

Type 2BZ Wi-Fi® + Bluetooth® Module

Infineon Chipset CYW54590 for 802.11a/b/g/n/ac 2x2 MIMO
+ Bluetooth 5.2 Datasheet - Rev. C

- Design Name: Type 2BZ
- Module P/N: LBEE5XV2BZ-883



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About This Document

Type 2BZ is a small and very high-performance module based on Infineon CYW54590 combo chipset which supports Wi-Fi 802.11a/b/g/n/ac 2x2 MIMO + Bluetooth 5.2 BR/EDR/LE. This datasheet describes Type 2BZ module in detail.



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.









Audience & Purpose

Intended audience includes any customer looking to integrate this module into their product; specifically RF, hardware, software, and systems engineers.

Document Conventions

Table 1 describes the document conventions.


Table 1: Document Conventions

Conventions	Description
	Warning Note Indicates very important note. Users are strongly recommended to review.
	Info Note Intended for informational purposes. Users should review.
	Menu Reference Indicates menu navigation instructions. Example: Insert → Tables → Quick Tables → Save Selection to Gallery 
	External Hyperlink This symbol indicates a hyperlink to an external document or website. Example: Murata  Click on the text to open the external link.
	Internal Hyperlink This symbol indicates a hyperlink within the document. Example: Scope  Click on the text to open the link.
<code>Console input/output or code snippet</code>	Console I/O or Code Snippet This text Style denotes console input/output or a code snippet.
<code># Console I/O comment // Code snippet comment</code>	Console I/O or Code Snippet Comment This text Style denotes a console input/output or code snippet comment. <ul style="list-style-type: none"> • Console I/O comment (preceded by "#") is for informational purposes only and does not denote actual console input/output. • Code Snippet comment (preceded by "//") may exist in the original code.

1 Scope

This specification characterizes the IEEE 802.11a/b/g/n/ac 2x2 MIMO + Bluetooth 5.2 BR/EDR/LE combo module.

2 Key Features

- ◆ Infineon CYW54590 inside
- ◆ Supports IEEE 802.11a/b/g/n/ac 2x2: Dual band 2.4 GHz and 5 GHz
- ◆ MIMO with 20 MHz, 40 MHz, and 80 MHz channels
- ◆ Up to MCS9 data rates (866 Mbps)
- ◆ Supports Bluetooth specification version 5.2
- ◆ For supported Bluetooth functions, refer to [Bluetooth SIG site](#) 
- ◆ WLAN interface: SDIO 3.0
- ◆ Bluetooth interface: HCI UART, I²S, and PCM
- ◆ Temperature Range: -40 °C to 85 °C
- ◆ Dimensions 11.4 x 8.9 x 1.4 mm
- ◆ Weight: 0.36 g
- ◆ MSL: 3
- ◆ Surface-mount type
- ◆ RoHS compliant

3 Ordering Information

The part number and associated ordering information is shown in **Table 2**.

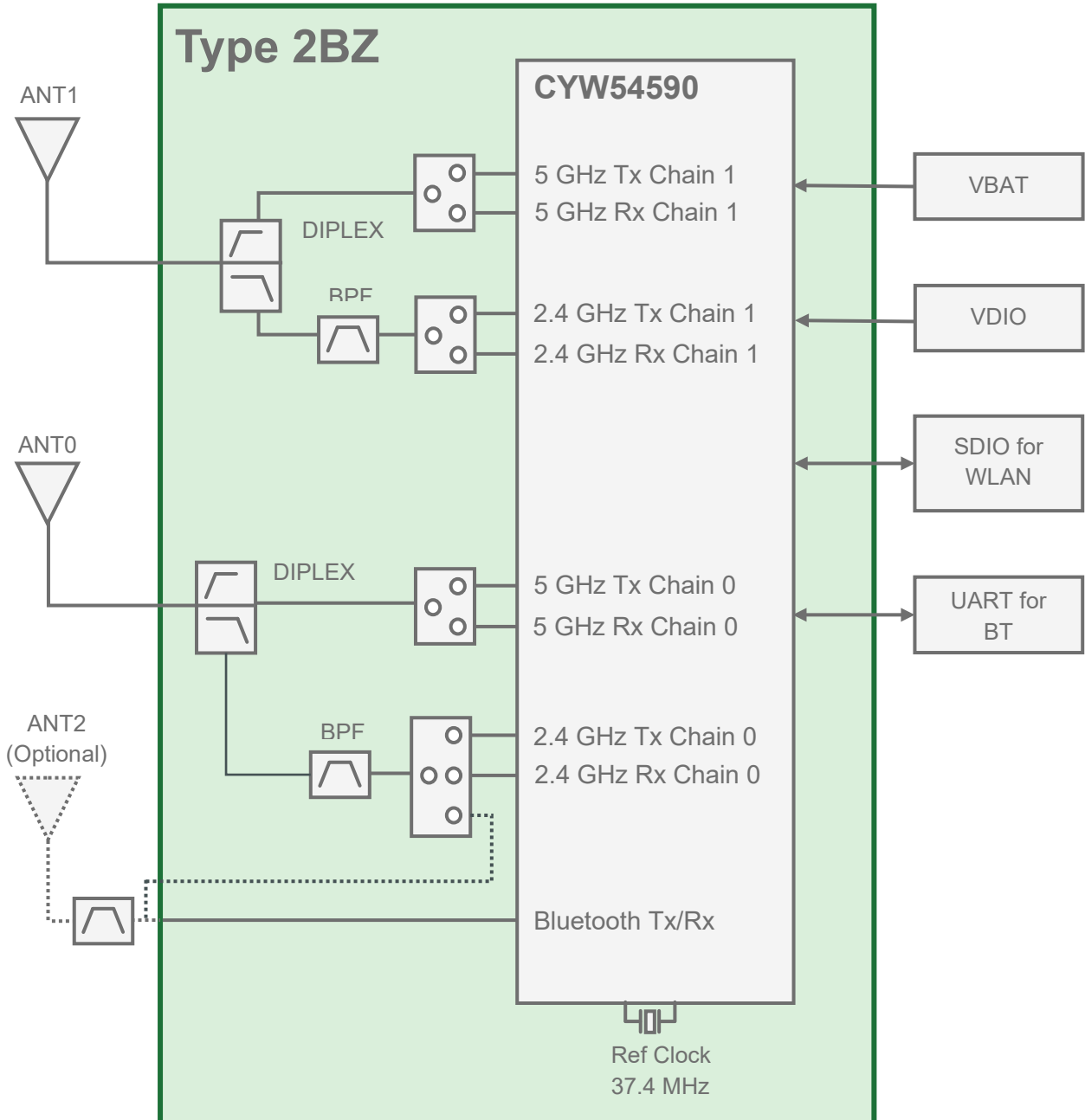
Table 2: Ordering Information

Ordering Part Number	Description
LBEE5XV2BZ-883	Module order
LBEE5XV2BZ-SMP	Sample module order (If module samples are not available through distribution, contact Murata referencing this part number)
EAR00414	Embedded Artists Type 2BZ M.2 EVB (default EVB available through distribution)
LBEE5XV2BZ-EVB	Murata Type 2BZ M.2 EVB (contact Murata as this is special order item)

4 Block Diagram

The Type 2BZ block diagram is presented in **Figure 1**.

Figure 1: Block Diagram



5 Dimensions, Markings, and Terminal Configurations

The dimensions, markings, and terminal configurations are labelled in **Figure 2**.

Figure 2: Dimensions, Markings and Terminal Configurations

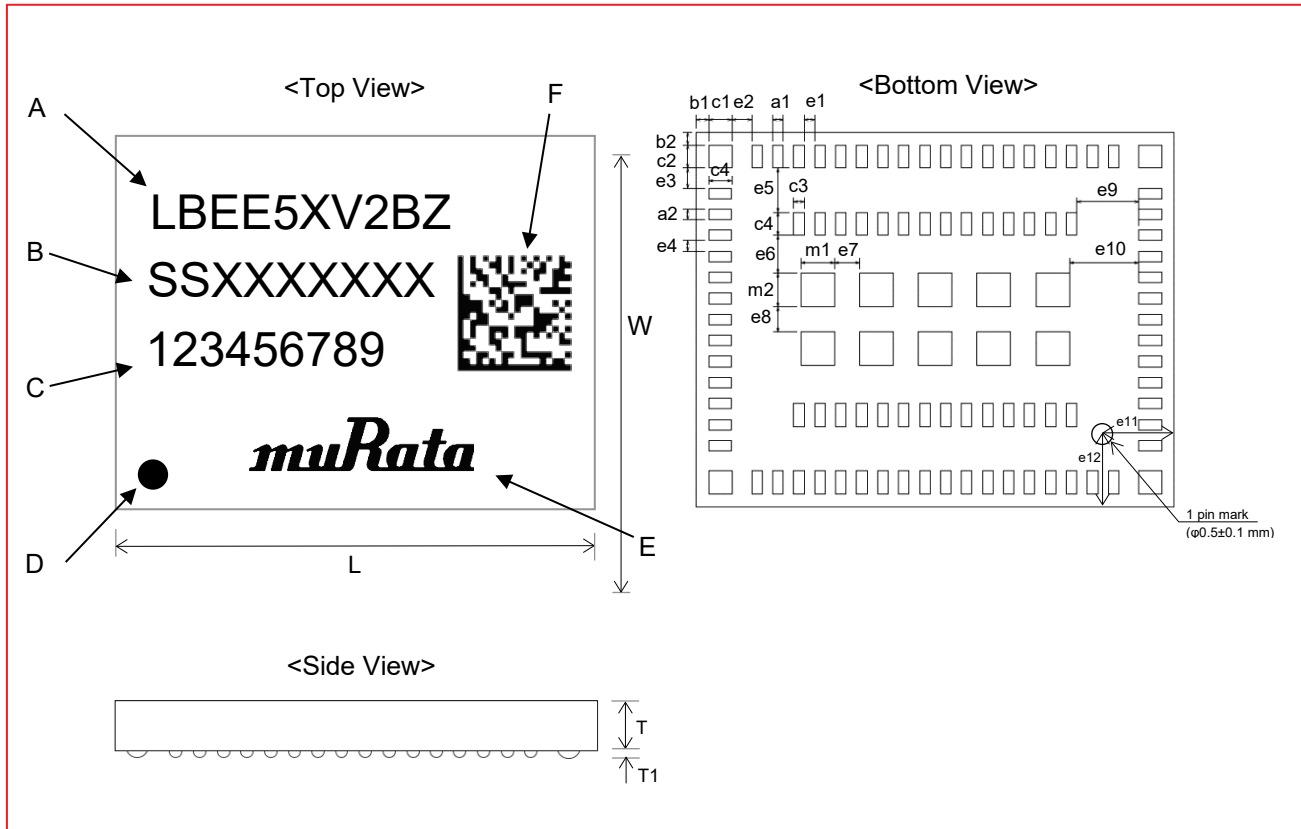


Table 3 describes the marking labels for the top and bottom view as shown in **Figure 2**.

Table 3: Markings

Markings	Meaning
A	Module Part Number
B	Inspection Number
C	Serial Number
D	Pin 1 Marking
E	Murata Logo
F	2D code

Table 4 describes the Type 2BZ dimensions.

Table 4: Dimensions

Mark	Dimensions (mm)	Mark	Dimensions (mm)	Mark	Dimensions (mm)	Mark	Dimensions (mm)
L	11.4 ± 0.2	W	8.9 ± 0.2	T	1.4 maximum	T1	0.04 typical
a1	0.25 ± 0.1	a2	0.25 ± 0.1	b1	0.3 ± 0.2	b2	0.3 ± 0.2
c1	0.55 ± 0.1	c2	0.55 ± 0.1	c3	0.25 ± 0.1	c4	0.55 ± 0.1
e1	0.25 ± 0.1	e2	0.475 ± 0.1	e3	0.475 ± 0.1	e4	0.25 ± 0.1
e5	1.05 ± 0.1	e6	0.9 ± 0.1	e7	0.6 ± 0.1	e8	0.6 ± 0.1
e9	1.475 ± 0.1	e10	1.65 ± 0.1	e11	1.787 ± 0.2	e12	1.609 ± 0.2
m1	0.8 ± 0.1	m2	0.8 ± 0.1				

6 Module Pin Descriptions

This section describes the module pin assignments layout descriptions along with the pin descriptions.

6.1 Pin Assignments

The pin assignment (top view) layout is shown in **Figure 3**.

Figure 3: Pin Assignments (Top View)

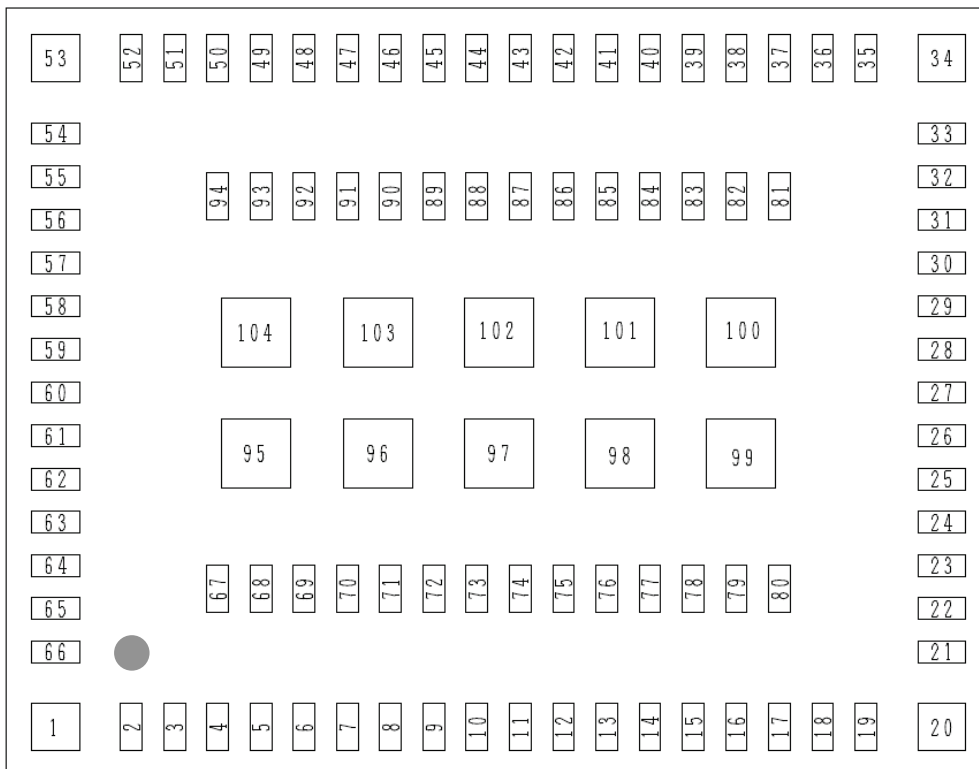


Table 5 describes the terminal configurations.

Table 5: Terminal Configurations

No.	Terminal Name	No.	Terminal Name	No.	Terminal Name
1	GND	31	RF_SW_CTRL11	61	SDIO_DATA_3
2	GPIO_17	32	GND	62	SDIO_DATA_2
3	GPIO_18	33	ANT_1	63	SDIO_DATA_1
4	GPIO_19	34	GND	64	GND
5	WL_REG_ON	35	GND	65	VBAT
6	BT_REG_ON	36	BT_UART_RTS_N	66	VBAT
7	GND	37	BT_UART_CTS_N	67-73	GND
8	VDDIO	38	BT_UART_RXD	74	BT_PCM_IN
9	GND	39	BT_UART_TXD	75	BT_PCM_OUT
10	GND	40	GPIO_5	76	BT_PCM_CLK
11	GND	41	GPIO_4	77	BT_PCM_SYNC
12	BT_OUT	42	GPIO_7	78	GND
13	GND	43	GPIO_6	79	RF_SW_CTRL4
14	BT_IN	44	NC	80	GND
15	GND	45	NC	81	RF_SW_CTRL12
16	RF_SW_CTRL5	46	NC	82	BT_GPIO_5
17	GND	47	GND	83	BT_GPIO_4
18	GND	48	NC	84	BT_GPIO_2
19	ANT_0	49	NC	85	BT_GPIO_3
20	GND	50	GND	86	GPIO_3
21	GND	51	NC	87	JTAG_SEL
22	BT_HOST_WAKE	52	NC	88	GPIO_2
23	BT_DEV_WAKE	53	GND	89	GPIO_1
24	CLK_REQ	54	NC	90	GPIO_0
25	LPO_IN	55	NC	91	GPIO_8
26	BT_I2S_DO	56	GND	92	GPIO_9
27	BT_I2S_DI	57	VDDIO	93	GPIO_10
28	BT_I2S_CLK	58	SDIO_CMD	94	GPIO_11
29	BT_I2S_WS	59	SDIO_CLK	95-104	GND
30	GND	60	SDIO_DATA_0		

6.2 Pin Descriptions

Type 2BZ module pins are described in **Table 6**.

Table 6: Pin Descriptions

No.	Pin Name	Type	Connection to IC Pin Name	Description
1	GND	-	-	Ground
2	GPIO_17	I/O	GPIO_17	Programmable GPIO Pin
3	GPIO_18	I/O	GPIO_18	Programmable GPIO Pin
4	GPIO_19	I/O	GPIO_19	Programmable GPIO Pin
5	WL_REG_ON	I	WL_REG_ON	Used by PMU to power up or power down the internal CYW54590 regulators used by the WLAN section. Also, when de-asserted, this pin holds the WLAN section in reset. This pin has an internal 200 kΩ pull-down resistor that is enabled by default. It can be disabled through programming.
6	BT_REG_ON	I	BT_REG_ON	Used by PMU to power up or power down the internal CYW54590 regulators used by the Bluetooth section. Also, when de-asserted, this pin holds the Bluetooth section in reset. This pin has an internal 200 kΩ pull-down resistor that is enabled by default. It can be disabled through programming.
7	GND			Ground
8	VDDIO	I	SYS_VDDIO WCC_VDDIO BT_VDDO VDDIO	IO supply
9	GND			Ground
10	GND			Ground
11	GND			Ground
12	BT_OUT			
13	GND			Ground
14	BT_IN			
15	GND			Ground
16	RF_SW_CTRL5	O	O	Programmable RF switch control lines. The control lines are programmable via the driver and NVRAM file.
17	GND			Ground
18	GND			Ground
19	ANT_0			RF Port for WLAN (2.4 GHz & 5 GHz) and BT
20	GND			Ground
21	GND			Ground
22	BT_HOST_WAKE	O	BT_HOST_WAKE	Host wake-up: Signal from the module to the host indicating that the module requires attention.

No.	Pin Name	Type	Connection to IC Pin Name	Description
23	BT_DEV_WAKE	I	BT_DEV_WAKE	Bluetooth device wake-up: Signal from the host to the module indicating that the host requires attention.
24	CLK_REQ	I/O	CLK_REQ	Reference clock request (shared by BT and WLAN). If not used, this can be no-connect.
25	LPO_IN	I	LPO_IN	External sleep clock input (32.768 kHz)
26	BT_I2S_DO	I/O	BT_I2S_DO	I ² S data output
27	BT_I2S_DI	I/O	BT_I2S_DI	I ² S data input
28	BT_I2S_CLK	I/O	BT_I2S_CLK	I ² S clock, can be master (output) or slave (input).
29	BT_I2S_WS	I/O	BT_I2S_WS	I ² S WS, can be master (output) or slave (input).
30	GND	-	-	Ground
31	RF_SW_CTRL11	O	RF_SW_CTRL11	Programmable RF switch control lines. The control lines are programmable via the driver and NVRAM file.
32	GND			Ground
33	ANT_1			RF Port for WLAN (2.4 GHz & 5 GHz)
34	GND			Ground
35	GND			Ground
36	BT_UART_RTS_N	O	BT_UART_RTS_N	UART request-to-send. Active-low request-to-send signal for the HCI UART interface. BT LED control pin.
37	BT_UART_CTS_N	I	BT_UART_CTS_N	UART clear-to-send. Active-low clear-to-send signal for the HCI UART interface.
38	BT_UART_RXD	I	BT_UART_RXD	UART serial input. Serial data input for the HCI UART interface.
39	BT_UART_TXD	O	BT_UART_TXD	UART serial output. Serial data output for the HCI UART interface.
40	GPIO_5		GPIO_5	Programmable GPIO pins.
41	GPIO_4		GPIO_4	
42	GPIO_7		GPIO_7	
43	GPIO_6		GPIO_6	
44	NC	-	-	No Connect
45	NC	-	-	No Connect
46	NC	-	-	No Connect
47	GND	-	-	Ground
48	NC	-	-	No Connect
49	NC	-	-	No Connect
50	GND	-	-	Ground
51	NC	-	-	No Connect
52	NC	-	-	No Connect
53	GND	-	-	Ground
54	NC	-	-	No Connect
55	NC	-	-	No Connect
56	GND	-	-	Ground

No.	Pin Name	Type	Connection to IC Pin Name	Description
57	VDDIO_SD	PWR	VDDIO_SD	1.8V–3.3V supply for SDIO pads.
58	SDIO_CMD	I/O	SDIO_CMD	SDIO command line.
59	SDIO_CLK	I	SDIO_CLK	SDIO clock input.
60	SDIO_DATA_0	I/O	SDIO_DATA_0	SDIO data line 0.
61	SDIO_DATA_3	I/O	SDIO_DATA_3	SDIO data line 3.
62	SDIO_DATA_2	I/O	SDIO_DATA_2	SDIO data line 2.
63	SDIO_DATA_1	I/O	SDIO_DATA_1	SDIO data line 1.
64	GND	-	-	Ground
65	VBAT	PWR	SR_VDDBAT5V	VBAT Supply
66			LDO_VDDBAT5V	
67-73	GND	-	-	Ground
74	BT_PCM_IN	I	BT_PCM_IN	PCM data input.
75	BT_PCM_OUT	O	BT_PCM_OUT	PCM data output.
76	BT_PCM_CLK	I/O	BT_PCM_CLK	PCM clock; can be master (output) or slave (input).
77	BT_PCM_SYNC	I/O	BT_PCM_SYNC	PCM sync; can be master (output) or slave (input).
78	GND	-	-	Ground
79	RF_SW_CTRL4	O	RF_SW_CTRL4	Programmable RF switch control lines. The control lines are programmable via the driver and NVRAM file.
80	GND	-	-	Ground
81	RF_SW_CTRL12	O	RF_SW_CTRL12	Programmable RF switch control lines. The control lines are programmable via the driver and NVRAM file.
82	BT_GPIO_5	I/O	BT_GPIO_5	Bluetooth general-purpose I/O.
83	BT_GPIO_4	I/O	BT_GPIO_4	
84	BT_GPIO_2	I/O	BT_GPIO_2	
85	BT_GPIO_3	I/O	BT_GPIO_3	
86	GPIO_3	I/O	GPIO_3	Programmable GPIO pins.
87	JTAG_SEL	I/O	JTAG_SEL	JTAG select: pull high to select the JTAG interface. If the JTAG interface is not used this pin may be left floating or connected to ground.
88	GPIO_2	I/O	GPIO_2	Programmable GPIO pins.
89	GPIO_1	I/O	GPIO_1	
90	GPIO_0	I/O	GPIO_0	
91	GPIO_8	I/O	GPIO_8	
92	GPIO_9	I/O	GPIO_9	
93	GPIO_10	I/O	GPIO_10	
94	GPIO_11	I/O	GPIO_11	
95-104	GND	-	-	Ground

7 Absolute Maximum Ratings

Table 7 shows the absolute maximum rating values.

Table 7: Absolute Maximum Ratings

Parameter		Minimum	Maximum	Unit
Storage Temperature		-40	+85	°C
Supply Voltage	VBAT	-0.5	+6.0	V
	VDDIO	-0.5	+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 is set within operating condition.

