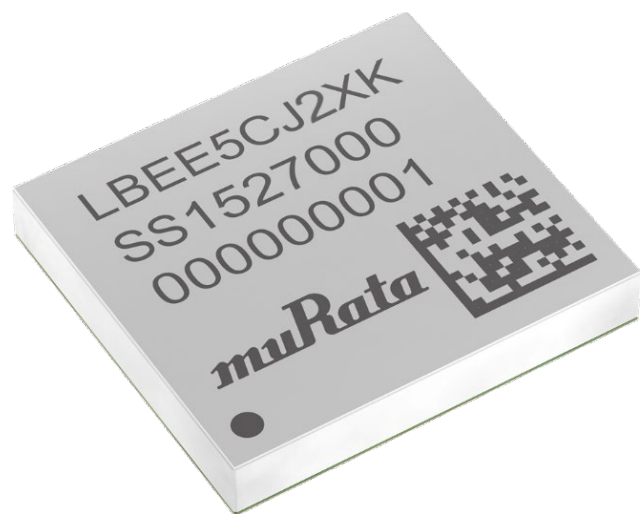


# Type 2XK Wi-Fi® + Bluetooth® Module

NXP IW416 Chipset for 802.11a/b/g/n + Bluetooth 5.2  
Datasheet - Rev. D

- Design Name: Type 2XK
- P/N: LBEE5CJ2XK-845



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## About This Document

Murata's Type 2XK is a small and high-performance module based on NXP's IW416 combo chipset, supporting IEEE 802.11a/b/g/n + Bluetooth 5.2 BR/EDR/LE. This datasheet describes Type 2XK 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. In particular, RF, hardware, software, and systems engineers.

## Document Conventions

**Table 1** describes the document conventions.

**Table 1: Document Conventions**


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



## 1 Scope

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

## 2 Key Features

- ◆ NXP IW416 inside
- ◆ Supports IEEE 802.11a/b/g/n specification: Dual band 2.4 GHz and 5 GHz
- ◆ SISO with 20 MHz and 40 MHz channels
- ◆ Up to MCS7 data rates (150 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, PCM, and I2S
- ◆ Temperature Range: - 40 °C to 85 °C
- ◆ Dimensions: 9.1 x 8.3 x 1.3 mm
- ◆ Weight: 268.8 mg
- ◆ MSL: 3
- ◆ Surface-mount type
- ◆ RoHS compliant
- ◆ Total Fit: 71

## 3 Ordering Information

**Table 2** provides the ordering information for Type 2XK module.

**Table 2: Ordering Information**

Ordering Part Number	Description
LBEE5CJ2XK-845	Module order
LBEE5CJ2XK-SMP	Sample module order (If module samples are not available through distribution, contact Murata referencing this part number)
LBEE5CJ2XK-EVB	Murata Type 2XK M.2 EVB (contact Murata as this is special order item)

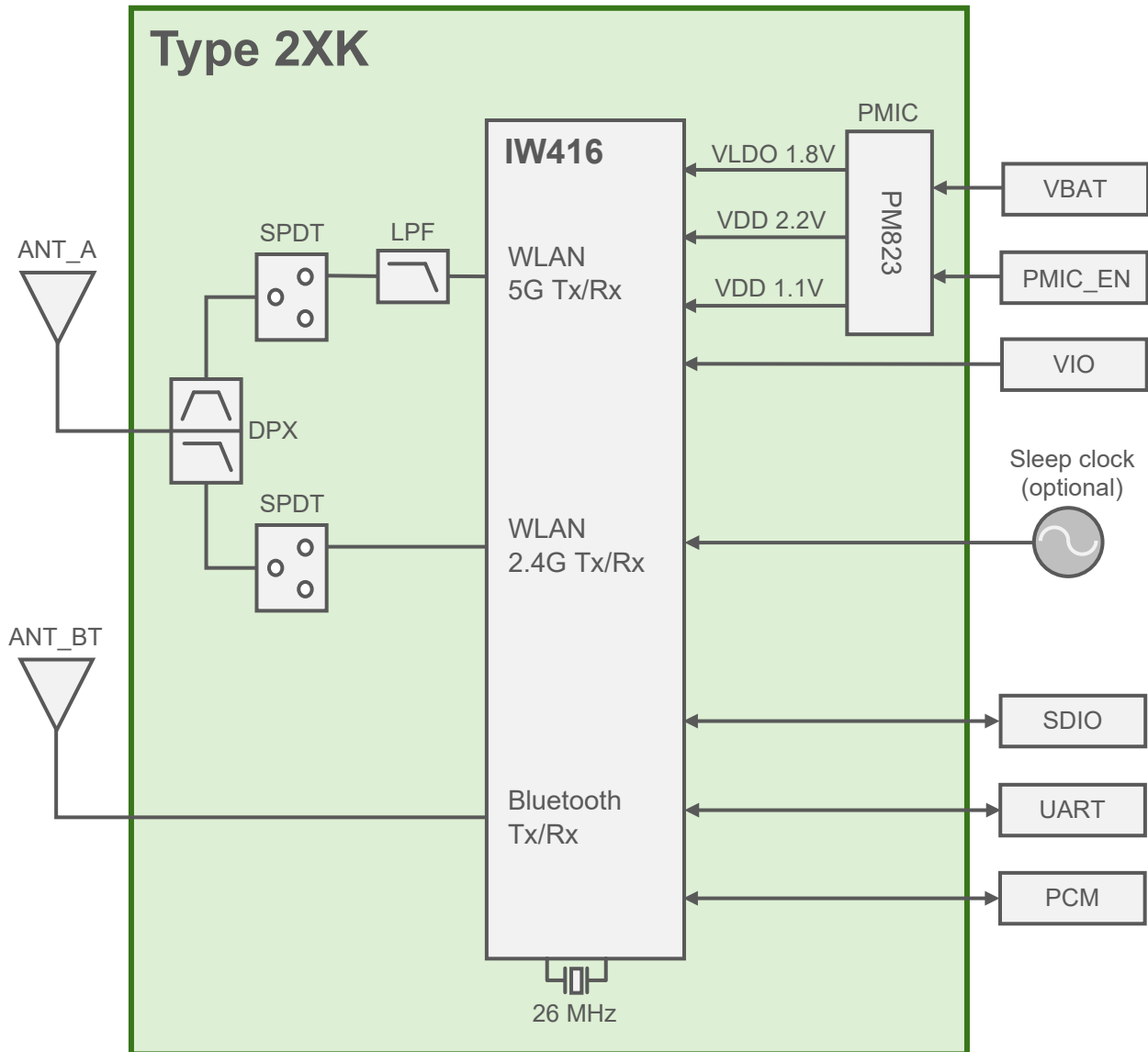


LBEE5CJ1XK is used in regulatory certification test report.

## 4 Block Diagram

Figure 1 shows the block diagram of Type 2XK module.


Figure 1: Block Diagram




## 5 Certification Information

This section has information about radio and Bluetooth certification.

### 5.1 Radio Certification

Transmit output power setting is defined by “txpower\_XX.bin” (XX is country code). The transmit power files are hosted at Murata GitHub for [Linux](#) . **Table 3** shows the transmit power file required for each region.



**Table 3: Transmit Power Limit Files**

Country	ID	Country Code	Tx Power Limit File
USA (FCC)	VPYLB1XK	US	txpower_US.bin
Canada (IC)	772C-LB1XK	CA	txpower_CA.bin
Europe	EN300328/301893, EN300440 conducted test report is prepared.	DE	txpower_EU.bin
Japan	Japanese type certification is prepared.  001-P01624	JP	txpower_JP.bin



Each country code is defined by Murata's db.txt file. Please ask your contact person from Murata.

