruction to apply static electricity to products, do not apply static electricity or excessive voltage while assembling and measuring.

5. Input Power Capacity :

Products shall be used in the input power capacity as specified in this specifications.

Inform Murata beforehand, in case that the components are used beyond such input power capacity range.

PRECONDITION TO USE OUR PRODUCTS

PLEASE READ THIS NOTICE BEFORE USING OUR PRODUCTS.

Please make sure that your product has been evaluated and confirmed from the aspect of the fitness for the specifications of our product when our product is mounted to your product.

All the items and parameters in this product specification/datasheet/catalog have been prescribed on the premise that our product is used for the purpose, under the condition and in the environment specified in this specification. You are requested not to use our product deviating from the condition and the environment specified in this specification.

Please note that the only warranty that we provide regarding the products is its conformance to the specifications provided herein. Accordingly, we shall not be responsible for any defects in products or equipment incorporating such products, which are caused under the conditions other than those specified in this specification.

WE HEREBY DISCLAIMS ALL OTHER WARRANTIES REGARDING THE PRODUCTS, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE, THAT THEY ARE DEFECT-FREE, OR AGAINST INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS.

The product shall not be used in any application listed below which requires especially high reliability for the prevention of such defect as may directly cause damage to the third party's life, body or property. You acknowledge and agree that, if you use our products in such applications, we will not be responsible for any failure to meet such requirements. Furthermore, YOU AGREE TO INDEMNIFY AND DEFEND US AND OUR AFFILIATES AGAINST ALL CLAIMS, DAMAGES, COSTS, AND EXPENSES THAT MAY BE INCURRED, INCLUDING WITHOUT LIMITATION, ATTORNEY FEES AND COSTS, DUE TO THE USE OF OUR PRODUCTS IN SUCH APPLICATIONS.

- Aircraft equipment. - Aerospace equipment - Undersea equipment.
- Power plant control equipment - Medical equipment.
- Transportation equipment (vehicles, trains, ships, elevator, etc.).
- Traffic signal equipment. - Disaster prevention / crime prevention equipment.
- Burning / explosion control equipment
- Application of similar complexity and/ or reliability requirements to the applications listed in the above.

We expressly prohibit you from analyzing, breaking, reverse-engineering, remodeling altering, and reproducing our product. Our product cannot be used for the product which is prohibited from being manufactured, used, and sold by the regulations and laws in the world.

We do not warrant or represent that any license, either express or implied, is granted under any our patent right, copyright, mask work right, or our other intellectual property right relating to any combination, machine, or process in which our products or services are used. Information provided by us regarding third-party products or services does not constitute a license from us to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from us under our patents or other intellectual property.

Please do not use our products, our technical information and other data provided by us for the purpose of developing of mass-destruction weapons and the purpose of military use.

Moreover, you must comply with "foreign exchange and foreign trade law", the "U.S. export administration regulations", etc.

Please note that we may discontinue the manufacture of our products, due to reasons such as end of supply of materials and/or components from our suppliers.

By signing on specification sheet or approval sheet, you acknowledge that you are the legal representative for your company and that you understand and accept the validity of the contents herein. When you are not able to return the signed version of specification sheet or approval sheet within 30 days from receiving date of specification sheet or approval sheet, it shall be deemed to be your consent on the content of specification sheet or approval sheet. Customer acknowledges that engineering samples may deviate from specifications and may contain defects due to their development status. We reject any liability or product warranty for engineering samples. In particular we disclaim liability for damages caused by

- the use of the engineering sample other than for evaluation purposes, particularly the installation or integration in the product to be sold by you,
- deviation or lapse in function of engineering sample,
- improper use of engineering samples.

We disclaim any liability for consequential and incidental damages.

If you can't agree the above contents, you should inquire our sales.