8 Operating Conditions

Table 8 shows the operating conditions for Type 2BZ module.

Table 8: Operating Conditions

Parameter		Minimum	Typical	Maximum	Unit
Operating Temperature		-40	25	85	°C
Specification Temperature		-10	25	70	°C
Operating Voltage	VBAT	3.0	3.3	4.8	V
	VDDIO	1.62	1.8 or 3.3	3.63	V



Minimum voltage of VBAT is sensitive to get RF performance, so please keep minimum voltages level at the input of these module terminals, otherwise RF performance significantly goes worse.

9 External LPO_IN Signal Requirements

The external LPO_IN signal requirements parameters are listed in **Table 9**.

Table 9: External LPO_IN Signal Requirements

Parameter	External LPO_IN Clock	Unit
Nominal input frequency	32.768	kHz
Frequency accuracy	+/-250	ppm
Duty cycle	30-70	%
Input signal amplitude	200 - 3300	mV, p-p
Signal type	Square-wave or sinewave	-
Input impedance ¹	> 100k	Ω
	< 5	pF
Clock jitter (during initial start-up)	<10,000	ppm

¹ When power is applied or switched off.

10 I/O States

The following notations are used in I/O State Table (**Table 10**).

- **I**: Input signal
- **O**: Output signal
- **I/O**: Input/Output signal
- **PU** = Pulled up
- **PD** = Pulled down
- **NoPull** = Neither pulled up nor pulled down
- Where applicable, the default value is shown in brackets (for example, [default value])

Table 10: I/O State Table

Name	I/O	Keeper	Active Mode	Low Power State/Sleep (All Power Present)	Power-down (BT_REG_ON and WL_REG_ON Held Low)	Out-of-Reset. Before SW Download (BT_REG_ON High. WL_REG_ON High)	Power-down (WL_REG_ON High and BT_REG_ON=0) and VDDIOs Are Present	Power Rail
WL_REG_ON BT_REG_ON	I	N	I: PD Pull-down can be disabled	I: PD Pull-down can be disabled	I: PD (of 200K)	I: PD (of 200K)	I: PD (of 200K)	
GPIO_0	I/O	Y	I/O: PU, PD, NoPull Programmable [PD]	I/O: PU, PD, NoPull Programmable [PD]	High-Z, NoPull	I: PD	I: PD	VDDIO
GPIO_1	I/O	Y	I/O: PU, PD, NoPull Programmable [NoPull]	I/O: PU, PD, NoPull Programmable [NoPull]	High-Z, NoPull	I: NoPull	I: NoPull	VDDIO
GPIO_2	I/O	Y	I/O: PU, PD, NoPull Programmable [NoPull]	I/O: PU, PD, NoPull Programmable [NoPull]	High-Z, NoPull	I: NoPullb	I: NoPull	VDDIO
GPIO_3	I/O	Y	I/O: PU, PD, NoPull Programmable [NoPull]	I/O: PU, PD, NoPull Programmable [NoPull]	High-Z, NoPull	I: NoPullb	I: NoPull	VDDIO
GPIO_4	I/O	Y	I/O: PU, PD, NoPull Programmable [NoPull]	I/O: PU, PD, NoPull Programmable [NoPull]	High-Z, NoPull	I: NoPullb	I: NoPull	VDDIO
GPIO_5	I/O	Y	I/O: PU, PD, NoPull Programmable [NoPull]	I/O: PU, PD, NoPull Programmable [NoPull]	High-Z, NoPull	I: NoPullb	I: NoPull	VDDIO
GPIO_6	I/O	Y	I/O: PU, PD, NoPull Programmable [NoPull]	I/O: PU, PD, NoPull Programmable [NoPull]	High-Z, NoPull	I: NoPullb	I: NoPull	VDDIO
GPIO_7	I/O	Y	I/O: PU, PD, NoPull	I/O: PU, PD, NoPull	High-Z, NoPull	I: NoPull	I: NoPull	VDDIO

Name	I/O	Keeper	Active Mode	Low Power State/Sleep (All Power Present)	Power-down (BT_REG_ON and WL_REG_ON Held Low)	Out-of-Reset. Before SW Download (BT_REG_ON High. WL_REG_ON High)	Power-down (WL_REG_ON High and BT_REG_ON=0) and VDDIOs Are Present	Power Rail
			Programmable [NoPull]	Programmable [NoPull]				
GPIO_8	I/O	Y	I/O: PU, PD, NoPull Programmable [NoPull]	I/O: PU, PD, NoPull Programmable [NoPull]	High-Z, NoPull	I: NoPull	I: NoPull	VDDIO
GPIO_9	I/O	Y	I/O: PU, PD, NoPull Programmable [PU]	I/O: PU, PD, NoPull Programmable [NoPull]	I: PU	I: PU	I:PU	VDDIO
GPIO_10	I/O	Y	I/O: PU, PD, NoPull Programmable [NoPull]	I/O: PU, PD, NoPull Programmable [NoPull]	High-Z, NoPull	I: NoPull	I: NoPull	VDDIO
GPIO_11	I/O	Y	I/O: PU, PD, NoPull Programmable [PU]	I/O: PU, PD, NoPull Programmable [PU]	I: PU	I: PU	I:PU	VDDIO
GPIO_17	I/O	Y	I/O: PU, PD, NoPull Programmable [NoPull]	I/O: PU, PD, NoPull Programmable [NoPull]	High-Z, NoPull	I: NoPull	I: NoPull	VDDIO
GPIO_18	I/O	Y	I/O: PU, PD, NoPull Programmable [NoPull]	I/O: PU, PD, NoPull Programmable [NoPull]	High-Z, NoPull	I: NoPull	I: NoPull	VDDIO
GPIO_19	I/O	Y	I/O: PU, PD, NoPull Programmable [NoPull]	I/O: PU, PD, NoPull Programmable [NoPull]	High-Z, NoPull	I: NoPull	I: NoPull	VDDIO
RF_SW_CTRL_X	O	N	O: NoPull	O: NoPull	High-Z, NoPull	O: NoPull	O: NoPull	VDDIO_RF
CLK_REQ	O	Y	Open drain or push-pull (programmable).Active high.	Open drain or push-pull (programmable).Active high.	High-Z, NoPull	Open drain. Active high	Open drain. Active high	BT_VDDO
BT_HOST_WAKE	O	Y	Input/Output; PU, PD, NoPull (programmable)	Input/Output; PU, PD, NoPull (programmable)	High-Z, NoPull	Input, PU	Input, PD	BT_VDDO
BT_DEV_WAKE	I	Y	Input/Output; PU, PD, NoPull (programmable)	Input/Output; PU, PD, NoPull (programmable)	High-Z, NoPull	Input, PD	Input, PD	BT_VDDO
BT_GPIO_2 BT_GPIO_3	I/O	Y	Input/Output; PU, PD, NoPull (programmable)	Input/Output; PU, PD, NoPull (programmable)	High-Z, NoPull	Input, PD	Input, PD	BT_VDDO
BT_GPIO_4 BT_GPIO_5	I/O	Y	Input/Output; PU, PD, NoPull (programmable)	Input/Output; PU, PD, NoPull (programmable)	High-Z, NoPull	Input, PU	Input, PU	BT_VDDO

Name	I/O	Keeper	Active Mode	Low Power State/Sleep (All Power Present)	Power-down (BT_REG_ON and WL_REG_ON Held Low)	Out-of-Reset. Before SW Download (BT_REG_ON High. WL_REG_ON High)	Power-down (WL_REG_ON High and BT_REG_ON=0) and VDDIOs Are Present	Power Rail
BT_UART_CTS_N	I	Y	Input, NoPull	Input, NoPull	High-Z, NoPull	Input, PU	Input, PU	BT_VDDO
BT_UART_RTS_N	O	Y	Output, NoPull	Output, NoPull	High-Z, NoPull	Input, PU	Input, PU	BT_VDDO
BT_UART_RXD	I	Y	Input, NoPull	Input, NoPull	High-Z, NoPull	Input, PU	Input, PU	BT_VDDO
BT_UART_TXD	O	Y	Output, NoPull	Output, NoPull	High-Z, NoPull	Input, PU	Input, PU	BT_VDDO
BT_PCM_CLK	I/O	Y	Input, NoPull	Input, NoPull	High-Z, NoPull	Input, PD	Input, PD	BT_VDDO
BT_PCM_IN	I/O	Y	Input, NoPull	Input, NoPull	High-Z, NoPull	Input, PD	Input, PD	BT_VDDO
BT_PCM_OUT	I/O	Y	Input, NoPull	Input, NoPull	High-Z, NoPull	Input, PD	Input, PD	BT_VDDO
BT_PCM_SYNC	I/O	Y	Input, NoPull	Input, NoPull	High-Z, NoPull	Input, PD	Input, PD	BT_VDDO
BT_I ² S_CLK	I/O	Y	Input, NoPull	Input, NoPull	High-Z, NoPull	High-Z, NoPull	High-Z, NoPull	BT_VDDO
BT_I ² S_DO	I/O	Y	Output, NoPull	Output, NoPull	High-Z, NoPull	Input, PD	Input, PD	BT_VDDO
BT_I ² S_DI	I/O	Y	Input, NoPull	Input, NoPull	High-Z, NoPull	Input, PD	Input, PD	BT_VDDO
BT_I ² S_WS	I/O	Y	Input, NoPull	Input, NoPull	High-Z, NoPull	High-Z, NoPull	High-Z, NoPull	BT_VDDO

11 Power Sequences

This section describes the power-on and power-off sequences for WLAN and Bluetooth.

11.1 Power-On Sequences

This section describes the power-on sequences and the sequence timing data for WLAN and Bluetooth. The conditions are as below:

- VBAT and VDDIO should not rise 10%-90% faster than 40 microseconds.
- VBAT should be up before or at the same time as VDDIO. VDDIO should NOT be present fast or be held high before VBAT is high.
- WL_REG_ON and BT_REG_ON should be up after sleep clock oscillation is stabilized.
- Please proceed reset by WL_REG_ON and BT_REG_ON until it starts normally if it doesn't wake from sleep properly or it is presented with uncertain status.
- Please keep repeats power off sequence and power-on sequence several times until it started normally.
- The CYW54590 has an internal power-on reset (POR) circuit. The device will be held in reset for a maximum of 110 ms after internal regulators and VDDIO have passed the POR threshold. Wait at least 150 ms after WL_REG_ON is driven high before initiating SDIO accesses.

Figure 4 shows the power-on sequence for WLAN ON and BT ON.

Figure 4: Power-On Sequence - WLAN ON and BT ON

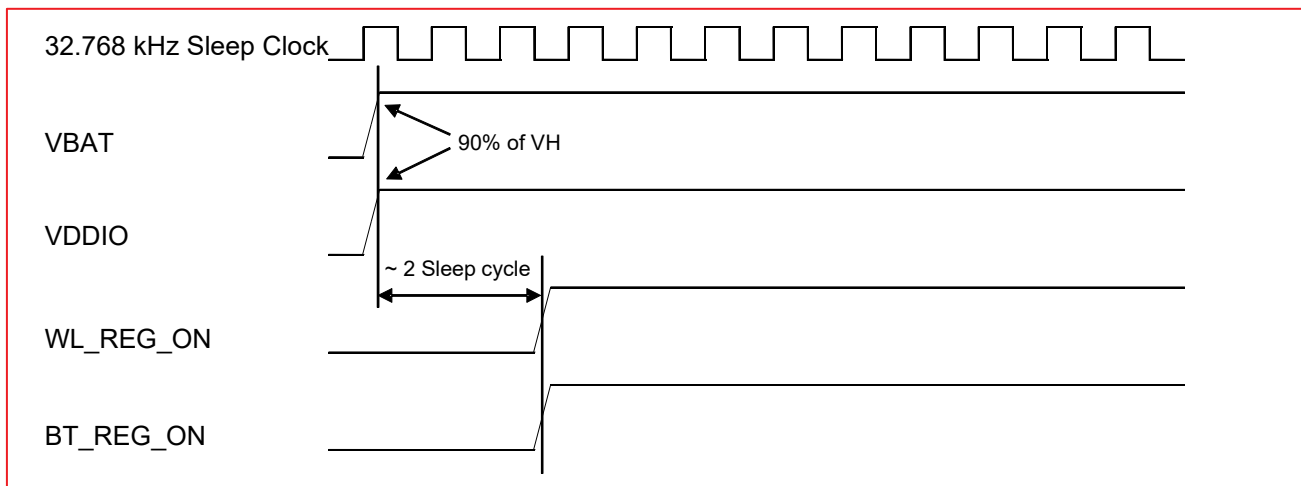


Figure 5 shows the power-on sequence for WLAN OFF and BT OFF.

Figure 5: Power-On Sequence - WLAN OFF and BT OFF

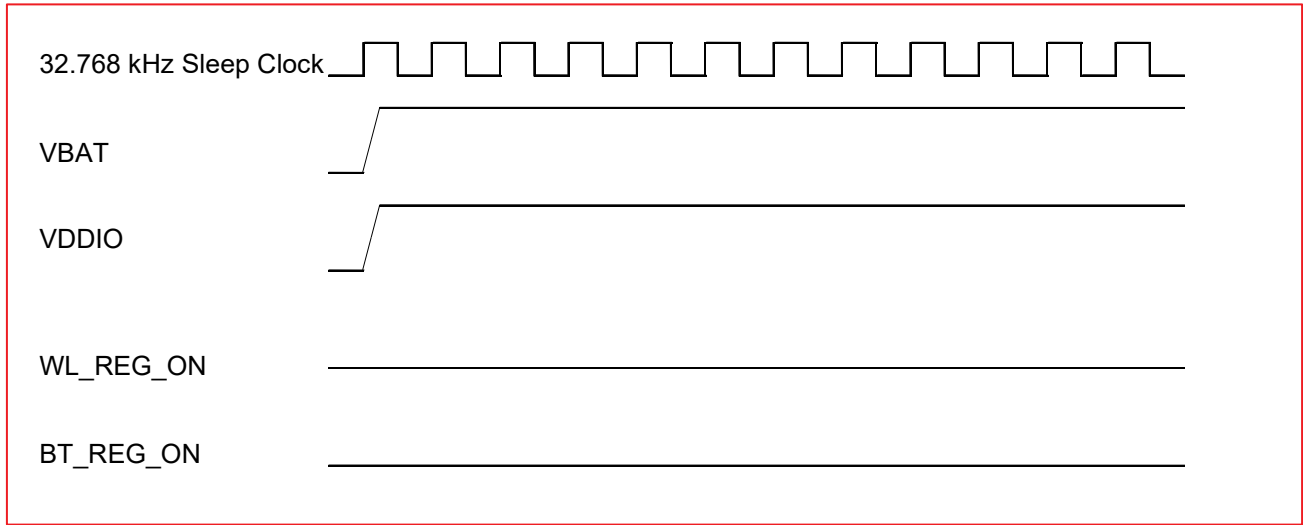


Figure 6 shows the power-on sequence for WLAN ON and BT OFF.

Figure 6: Power-On Sequence - WLAN ON and BT OFF

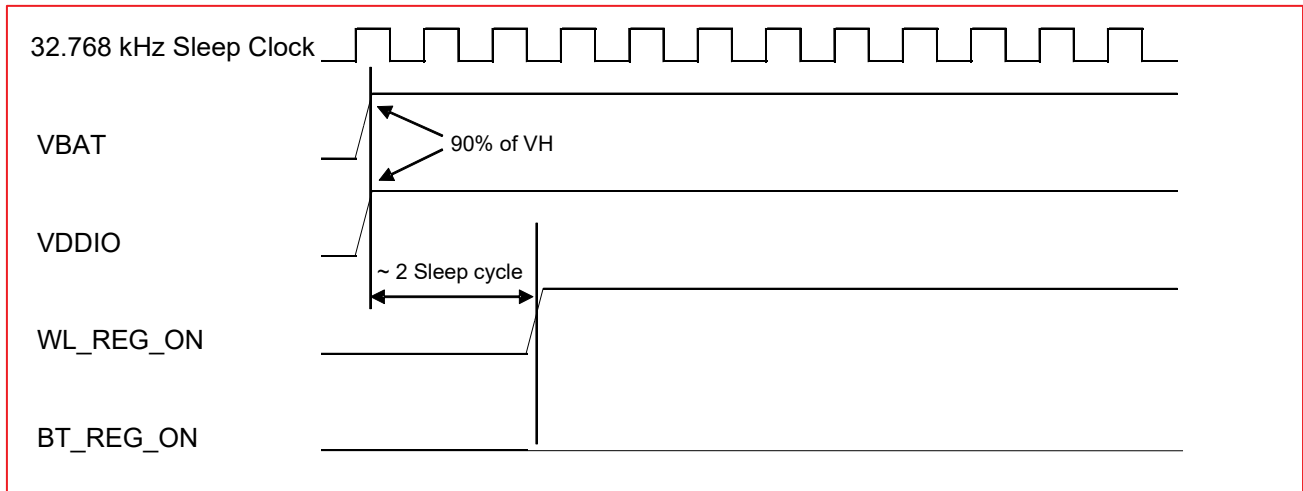
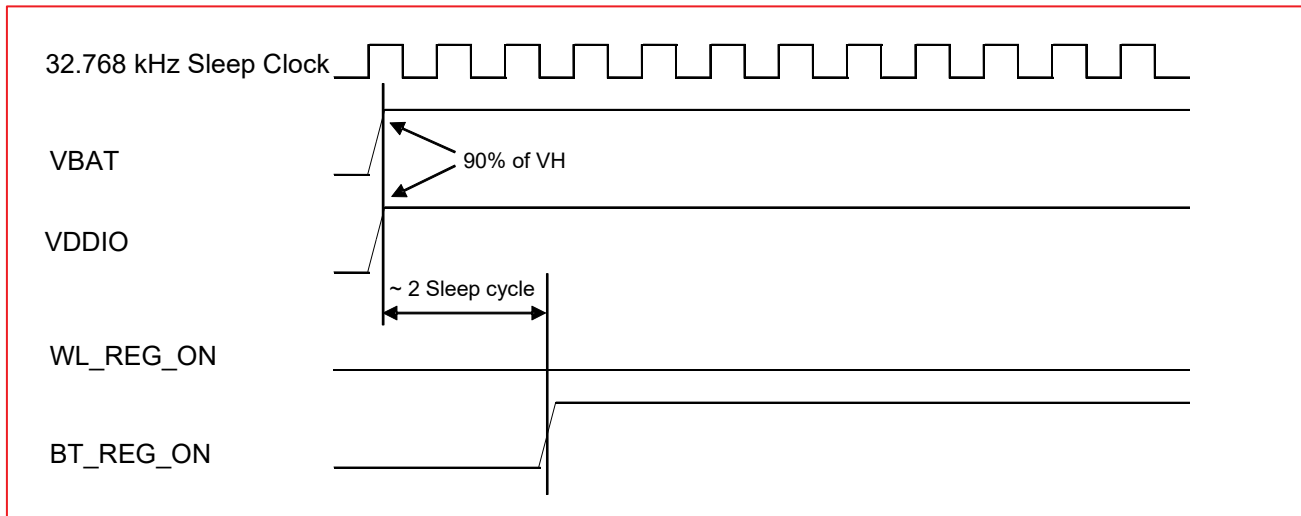


Figure 7 shows the power-on sequence for WLAN OFF and BT ON.

Figure 7: Power-On Sequence - WLAN OFF and BT ON



11.2 Power-Off Sequences

This section describes the power-off sequence and the sequence timing data. The conditions are described below:

- VDDIO should be down before or at the same time as VBAT. VBAT should NOT be down earlier than VDDIO low. VDDIO becomes low state is prior to VBAT low.
- VBAT and VDDIO should be down after WL_REG_ON and BT_REG_ON are low. Waiting time from REG_ON down to power supply off is not prescribed.

Figure 8 shows the power-off sequence for WLAN ON and BT ON.

Figure 8: Power-Off Sequence - WLAN ON and BT ON

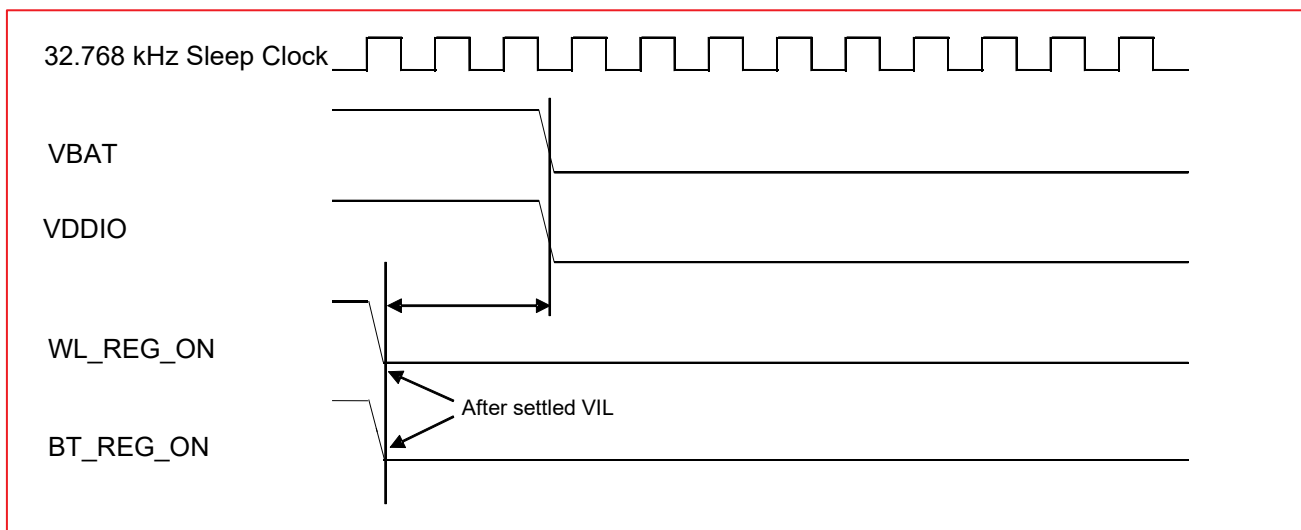


Figure 9 shows the power-off sequence for WLAN OFF and BT OFF.

Figure 9: Power-Off Sequence - WLAN OFF and BT OFF

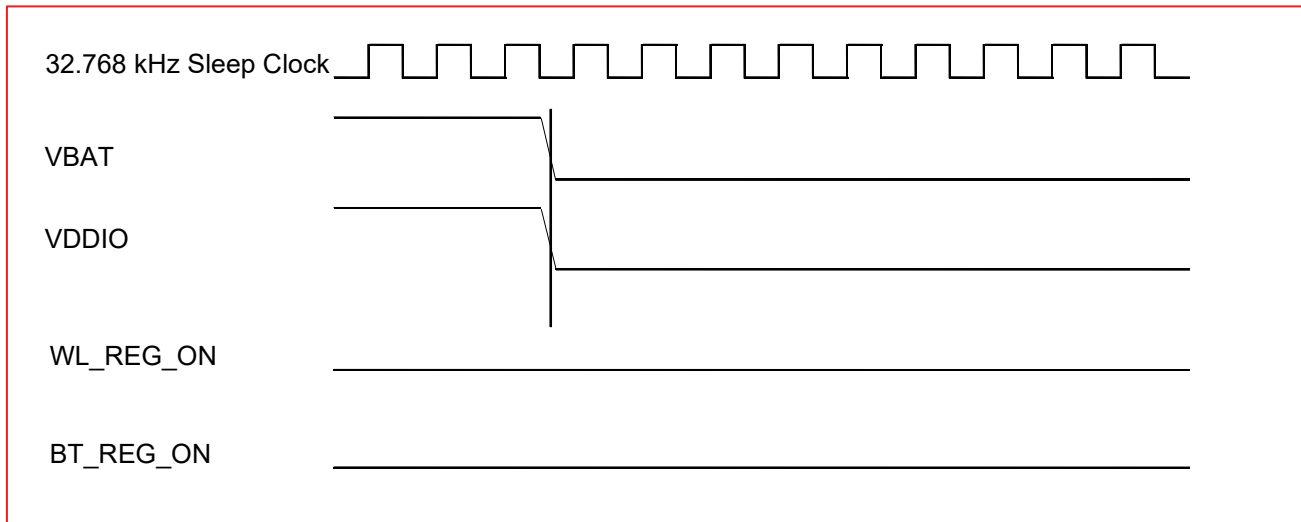


Figure 10 shows the power-off sequence for WLAN ON and BT OFF.