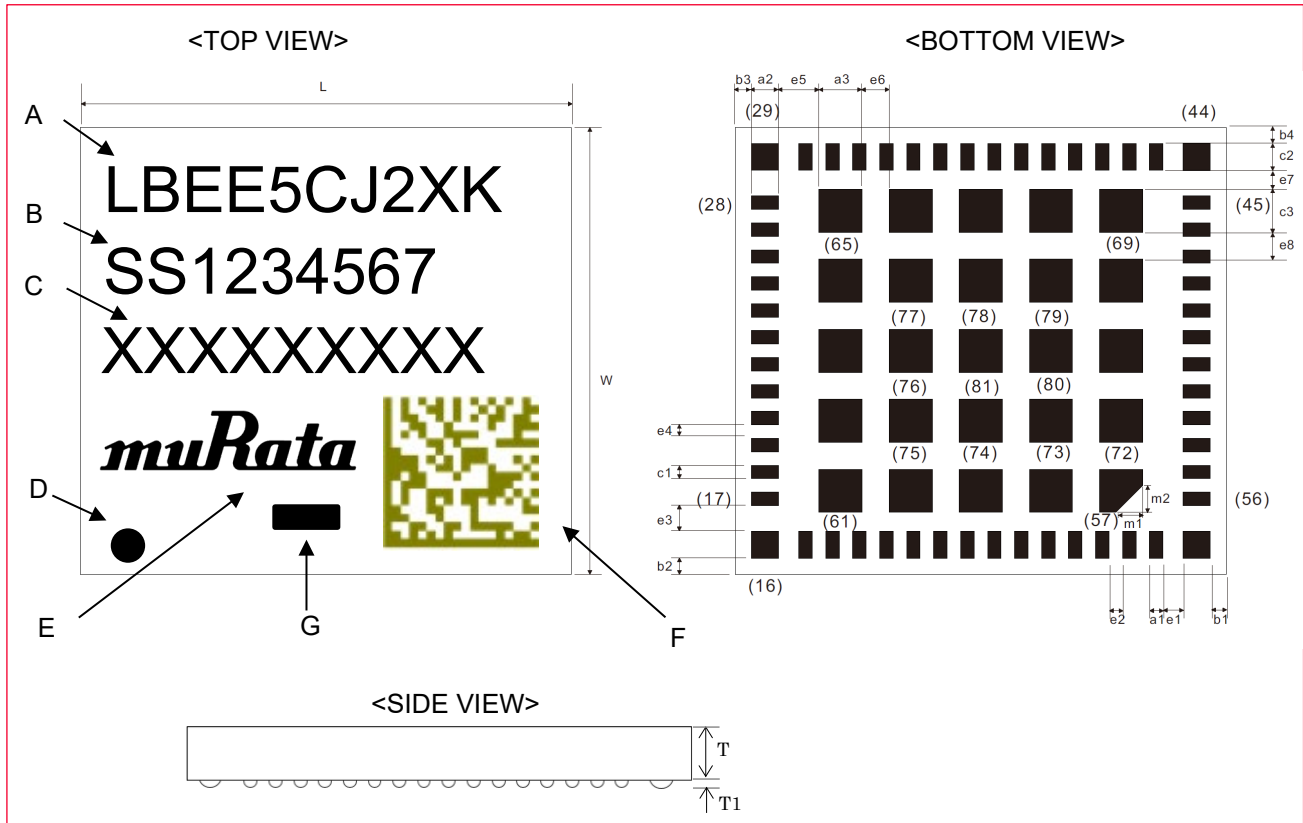
### 5.2 Bluetooth Qualification

- QDID: 169159
- Set Bluetooth Tx Power to Class 1 by using [bt\\_power\\_config\\_1.sh](#) .
- For supported Bluetooth functions, refer to [Bluetooth SIG site](#) .

## 6 Dimensions, Markings and Terminal Configurations

This section has information on dimensions, markings, and terminal configurations for Type 2XK.

**Figure 2: Dimensions, Markings and Terminal Configurations**



**Table 4: Markings**

Marking	Meaning
A	Module Type
B	Inspection Number
C	Serial Number
D	Pin 1 Marking
E	Murata Logo
F	2D code
G	Identification mark

**Table 5: Dimensions**

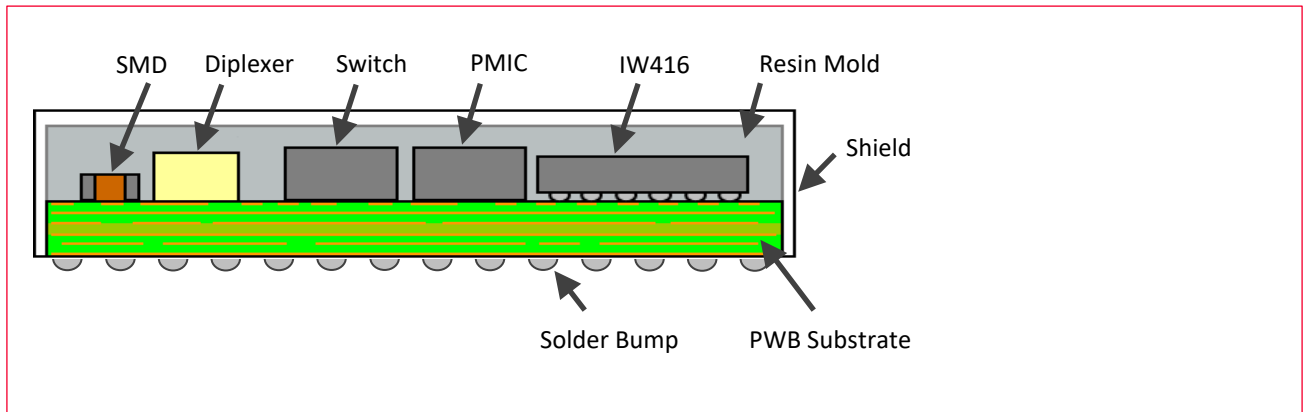
Marks	Dimensions	Marks	Dimensions	Marks	Dimensions	Marks	Dimensions
L	9.1 ± 0.2	W	8.3 ± 0.2	T	1.3 maximum	a1	0.25 ± 0.1
a2	0.5 ± 0.1	a3	0.8 ± 0.2	b1	0.3 ± 0.2	b2	0.3 ± 0.2
b3	0.3 ± 0.2	b4	0.3 ± 0.2	c1	0.25 ± 0.1	c2	0.5 ± 0.1
c3	0.8 ± 0.1	e1	0.375 ± 0.1	e2	0.25 ± 0.1	e3	0.475 ± 0.1
e4	0.25 ± 0.1	e5	0.75 ± 0.1	e6	0.5 ± 0.1	e7	0.35 ± 0.1
e8	0.5 ± 0.1	m1	0.5 ± 0.2	m2	0.5 ± 0.2	T1	0.045 typical



T dimension does not include height of solder bumps.  
Unit of Dimensions are in mm.

Figure 3 shows the structure of Type 2XK.

Figure 3: Structure



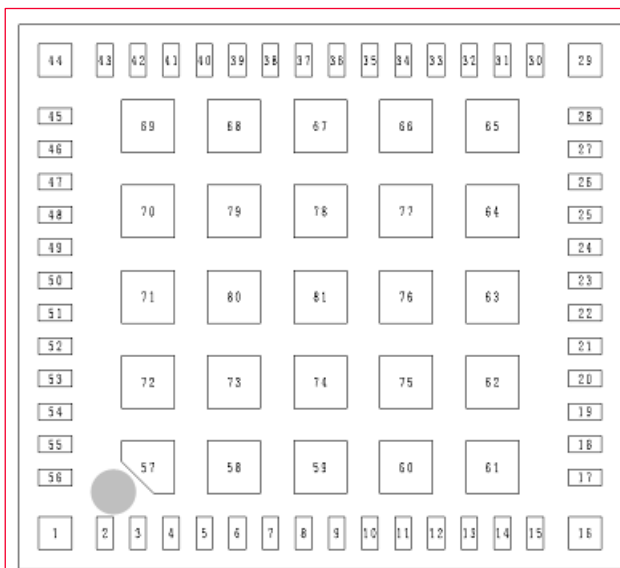
## 7 Module Pin Descriptions

This section has the pin descriptions of Type 2XK and pin assignments layout descriptions.

### 7.1 Pin Assignments

The pin assignment (Top View) layout is shown in Figure 4.

Figure 4: Pin Assignments Top View



**Table 6** illustrates the terminal configurations.

**Table 6: Terminal Configurations**

No.	Terminal Name	No.	Terminal Name	No.	Terminal Name
1	GND	20	GPIO(3) TDO	39	GND
2	VIO	21	GND	40	GND
3	SD_D2	22	VBAT	41	GND
4	SD_CLK	23	VBAT	42	RF_CNTL2_N
5	SD_D0	24	GND	43	RF_CNTL3_P
6	SD_CMD	25	GND	44	GND
7	GPIO(9) UART_RXD	26	GND	45	Reserved
8	GPIO(6)	27	GND	46	GND
9	GPIO(7)	28	GND	47	BT_ANT DEDICATED
10	NC	29	GND	48	GND
11	GPIO(4)	30	GND	49	GND
12	GPIO(1)	31	PMIC_EN	50	GND
13	GPIO(15) TMS	32	WCI_SOUT	51	GPIO(11) UART_RTS
14	GPIO(5)	33	WCI_SIN	52	GPIO(0)
15	GPIO(8) UART_CTS	34	GPIO(12)	53	GPIO(13)
16	GND	35	RF_CNTL1_P	54	GPIO(10) UART_TXD
17	GPIO(14) TCK	36	RF_CNTL0_N	55	SD_D3
18	GPIO(2) TDI	37	GND	56	SD_D1
19	SLP_CLK_IN	38	RF_ANT	57-81	GND

## 7.2 Pin Descriptions

**Table 7** shows the pin description for Type 2XK modules.

**Table 7: Pin Descriptions**

No.	Pin Name	Type	Connection to IC Pin Name	Description
1	GND			Ground
2	VIO	P	VIO VIO_RF VIO_SD	Power supply
3	SD_D2	I	SD_DAT[2]	SDIO 4-bit mode: Data line Bit[2] or read wait (optional) SDIO 1-bit mode: Read wait (optional)
4	SD_CLK	I	SD_CLK	SDIO Clock input
5	SD_D0	I	SD_DAT[0]	SDIO 4-bit mode: Data line Bit[0] SDIO 1-bit mode: Data line
6	SD_CMD	I/O	SD_CMD	SDIO 4-bit mode: Command/response (input/output) SDIO 1-bit mode: Command line
7	GPIO(9)	I/O	GPIO[9]	GPIO mode: GPIO[9] (input/output)

No.	Pin Name	Type	Connection to IC Pin Name	Description
	UART_RXD			UART mode: UART_SIN (input)
8	GPIO(6)	I/O	GPIO[6]	GPIO mode: GPIO[6] (input/output) PCM mode: PCM_CLK - PCM data clock (input if slave, output if master). I2S mode: I2S_BCLK - I2S bit clock (input if slave, output if master). PTA mode: EXT_PRI - External radio priority signal (input).
9	GPIO(7)	I/O	GPIO[7]	GPIO mode: GPIO[7] (input/output) PCM mode: PCM_SYNC - PCM frame sync (input if slave, output if master). I2S mode: I2S_LRCLK - I2S left-right clock (input if slave, output if master). PTA mode: EXT_REQ - Request from the external radio (input).
10	NC		-	NC *Floating terminal pad. Recommended grounding for mechanical strength.
11	GPIO(4)	I/O	GPIO[4]	GPIO mode: GPIO[4] (input/output) PCM mode: PCM_DOUT <sup>1</sup> - PCM transmit signal (output). I2S mode: I2S_DOUT/I2S_DIN (depending on the configuration. If GPIO[5] is configured as I2S_DIN, then GPIO[4] is set as I2S_DOUT, and vice-verse). PTA mode: EXT_FREQ - External radio frequency signal (input). Out-of-band wake-up mode: IW416 Alternate Bluetooth to host wake-up signal (output) <sup>2</sup>
12	GPIO(1)	I/O	GPIO[1]	GPIO mode: GPIO[1] (input/output) This pin is used as a configuration pin: CON[9] (input). PTA mode: EXT_STATE - External radio state signal (input). Out-of-band wake-up mode: IW416 Wi-Fi to host wake-up signal (output) Do not drive this signal during boot-up
13	GPIO(15) TMS	I/O	GPIO[15]	GPIO mode: GPIO[15] (input/output) Reset recovery mode: Independent software reset for Bluetooth subsystem (input)
14	GPIO(5)	I/O	GPIO[5]	GPIO mode: GPIO[5] (input/output) PCM mode: PCM_DIN <sup>3</sup> - PCM receive signal (input). I2S mode: I2S_DOUT/I2S_DIN - I2S transmit/receive signal (output/input) (depending on the configuration). PTA mode: EXT_GNT - External radio grant signal (output).
15	GPIO(8) UART_CTS	I/O	GPIO[8]	GPIO mode: GPIO[8] (input/output) This pin is used as a configuration pin: CON[7] (input) UART mode: UART_CTSn - UART clear-to-send input signal (input, active low). Do not drive this signal during boot-up.
16	GND			Ground
17	GPIO(14) TCK	I/O	GPIO[14]	GPIO mode: GPIO[14] (input/output) Reset recovery mode: Independent software reset for Wi-Fi subsystem (input)
18	GPIO(2) TDI	I/O	GPIO[2]	GPIO mode: GPIO[2] (input/output) Power management mode: DVSC[0], Digital voltage scaling control (output)

<sup>1</sup> The function can be swapped with GPIO(5) using a software command without affecting the hardware connection.

<sup>2</sup> If PCM not used in application, GPIO(4) can be used as Bluetooth to host wake-up signal.

<sup>3</sup> The function can be swapped with GPIO(4) using a software command without affecting the hardware connection.

No.	Pin Name	Type	Connection to IC Pin Name	Description
19	SLP_CLK_IN	I	SLP_CLK_IN	Sleep Clock Input (optional) Used for lower power operation in sleep mode: An external sleep clock of 32.768 kHz can be used for lowest current consumption in sleep mode. An external sleep clock is required if automatic reference clock frequency detection is used. If no external sleep clock is used, leave this pin floating (DNC).
20	GPIO(3) TDO	I/O	GPIO[3]	GPIO mode: GPIO[3] (input/output) Power management mode: DVSC[1], Digital voltage scaling control (output) PCM mode: PCM_MCLK (output) - PCM clock signal (output, optional). I2S mode: I2S_CCLK - I2S clock (output, optional).
21	GND			Ground
22	VBAT	P	PVIN(PMIC)	Power supply
23	VBAT	P	PVIN(PMIC)	Power supply
24	GND			Ground
25	GND			Ground
26	GND			Ground
27	GND			Ground
28	GND			Ground
29	GND			Ground
30	GND			Ground
31	PMIC_EN	I	EN(PMIC)	Enable build-in PMIC. Logic high enables internal regulators and internal hardware reset is de-asserted. Logic low disables regulators and internal hardware reset is asserted. Do not float this pin
32	WCI_SOUT			WCI-2_SOUT (output)
33	WCI_SIN			WCI-2_SIN (input)
34	GPIO(12)	I/O	GPIO[12]	GPIO mode: GPIO[12] (input/output) UART mode: UART_DSRn - UART data-set-ready (input) (active low). Host wake-up mode: Host to IW416 Bluetooth wake-up (input)
35	RF_CNTL1_P	O	RF_CNTL1_P	Reserved Set to 1.
36	RF_CNTL0_N	O	RF_CNTL0_N	RF Control 0—RF Control Output Low (output) This pin is used as a configuration pin: CON[0] (input).
37	GND			Ground
38	RF_ANT			
39	GND			Ground
40	GND			Ground
41	GND			Ground
42	RF_CNTL2_N	O	RF_CNTL2_N	Reserved Do not pull-up externally.
43	RF_CNTL3_P	O	RF_CNTL3_P	Reserved
44	GND			Ground
45	Reserved	I		Connect to via 49.9Ω to the Ground
46	GND			Ground
47	BT_ANT DEDICATED	O		BT output
48	GND			Ground