Figure 10: Power-Off Sequence - WLAN ON and BT OFF

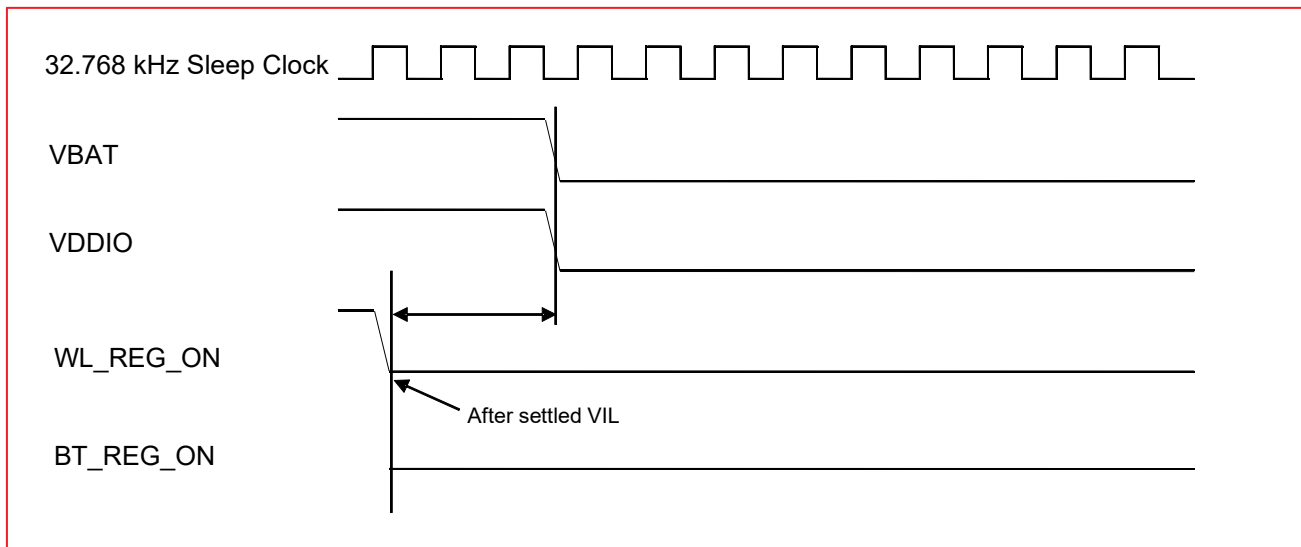
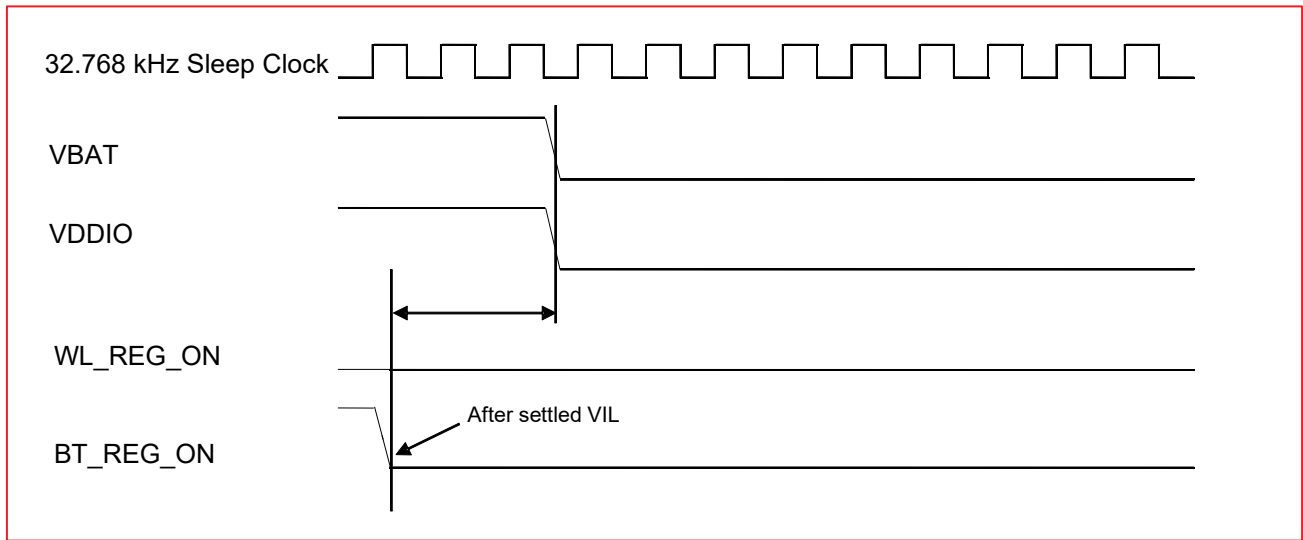


Figure 11 shows the power-off sequence for WLAN OFF and BT ON.

Figure 11: Power-Off Sequence - WLAN OFF and BT ON



12 Interface Timing and AC Characteristics

This section has sequence diagrams for Bluetooth UART timing, Bluetooth startup signaling sequence, Bluetooth PCM interface timing and Bluetooth I2S interface timing.

12.1 Bluetooth UART Timing

Bluetooth UART timing diagram and parameters are shown in **Figure 12** and **Table 11**.

Figure 12: UART Timing Diagram

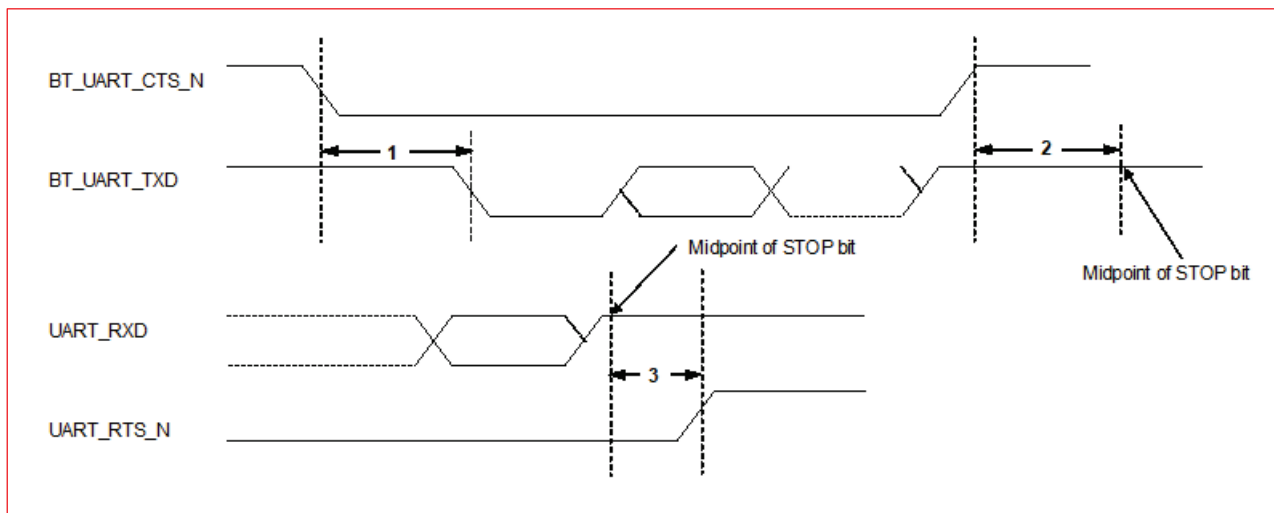


Table 11: UART Timing Parameters

Symbol	Parameter	Minimum	Typical	Maximum	Unit
1	Delay time, UART_CTS_N low to UART_TXD valid			1.5	Bit periods
2	Setup time, UART_CTS_N high before midpoint of stop bit			0.5	Bit periods
3	Delay time, midpoint of stop bit to UART_RTS_N high			0.5	Bit periods

12.2 Bluetooth Startup Signaling Sequence

Bluetooth startup signaling sequence graph and its parameters are shown in **Figure 13** and **Table 12**.

Figure 13: Bluetooth Startup Signaling Sequence Graph

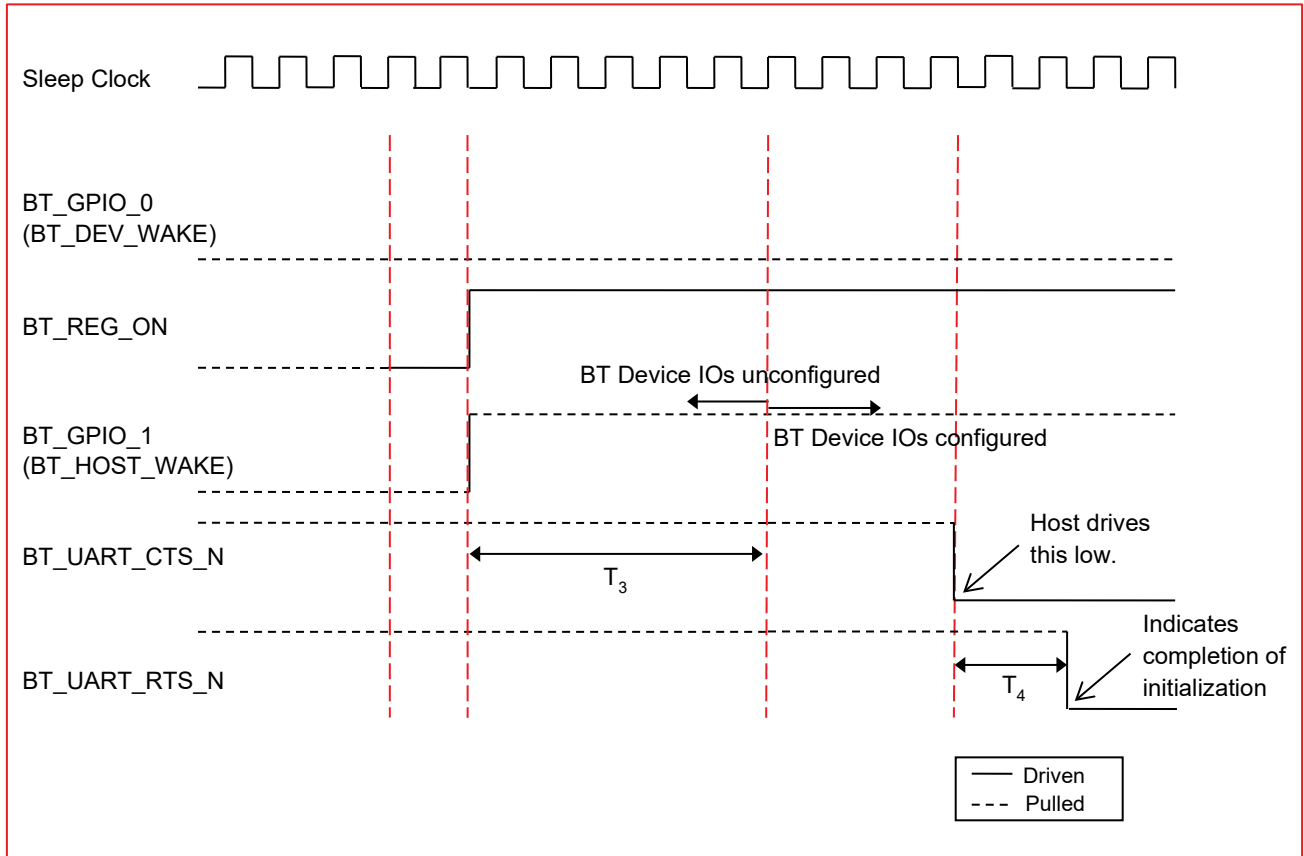


Table 12: Bluetooth Startup Signaling Sequence Parameters

Symbol	Parameter	Minimum	Typical	Maximum	Unit
T ₃	Time for the BT device to settle its IOs after BT_REG_ON is asserted.			40.0	ms
T ₄	Time for the BT device to drive UART_RTS_N low after the host drives UART_CTS_N low			10.0	ms

12.3 Bluetooth PCM Timing

This section describes the data formatting, wideband speech support, and various sync modes.

12.3.1 Data Formatting

The IC used in the module may be configured to generate and accept several different data formats. For conventional narrowband speech mode, the IC uses 13 of the 16 bits in each PCM frame. The location and order of these 13 bits can be configured to support various data formats on PCM interface. The remaining three bits are ignored on the input and may be filled with 0s, 1s, a sigh bit, or a programmed value on the output. The default format is 13-bit 2's complement data, left justified, and clocked MSB first.

12.3.2 Wideband Speech Support

When the host encodes wideband speech (WBS) packets in transparent mode, the encoded packets are transferred over the PCM bus for an eSCO voice connection. In this mode, the PCM bus is typically configured in master mode for a 4 kHz sync rate with 16-bit samples, resulting in a 64-kbps bit rate. The IC also supports slave transparent mode using a proprietary rate-matching scheme. IN SBC-code mode, linear 16-bit data at 16 kHz (256 kbps rate) is transferred over the PCM bus.

12.3.3 Short Frame Sync - Master Mode

Figure 14 and **Table 13** show the short frame sync signal and its parameters in master mode.

Figure 14: Short Frame Sync Signal - Master Mode

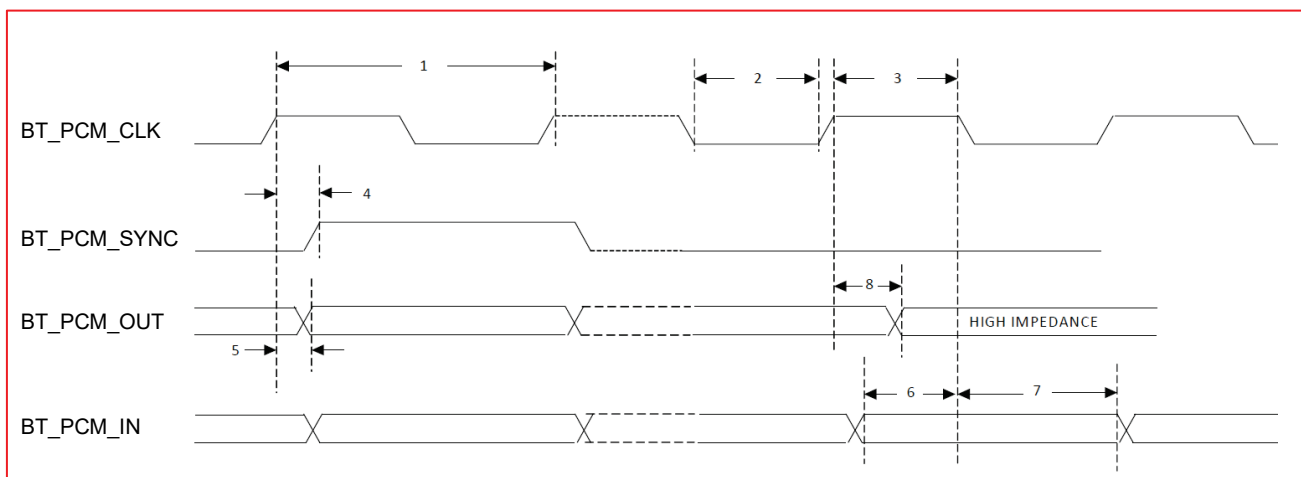


Table 13: Short Frame Sync Signal Parameters - Master Mode

Reference	Description	Minimum	Typical	Maximum	Unit
1	PCM bit clock frequency			12.0	MHz
2	PCM bit clock High	41.0			ns
3	PCM bit clock Low	41.0			ns
4	PCM_SYNC delay	0		25.0	ns
5	PCM_OUT delay	0		25.0	ns
6	PCM_IN setup	8			ns

Reference	Description	Minimum	Typical	Maximum	Unit
7	PCM_IN hold	8			ns
8	Delay from rising edge of PCM_BCLK during last bit period to PCM_OUT becoming high impedance.	0		25.0	ns

12.3.4 Short Frame Sync - Slave Mode

Figure 15 and Table 14 show the short frame sync signal and its parameters in slave mode.

Figure 15: Short Frame Sync Signal - Slave Mode

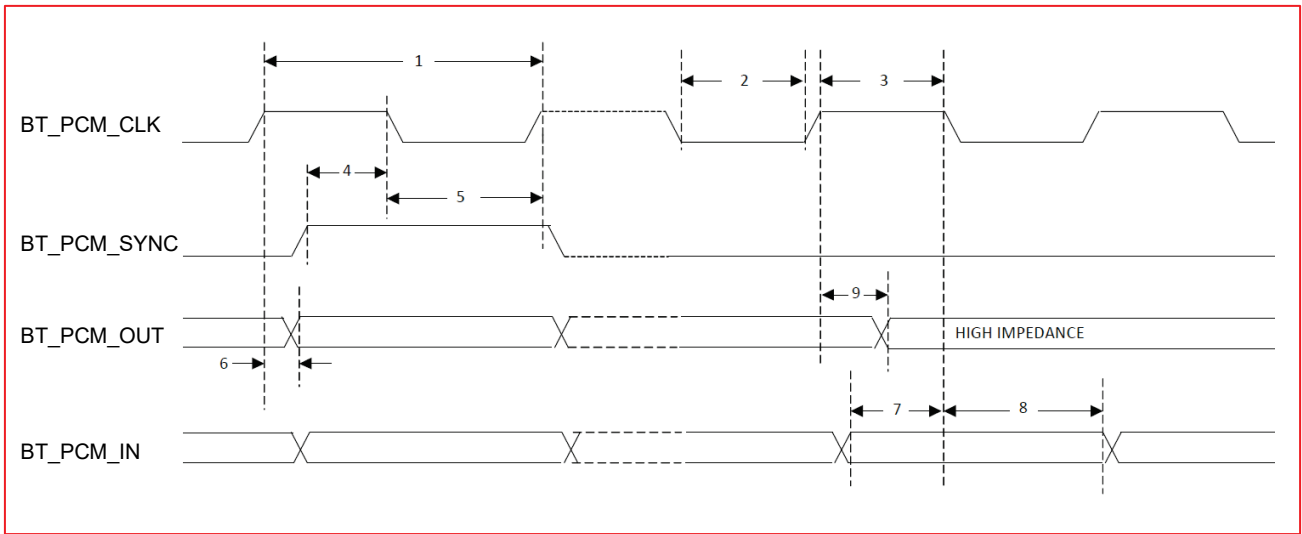


Table 14: Short Frame Sync Signal Parameters - Slave Mode

Reference	Description	Minimum	Typical	Maximum	Unit
1	PCM bit clock frequency			12.0	MHz
2	PCM bit clock High	41.0			ns
3	PCM bit clock Low	41.0			ns
4	PCM_SYNC setup	8.0			ns
5	PCM_SYNC hold	8.0			ns
6	PCM_OUT delay	0		25.0	ns
7	PCM_IN setup	8.0			ns
8	PCM_IN hold	8.0			ns
9	Delay from rising edge of PCM_BCLK during last bit period to PCM_OUT becoming high impedance.	0		25.0	ns

12.3.5 Long Frame Sync - Master Mode

Figure 16 and Table 15 show the long frame sync signal and its parameters in master mode.

Figure 16: Long Frame Sync Signal - Master Mode

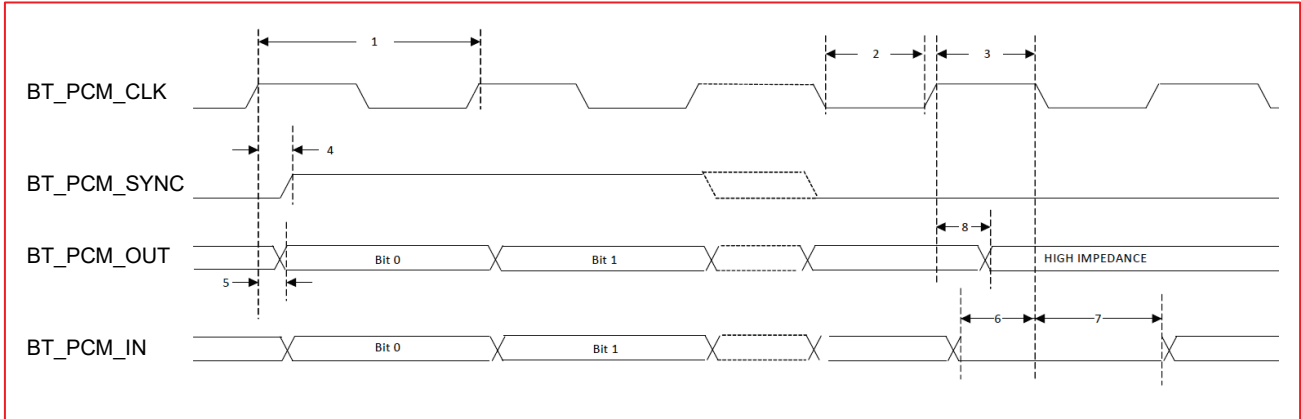


Table 15: Long Frame Sync Signal Parameters - Master Mode

Reference	Description	Minimum	Typical	Maximum	Unit
1	PCM bit clock frequency			12.0	MHz
2	PCM bit clock High	41.0			ns
3	PCM bit clock Low	41.0			ns
4	PCM_SYNC delay	0		25.0	ns
5	PCM_OUT delay	0		25.0	ns
6	PCM_IN setup	8.0			ns
7	PCM_IN hold	8.0			ns
8	Delay from rising edge of PCM_BCLK during last bit period to PCM_OUT becoming high impedance	0		25.0	ns

12.3.6 Long Frame Sync - Slave Mode

Figure 17 and Table 16 show the long frame sync signal and its parameters in slave mode.

Figure 17: Long Frame Sync Signal - Slave Mode

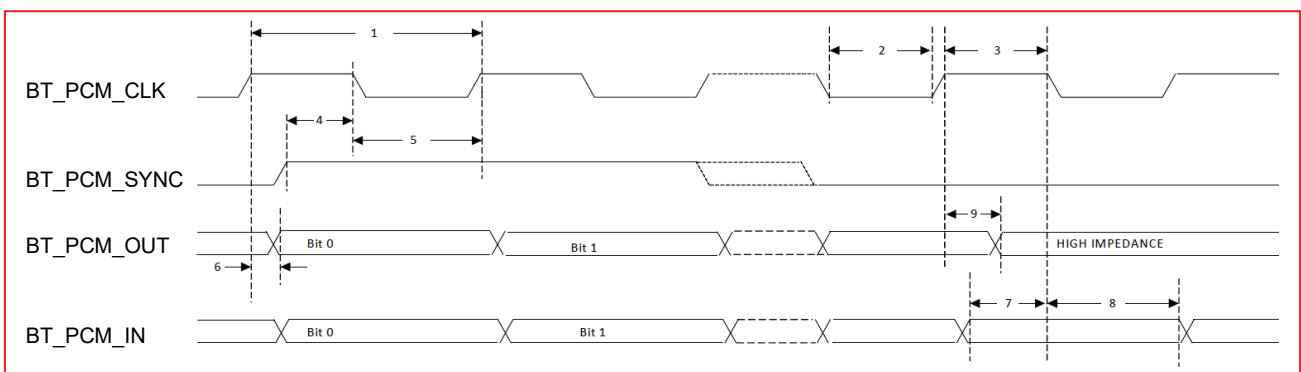


Table 16: Long Frame Sync Signal Parameters - Slave Mode

Reference	Description	Minimum	Typical	Maximum	Unit
1	PCM bit clock frequency			12.0	MHz
2	PCM bit clock High	41.0			ns
3	PCM bit clock Low	41.0			ns
4	PCM_SYNC setup	8.0			ns
5	PCM_SYNC hold	8.0			ns
6	PCM_OUT delay	0		25.0	ns
7	PCM_IN setup	8.0			ns
8	PCM_IN hold	8.0			ns
9	Delay from rising edge of PCM_BCLK during last bit period to PCM_OUT becoming high impedance.	0		25.0	ns

12.4 Bluetooth I²S Interface Timing

The IC used in the module supports I²S format. The module supports only PCM digital audio ports through I²S format.

The I²S signals are:

- I²S clock: I²S SCK (Module pin: BT_PCM_CLK)
- I²S Word Select: I²S WS (Module pin: BT_PCM_SYNC)
- I²S Data Out: I²S SDO (Module pin: BT_PCM_OUT)
- I²S Data In: I²S SDI (Module pin: BT_PCM_IN)

I²S SCK and I²S WS become outputs in master mode and inputs in slave mode, while I²S SDO always stays as an output. The channel word length is 16 bits, and the data is justified so that the MSB of the left-channel data is aligned with the MSB of the I²S bus, per the I²S specification. The MSB of each data word is transmitted one bit clock cycle after the I²S WS transition, synchronous with the falling edge of bit clock. Left-channel data is transmitted when I²S WS is low, and right-channel data is transmitted when I²S WS is high. Data bits sent by the CYW89335 are synchronized with the falling edge of I²S_SCK and should be sampled by the receiver on the rising edge of I²S_SCK.

The clock rate in master mode is either of the following:

- 48 kHz x 32 bits per frame = 1.536 MHz
- 48 kHz x 50 bits per frame = 2.400 MHz

The master clock is generated from the input reference clock using a N/M clock divider.

In the slave mode, any clock rate is supported up to a maximum of 3.072 MHz

Table 17 shows the timing for I²S transmitters and receivers.

Table 17: Timing for I²S Transmitters and Receivers

	Transmitter				Receiver				Note
	Lower Limit		Upper Limit		Lower Limit		Upper Limit		
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	
Clock Period T	T_{tr}				T_r				a
Master Mode: Clock generated by transmitter or receiver									
HIGH t_{HC}	$0.35T_{tr}$				$0.35T_{tr}$				b
LOW t_{LC}	$0.35T_{tr}$				$0.35T_{tr}$				b
Slave Mode: Clock accepted by transmitter or receiver									
HIGH t_{HC}		$0.35T_{tr}$				$0.35T_{tr}$			c
LOW t_{LC}		$0.35T_{tr}$				$0.35T_{tr}$			c
Rise time t_{RC}			$0.15T_{tr}$						d
Transmitter									
Delay t_{dtr}				$0.8T$					e
Hold time t_{htr}	0								d
Receiver									
Setup time t_{sr}						$0.2T_r$			f
Hold time t_{hr}						0			f

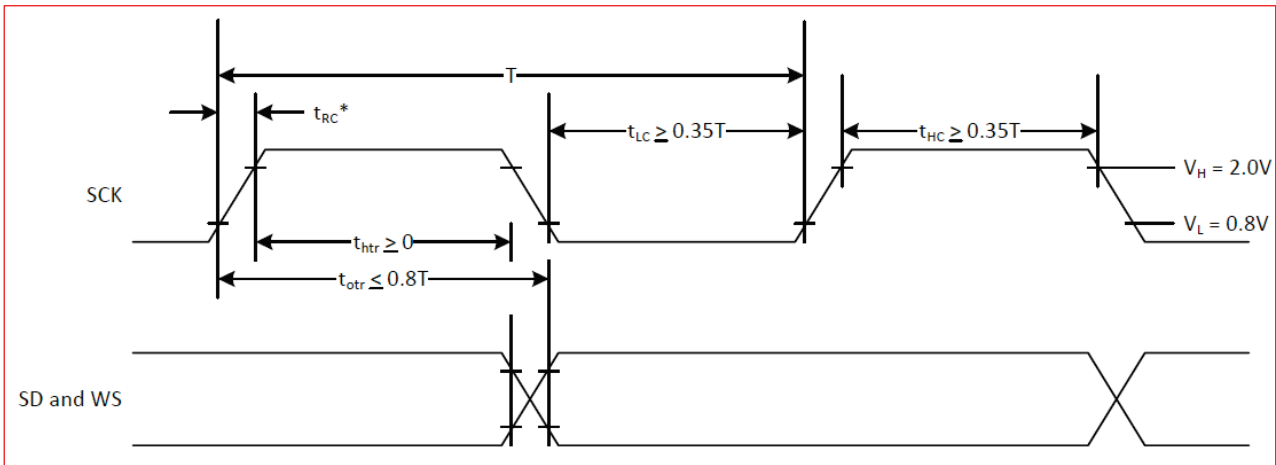
- The system clock period T must be greater than T_{tr} and T_r because both the transmitter and receiver have to be able to handle the data transfer rate.
- At all data rates in master mode, the transmitter or receiver generates a clock signal with a fixed mark/space ratio. For this reason, t_{HC} and t_{LC} specified with respect to T .
- In slave mode, the transmitter and receiver need a clock signal with minimum HIGH and LOW periods so that they can detect the signal. So long as the minimum periods are greater than $0.35T_{tr}$ any clock that meets the requirements can be used.
- Because the delay (t_{dtr}) and the maximum transmitter speed (defined by T_{tr}) are related, a fast transmitter driven by a slow clock edge can result in t_{dtr} not exceeding t_{RC} which means t_{htr} becomes zero or negative. Therefore, the transmitter has guarantee that t_{htr} is greater than or equal to zero, so long as the clock rise-time t_{RC} is not more than t_{RC} where t_{RCmax} is not less than $0.15T_{tr}$.
- To allow data to be clocked out on a falling edge, the delay is specified with respect to the rising edge of the clock signal and T , always giving the receiver sufficient setup time.
- The data setup and hold time must not be less than the specified receiver setup and hold time.



The time periods specified in below figures are defined by the transmitter speed. The receiver specifications must match transmitter performance.

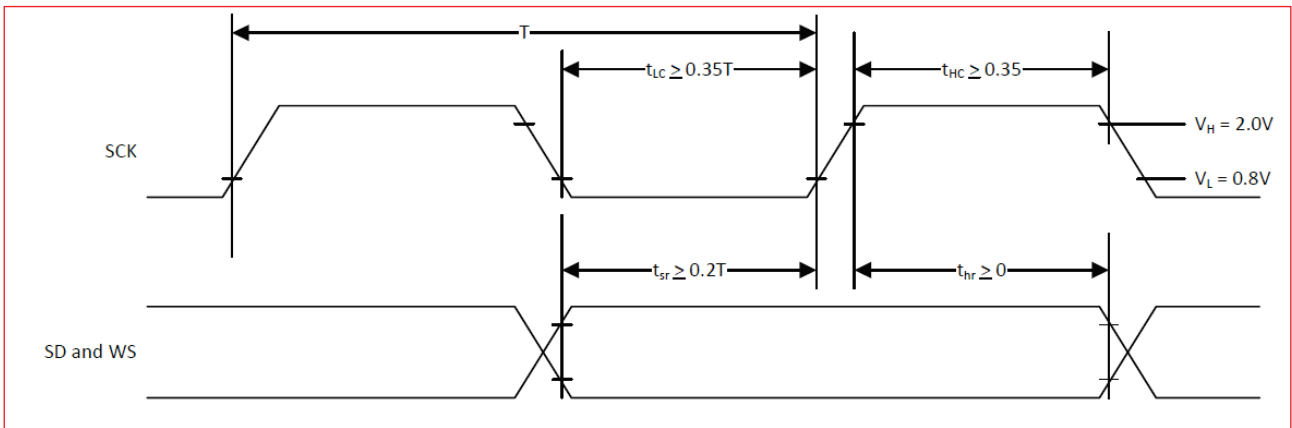
Figure 18 and Figure 19 shows I²S transmitter and receiver timing diagrams.

Figure 18: I²S Transmitters Timing



- T = Clock period
- T_{tr} = Minimum allowed clock period for transmitter
- $T = T_{tr}$
- t_{RC} is only relevant for transmitters in slave mode

Figure 19: I²S Receivers Timing



- T = Clock period
- T_r = Minimum allowed clock period for transmitter
- $T > T_r$

12.5 WLAN SDIO Timing

This section describes the WLAN SDIO timings.

12.5.1 SDIO Timing - Default Mode

The SDIO default timing diagram and parameters are shown in **Figure 20** and **Table 18**.

Figure 20: SDIO Timing Diagram - Default Mode

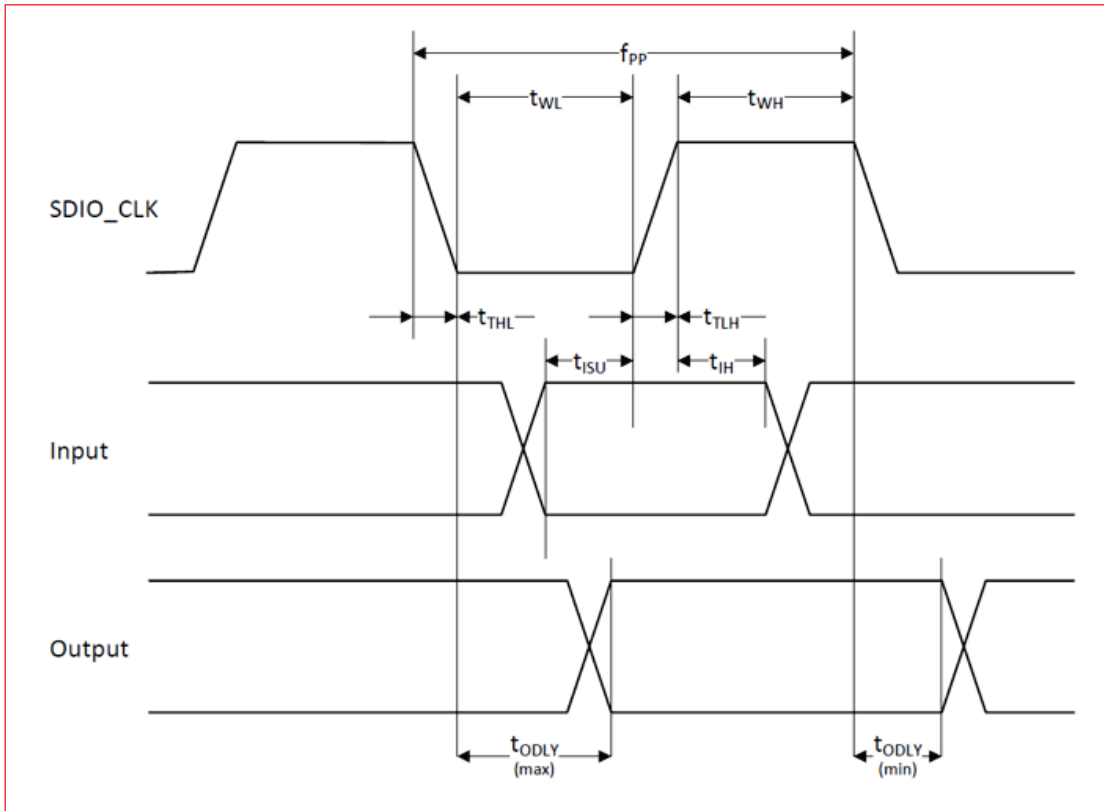


Table 18: SDIO Bus Timing Parameters - Default Mode

Parameter	Symbol	Minimum	Typical	Maximum	Unit
SDIO CLK (All values are referred to minimum VIH and maximum VIL)					
Frequency - Data Transfer Mode	f_{PP}	0		25	MHz
Frequency - Identification Mode	f_{OD}	0		400	kHz
Clock Low Time	t_{WL}	10.0			ns
Clock High Time	t_{WH}	10.0			ns
Clock Rise Time	t_{TLH}			10.0	ns
Clock low Time	t_{THL}			10.0	ns
Inputs: CMD, DAT (referenced to CLK)					
Input Setup Time	t_{ISU}	5.0			ns
Input Hold Time	t_{IH}	5.0			ns
Outputs: CMD, DAT (referenced to CLK)					

Parameter	Symbol	Minimum	Typical	Maximum	Unit
Output Delay time - Data Transfer Mode	t_{ODLY}	0		14.0	ns
Output Delay time - Identification Mode	t_{ODLY}	0		50.0	ns



- Timing is based on $CL \leq 40$ pF load on CMD and Data.
- Minimum (V_{ih}) = $0.7 \cdot V_{IO}$ and maximum (V_{il}) = $0.2 \cdot V_{IO}$.

12.5.2 SDIO Timing - High Speed Mode

The SDIO high speed timing diagram and parameters are shown in **Figure 21** and **Table 19**.

Figure 21: SDIO Timing Diagram - High-Speed Mode

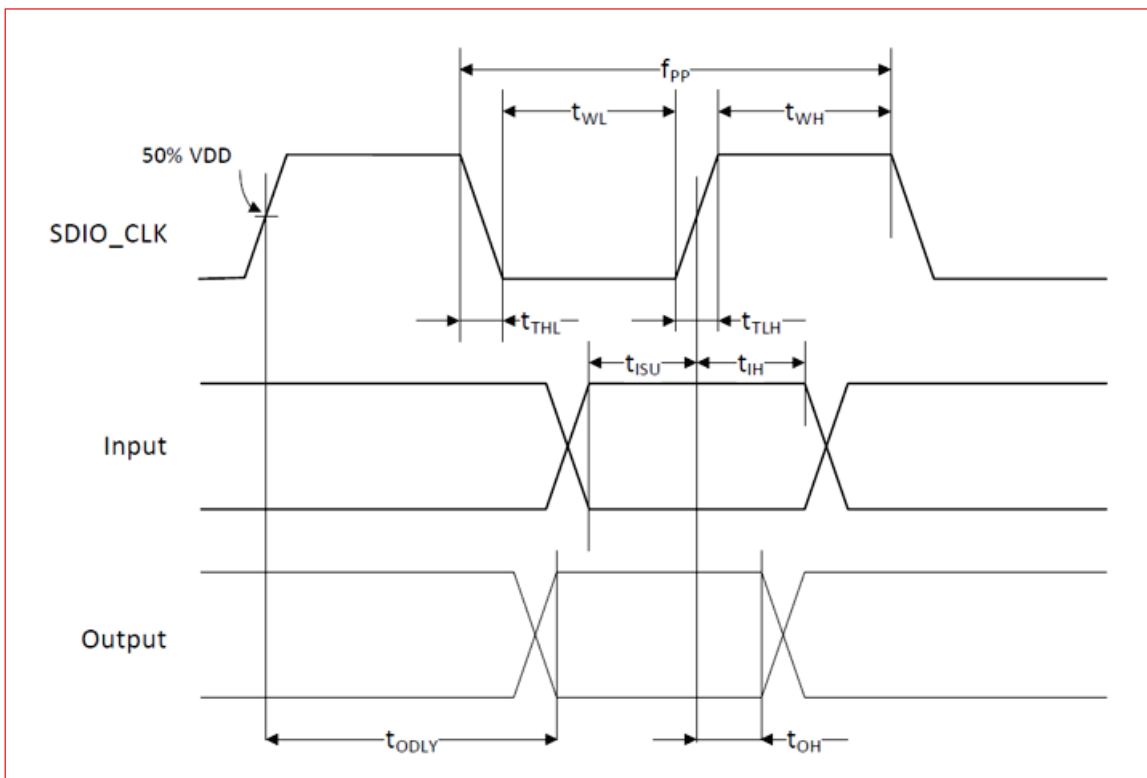


Table 19: SDIO Bus Timing Parameters - High-Speed Mode

Parameter	Symbol	Minimum	Typical	Maximum	Unit
SDIO CLK (All values are referred to minimum V_{IH} and maximum V_{IL})					
Frequency - Data Transfer Mode	f_{PP}	0		50	MHz
Frequency - Identification Mode	f_{OD}	0		400	kHz
Clock Low Time	t_{WL}	7.0			ns
Clock High Time	t_{WH}	7.0			ns
Clock Rise Time	t_{TLH}			3.0	ns
Clock low Time	t_{THL}			3.0	ns

Parameter	Symbol	Minimum	Typical	Maximum	Unit
Inputs: CMD, DAT (referenced to CLK)					
Input Setup Time	t_{ISU}	6.0			ns
Input Hold Time	t_{IH}	2.0			ns
Outputs: CMD, DAT (referenced to CLK)					
Output Delay time - Data Transfer Mode	t_{ODLY}			14.0	ns
Output Delay time - Identification Mode	t_{OH}	2.5.0			ns
Total system capacitance (each line)	CL			40.0	pF



- Timing is based on $CL \leq 40$ pF load on CMD and Data.
- Minimum (V_{ih}) = $0.7 \cdot V_{IO}$ and maximum (V_{il}) = $0.2 \cdot V_{IO}$.

12.5.3 SDIO Bus Timing Specifications in SDR Modes

This section describes the SDIO Bus timing specifications in SDR Modes.

12.5.3.1 Clock Timing

The SDIO bus clock timing diagram and parameters are shown in **Figure 22** and **Table 20**.

Figure 22: SDIO Bus Clock Timing Diagram - SDR Modes

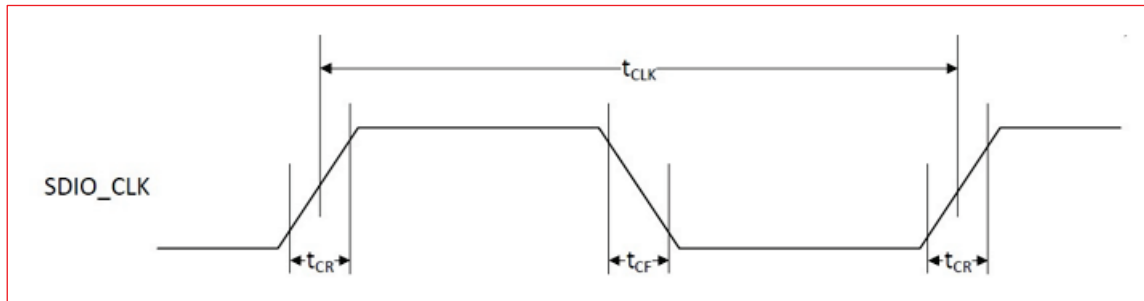


Table 20: SDIO Bus Clock Timing Parameters - SDR Modes

Parameter	Symbol	Minimum	Maximum	Typical	Comments
	t_{CLK}	40.0	ns	SDR12 mode	SDR12 mode
		20.0	ns	SDR25 mode	SDR25 mode
		10.0	ns	SDR50 mode	SDR50 mode
		4.8	ns	SDR104 mode	SDR104 mode
	t_{CR}, t_{CF}		$0.2 \times t_{CLK}$	ns	$t_{CR}, t_{CF} < 2.00$ ns (maximum)@100 MHz, $C_{CARD} = 10$ pF $t_{CR}, t_{CF} < 0.96$ ns (maximum)@208 MHz, $C_{CARD} = 10$ pF
Clock duty		30.0	70.0	%	

12.5.3.2 Device Input Timing

The SDIO bus device input timing diagram and parameters are shown in **Figure 23** and **Table 21**.

Figure 23: SDIO Bus Input Timing Diagram - SDR Modes

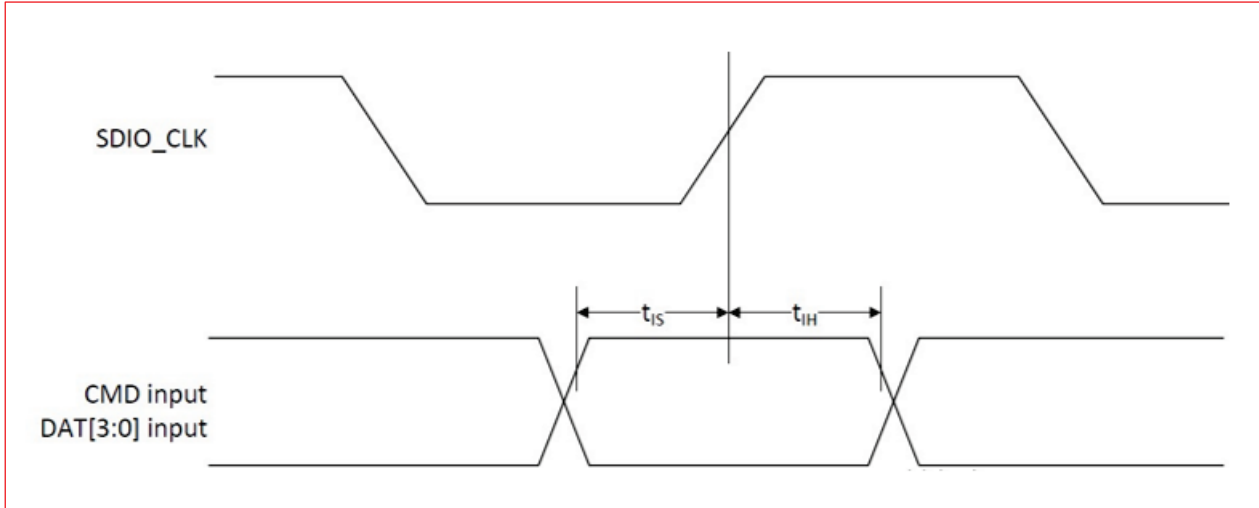


Table 21: SDIO Bus Input Timing Parameters - SDR Modes

Symbol	Minimum	Maximum	Unit	Comments
SDR104 Mode				
t_{1s}	1.4		ns	CCARD = 10 pF, VCT = 0.975V
t_{1H}	0.8		ns	CCARD = 5 pF, VCT = 0.975V
SDR50 Mode				
t_{1s}	3.0		ns	CCARD = 10 pF, VCT = 0.975V
t_{1H}	0.8		ns	CCARD = 5 pF, VCT = 0.975V
SDR25 Mode				
t_{1s}	3.0		ns	CCARD = 10 pF, VCT = 0.975V
t_{1H}	0.8		ns	CCARD = 5 pF, VCT = 0.975V
SDR12 Mode				
t_{1s}	3.0		ns	CCARD = 10 pF, VCT = 0.975V
t_{1H}	0.8		ns	CCARD = 5 pF, VCT = 0.975V

12.5.3.3 Device Output Timing

This section describes the SDIO bus output timing.

12.5.3.3.1 SDIO Bus Output Timing – SDR Modes up to 100 MHz

SDIO bus output timing diagram and parameters at SDR modes up to 100 MHz are shown in **Figure 24** and **Table 22**.