No.	Pin Name	Type	Connection to IC Pin Name	Description
49	GND			Ground
50	GND			Ground
51	GPIO(11) UART_RTS	I/O	GPIO[11]	GPIO mode: GPIO[11] (input/output) This pin is used as a configuration pin: CON[8] (input) UART mode: UART_RTSn - UART request-to-send (output) (active low). Do not drive this signal during boot-up
52	GPIO(0)	I/O	GPIO[0]	GPIO mode: GPIO[0] (input/output)
53	GPIO(13)	I/O	GPIO[13]	GPIO mode: GPIO[13] (input/output) UART mode: UART_DTRn - UART data-terminal-ready (output). Out-of-band wake-up mode: Host to IW416 Wi-Fi wake-up (input)
54	GPIO(10) UART_TXD	I/O	GPIO[10]	GPIO mode: GPIO[10] (input/output) UART mode: UART_SOUT - UART serial (output).
55	SD_D3	I	SD_DAT[3]	SDIO 4-bit mode: Data line Bit[3] SDIO 1-bit mode: Reserved
56	SD_D1	I	SD_DAT[1]	SDIO 4-bit mode: Data line Bit[1] SDIO 1-bit mode: Interrupt
57-81	GND			Ground



Not all GPIO pins can be used for Host-to-SoC wake-up signals.

## 7.3 Configuration Pins

**Table 8** shows the pins used as configuration inputs to set parameters following a reset. The definitions of these pins change immediately after reset to their usual function.

**Table 8: Configuration Pins**

Configuration Bits	Pin Name	Configuration Function
CON[9]	GPIO[1]	Reserved Set to 111.
CON[8]	GPIO[11]	
CON[7]	GPIO[8]	
CON[1]	RF_CNTL2_N	<b>Firmware Boot Options:</b> No hardware impacts. Software reads and boots accordingly. See <b>Table 9</b> . <b>Note:</b> Boot code needs to use this host boot strap status to decide the correct boot sequence.
CON[0]	RF_CNTL0_N	

Table 9: Configuration Functions for Wi-Fi and Bluetooth/LE

CON[1]	CON[0]	Wi-Fi	Bluetooth/LE
1	0	SDIO	UART
1	1	Reserved	Reserved



To set a configuration bit to 0, attach a 50 kΩ - 100 kΩ resistor from the pin to ground. No external circuitry is required to set a configuration bit to 1.

## 7.4 Pin States

Pin states information for **Table 10** include:

- After firmware is downloaded, the pads (GPIO, Serial interface, RF control) are programmed in functional mode per the functionality of the pins.
- For SDIO, once the command is received from the host, the pads are configured accordingly.
- Pull-up and pull-down are only effective when the pad is in input mode.
- The power-down state shown is the default configuration. Many pads have programmable power-down values, which can be set by firmware.
- Do not need any termination to the open pins in input mode that have an Internal Pull-up/Pull-down resistor (PU/PD). Do not need any termination to the open pins in output mode.

Table 10: I/O State Table

Pin Name	Supply	No Pad Power State	Reset State	HW State <sup>4</sup>	PD State <sup>5</sup>	PD Prog <sup>6</sup>	Internal PU/PD	Int'l Pull Value[Ω] <sup>7</sup>
GPIO0	VIO	tristate	output	output	drive low	yes	nominal PU	90K
GPIO1	VIO	tristate	input	input	tristate	yes	weak PU	800K
GPIO2	VIO	tristate	input	input	tristate	yes	weak PU	800K
GPIO3	VIO	tristate	input	input	tristate	yes	weak PU	800K
GPIO4	VIO	tristate	output	input	tristate	yes	nominal PU	90K
GPIO5	VIO	tristate	input	input	tristate	yes	weak PU	800K
GPIO6	VIO	tristate	input	input	tristate	yes	nominal PU	90K
GPIO7	VIO	tristate	input	input	tristate	yes	nominal PU	90K
GPIO8	VIO	tristate	input	input	drive low	yes	weak PU	800K
GPIO9	VIO	tristate	output	input	tristate	yes	nominal PU	90K
GPIO10	VIO	tristate	input	input	tristate	yes	nominal PU	90K
GPIO11	VIO	tristate	output	input	drive high	yes	weak PU	800K
GPIO12	VIO	tristate	input	input	tristate	yes	nominal PU	90K
GPIO13	VIO	tristate	input	input	drive high	yes	nominal PU	90K
SD_CLK	VIO_SD	tristate	input	Input	tristate	no	nominal PD	90K
SD_CMD	VIO_SD	tristate	input	Input	tristate	no	nominal PD	90K
SD_D0	VIO_SD	tristate	input	Input	tristate	no	nominal PD	90K
SD_D1	VIO_SD	tristate	input	Input	tristate	no	nominal PD	90K

<sup>4</sup> Hardware default state after reset

<sup>5</sup> Power-down state

<sup>6</sup> Power-down state programmable

<sup>7</sup> Calculate appropriate external pull values with internal pull value

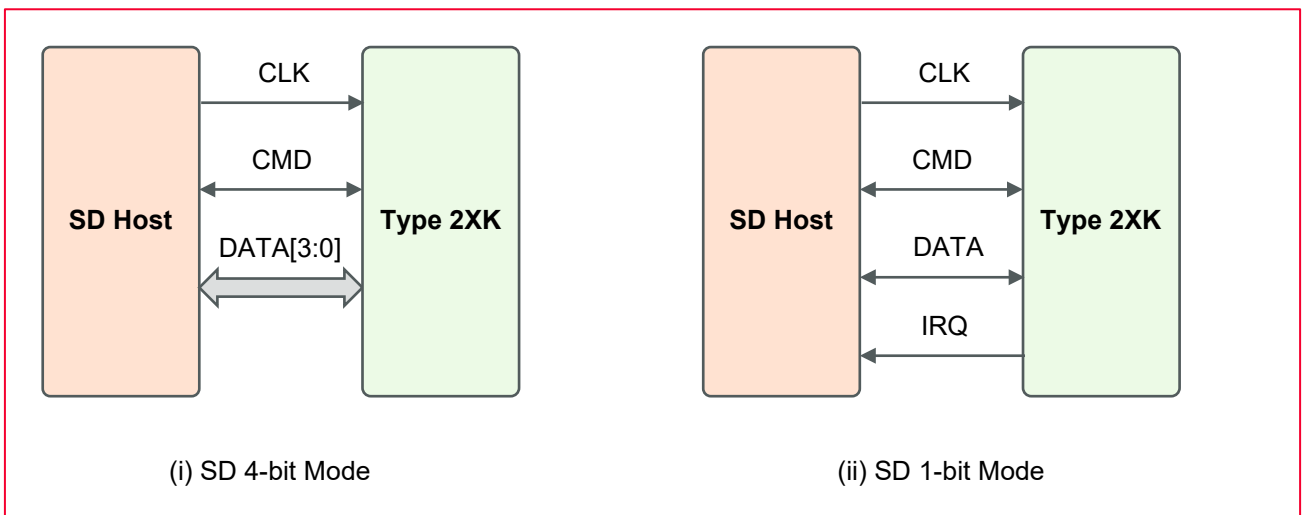
Pin Name	Supply	No Pad Power State	Reset State	HW State <sup>4</sup>	PD State <sup>5</sup>	PD Prog <sup>6</sup>	Internal PU/PD	Int'l Pull Value[Ω] <sup>7</sup>
SD_D2	VIO_SD	tristate	input	Input	tristate	no	nominal PD	90K
SD_D3	VIO_SD	tristate	input	Input	tristate	no	nominal PD	90K
RF_CNTL0_N	VIO_RF	tristate	input	output	drive low	yes	weak PU	800K
RF_CNTL1_P	VIO_RF	tristate	input	output	drive high	yes	weak PU	800K
RF_CNTL2_N	VIO_RF	tristate	input	output	drive low	yes	weak PU	800K
RF_CNTL3_P	VIO_RF	tristate	input	output	drive high	yes	weak PU	800K
SLP_CLK_IN	AVDD18	tristate	input	input	tristate	no	nominal PU	90K
WCI-2_SIN	AVDD18	tristate	input	input	tristate	no	weak PU	800K
WCI-2_OUT	AVDD18	tristate	output	output	tristate	no	weak PU	800K

**Table 11** shows the pin descriptions for Type 2XK module. **Figure 5** shows the SDIO pin diagram for Type 2XK module.