Figure 24: SDIO Bus Output Timing Diagram - SDR Modes up to 100 MHz

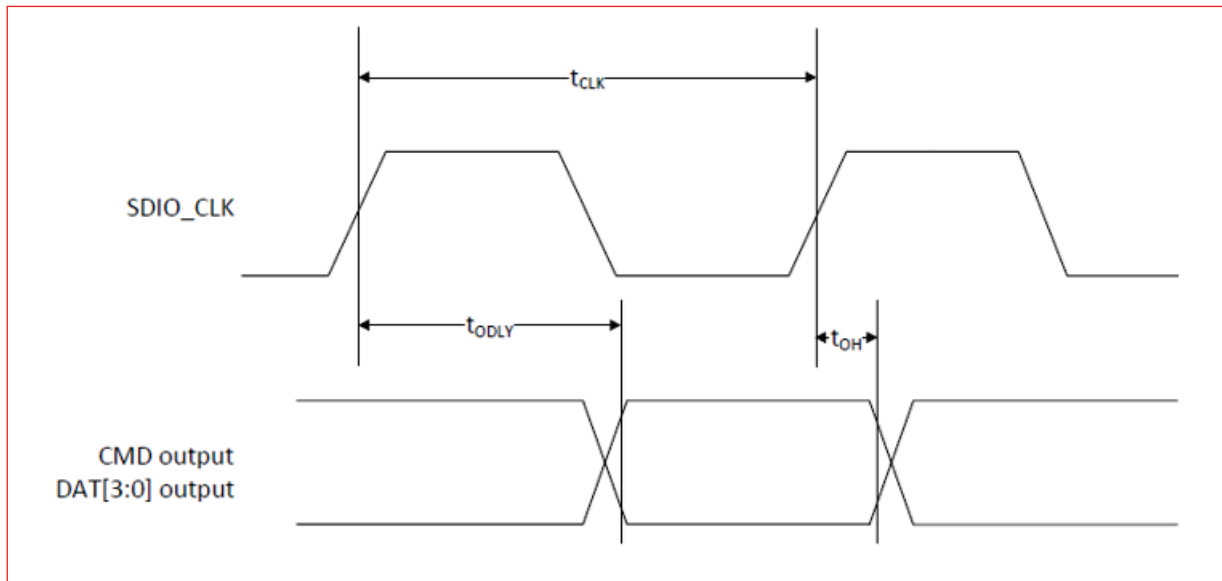


Table 22: SDIO Bus Output Timing Parameters - SDR Modes up to 100 MHz

Symbol	Minimum	Maximum	Unit	Comments
t _{ODLY}		7.5	ns	t _{CLK} ≥ 10 ns CL = 30 pF using driver typeB for SDR50
t _{ODLY}		14.0	ns	t _{CLK} ≥ 20 ns CL = 40 pF using for SDR12, SDR25
t _{OH}	1.5		ns	Hold time at the t _{ODLY} (minimum) CL = 15 pF

12.5.3.3.2 SDIO Bus Output Timing - SDR Modes 100 MHz to 208 MHz

SDIO bus output timing diagram and parameters at SDR modes 100 MHz to 208 MHz are shown in **Figure 25** and **Table 23**.

Figure 25: SDIO Bus Output Timing Diagram - SDR Modes 100 MHz to 208 MHz

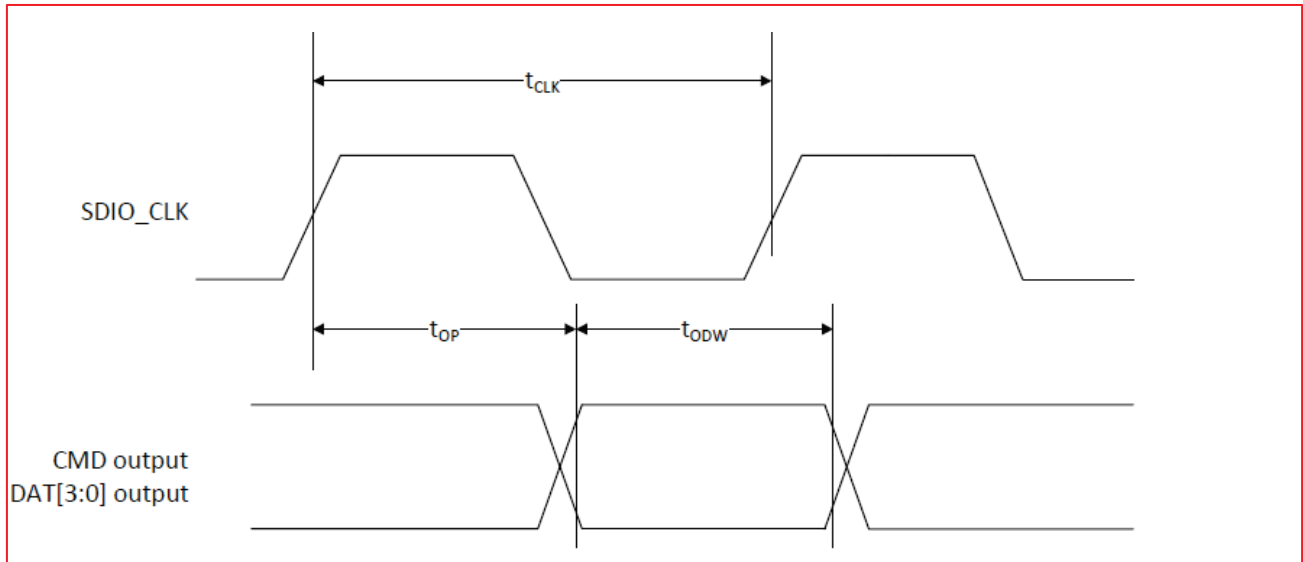


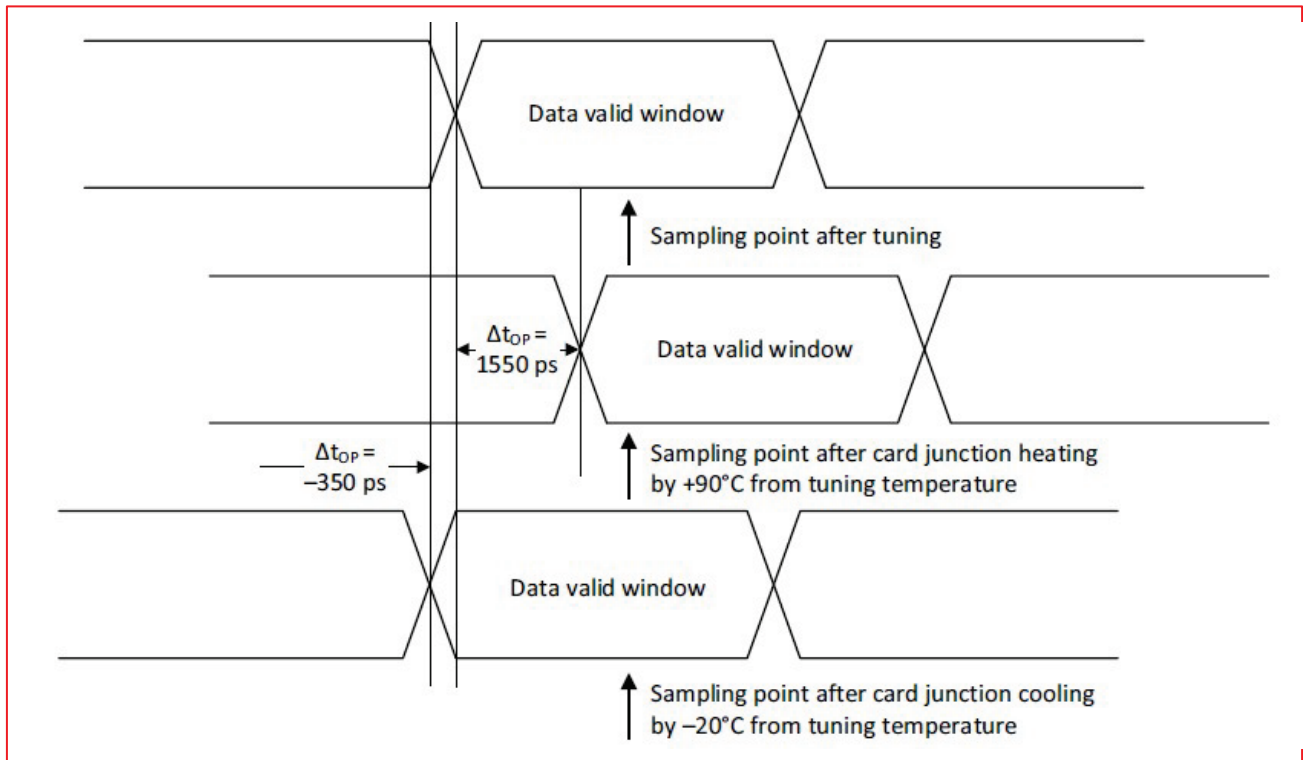
Table 23: SDIO Bus Output Timing Parameters - SDR Modes 100 MHz to 208 MHz

Symbol	Minimum	Maximum	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	$t_{ODW} = 2.88 \text{ ns @ } 208 \text{ MHz}$

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

Figure 26 describes the SDIO bus output timing sequence in SDR modes 100 MHz to 208 MHz.

Figure 26: SDIO Bus Output Timing Sequence - SDR Modes 100 MHz to 208 MHz



13 Electrical Characteristics

13.1 DC/RF Characteristics for IEEE 802.11b - 2.4 GHz

Conditions: 25 °C, VBAT = 3.3V, 11 Mbps mode unless otherwise specified.

Table 24: DC/RF Characteristics for IEEE 802.11b - 2.4 GHz

Characteristics	Value			
Specification	IEEE 802.11b - 2.4 GHz			
Mode	DSSS / CCK			
Channel Frequency (spacing)	2412 to 2472 MHz (5 MHz)			
Data Rate	1, 2, 5.5, 11 Mbps			
Current Consumption	Minimum	Typical	Maximum	Unit
• Tx mode		370	470	mA
• Rx mode		100	150	mA
Transmitter	Minimum	Typical	Maximum	Unit
Power Levels	14.5	17	19.5	dBm
Spectrum Mask				
• 1st side lobes			-30	dBr
• 2nd side lobes			-50	dBr
Power-on/off ramp			2.0	μs
RF Carrier Suppression	15			dB
Modulation Accuracy			35	%
Frequency Tolerance	-20		20	ppm
Spurious Emissions (BW = 100 kHz)				
• 30 Hz ≤ f < 1000 MHz			-36	dBm
• 1000 MHz ≤ f < 12750 MHz			-30	dBm
• 1800 MHz < f ≤ 1900 MHz			-47	dBm
• 5150 MHz < f ≤ 5300 MHz			-47	dBm
Receiver	Minimum	Typical	Maximum	Unit
Minimum Input Level (FER ≤ 8%)			-76	dBm
Maximum Input Level (FER ≤ 8%)	-10			dBm
Adjacent Channel Rejection (FER ≤ 8%)	35			dB

13.2 DC/RF Characteristics for IEEE 802.11g - 2.4 GHz

Conditions: 25 °C, VBAT =3.3V, 54 Mbps mode unless otherwise specified.

Table 25: DC/RF Characteristics for IEEE 802.11g - 2.4 GHz

Characteristics	Value			
Specification	IEEE 802.11g - 2.4 GHz			
Mode	OFDM			
Channel Frequency	2412 to 2472 MHz (5 MHz)			
Data Rate	6, 9, 12, 18, 24, 36, 48, 54 Mbps			
Current Consumption	Minimum	Typical	Maximum	Unit
• Tx mode		330	430	mA
• Rx mode		100	150	mA
Transmitter	Minimum	Typical	Maximum	Unit
Power Levels	12.5	15	17.5	dBm
Spectrum Mask				
• at fc +/- 11 MHz			-20	dBr
• at fc +/- 20 MHz			-28	dBr
• at fc > +/- 30 MHz			-40	dBr
Constellation Error			-25	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions (BW = 100 kHz)				
• 30 Hz ≤ f < 1000 MHz			-36	dBm
• 1000 MHz ≤ f < 12750 MHz			-30	dBm
• 1800 MHz < f ≤ 1900 MHz			-47	dBm
• 5150 MHz < f ≤ 5300 MHz			-47	dBm
Receiver	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER ≤ 10%)			-65	dBm
Maximum Input Level (PER ≤ 10%)	-20			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-1			dB

13.3 DC/RF Characteristics for IEEE 802.11n - 2.4 GHz

Conditions: 25 °C, VBAT = 3.3V, 65 Mbps (MCS7 - HT 20 MHz) mode unless otherwise specified.

Table 26: DC/RF Characteristics for IEEE 802.11n - 2.4 GHz

Characteristics	Value			
Specification	IEEE 802.11n - 2.4 GHz			
Mode	OFDM			
Channel Frequency	2412 to 2472 MHz (5 MHz)			
Data Rate	6.5, 13, 19.5, 26, 39, 52, 58.5, 65 Mbps			
Current Consumption	Minimum	Typical	Maximum	Unit
• Tx mode		330	430	mA
• Rx mode		100	150	mA
Transmitter	Minimum	Typical	Maximum	Unit
Power Levels	12.5	15	17.5	dBm
Spectrum Mask				
• at $f_c \pm 11$ MHz			-20	dB
• at $f_c \pm 20$ MHz			-28	dB
• at $f_c \geq \pm 30$ MHz			-45	dB
Constellation Error (Measured at enhanced mode)			-27	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions (BW = 100 kHz)				
• $30 \text{ Hz} \leq f < 1000 \text{ MHz}$			-36	dBm
• $1000 \text{ MHz} \leq f < 12750 \text{ MHz}$			-30	dBm
• $1800 \text{ MHz} < f \leq 1900 \text{ MHz}$			-47	dBm
• $5150 \text{ MHz} < f \leq 5300 \text{ MHz}$			-47	dBm
Receiver	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER \leq 10%)			-64	dBm
Maximum Input Level (PER \leq 10%)	-20			dBm
Adjacent Channel Rejection (PER \leq 10%)	-2			dB

13.4 DC/RF Characteristics for IEEE 802.11a - 5 GHz

Condition: 25 °C, VBAT = 3.3V, 54 Mbps mode unless otherwise specified.

Table 27: DC/RF Characteristics for IEEE 802.11a - 5 GHz

Characteristics	Value			
Specification	IEEE 802.11a - 5 GHz			
Mode	OFDM			
Channel Frequency	5180 - 5825 MHz			
Data Rate	6, 9, 12, 18, 24, 36, 48, 54 Mbps			
Current Consumption	Minimum	Typical	Maximum	Unit
• Tx mode		400	500	mA
• Rx mode		120	170	mA
Transmitter	Minimum	Typical	Maximum	Unit
Power Levels	11.5	14	16.5	dBm
Spectrum Mask				
• at fc +/- 11 MHz			-20	dBr
• at fc +/- 20 MHz			-28	dBr
• at fc ≥ +/- 30 MHz			-40	dBr
Constellation Error			-25	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions (BW = 100 kHz)				
• 30 Hz ≤ f < 1000 MHz			-36	dBm
• 1000 MHz ≤ f < 26000 MHz			-30	dBm
Receiver	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER ≤ 10%)			-65	dBm
Maximum Input Level (PER ≤ 10%)	-30			dBm
Adjacent Channel Rejection (PER < 10%)	-1			dB

13.5 DC/RF Characteristics for IEEE 802.11n (HT20) - 5 GHz

Condition: 25 °C, VBAT = 3.3V, 65 Mbps (MCS7 - HT 20 MHz) mode unless otherwise specified.

Table 28: DC/RF Characteristics for IEEE 802.11n (HT20) - 5 GHz

Characteristics	Value			
Specification	IEEE 802.11n - 5 GHz			
Mode	OFDM			
Channel Frequency	5180 - 5825 MHz			
Data Rate	6.5, 13, 19.5, 26, 39, 52, 58.5, 65 Mbps			
Current Consumption	Minimum	Typical	Maximum	Unit
• Tx mode		380	480	mA
• Rx mode		120	170	mA
Transmitter	Minimum	Typical	Maximum	Unit
Power Levels	10.5	13	15.5	dBm
Spectrum Mask Margin				
• at fc +/- 11 MHz			-20	dBr
• at fc +/- 20 MHz			-28	dBr
• at fc ≥ +/- 30 MHz			-40	dBr
Constellation Error (Measured at enhanced mode)			-27	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions (BW = 100 kHz)				
• 30 Hz ≤ f < 1000 MHz			-36	dBm
• 1000 MHz ≤ f < 26000 MHz			-30	dBm
Receiver	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER ≤ 10%)			-64	dBm
Maximum Input Level (PER ≤ 10%)	-30			dBm
Adjacent Channel Rejection (PER < 10%)	16			dB

13.6 DC/RF Characteristics for IEEE 802.11n (HT40) - 5 GHz

Condition: 25 °C, VBAT = 3.3V, 135 Mbps (MCS7 - HT 40 MHz) mode unless otherwise specified.

Table 29: DC/RF Characteristics for IEEE 802.11n (HT40) - 5 GHz

Characteristics	Value			
Specification	IEEE 802.11n - 5 GHz			
Mode	OFDM			
Channel Frequency	5180 - 5825 MHz			
Data Rate	13.5,27,40.5,54,81,108,121.5,135 Mbps			
Current Consumption	Minimum	Typical	Maximum	Unit
• Tx mode		410	510	mA
• Rx mode		140	190	mA
Transmitter	Minimum	Typical	Maximum	Unit
Power Levels	9.5	12	14.5	dBm
Spectrum Mask				
• at fc +/- 21 MHz			-20	dBr
• at fc +/- 40 MHz			-28	dBr
• at fc ≥ +/- 60 MHz			-40	dBr
Constellation Error (Measured at enhanced mode)			-27	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions (BW = 100 kHz)				
• 30 Hz ≤ f < 1000 MHz			-36	dBm
• 1000 MHz ≤ f < 26000 MHz			-30	dBm
Receiver	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER ≤ 10%)			-61	dBm
Maximum Input Level (PER ≤ 10%)	-30			dBm
Adjacent Channel Rejection (PER < 10%)	-2			dB

13.7 DC/RF Characteristics for IEEE 802.11ac (HT40) - 5 GHz

Condition: 25 °C, VBAT =3.3V, 180 Mbps (MCS9 - HT 40 MHz) mode unless otherwise specified.

Table 30: DC/RF Characteristics for IEEE 802.11ac (HT40) - 5 GHz

Characteristics	Value			
Specification	IEEE 802.11ac - 5 GHz			
Mode	OFDM			
Channel Frequency	5190 - 5795 MHz			
Data Rate	13.5, 27, 40.5, 54, 81,108,121.5,135,162,180 Mbps			
Current Consumption	Minimum	Typical	Maximum	Unit
• Tx mode		420	520	mA
• Rx mode		140	200	mA
Transmitter	Minimum	Typical	Maximum	Unit
Power Levels	7.5	10	12.5	dBm
Spectrum Mask				
• at fc +/- 21 MHz			-20	dBr
• at fc +/- 40 MHz			-28	dBr
• at fc ≥ +/- 60 MHz			-40	dBr
Constellation Error (Measured at enhanced mode)			-32	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions (BW = 100 kHz)				
• 30 Hz ≤ f < 1000 MHz			-36	dBm
• 1000 MHz ≤ f < 26000 MHz			-30	dBm
Receiver	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER ≤ 10%)			-54	dBm
Maximum Input Level (PER ≤ 10%)	-30			dBm

13.8 DC/RF Characteristics for IEEE 802.11ac (HT80) - 5 GHz

Condition: 25 °C, VBAT = 3.3V, 390 Mbps (MCS9 - HT 80 MHz) mode unless otherwise specified.

Table 31: DC/RF Characteristics for IEEE 802.11ac (HT80) - 5 GHz

Characteristics	Value			
Specification	IEEE 802.11ac - 5 GHz			
Mode	OFDM			
Channel Frequency	5210 - 5775 MHz			
Data Rate	29.3, 58.5, 87.8, 117, 175.5, 234, 263.3, 292.5, 351, 390 Mbps			
Current Consumption	Minimum	Typical	Maximum	Unit
• Tx mode		440	540	mA
• Rx mode		180	250	mA
Transmitter	Minimum	Typical	Maximum	Unit
Power Levels	7.5	10	12.5	dBm
Spectrum Mask				
• at fc +/- 41 MHz			-20	dBr
• at fc +/- 80 MHz			-28	dBr
• at fc ≥ +/- 120 MHz			-40	dBr
Constellation Error (Measured at enhanced mode)			-32	dB
Spurious Emissions (BW = 100 kHz)				
• 30 Hz ≤ f < 1000 MHz			-36	dBm
• 1000 MHz ≤ f < 26000 MHz			-30	dBm
Receiver	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER ≤ 10%)			-51	dBm
Maximum Input Level (PER ≤ 10%)	-30			dBm
Adjacent Channel Rejection (PER < 10%)	-9			dB

13.9 DC/RF Characteristics for Bluetooth

Condition: 25 °C, VBAT = 3.3V

Table 32: DC/RF Characteristics for Bluetooth

Items	Contents			
Bluetooth Specification (power class)	Version 5.2 (Class2)			
Channel Frequency (spacing)	2402 to 2480 MHz (1 MHz)			
Current Consumption	Minimum	Typical	Maximum	Unit
• DH5 Packet 50% Rx/Tx slot duty cycle		50	65	mA
• 2DH5 Packet 50% Rx/Tx slot duty cycle		40	55	mA
• 3DH5 Packet 50% Rx/Tx slot duty cycle		40	45	mA
Transmitter	Minimum	Typical	Maximum	Unit
Output Power (at 1DH5)	7.5	11	14.5	dBm
Frequency Range	2400		2483.5	MHz
20 dB bandwidth			1	MHz
Adjacent Channel Power ²				
• [M-N] = 2			-20	dBm
• [M-N] ≥ 3			-40	dBm
Modulation Characteristics				
• Modulation $\Delta f_{1\text{avg}}$	140		175	kHz
• Modulation $\Delta f_{2\text{max}}$	115			kHz
• Modulation $\Delta f_{2\text{avg}} / \Delta f_{1\text{avg}}$	0.8			
Carrier Frequency Drift				
• 1slot	-25		+25	kHz
• 3slot / 5slot	-40		+40	kHz
• Maximum drift rate	-20		+20	kHz/50 μ s
EDR Relative Power	-4		+1	dB
EDR Carrier Frequency Stability and Modulation Accuracy				
• ω_i	-75		+75	kHz
• $\omega_i + \omega_o$	-75		+75	kHz
• ω_o	-10		+10	kHz
• RMS DEVM (DQPSK)			20	%
• Peak DEVM (DQPSK)			35	%
• 99% DEVM (DQPSK)			30	%
• RMS DEVM (8DPSK)			13	%
• Peak DEVM (8DPSK)			25	%
• 99% DEVM (8DPSK)			20	%
Spurious Emissions (BW = 100 kHz)				
• 30 Hz ≤ f < 1000 MHz			-36	dBm
• 1000 MHz ≤ f < 12750 MHz			-30	dBm
• 1800 MHz < f ≤ 1900 MHz			-47	dBm
• 5150 MHz < f ≤ 5300 MHz			-47	dBm
Receiver	Minimum	Typical	Maximum	Unit
Sensitivity (BER ≤ 0.1%)			-80	dBm
Maximum Input Level (BER ≤ 0.1%)	-20			dBm
EDR Sensitivity (BER ≤ 0.007%)				
• 8DPSK			-70	dBm

² Up to three spurious responses within Bluetooth limits are allowed.