**Table 11: SDIO Pin Descriptions**

No.	Pin Name	(i) SD 4-bit Mode		(ii) SD 1-bit Mode	
4	SDIO_CLK	CLK	Clock	CLK	Clock
5	SDIO_D0	DATA0	Data line 0	DATA	Data line
45	SDIO_D1	DATA1	Data line 1	IRQ	Interrupt
3	SDIO_D2	DATA2	Data line 2	RW	Read wait (optional)
46	SDIO_D3	DATA3	Data line 3	NC	Reserved
6	SDIO_CMD	CMD	Command/response	CMD	Command line

**Figure 5: SDIO Pins**



## 8 Absolute Maximum Ratings

The absolute maximum ratings are shown in **Table 12**.

**Table 12: Absolute Maximum Ratings**

Parameter		Minimum	Maximum	Unit
Storage Temperature		-40	85	°C
Supply Voltage	VBAT	-0.3	6.0	V
	VIO		4.0	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.

## 9 Operating Conditions

### 9.1 Operating Conditions

The operating conditions are shown in **Table 13**.

**Table 13: Operating Conditions**

Parameter		Minimum	Typical	Maximum	Unit
Operating Temperature	Ta	-40	25	+85	°C
	Tj			+125	°C
Supply Voltage	VBAT	2.7		5.5	V
	VIO	1.62	1.8	1.98	V
		2.97	3.3	3.47	V
IO Current	VIO		0.1	0.5	mA
Peak Current	VBAT		550	850	mA



- Operation beyond the recommended operating conditions is neither recommended nor guaranteed.
- Peak current of VBAT (RF portion) is happen during DPD calibration when the firmware is downloaded.

### 9.2 External Sleep Clock Requirements

**Table 14** shows the external sleep clock requirements for Type 2XK module.

**Table 14: External Sleep Clock Requirements**

Symbol	Parameter	Minimum	Typical	Maximum	Unit
CLK	Clock frequency range/accuracy: <ul style="list-style-type: none"> <li>• CMOS input clock signal type</li> <li>• <math>\pm 250</math> ppm (initial, aging, temperature)</li> </ul>		32.768		kHz
PN	Phase Noise Requirement (@ 100 kHz)		-125		dBc/Hz
Jc	Cycle jitter		1.5		ns (RMS)

Symbol	Parameter	Minimum	Typical	Maximum	Unit
SR	Slew rate limit (10-90%)			100	ns
DC	Duty cycle tolerance	20		80	%



Voltage input level = 1.8V

## 9.3 Digital I/O Requirements

**Table 15** shows the digital I/O requirements for Type 2XK module.

**Table 15: Digital I/O Requirements Parameters**

Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
V <sub>IH</sub>	Input high voltage		0.7*V <sub>IO</sub>		V <sub>IO</sub> + 0.4	V
V <sub>IL</sub>	Input low voltage		-0.4		0.3*V <sub>IO</sub>	V
V <sub>HYS</sub>	Input hysteresis		100			mV
V <sub>OH</sub>	Output high voltage		V <sub>IO</sub> -0.4			V
V <sub>OL</sub>	Output low voltage				0.4	V

## 9.4 Package Thermal Conditions

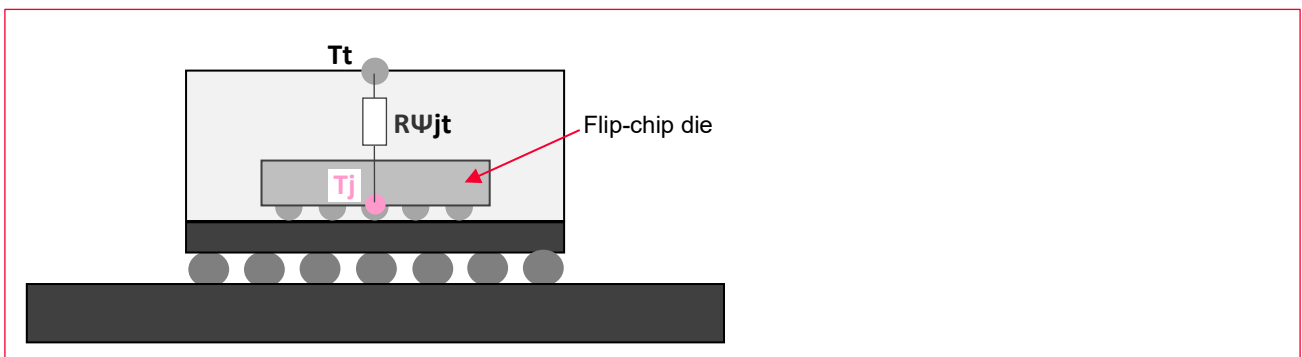
The package thermal conditions as shown in **Figure 6** are as below:

- R $\Psi$ jt : 3.56 °C/W
- R $\Psi$ jt = (T<sub>j</sub> - T<sub>t</sub>)/P



T<sub>j</sub>: Junction temperature (°C), T<sub>t</sub>: Top temperature (°C), P: Total Power Consumption (W)

**Figure 6: Package Thermal Conditions**



## 10 Power Sequence

This section describes the power-on and power-off sequences along with their parameters.

### 10.1 Power-On Sequence

- VBAT and VIO must be good (90%) at the same time or before assert PMIC\_EN (= 0 to 1).
- Rump-up time of VIO must be < 100 ms

Figure 7: Power-On Sequence Graph

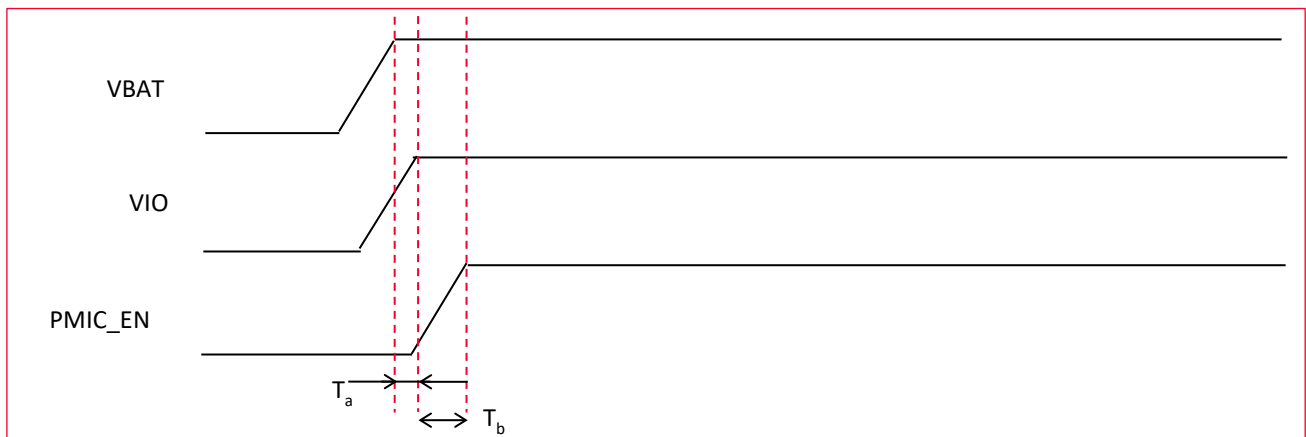


Table 16: Power-On Sequence Parameters

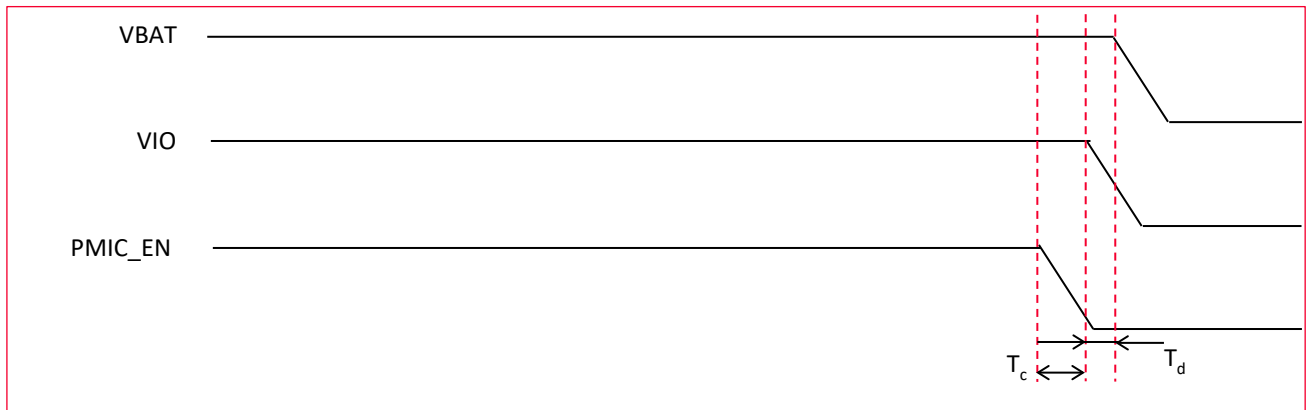
Symbol	Parameter	Minimum	Typical	Maximum	Unit
$T_a$	VBAT to VIO time	0			ms
$T_b$	VIO to PMIC_EN time	0			ms

### 10.2 Power-Off Sequence

#### 10.2.1 Power-Off Sequence

- VBAT and VIO must be down at the same time or before de-assert PMIC\_EN (= 1 to 0).
- Rump-down time of VIO must be < 100 ms

**Figure 8: Power-Off Sequence Graph**



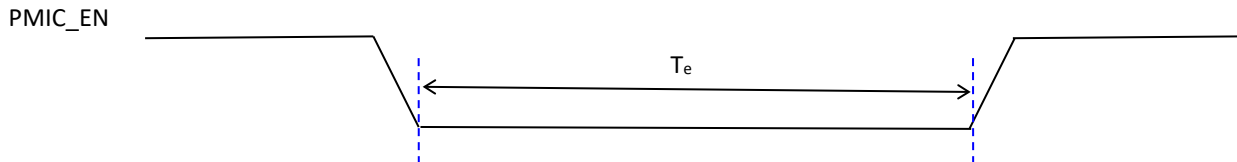
**Table 17: Power-Off Sequence Parameters**

Symbol	Parameter	Minimum	Typical	Maximum	Unit
$T_c$	PMIC_EN to VIO time	0			ms
$T_d$	VIO to VBAT time	0			ms

### 10.2.2 Host Power Off Pin (PMIC\_EN) Usage

PMIC\_EN must be asserted a minimum of 100ms.

**Figure 9: Host Power Off Pin (PMIC\_EN) Usage Graph**



**Table 18: Host Power Off Pin (PMIC\_EN) Usage Parameters**

Symbol	Parameter	Minimum	Typical	Maximum	Unit
$T_e$	PMIC_EN deassert to assert	100			ms

# 11 Interface Timing

This section describes the interface timings, its speed modes, related parameters, and graphs.

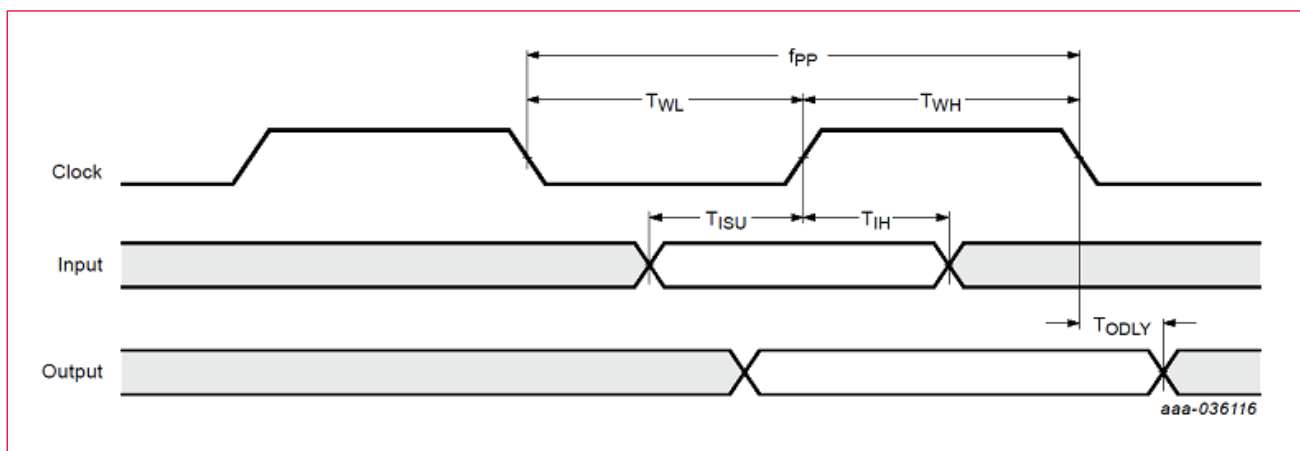
## 11.1 SDIO Timing

This section describes the SDIO timings for different modes.

### 11.1.1 Default Speed Mode

The default speed mode is shown in **Figure 10**.

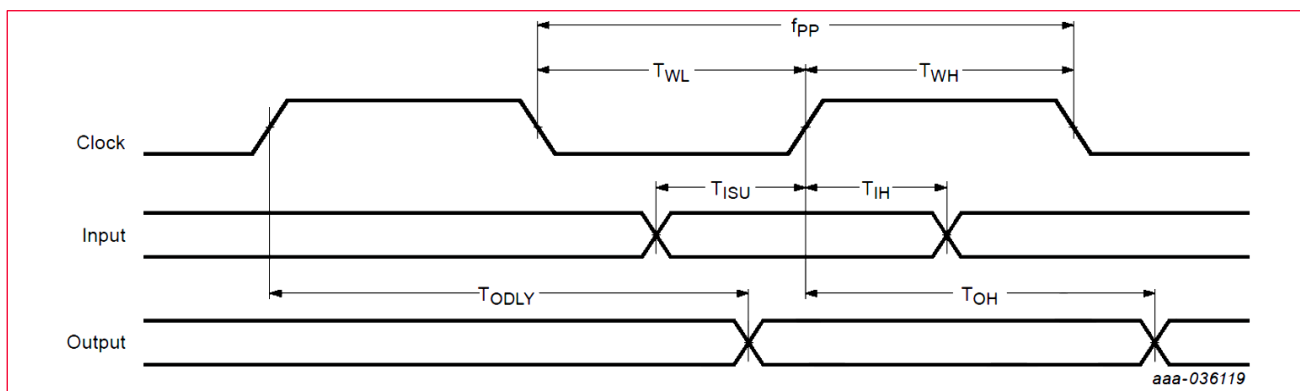
**Figure 10: SDIO Protocol Timing Diagram - Default Speed Mode**



### 11.1.2 High Speed Mode

The high speed mode is shown in **Figure 11**.