13.10 DC/RF Characteristics for Bluetooth Low Energy

Condition: 25 °C, VBAT = 3.3V

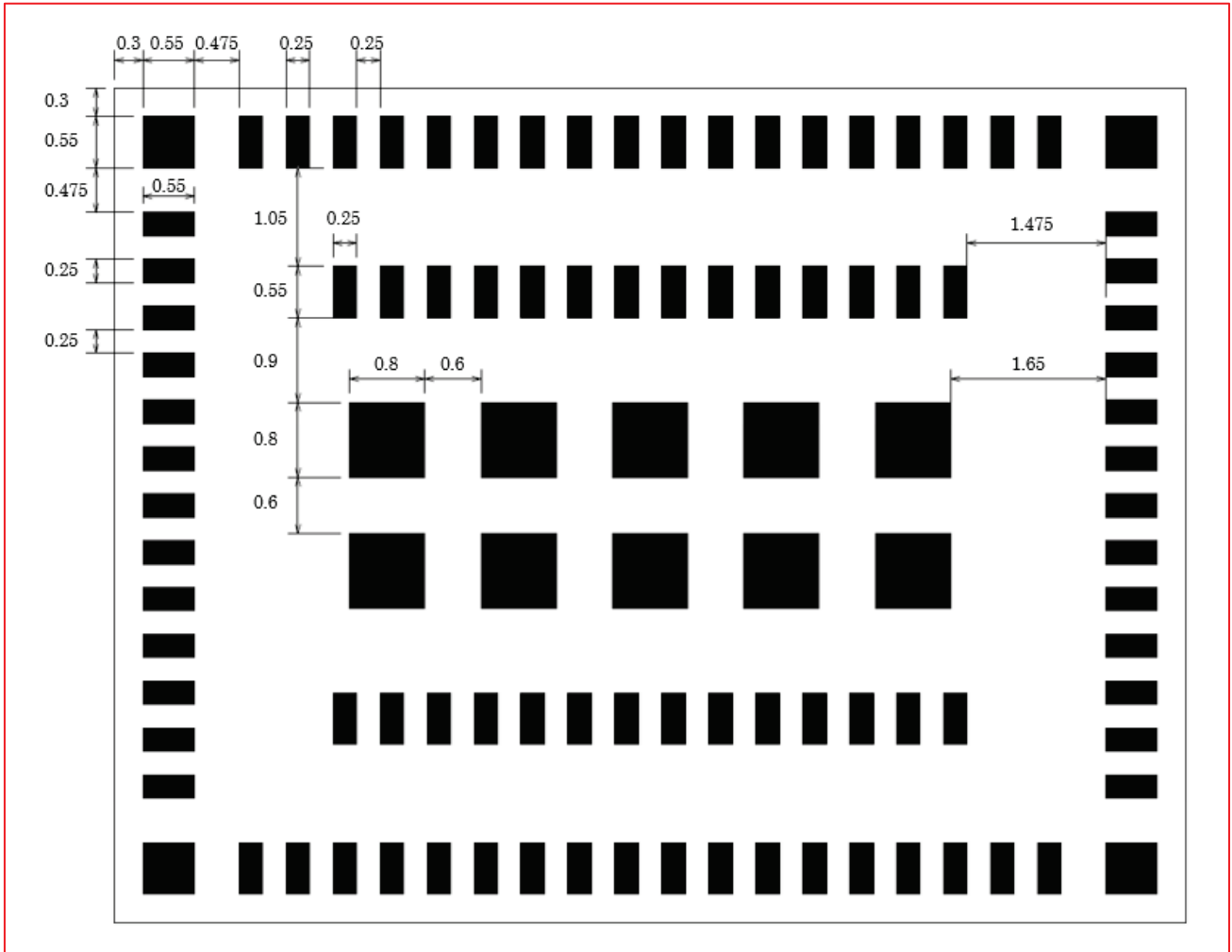
Table 33: DC/RF Characteristics for BLE

Items	Contents			
Bluetooth Specification (power class)	Version 5.2(LE)			
Channel Frequency (spacing)	2402 to 2480 MHz (2 MHz)			
Number of RF Channel	40			
Current Consumption	Minimum	Typical	Maximum	Unit
• Tx mode		30	45	mA
• Rx mode		15	25	mA
Item/Condition	Minimum	Typical	Maximum	Unit
Center Frequency	2402		2480	MHz
Channel Spacing		2		MHz
Number of RF channel		40		
Output Power	0	3	7.5	dBm
Modulation Characteristics				
• $\Delta f_{1\text{avg}}$	225		275	kHz
• $\Delta f_{2\text{max}}$ (at 99.9%)	185			kHz
• $\Delta f_{2\text{avg}} / \Delta f_{1\text{avg}}$	0.8			
Carrier Frequency Offset and Drift				
• Frequency Offset			150	kHz
• Frequency Drift			50	kHz
• Drift Rate			20	kHz
Receiver Sensitivity (PER < 30.8%)			-70	dBm
Maximum Input Signal Level (PER < 30.8%)	-10			dBm
PER Report Integrity (-30 dBm input)	50		65.4	%

14 Land Pattern

Figure 27 shows the land pattern diagram of Type 2BZ.

Figure 27: Land Pattern (Unit: mm)



15 Radio Regulatory Certification by Country for LBEE5XV2BZ

This section includes regulatory certification information / user manual of the following regions:


- Japan
- FCC
- ISED
- Europe

15.1 Japan

- Application Model Name: LBEE5XV2BZ
- Certification Number: 007-AJ0192



This module is a product that has been authorized construction design certification based on the following certificate of construction type.

	<ul style="list-style-type: none"> • In the 5 GHz frequency band, three types of 5.2 GHz / 5.3 GHz / 5.6 GHz bands (W52 / W53 / W56) can be used. • Outdoor use of the 5.2 GHz / 5.3 GHz band wireless LAN (W52 / W53) is prohibited by the Certificate of Construction Type. • W53 / W56 for STA function only.
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The end product or user manual is recommended to describe all the contents shown below.


	<ul style="list-style-type: none"> • This product has built-in specified radio equipment which received construction design certification (certification number: 007-AJ0192) based on the Certificate of Construction. • The W52 / W53 in the 5 GHz band is prohibited from outdoor use under the Japanese Certificate of Construction Type.
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Table 34, **Table 35**, and **Table 36** show the IC SISO, MIMO, simultaneous transmission per antenna port power table for 2.4 GHz for WLAN and Bluetooth. **Table 37** shows the IC SISO simultaneous transmission per antenna port power table for 5 GHz WLAN.

Table 38 shows the IC MIMO simultaneous transmission per antenna port power table for 5 GHz WLAN.

Table 34: Japan Power Level 2.4 GHz WLAN Per Antenna Port (SISO/1SS)

Mode	Rate	Maximum Tune Up Tolerance (dBm)
Channels		1 ~ 13
IEEE 802.11b	All Rates	13.5 ± 2.5
IEEE 802.11g	6 Mbps, 9 Mbps, 12 Mbps, 18 Mbps	15.5 ± 2.5
	24 Mbps, 36 Mbps, 48 Mbps, 54 Mbps	15.0 ± 2.5
IEEE 802.11n (HT20)	MCS0, MCS1, MCS2, MCS3	15.5 ± 2.5
	MCS4, MCS5, MCS6, MCS7	15.0 ± 2.5
Equivalent to IEEE 802.11ac (VHT20)	MCS0, MCS1, MCS2, MCS3	15.5 ± 2.5
	MCS4, MCS5, MCS6, MCS7	15.0 ± 2.5
	MCS8	14.0 ± 2.5

Table 35: Japan Power Level 2.4 GHz WLAN Per Antenna Port (MIMO/2SS)

Mode	Rate	Maximum Tune Up Tolerance (dBm)
Channels		1 ~ 13
IEEE 802 11n (HT20)	MCS8, MCS9, MCS10, MCS11, MCS12, MCS13, MCS14, MCS15	12.5 ± 2.5
Equivalent to IEEE 802 11ac (VHT20)	MCS0, MCS1, MCS2, MCS3, MCS4, MCS5, MCS6, MCS7, MCS8	12.5 ± 2.5

Table 36: Japan Power Level 2.4 GHz BT/BLE Per Antenna Port

Frequency (MHz)	Typical Output Power Level (dBm)		
	DH5	3DH5	BLE
2402	11	7	3
2440	11	7	3
2480	11	7	3



The Japan Bluetooth power table (**Table 36**) is valid for FCC, ISED, and Europe.

Table 37: Japan Power Level 5 GHz WLAN Per Antenna Port (SISO/1SS)

Mode	Channel	Rate	Maximum Tune Up Tolerance (dBm)
IEEE 802.11a	36 ~ 48	6 Mbps, 9 Mbps, 12 Mbps, 18 Mbps, 24 Mbps	12.5 ± 2.5
		36 Mbps, 48 Mbps, 54 Mbps	12.5 ± 2.5
	52 ~ 64	6 Mbps, 9 Mbps, 12 Mbps, 18 Mbps, 24 Mbps	12.5 ± 2.5
		36 Mbps, 48 Mbps, 54 Mbps	12.5 ± 2.5
	100 ~ 144	6 Mbps, 9 Mbps, 12 Mbps, 18 Mbps, 24 Mbps	15.0 ± 2.5
		36 Mbps, 48 Mbps, 54 Mbps	14.0 ± 2.5
IEEE 802.11n/ac (HT20)	36 ~ 48	MCS0 ~ MCS3	12.5 ± 2.5
		MCS4 ~ MCS6	12.5 ± 2.5
		MCS7	12.5 ± 2.5
	52 ~ 64	MCS0 ~ MCS3	12.75 ± 2.5
		MCS4 ~ MCS6	12.75 ± 2.5
		MCS7	12.75 ± 2.5
	100 ~ 144	MCS0 ~ MCS3	15.0 ± 2.5
		MCS4 ~ MCS6	14.0 ± 2.5
		MCS7	13.0 ± 2.5
IEEE 802.11n/ac (HT40)	38 ~ 46	MCS0 ~ MCS5	13.25 ± 2.5
		MCS6	13.0 ± 2.5
		MCS7	12.0 ± 2.5
	54 ~ 62	MCS0 ~ MCS5	13.5 ± 2.5
		MCS6	13.0 ± 2.5
		MCS7	12.0 ± 2.5
	102 ~ 142	MCS0 ~ MCS5	14.0 ± 2.5
		MCS6	13.0 ± 2.5
		MCS7	12.0 ± 2.5
IEEE 802.11ac (VHT20)	36 ~ 48	MCS8	12.0 ± 2.5
	52 ~ 64	MCS8	12.0 ± 2.5
	100 ~ 144	MCS8	12.0 ± 2.5
IEEE 802.11ac (VHT40)	38 ~ 46	MCS8	11.0 ± 2.5
		MCS9	10.0 ± 2.5
	54 ~ 62	MCS8	11.0 ± 2.5
		MCS9	10.0 ± 2.5
	102 ~ 142	MCS8	11.0 ± 2.5
		MCS9	10.0 ± 2.5
IEEE 802.11ac (VHT80)	42	MCS0 ~ MCS5	13.0 ± 2.5
		MCS6	13.0 ± 2.5
		MCS7	12.0 ± 2.5
		MCS8	11.0 ± 2.5
		MCS9	10.0 ± 2.5
	58	MCS0 ~ MCS5	13.0 ± 2.5
		MCS6	13.0 ± 2.5
		MCS7	12.0 ± 2.5
		MCS8	11.0 ± 2.5
		MCS9	10.0 ± 2.5
	106 ~ 138	MCS0 ~ MCS5	14.0 ± 2.5
		MCS6	13.0 ± 2.5
		MCS7	12.0 ± 2.5
		MCS8	11.0 ± 2.5
		MCS9	10.0 ± 2.5

Table 38: Japan Power Level 5 GHz WLAN Per Antenna Port (MIMO/2SS)

Mode	Channel	Rate	Maximum Tune Up Tolerance (dBm)
IEEE 802.11n (HT20)	36 ~ 48	MCS8 ~ MCS15	11.0 ± 2.5
IEEE 802.11n (HT40)	38 ~ 46	MCS8 ~ MCS15	11.0 ± 2.5
IEEE 802.11ac (VHT20)	36 ~ 48	MCS0 ~ MCS8	11.0 ± 2.5
IEEE 802.11ac (VHT40)	38 ~ 46	MCS0 ~ MCS8	11.0 ± 2.5
		MCS9	10.0 ± 2.5
IEEE 802.11ac (VHT80)	42	MCS0 ~ MCS8	11.0 ± 2.5
		MCS9	10.0 ± 2.5

15.2 FCC

- Model Name: LBEE5XV2BZ
- FCC ID: VPYLBEE5XV1XA

Since this module is not sold to general end users directly, there is no user manual for this module. Therefore, for the details about this module, please refer to the specification sheet of module.



1. This module should be installed in the host device according to the interface specification (installation procedure).
2. The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the end user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as shown in User manual.

15.2.1 Information to Display on Host Device and User Manual

15.2.1.1 Information on Host Device

The following information must be indicated on the host device of this module:

- Contains Transmitter Module **FCC ID: VPYLBEE5XV1XA** or Contains FCC ID: **VPYLBEE5XV1XA**



This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

- This device may not cause harmful interference.
- This device must accept any interference received, including interference that may cause undesired operation.



If it is difficult to describe this statement on the host device due to the size, please describe in the user's manual and also either describe on the device packaging or on a removable label attached to the device.

15.2.1.2 Information in User Manual

The following statements must be described on the user manual of the host device of this module:

- **FCC CAUTION:** Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.
- This transmitter must not be co-located or operated in conjunction with any other antenna or transmitter.

15.2.2 Equipment Installation for FCC

There are two types of installation for host device.

15.2.2.1 Portable Equipment

Equipment for which the spaces between human body and antenna are used within 20 cm. When installing it in a portable equipment, please describe the following information to the manual.



It is necessary to take a SAR test with your set mounting this module. Class II permissive change application is necessary using the SAR report. Please contact Murata.

15.2.2.2 Mobile Equipment

Equipment used at position in which the spaces between human body and antenna exceeded 20 cm. When installing it in a mobile equipment, please describe the following information to the manual.



This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment and meets the FCC radio frequency (RF) Exposure Guidelines. This equipment should be installed and operated keeping the radiator at least 20 cm or more away from person's body.

15.2.3 Compliance with FCC requirement 15.407(c)

Data transmission is always initiated by software, which is the passed down through the MAC, through the digital and analog baseband, and finally to the RF chip. Several special packets are initiated by the MAC. These are the only ways the digital baseband portion will turn on the RF transmitter, which it then turns off at the end of the packet. Therefore, the transmitter will be on only while one of the aforementioned packets is being transmitted. In other words, this device automatically discontinues transmission in case of either absence of information to transmit or operational failure.



Frequency Tolerance: ± 20 ppm

15.2.4 Power Level for FCC

Table 39 and **Table 40** show the IC SISO, MIMO, simultaneous transmission per antenna port power table for 2.4 GHz for WLAN. **Table 41**, **Table 42**, and **Table 43** show the IC SISO simultaneous transmission per antenna port power table for 5 GHz WLAN.

Table 44, **Table 45**, and **Table 46** show the IC MIMO simultaneous transmission per antenna port power table for 5 GHz WLAN.

Table 39: FCC Power Level 2.4 GHz WLAN Per Antenna Port (SISO/1SS)

Mode	Rate	Typical Output Power Level (dBm)										
		1	2	3	4	5	6	7	8	9	10	11
Channels		1	2	3	4	5	6	7	8	9	10	11
IEEE 802.11b	All Rates	14.5	15.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	15.0	15.5
IEEE 802.11g	All Rates	12.5	14.0	14.0	14.5	14.5	15.5	16.5	15.5	15.0	14.0	12.5
IEEE 802.11n (HT20)	MCS0 ~ MCS7	11.0	13.0	14.0	14.0	14.5	15.5	15.5	15.0	14.5	12.5	11.5
Equivalent to IEEE 802.11ac (VHT20)	MCS0 ~ MCS7	11.0	13.0	14.0	14.0	14.5	15.5	15.5	15.0	14.5	12.5	11.5
	MCS8	11.0	13.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	12.5	11.5

Table 40: FCC Power Level 2.4 GHz WLAN Per Antenna Port (MIMO/2SS)

Mode	Rate	Typical Output Power Level (dBm)										
		1	2	3	4	5	6	7	8	9	10	11
Channels		1	2	3	4	5	6	7	8	9	10	11
IEEE 802.11n (HT20)	MCS8 ~ MCS15	8.0	11.0	11.5	13.0	13.0	14.0	14.0	13.0	12.0	10.5	10.0
Equivalent to IEEE 802.11ac (VHT20)	MCS0 ~ MCS8	8.0	11.0	11.5	13.0	13.0	14.0	14.0	13.0	12.0	10.5	10.0

Table 41: FCC Power Level 5 GHz WLAN Per Antenna Port (SISO/1SS) (W52-53)

Mode	Rate	Typical Output Power (dBm)						
		36	40	44 ~ 48	52 ~ 56	60	64	
11a	6 ~ 24 Mbps	10.0	13.5	13.5	15.0	15.0	10.5	
	36 ~ 54 Mbps	10.0	13.5	13.5	14.0	14.0	10.5	
11n HT20	MCS0 ~ MCS3	9.0	13.5	13.5	15.0	15.0	10.0	
	MCS4 ~ MCS6	9.0	13.5	13.5	14.0	14.0	10.0	
	MCS7	9.0	13.5	13.0	13.0	13.0	10.0	
11ac VHT20	MCS0 ~ MCS3	9.0	13.5	13.5	15.0	15.0	10.0	
	MCS4 ~ MCS6	9.0	13.5	13.5	14.0	14.0	10.0	
	MCS7	9.0	13.0	13.0	13.0	13.0	10.0	
	MCS8	9.0	12.0	12.0	12.0	12.0	10.0	
Channels		38	46	54	62			
11n/ac HT40	MCS0 ~ MCS5	10.5	13.0	14.0	9.5			
	MCS6	10.5	13.0	13.0	9.5			
	MCS7	10.5	12.0	12.0	9.5			
11ac VHT40	MCS8	10.5	11.0	11.0	9.5			
	MCS9	10.5	10.0	10.0	9.5			
Channels		42	58					
11ac VHT80	MCS0 ~ MCS9	8.0		5.5				

Table 42: FCC Power Level 5 GHz WLAN Per Antenna Port (SISO/1SS) (W56)

Mode	Rate	Typical Output Power (dBm)						
Channels		100	104	108~112	116~128	132~136	140	144
11a	6 ~ 24 Mbps	10.0	15.0	15.0	15.0	15.0	10.0	15.0
	36 ~ 54 Mbps	10.0	14.0	14.0	14.0	14.0	10.0	14.0
11n/ac HT20	MCS0 ~ MCS3	9.0	15.0	15.0	15.0	15.0	9.0	15.0
	MCS4 ~ MCS6	9.0	14.0	14.0	14.0	14.0	9.0	14.0
	MCS7	9.0	13.0	13.0	13.0	13.0	9.0	13.0
11ac VHT20	MCS8	9.0	12.0	12.0	12.0	12.0	9.0	12.0
Channels		102	110	118~126	134	142		
11n/ac HT40	MCS0 ~ MCS5	8.5	14.0	14.0	12.0	14.0		
	MCS6	8.5	13.0	13.0	12.0	13.0		
	MCS7	8.5	12.0	12.0	12.0	12.0		
11ac VHT40	MCS8	8.5	11.0	11.0	11.0	11.0		
	MCS9	8.5	10.0	10.0	10.0	10.0		
Channels		106	122	138				
11ac VHT80	MCS0 ~ MCS5	7.5	14.0	14.0			14.0	
	MCS6	7.5	13.0	13.0			13.0	
	MCS7	7.5	12.0	12.0			12.0	
	MCS8	7.5	11.0	11.0			11.0	
	MCS9	7.5	10.0	10.0			10.0	

Table 43: FCC Power Level 5 GHz WLAN Per Antenna Port (SISO/1SS) (W58)

Mode	Rate	Typical Output Power (dBm)	
Channels		149 ~ 161	165
11a	6 ~ 24 Mbps	15.0	15.0
	36 ~ 54 Mbps	14.0	14.0
11n/ac HT20	MCS0 ~ MCS3	15.0	15.0
	MCS4 ~ MCS6	14.0	14.0
	MCS7	13.0	13.0
11ac VHT20	MCS8	12.0	12.0
Channels		151 ~ 159	
11n/ac HT40	MCS0 ~ MCS5	14.0	
	MCS6	13.0	
	MCS7	12.0	
11ac VHT40	MCS8	11.0	
	MCS9	10.0	
Channels		155	
11ac VHT80	MCS0 ~ MCS6	13.0	
	MCS7	12.0	
	MCS8	11.0	
	MCS9	10.0	

Table 44: FCC Power Level 5 GHz WLAN Per Antenna Port (MIMO/2SS) (W52-53)

Mode	Rate	Typical Output Power (dBm)					
Channels		36	40	44 ~ 48	52 ~ 56	60	64
11n HT20	MCS8 ~ MCS14	7.5	10.5	10.5	14.0	14.0	7.0
	MCS15	7.5	10.5	10.5	13.0	13.0	7.0
11ac VHT20	MCS0 ~ MCS6	7.5	10.5	10.5	14.0	14.0	7.0
	MCS7	7.5	10.5	10.5	13.0	13.0	7.0
	MCS8	7.5	10.5	10.5	12.0	12.0	7.0
Channels		38	46	54	62		
11n/ac HT40	MCS8 ~ MCS13	7.5	10.0	14.0	7.0		
	MCS14	7.5	10.0	13.0	7.0		
	MCS15	7.5	10.0	12.0	7.0		
11ac VHT40	MCS0 ~ MCS5	7.5	10.0	14.0	7.0		
	MCS6	7.5	10.0	13.0	7.0		
	MCS7	7.5	10.0	12.0	7.0		
	MCS8	7.5	10.0	11.0	7.0		
	MCS9	7.5	10.0	10.0	7.0		
Channels		42	58				
11ac VHT80	MCS0 ~ MCS9	6.0		4.0			

Table 45: FCC Power Level 5 GHz WLAN Per Antenna Port (MIMO/2SS) (W56)

Mode	Rate	Typical Output Power (dBm)						
Channels		100	104	108~112	116~128	132~136	140	144
11n HT20	MCS8 ~ MCS11	7.0	14.5	14.5	14.5	14.5	6.0	14.5
	MCS12 ~ MCS14	7.0	14.0	14.0	14.0	14.0	6.0	14.0
	MCS15	7.0	13.0	13.0	13.0	13.0	6.0	13.0
11ac VHT20	MCS0 ~ MCS3	7.0	14.5	14.5	14.5	14.5	6.0	14.5
	MCS4 ~ MCS6	7.0	14.0	14.0	14.0	14.0	6.0	14.0
	MCS7	7.0	13.0	13.0	13.0	13.0	6.0	13.0
	MCS8	7.0	12.0	12.0	12.0	12.0	6.0	12.0
Channels		102	110	118~126	134	142		
11n/ac HT40	MCS8 ~ MCS13	8.0	14.0	14.0	9.0	14.0		
	MCS14	8.0	13.0	13.0	9.0	13.0		
	MCS15	8.0	12.0	12.0	9.0	12.0		
11ac VHT40	MCS0 ~ MCS5	8.0	14.0	14.0	9.0	14.0		
	MCS6	8.0	13.0	13.0	9.0	13.0		
	MCS7	8.0	12.0	12.0	9.0	12.0		
	MCS8	8.0	11.0	11.0	9.0	11.0		
	MCS9	8.0	10.0	10.0	9.0	10.0		
Channels		106	122	138				
11ac VHT80	MCS0 ~ MCS5	5.5	14.0	14.0				
	MCS6	5.5	13.0	13.0				
	MCS7	5.5	12.0	12.0				

Mode	Rate	Typical Output Power (dBm)		
	MCS8	5.5	11.0	11.0
	MCS9	5.5	10.0	10.0

Table 46: FCC Power Level 5 GHz WLAN Per Antenna Port (MIMO/2SS) (W58)

Mode	Rate	Typical Output Power (dBm)	
Channels		149 ~ 161	165
11n HT20	MCS8 ~ MCS11	15.0	15.0
	MCS12 ~ MCS14	14.0	14.0
	MCS15	13.0	13.0
11ac VHT20	MCS0 ~ MCS3	15.0	15.0
	MCS4 ~ MCS6	14.0	14.0
	MCS7	13.0	13.0
	MCS8	12.0	12.0
Channels		151 ~ 159	
11n/ac HT40	MCS8 ~ MCS13	14.0	
	MCS14	13.0	
	MCS15	12.0	
11ac VHT40	MCS0 ~ MCS5	14.0	
	MCS6	13.0	
	MCS7	12.0	
	MCS8 ~ MCS13	14.0	
	MCS14	13.0	
Channels		155	
11ac VHT80	MCS0 ~ MCS9	10.5	

15.3 ISED

- Model Name: “LBEE5XV2BZ_SANT”, “LBEE5XV2BZ_DANT”
- IC Number: 772C-LBEE5XV1XA

This module is not sold to general end users directly, therefore, there is no user manual of module. For the details about this module, please refer to the specification sheet for the same.



1. This module should be installed in the host device according to the interface specification (installation procedure).
2. The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the end user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as shown in User manual.

Table 47 shows the certified antenna list for type 2BZ module.

Table 47: Certified Antenna List

No.	Maker	Support Antenna				
		P/N	Form Factor	Type	Gain (dBi)	
					2.4 GHz	5 GHz
1	Molex	146153	u.FL/flexible	dipole	3.2	4.25
2	Molex	146187	u.FL/flexible	dipole	3.4	4.75

15.3.1 Information to Display on Host Device and User Manual

15.3.1.1 Information on Host Device

The following information must be indicated on the host device of this module:

- **Contains IC:** 772C-LBEE5XV1XA
- In case of the final product which can be carried around to outdoor. The following indication is necessary to the final product.



When the STA function is used in channel 52, 54, 58.
 At the time of the channel 52 or 54 or 58 setting, please indicate “for indoor use only channel”.
 During connecting, please show the channel number which connects.
 And please indicate that the end user may find out “for indoor use only channel”.

- If the final product uses the following frequency, please note that there is a limit.

English Version

For indoor use only (5150 – 5250 MHz band)

French Version

Pour usage intérieur seulement (5150 - 5250 MHz band)

15.3.1.2 Information in User Manual

The following statements must be described on the user manual of the host device of this module:

<p>English Version</p> <p>This device complies with Industry Canada's applicable license-exempt RSSs. Operation is subject to the following two conditions:</p> <ul style="list-style-type: none"> • This device may not cause interference; and • This device must accept any interference, including interference that may cause undesired operation of the device.
<p>French Version</p> <p>Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:</p> <ul style="list-style-type: none"> • l'appareil ne doit pas produire de brouillage. • l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.
<p>English Version</p> <p>Data transmission is always initiated by software, which is the passed down through the MAC, through the digital and analog baseband, and finally to the RF chip. Several special packets are initiated by the MAC. These are the only ways the digital baseband portion will turn on the RF transmitter, which it then turns off at the end of the packet. Therefore, the transmitter will be on only while one of the aforementioned packets is being transmitted. In other words, this device automatically discontinue transmission in case of either absence of information to transmit or operational failure.</p>
<p>French Version</p> <p>La transmission des données est toujours initiée par le logiciel, puis les données sont transmises par l'intermédiaire du MAC, par la bande de base numérique et analogique et, enfin, à la puce RF. Plusieurs paquets spéciaux sont initiés par le MAC. Ce sont les seuls moyens pour qu'une partie de la bande de base numérique active l'émetteur RF, puis désactive celui-ci à la fin du paquet. En conséquence, l'émetteur reste uniquement activé lors de la transmission d'un des paquets susmentionnés. En d'autres termes, ce dispositif interrompt automatiquement toute transmission en cas d'absence d'information à transmettre ou de défaillance.</p>

<p>English Version</p> <p>This radio transmitter (IC Number: 772C-LBEE5XV1XA) has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.</p>
<p>French Version</p> <p>Le présent émetteur radio (IC Number: 772C-LBEE5XV1XA) a été approuvé par Innovation, Sciences et Développement économique Canada pour fonctionner avec les types d'antenne énumérés ci dessous et ayant un gain admissible maximal. Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué pour</p>

15.3.2 Equipment Installation for ISED

There are two types of installation for host device.

15.3.2.1 Portable Equipment

Equipment for which the spaces between human body and antenna are used within 20 cm. When installing it in a portable equipment, please describe the following warning to the manual.



It is necessary to take a SAR test with your set mounting this module. Class IV permissive change application is necessary using the SAR report. Please contact Murata.

15.3.2.2 Mobile Equipment

Equipment used at position in which the spaces between human body and antenna exceeded 20 cm. When installing it in a mobile equipment, please describe the following information to the manual.

English Version

This equipment complies with IC radiation exposure limits set forth for an uncontrolled environment and meets RSS-102 of the IC radio frequency (RF) Exposure rules. This equipment should be installed and operated keeping the radiator at least 20 cm or more away from person's body.

French Version

Cet équipement est conforme aux limites d'exposition aux rayonnements énoncées pour un environnement non contrôlé et respecte les règles d'exposition aux fréquences radioélectriques (RF) CNR-102 de l'IC. Cet équipement doit être installé et utilisé en gardant une distance de 20 cm ou plus entre le radiateur et le corps humain.

15.3.3 Power Level for ISED

Table 48 and **Table 49** show the IC SISO, MIMO, simultaneous transmission per antenna port power table for 2.4 GHz for WLAN. **Table 50**, **Table 51**, and **Table 52** show the IC SISO simultaneous transmission per antenna port power table for 5 GHz WLAN.

Table 53, **Table 54**, and **Table 55** show the IC MIMO simultaneous transmission per antenna port power table for 5 GHz WLAN.

Table 48: ISED Power Level 2.4 GHz WLAN Per Antenna Port (SISO/1SS)

Mode	Rate	Typical Output Power Level (dBm)										
		1	2	3	4	5	6	7	8	9	10	11
Channels												
IEEE 802.11b	All Rates	14.5	15.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	15.0	15.5
IEEE 802.11g	All Rates	12.5	14.0	14.0	14.5	14.5	15.5	16.5	15.5	15.0	14.0	12.5
IEEE 802.11n (HT20)	MCS0 ~ MCS3	11.0	13.0	14.0	14.0	14.5	15.5	15.5	15.0	14.5	12.5	11.5
	MCS4 ~ MCS7	11.0	13.0	14.0	14.0	14.5	15.0	15.0	15.0	14.5	12.5	11.5
Equivalent to IEEE 802.11ac (VHT20)	MCS0 ~ MCS3	11.0	13.0	14.0	14.0	14.5	15.5	15.5	15.0	14.5	12.5	11.5
	MCS4 ~ MCS7	11.0	13.0	14.0	14.0	14.5	15.0	15.0	15.0	14.5	12.5	11.5
	MCS8	11.0	13.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	12.5	11.5

Table 49: ISED Power Level 2.4 GHz WLAN Per Antenna Port (MIMO/2SS)

Mode	Rate	Typical Output Power Level (dBm)										
		1	2	3	4	5	6	7	8	9	10	11
Channels												
IEEE 802.11n (HT20)	MCS8 ~ MCS15	8.0	11.0	11.5	13.0	13.0	14.0	14.0	13.0	12.0	10.5	10.0
Equivalent to IEEE 802.11ac (VHT20)	MCS0 ~ MCS8	8.0	11.0	11.5	13.0	13.0	14.0	14.0	13.0	12.0	10.5	10.0

Table 50: ISED Power Level 5 GHz WLAN Per Antenna Port (SISO/1SS) (W52-53)

Mode	Rate	Typical Output Power (dBm)						
Channels		36	40	44 ~ 48	52 ~ 56	60	64	
11a	6 ~ 24 Mbps	10.0	13.5	13.5	15.0	15.0	10.5	
	36 ~ 54 Mbps	10.0	13.5	13.5	14.0	14.0	10.5	
11n HT20	MCS0 ~ MCS3	9.0	13.5	13.5	15.0	15.0	10.0	
	MCS4 ~ MCS6	9.0	13.5	13.5	14.0	14.0	10.0	
	MCS7	9.0	13.5	13.0	13.0	13.0	10.0	
11ac VHT20	MCS0 ~ MCS3	9.0	13.5	13.5	15.0	15.0	10.0	
	MCS4 ~ MCS6	9.0	13.5	13.5	14.0	14.0	10.0	
	MCS7	9.0	13.0	13.0	13.0	13.0	10.0	
	MCS8	9.0	12.0	12.0	12.0	12.0	10.0	
Channels		38		46	54		62	
11n/ac HT40	MCS0 ~ MCS5	10.5		13.0		14.0	9.5	
	MCS6	10.5		13.0		13.0	9.5	
	MCS7	10.5		12.0		12.0	9.5	
11ac VHT40	MCS8	10.5		11.0		11.0	9.5	
	MCS9	10.5		10.0		10.0	9.5	
Channels		42			58			
11ac VHT80	MCS0 ~ MCS9	8.0				5.5		

Table 51: ISED Power Level 5 GHz WLAN Per Antenna Port (SISO/1SS) (W56)

Mode	Rate	Typical Output Power (dBm)								
Channels		100	104	108~112	116	120~128	132~136	140	144	
11a	6 ~ 24 Mbps	10.0	15.0	15.0	15.0		15.0	10.0	15.0	
	36 ~ 54 Mbps	10.0	14.0	14.0	14.0		14.0	10.0	14.0	
11n/ac HT20	MCS0 ~ MCS3	9.0	15.0	15.0	15.0		15.0	9.0	15.0	
	MCS4 ~ MCS6	9.0	14.0	14.0	14.0		14.0	9.0	14.0	
	MCS7	9.0	13.0	13.0	13.0		13.0	9.0	13.0	
11ac VHT20	MCS8	9.0	12.0	12.0	12.0		12.0	9.0	12.0	
Channels		102		110	118~126		134	142		
11n/ac HT40	MCS0 ~ MCS5	8.5		14.0			12.0		14.0	
	MCS6	8.5		13.0			12.0		13.0	
	MCS7	8.5		12.0			12.0		12.0	
11ac VHT40	MCS8	8.5		11.0			11.0		11.0	
	MCS9	8.5		10.0			10.0		10.0	
Channels		106			122			138		
11ac VHT80	MCS0 ~ MCS5	7.5						14.0		
	MCS6	7.5						13.0		
	MCS7	7.5						12.0		
	MCS8	7.5						11.0		
	MCS9	7.5						10.0		

Table 52: ISED Power Level 5 GHz WLAN Per Antenna Port (SISO/1SS) (W58)

Mode	Rate	Typical Output Power (dBm)	
Channels		149 ~ 161	165
11a	6 ~ 24 Mbps	15.0	15.0
	36 ~ 54 Mbps	14.0	14.0
11n/ac HT20	MCS0 ~ MCS3	15.0	15.0
	MCS4 ~ MCS6	14.0	14.0
	MCS7	13.0	13.0
11ac VHT20	MCS8	12.0	12.0
Channels		151 ~ 159	
11n/ac HT40	MCS0 ~ MCS5	14.0	
	MCS6	13.0	
	MCS7	12.0	
11ac VHT40	MCS8	11.0	
	MCS9	10.0	
Channels		155	
11ac VHT80	MCS0 ~ MCS6	13.0	
	MCS7	12.0	
	MCS8	11.0	
	MCS9	10.0	

Table 53: ISED Power Level 5 GHz WLAN Per Antenna Port (MIMO/2SS) (W52-53)

Mode	Rate	Typical Output Power (dBm)							
Channels		36	40	44	48	52 ~ 56	60	64	
11n HT20	MCS8 ~ MCS14	7.5	6.0	10.5	5.5	14.0	14.0	7.0	
	MCS15	7.5	6.0	10.5	5.5	13.0	13.0	7.0	
11ac VHT20	MCS0 ~ MCS6	7.5	6.0	10.5	5.5	14.0	14.0	7.0	
	MCS7	7.5	6.0	10.5	5.5	13.0	13.0	7.0	
	MCS8	7.5	6.0	10.5	5.5	12.0	12.0	7.0	
Channels		38		46		54		62	
11n/ac HT40	MCS8 ~ MCS13	7.5		10.0		14.0		7.0	
	MCS14	7.5		10.0		13.0		7.0	
	MCS15	7.5		10.0		12.0		7.0	
11ac VHT40	MCS0 ~ MCS5	7.5		10.0		14.0		7.0	
	MCS6	7.5		10.0		13.0		7.0	
	MCS7	7.5		10.0		12.0		7.0	
	MCS8	7.5		10.0		11.0		7.0	
	MCS9	7.5		10.0		10.0		7.0	
Channels		42				58			
11ac VHT80	MCS0 ~ MCS9	6.0				4.0			

Table 54: ISED Power Level 5 GHz WLAN Per Antenna Port (MIMO/2SS) (W56)

Mode	Rate	Typical Output Power (dBm)							
Channels		100	104	108~112	116	120~128	132~136	140	144
11n HT20	MCS8 ~ MCS11	7.0	14.5	14.5	14.5		14.5	6.0	14.5
	MCS12 ~ MCS14	7.0	14.0	14.0	14.0		14.0	6.0	14.0
	MCS15	7.0	13.0	13.0	13.0		13.0	6.0	13.0
11ac VHT20	MCS0 ~ MCS3	7.0	14.5	14.5	14.5		14.5	6.0	14.5
	MCS4 ~ MCS6	7.0	14.0	14.0	14.0		14.0	6.0	14.0
	MCS7	7.0	13.0	13.0	13.0		13.0	6.0	13.0
	MCS8	7.0	12.0	12.0	12.0		12.0	6.0	12.0
Channels		102	110	118~126		134	142		
11n/ac HT40	MCS8 ~ MCS13	8.0	14.0			9.0	14.0		
	MCS14	8.0	13.0			9.0	13.0		
	MCS15	8.0	12.0			9.0	12.0		
11ac VHT40	MCS0 ~ MCS5	8.0	14.0			9.0	14.0		
	MCS6	8.0	13.0			9.0	13.0		
	MCS7	8.0	12.0			9.0	12.0		
	MCS8	8.0	11.0			9.0	11.0		
	MCS9	8.0	10.0			9.0	10.0		
Channels		106	122			138			
11ac VHT80	MCS0 ~ MCS5	5.5				14.0			
	MCS6	5.5				13.0			
	MCS7	5.5				12.0			
	MCS8	5.5				11.0			
	MCS9	5.5				10.0			

Table 55: ISED Power Level 5 GHz WLAN Per Antenna Port (MIMO/2SS) (W58)

Mode	Rate	Typical Output Power (dBm)	
Channels		149 ~ 161	165
11n HT20	MCS8 ~ MCS11	15.0	15.0
	MCS12 ~ MCS14	14.0	14.0
	MCS15	13.0	13.0
11ac VHT20	MCS0 ~ MCS3	15.0	15.0
	MCS4 ~ MCS6	14.0	14.0
	MCS7	13.0	13.0
	MCS8	12.0	12.0
Channels		151 ~ 159	
11n/ac HT40	MCS8 ~ MCS13	14.0	
	MCS14	13.0	
	MCS15	12.0	
11ac VHT40	MCS0 ~ MCS5	14.0	
	MCS6	13.0	
	MCS7	12.0	
	MCS8	11.0	

Mode	Rate	Typical Output Power (dBm)
	MCS9	10.0
Channels		155
11ac VHT80	MCS0 ~ MCS9	10.5

15.3.4 ISED Operation Mode and Frequency Band

Table 56 shows the operation and frequency band for ISED.

Table 56: Operation Mode and Frequency Band

WLAN	STA	2.4 GHz	11b/g/n/ac	HT20	1ch-11ch
		5 GHz	11a	HT20	W52/53/56/58 with ch144/142/138 DFS (Device without Radar detection capability) No TPC
			11n	HT20/40	
	11ac	VHT20/40/80			
	AP	2.4 GHz	11b/g/n/ac	HT20	1ch-11ch
		5 GHz	11a	HT20	W52/58 with ch144/142/138 No TPC
11n			HT20/40		
11ac	VHT20/40/80				
BT	BR / EDR / LE (1/2 Mbps)				

15.3.5 ISED Theory of Operation

Table 57 shows the theory of operation for WLAN.

Table 57: ISED Theory of Operation for WLAN - Channel List

Frequency of Operation		Scan	Ad-hoc	
2.4 GHz	11b/g/n (HT20)	2412-2462 MHz	Active	Yes
	BT	2402-2480 MHz	N/A	N/A
	BLE	2402-2480 MHz	N/A	N/A
W52	11a/n/ac ((V)HT20)	5180-5240 MHz	Active	Yes
	11n/ac ((V)HT40)	5190-5230 MHz	Active	Yes
	11ac (VHT80)	5210 MHz	Active	Yes
W53	11a/n/ac ((V)HT20)	5260-5320 MHz	Passive	No
	11n/ac ((V)HT40)	5270-5310 MHz	Passive	No
	11ac (VHT80)	5290 MHz	Passive	No
W56	11a/n/ac ((V)HT20)	5500-5720 MHz ³	Passive	No
	11n/ac ((V)HT40)	5510-5710 MHz ³	Passive	No
	11ac (VHT80)	5530-5690 MHz ³	Passive	No
W58	11a/n/ac ((V)HT20)	5745-5825 MHz	Active	Yes

³ The frequency band 5600 MHz-5640 MHz (11a/n/ac 20M band), 5590 MHz-5630 MHz (11n/ac 40M band) and 5610 MHz (11ac 80M band) is restricted in ISED.

	11n/ac ((V)HT40)	5755-5795 MHz	Active	Yes
	11ac (VHT80)	5775 MHz	Active	Yes



End users are not permitted to modify the software because F/W & driver are installed in device.

15.4 Europe

Table 58 and **Table 59** show the IC SISO, MIMO, simultaneous transmission per antenna port power table for 2.4 GHz for WLAN. **Table 60**, **Table 61**, and **Table 62** show the IC SISO simultaneous transmission per antenna port power table for 5 GHz WLAN.

Table 63, **Table 64**, and **Table 65** show the IC MIMO simultaneous transmission per antenna port power table for 5 GHz WLAN.

Table 58: Europe Power Level 2.4 GHz WLAN Per Antenna Port (SISO/1SS)

Mode	Rate	Typical Output Power Level (dBm)	
Channels		1 ~ 12	13
IEEE 802.11b	All Rates	11.5	11.5
IEEE 802.11g	All Rates	13.5	13.0
IEEE 802.11n (HT20)	MCS0 ~ MCS7	14.0	13.25
Equivalent to IEEE 802.11ac (VHT20)	MCS0 ~ MCS8	14.0	13.25

Table 59: Europe Power Level 2.4 GHz WLAN Per Antenna Port (MIMO/2SS)

Mode	Rate	Typical Output Power Level (dBm)	
Channels		1 ~ 12	13
IEEE 802.11n (HT20)	MCS8 ~ MCS15	11.0	10.25
Equivalent to IEEE 802.11ac (VHT20)	MCS0 ~ MCS8	11.0	10.25

Table 60: Europe Power Level 5 GHz WLAN Per Antenna Port (SISO/1SS) (W52-53)

Mode	Rate	Typical Output Power (dBm)
Channels		36 ~ 64
11a	6 ~ 54 Mbps	13.0
11n/ac HT20	MCS0 ~ MCS7	13.0
11ac VHT20	MCS8	12.0
Channels		38 ~ 62
11n/ac HT40	MCS0 ~ MCS5	14.0
	MCS6	13.0
	MCS7	12.0
11ac VHT40	MCS8	11.0
	MCS9	10.0

Mode	Rate	Typical Output Power (dBm)
Channels		42 ~ 58
11ac VHT80	MCS0 ~ MCS5	14.0
	MCS6	13.0
	MCS7	12.0
	MCS8	11.0
	MCS9	10.0

Table 61: Europe Power Level 5 GHz WLAN Per Antenna Port (SISO/1SS) (W56)

Mode	Rate	Typical Output Power (dBm)			
Channels		100 ~ 128	132 ~ 136	140	144
11a	6 ~ 54 Mbps	13.0	13.0	13.0	13.0
11n/ac HT20	MCS0 ~ MCS7	13.0	13.0	13.0	13.0
11ac VHT20	MCS8	12.0	12.0	12.0	12.0
Channels		102 ~ 126	134	142	
11n/ac HT40	MCS0 ~ MCS5	14.0	14.0		
	MCS6	13.0	13.0		
	MCS7	12.0	12.0		
11ac VHT40	MCS8	11.0	11.0		
	MCS9	10.0	10.0		
Channels		106 ~ 122		138	
11ac VHT80	MCS0 ~ MCS5	14.0			
	MCS6	13.0			
	MCS7	12.0			
	MCS8	11.0			
	MCS9	10.0			

Table 62: Europe Power Level 5 GHz WLAN Per Antenna Port (SISO/1SS) (W58)

Mode	Rate	Typical Output Power (dBm)	
Channels		149 ~ 161	165
11a	6 ~ 54 Mbps	6.5	6.5
11n/ac HT20	MCS0 ~ MCS7	6.5	6.5
11ac VHT20	MCS8	6.5	6.5
Channels		151 ~ 159	
11n/ac HT40	MCS0 ~ MCS7	6.5	
11ac VHT40	MCS8	6.5	
Channels		155	
11ac VHT80	MCS0 ~ MCS9	6.5	

Table 63: Europe Power Level 5 GHz WLAN Per Antenna Port (MIMO/2SS) (W52-53)

Mode	Rate	Typical Output Power (dBm)
Channels		36 ~ 64
11n HT20	MCS0 ~ MCS7	13.0
11ac VHT20	MCS8	12.0
Channels		38 ~ 62
11n HT40	MCS8 ~ MCS14	12.5
	MCS15	12.0
11ac VHT40	MCS0 ~ MCS6	12.5
	MCS7	12.0
	MCS8	11.0
	MCS9	10.0
Channels		42 ~ 58
11ac VHT80	MCS0 ~ MCS7	12.0
	MCS8	11.0
	MCS9	10.0

Table 64: Europe Power Level 5 GHz WLAN Per Antenna Port (MIMO/2SS) (W56)

Mode	Rate	Typical Output Power (dBm)			
Channels		100 ~ 128	132 ~ 136	140	144
11n/ac HT20	MCS8 ~ MCS15	10.0	10.0	10.0	10.0
11ac VHT20	MCS0 ~ MCS8	10.0	10.0	10.0	10.0
Channels		102 ~ 126	134	142	
11n/ac HT40	MCS8 ~ MCS14	12.5	12.5		
	MCS15	12.0	12.0		
11ac VHT40	MCS0 ~ MCS6	12.5	12.5		
	MCS7	12.0	12.0		
	MCS8	11.0	11.0		
	MCS9	10.0	10.0		
Channels		106 ~ 122	138		
11ac VHT80	MCS0 ~ MCS7	12.0			
	MCS8	11.0			
	MCS9	10.0			

Table 65: Europe Power Level 5 GHz WLAN Per Antenna Port (MIMO/2SS) (W58)

Mode	Rate	Typical Output Power (dBm)	
Channels		149 ~ 161	165
11n/ac HT20	MCS8 ~ MCS15	3.5	3.5
11ac VHT20	MCS0 ~ MCS8	3.5	3.5
Channels		151 ~ 159	
11n/ac HT40	MCS8 ~ MCS15	3.5	
11ac VHT40	MCS0 ~ MCS8	3.5	

Mode	Rate	Typical Output Power (dBm)
Channels		155
11ac VHT80	MCS0 ~ MCS9	2.5

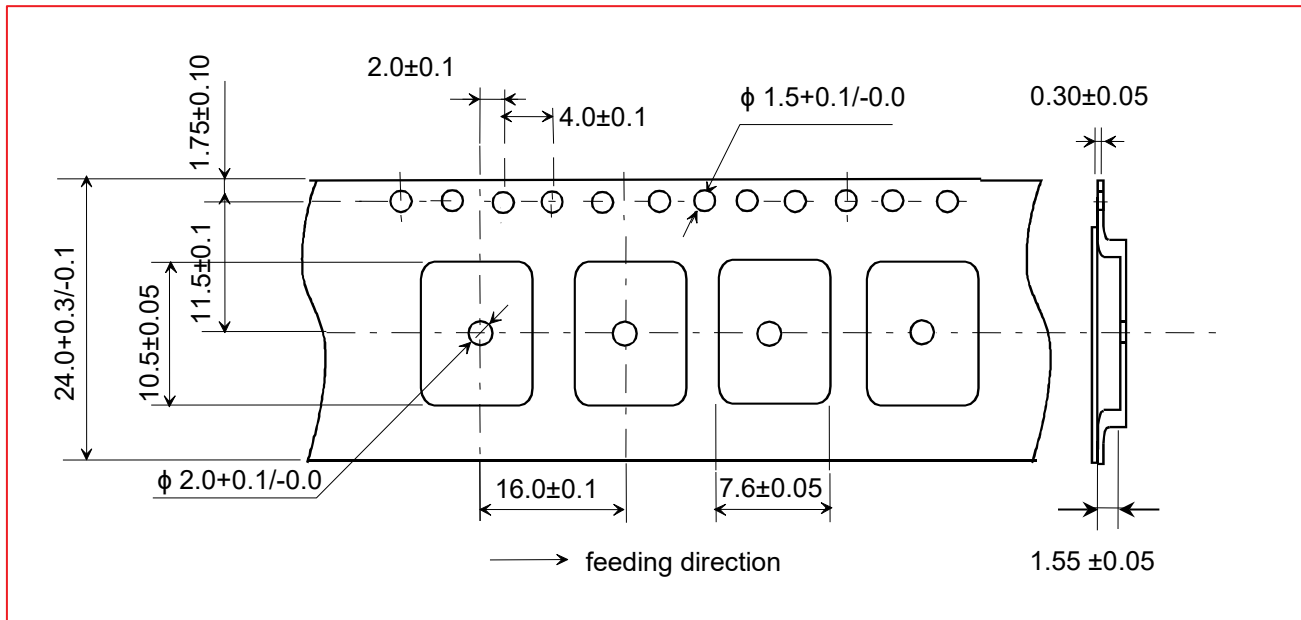
16 Tape and Reel Packing

This section provides the general specifications for tape and reel packing.

16.1 Dimensions of Tape (Plastic Tape)

Figure 28 shows the dimensions of tape (plastic tape).

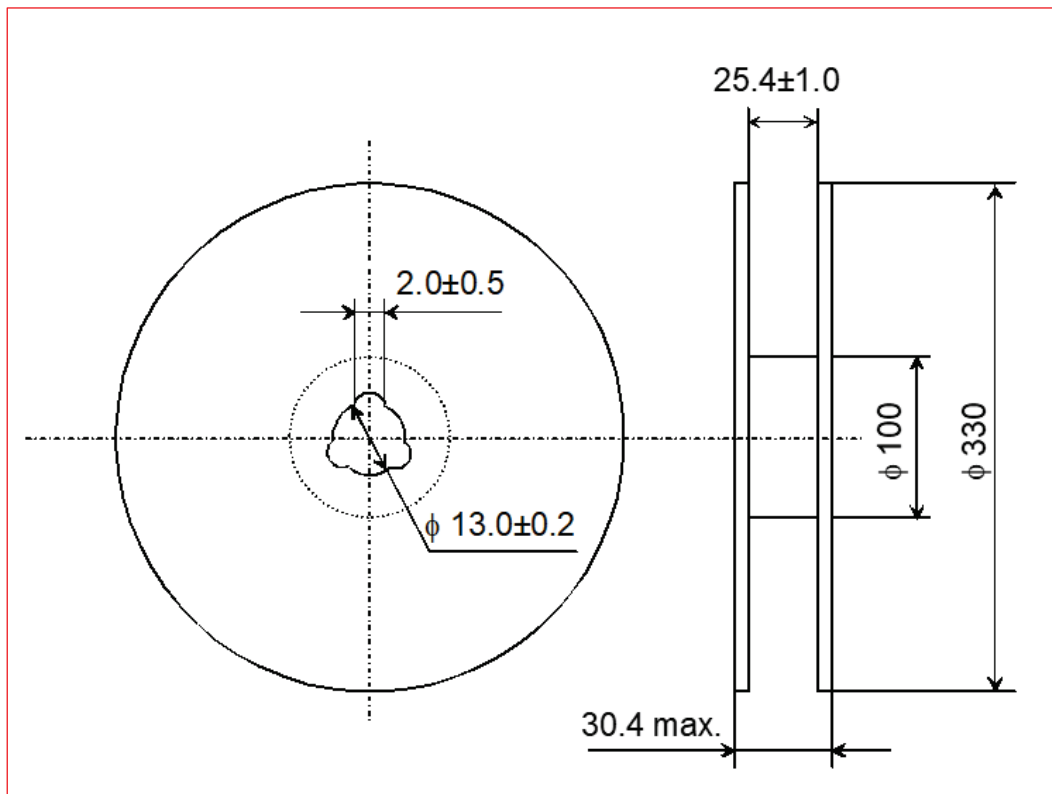
Figure 28: Dimensions of Tape (Unit: mm)



16.2 Dimensions of Reel

Figure 29 shows the dimensions of reel.

Figure 29: Dimensions of Reel (Unit: mm)



16.3 Taping Diagrams

Figure 30 shows the taping diagrams.

Figure 30: Taping Diagrams

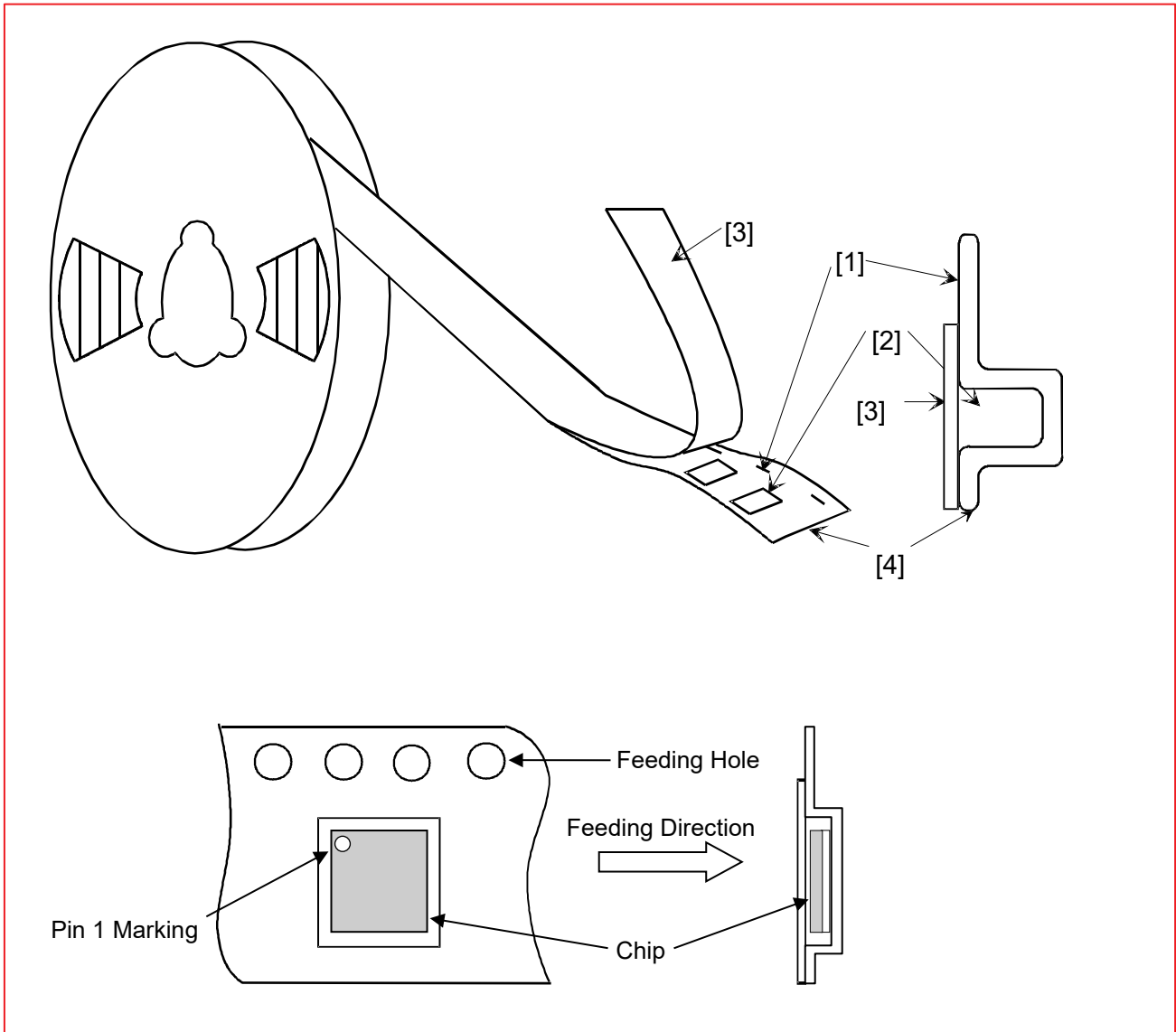


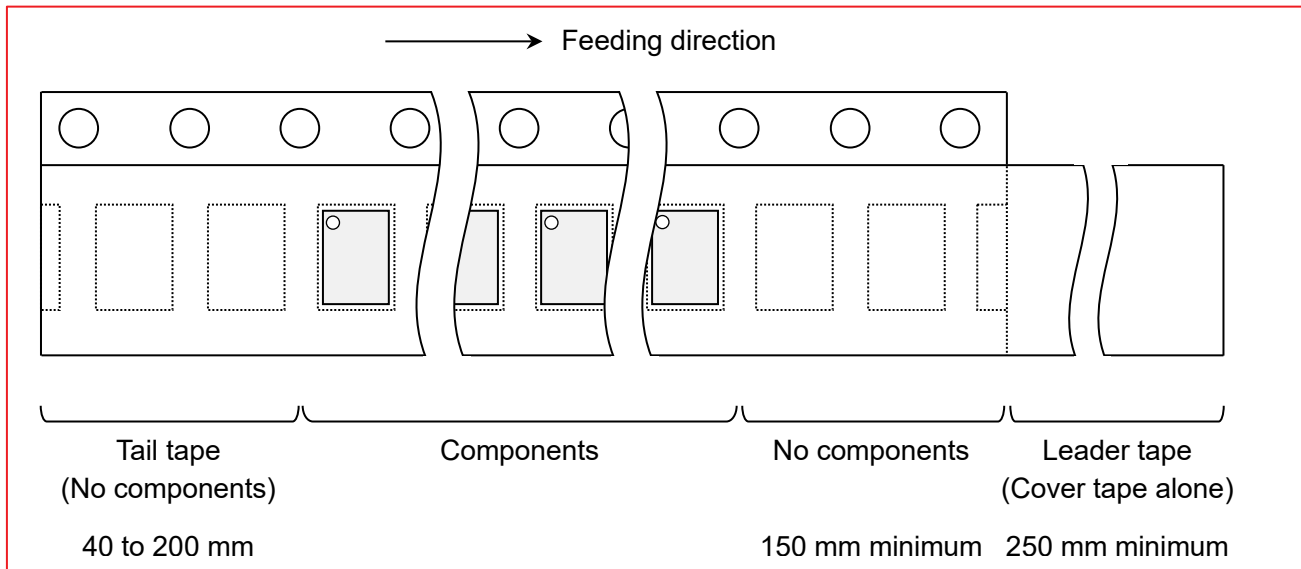
Table 66: Taping Specifications

Mark	Descriptions
[1] Feeding Hole	As specified in Dimensions of Tape
[2] Hole for chip	As specified in Dimensions of Tape
[3] Cover tape	62 μm in thickness
[4] Base tape	As specified in Dimensions of Tape

16.4 Leader and Tail Tape

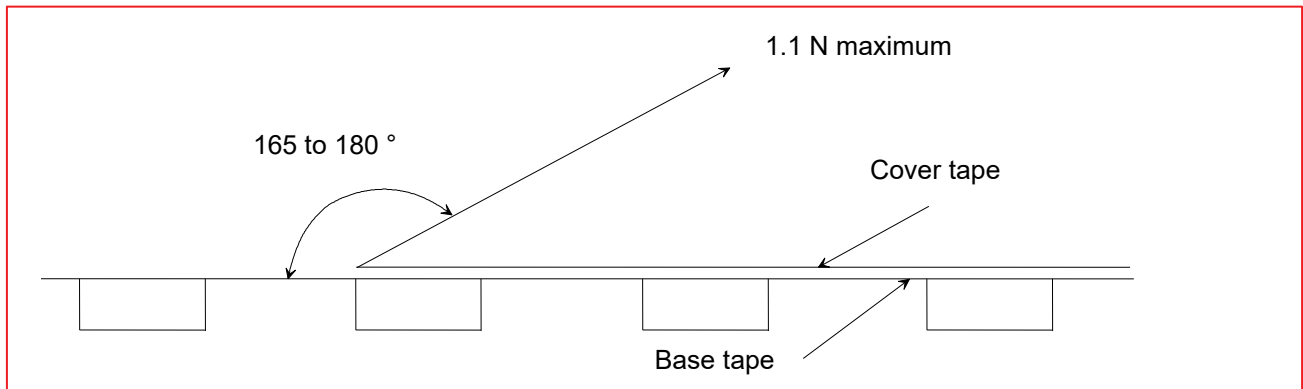
Figure 31 shows the leader and tail tape.

Figure 31: Leader and Tail Tape



- The tape for chips is wound clockwise, the feeding holes to the right side as the tape is pulled toward the user.
- The cover tape and base tape are not adhered at no components area for 250 mm minimum.
- Tear off strength against pulling of cover tape: 5 N minimum.
- Packaging unit: 1000 pcs. / Reel
- Material:
 - Base tape: Plastic
 - Reel: Plastic
- Cover tape, cavity tape and reel are made the anti-static processing.
- Peeling off force: 1.1 N maximum in the direction of peeling as shown in **Figure 32**.

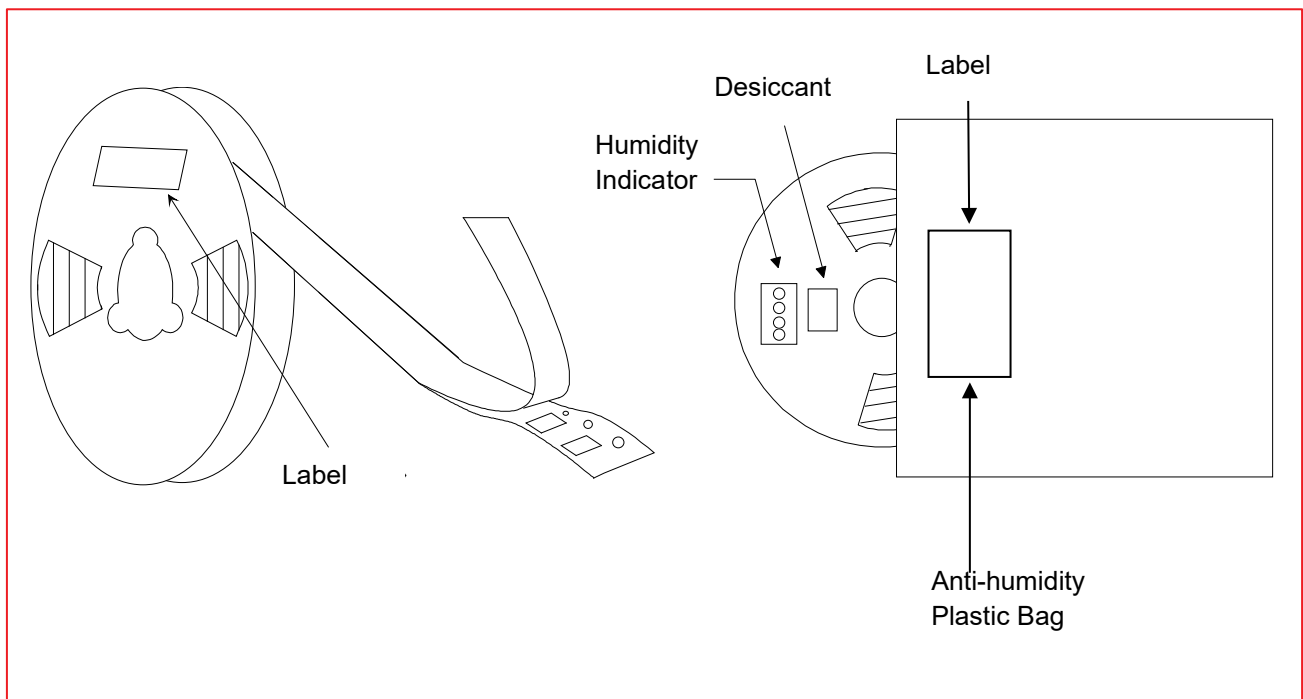
Figure 32: Peeling Off Force



16.5 Packaging (Humidity Proof Packing)

Figure 33 shows the humidity proof packaging.

Figure 33: Humidity Proof Packaging



Tape and reel must be sealed with the anti-humidity plastic bag. The bag contains the desiccant and the humidity indicator.

17 Notice

17.1 Storage Conditions

- Please use this product within 6 months after receipt.
- The product shall be stored without opening the packing under the ambient temperature from 5 to 35 °C and humidity from 20 to 70 %RH (Packing materials may be deformed at the temperature over 40 °C).
- The product left more than 6 months after reception; it needs to be confirmed the solderability before used.
- The product shall be stored in noncorrosive 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.
- This product is applicable to MSL3 (Based on JEDEC Standard J-STD-020)
 - After the packing opened, the product shall be stored at ≤ 30 °C / ≤ 60 %RH and the product shall be used within 168 hours.
 - When the color of the indicator in the packing changed, the product shall be baked before soldering.
- Baking condition: 125 +5/-0 °C, 24 hours, 1 time
- The products shall be baked on the heat-resistant tray because the materials (Base Tape, Reel Tape and Cover Tape) are not heat-resistant.

17.2 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 bare hands that may result in poor solder ability and destroy by static electrical charge.

17.3 Standard PCB Design (Land Pattern and Dimensions)

- All the ground terminals should be connected to the ground patterns. Furthermore, the ground pattern should be provided between IN and OUT terminals. Please refer to the specifications for the standard land dimensions.
- The recommended land pattern and dimensions is as Murata's standard. The characteristics of products may vary depending on the pattern drawing method, grounding method, land dimensions, land forming method of the NC terminals and the PCB material and thickness. Therefore, be sure to verify the characteristics in the actual set. When using non-standard lands, contact Murata beforehand.

17.4 Notice for Chip Placer

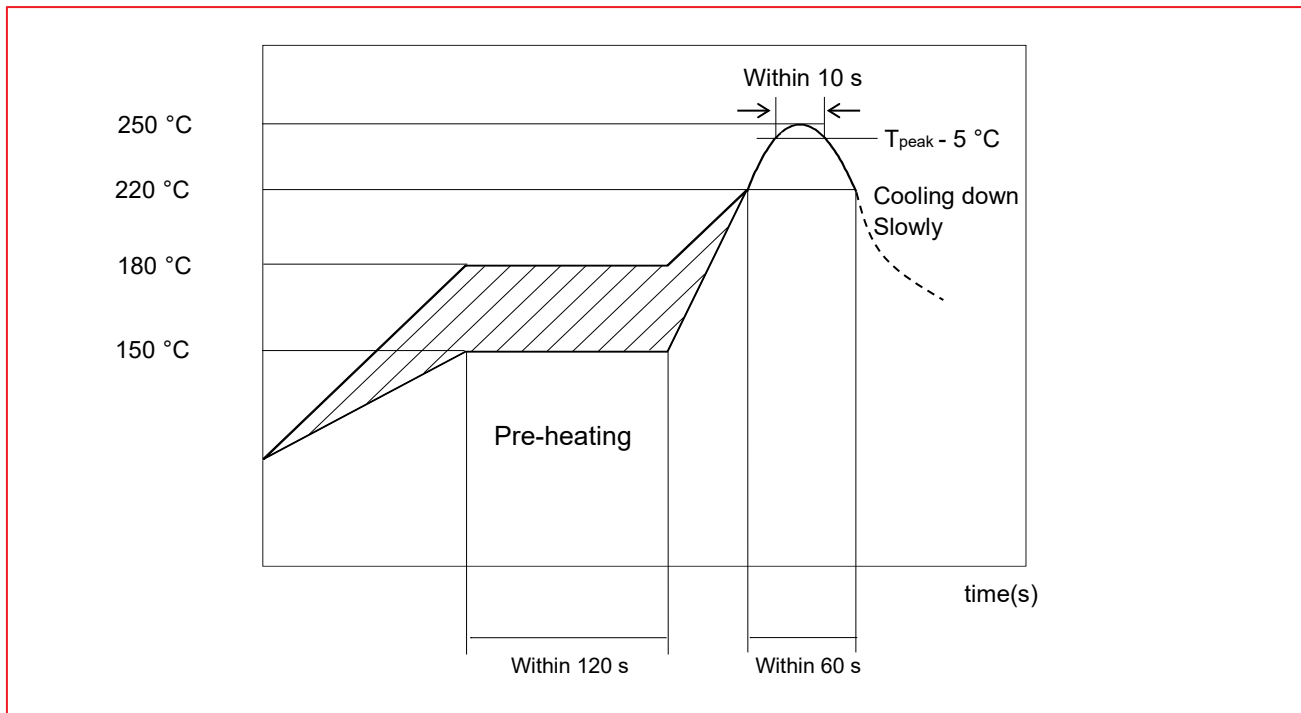
When placing products on the PCB, products may be stressed and broken by uneven forces from a worn-out chucking locating claw or a suction nozzle. To prevent products from such damages, make sure to follow the specifications for the maintenance of the chip placer being used. For the positioning of products on the PCB, be aware that mechanical chucking may damage products.

17.5 Soldering Conditions

The recommendation conditions of soldering are as shown in **Figure 34**.

Soldering must be carried out by the above-mentioned conditions to prevent products from damage. Set up the highest temperature of reflow within 260 °C. Contact Murata before use if concerning other soldering conditions.

Figure 34: Reflow Soldering Standard Conditions (Example)



Please use the reflow within 2 times.

Use rosin type flux or weakly active flux with a chlorine content of 0.2 wt % or less

17.6 Cleaning

Since this Product is Moisture Sensitive, any cleaning is not recommended. If any cleaning process is done the customer is responsible for any issues or failures caused by the cleaning process.

17.7 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.



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

17.8 Input Power Capacity

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

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

18 Preconditions 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.

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- Undersea equipment.
- Power plant control equipment.
- Medical equipment.
- Traffic signal equipment.

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

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- Deviation or lapse in function of engineering sample,
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Revision History

Revision Code	Date	Changed Item	Comment
	2021.12.15	First Issue	
A	2022.06.15	Title Page 4 Page 5 Page 8 Page 50	<ul style="list-style-type: none"> • Adding MP part number • Block Diagram • Adding specification temperature • Revising typo in pin description • Revising regulatory certification
B	2022.09.14	Page 3	<ul style="list-style-type: none"> • Block Diagram
C	2023.09.13	2. Key Features 4. Sample Ordering Information 10. Reference Peripheral Circuit 14. Electrical Characteristics Appendix	<ul style="list-style-type: none"> • Updated information. • Renamed section. Moved to before Block diagram. • Moved section to HW app note. • Renamed section. • Moved Appendix information into Section 15. • Added transmit power tables. • Added Europe section. • Moved Appendix information into Section 15. • Moved antenna sections to HW app note. <p>Updated to new format</p>



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