**Figure 11: SDIO Protocol Timing Diagram - High Speed Mode**



**Table 19: SDIO Timing Data - High Speed Mode**

Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
$f_{PP}$	Clock frequency	Normal	0		25	MHz
		High speed	0		50	MHz
$T_{WL}$	Clock low time	Normal	10			ns



Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
T <sub>WH</sub>	Clock high time	High speed	7			ns
		Normal	10			ns
		High speed	7			ns
T <sub>ISU</sub>	Input Setup Time	Normal	5			ns
		High speed	6			ns
T <sub>IH</sub>	Input hold Time	Normal	5			ns
		High speed	2			ns
T <sub>ODLY</sub>	Output delay time	Normal			14	ns
	CL ≤ 40 pF (1 card)	High speed			14	ns
T <sub>OH</sub>	Output hold time	High speed	2.5			ns



For SDIO 2.0 running at 25 MHz and 50 MHz clock frequency, VIO\_SD must be 3.3V.

### 11.1.3 SDR12, SDR25, and SDR50 Modes up to 100 MHz (1.8 V)

Figure 12 shows the SDIO protocol timing diagram for SDR12, SDR25, SDR50 modes (up to 100 MHz & 1.8 V).

Figure 12: SDIO Protocol Timing Diagram - SDR12, SDR25, and SDR50 Modes

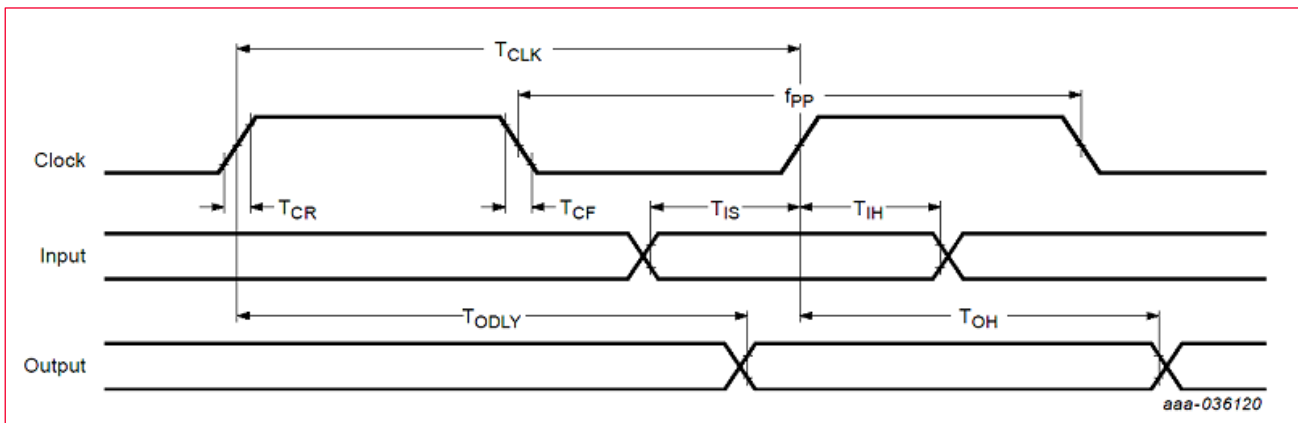


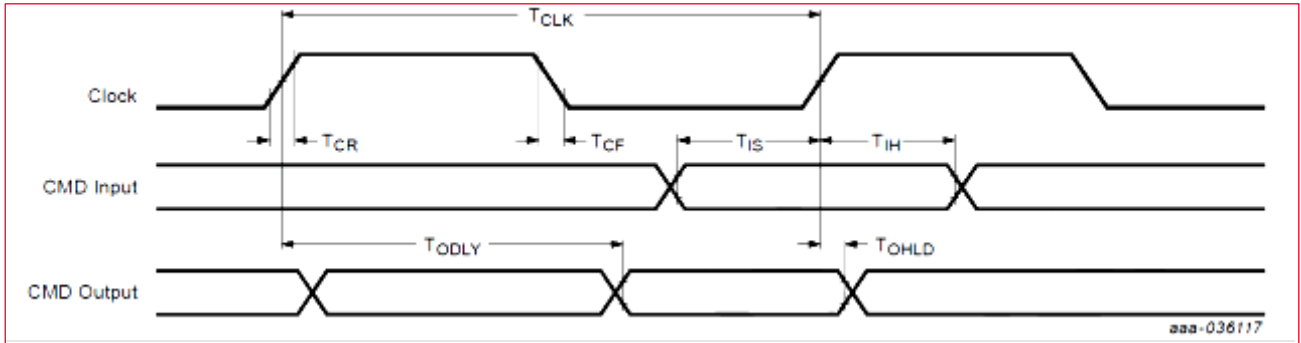
Table 20: SDIO Protocol Timing Parameters - SDR12, SDR25, and SDR50 Modes

Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
f <sub>PP</sub>	Clock frequency	SDR12/25/50	25		100	MHz
T <sub>IS</sub>	Input setup time	SDR12/25/50	3			ns
T <sub>IH</sub>	Input hold time	SDR12/25/50	0.8			ns
T <sub>CLK</sub>	Clock time	SDR12/25/50	10		40	ns
T <sub>CR</sub> , T <sub>CF</sub>	Rise time, fall time T <sub>CR</sub> , T <sub>CF</sub> < 2 ns (maximum) at 100 MHz C <sub>CARD</sub> = 10 pF	SDR12/25/50			0.2 * T <sub>CLK</sub>	ns
T <sub>ODLY</sub>	Output delay time C <sub>L</sub> ≤ 30 pF	SDR12/25/50			7.5	ns
T <sub>OH</sub>	Output hold time C <sub>L</sub> = 15 pF	SDR12/25/50	1.5			ns

### 11.1.4 DDR50 Mode at 50 MHz (1.8V)

Figure 13 shows the SDIO CMD timing diagram for DDR50 mode (up to 50 MHz and 1.8V).

Figure 13: SDIO CMD Timing Diagram - DDR50 Mode



In DDR50 mode, DAT[3:0] lines are sampled on both edges of the clock (not applicable for CMD line).

Figure 14 shows the SDIO DATA timing diagram for DDR50 mode.

Figure 14: SDIO DATA Timing Diagram - DDR50 Mode

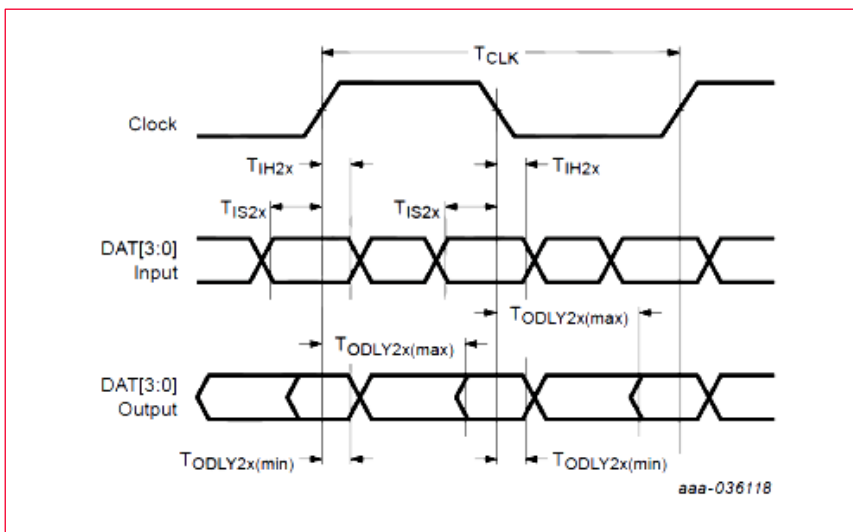


Table 21: SDIO Protocol Timing Parameters - DDR50 Mode

Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
<b>Clock</b>						
T <sub>CLK</sub>	Clock time 50 MHz (maximum) between rising edges	DDR50	20			ns
T <sub>CR</sub> , T <sub>CF</sub>	Rise time, fall time T <sub>CR</sub> , T <sub>CF</sub> < 4.00 ns(maximum) at 50 MHz C <sub>CARD</sub> =10 pF	DDR50			0.2*T <sub>CLK</sub>	ns
Clock Duty		DDR50	45		55	%

Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
<b>CMD Input (referenced to clock rising edge)</b>						
T <sub>IS</sub>	Input setup time C <sub>CARD</sub> ≤ 10 pF (1 card)	DDR50	6			ns
T <sub>IH</sub>	Input hold time C <sub>CARD</sub> ≤ 10 pF (1 card)	DDR50	0.8			ns
<b>CMD Output (referenced to clock rising edge)</b>						
T <sub>ODLY</sub>	Output delay time during data transfer mode C <sub>L</sub> ≤ 30 pF (1 card)	DDR50			13.7	ns
T <sub>OHLd</sub>	Output hold time C <sub>L</sub> ≥ 15 pF (1 card)	DDR50	1.5			ns
<b>DAT [3:0] Input (referenced to clock rising and falling edges)</b>						
T <sub>IS2x</sub>	Input setup time C <sub>CARD</sub> ≤ 10 pF (1 card)	DDR50	3			ns
T <sub>IH2x</sub>	Input hold time C <sub>CARD</sub> ≤ 10 pF (1 card)	DDR50	0.8			ns
<b>DAT [3:0] Output (referenced to clock rising and falling edges)</b>						
T <sub>ODLY2x (max)</sub>	Output delay time during data transfer mode C <sub>L</sub> ≤ 25 pF (1 card)	DDR50			7.0	ns
T <sub>ODLY2x (min)</sub>	Output hold time C <sub>L</sub> ≥ 15 pF (1 card)	DDR50	1.5			ns

## 11.2 UART Timing (Default Mode)

Figure 15 show the UART timing default mode. The default baud rate is 115200 bps. Baud rate is configurable by the host stack.

Figure 15: UART Timing Diagram

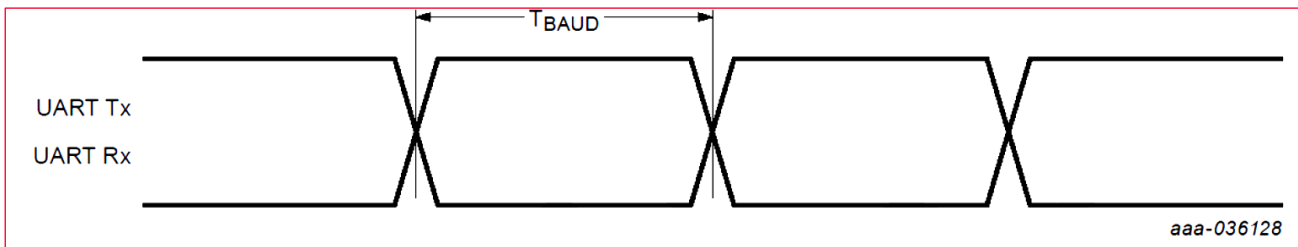


Table 22: UART Timing Data

Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
T <sub>BAUD</sub>	Baud rate	38.4 MHz	250			ns



The acceptable deviation from the UART Rx target baud rate is ±3%.

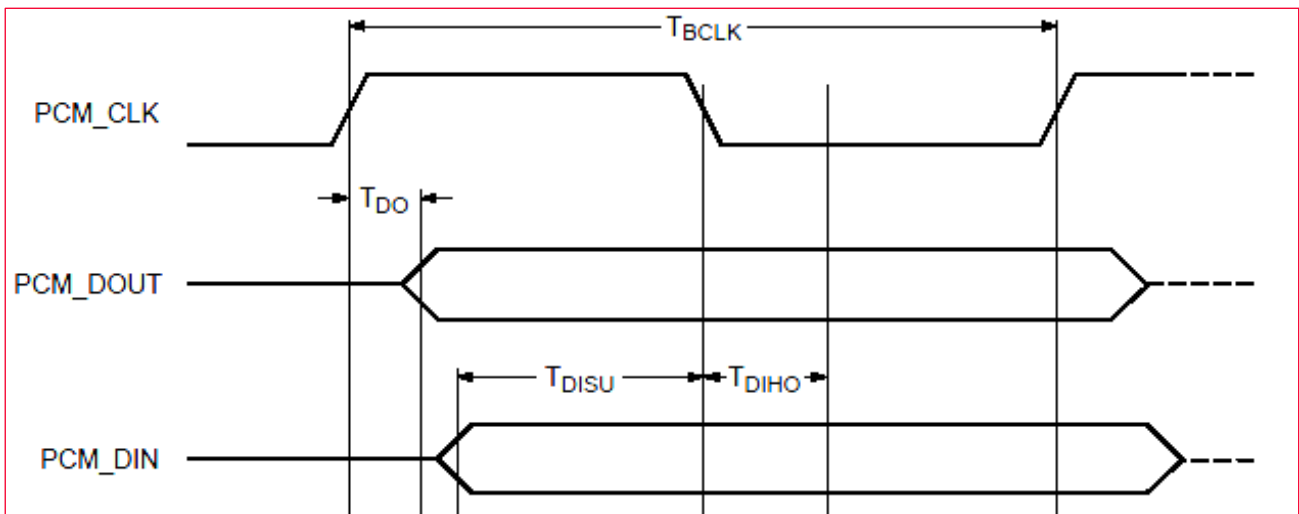
## 11.3 Bluetooth PCM Timing

This section describes the master and slave modes for Bluetooth PCM and data signals along with their parameters.

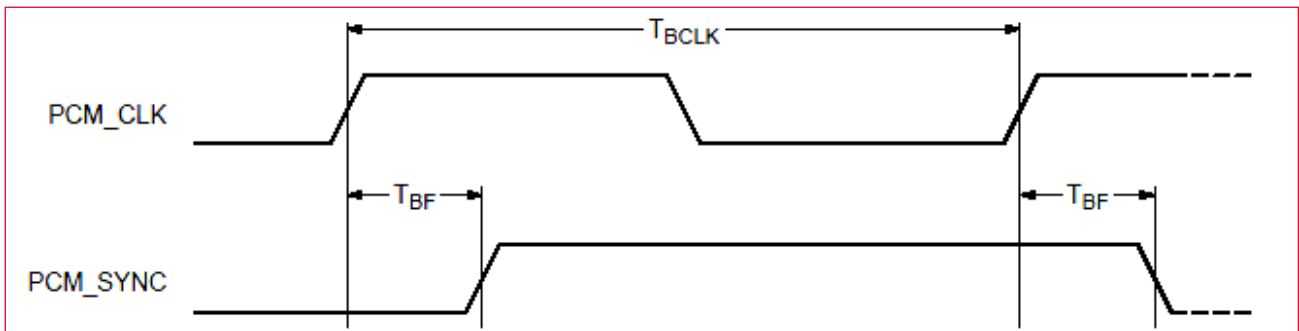
### 11.3.1 Master Mode

**Figure 16** and **Figure 17** shows the timing diagram of master mode for Bluetooth data and PCM\_SYNC signals.

**Figure 16: Bluetooth Data Signal - Master Mode**



**Figure 17: Bluetooth PCM\_SYNC Signal - Master Mode**



**Table 23** lists information about the data and PCM\_SYNC signals in master mode.

**Table 23: Symbol Definition for Data Signal & PCM\_SYNC Signal - Master Mode**

Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
$F_{BCLK}$	Bit clock frequency			2/2.048		MHz
$Duty\ Cycle_{BCLK}$	Bit clock duty cycle		0.4	0.5	0.6	
$T_{BCLK\ rise/fall}$	PCM_CLK rise/fall time			3		ns
$T_{DO}$	Delay from PCM_CLK rising edge to PCM_DOUT rising edge				15	ns

Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
$T_{DISU}$	Setup time for PCM_DIN before PCM_CLK falling edge		20			ns
$T_{DIHO}$	Hold time for PCM_DIN after PCM_CLK falling edge		15			ns
$T_{BF}$	Delay from PCM_CLK rising edge to PCM_SYNC rising edge				15	ns

### 11.3.2 Slave Mode

Figure 18 and Figure 19 shows the timing diagram of slave mode for data and PCM\_SYNC signals. Table 24 lists information about the data and PCM\_SYNC signals in slave mode.

Figure 18: Bluetooth Data Signal - Slave Mode

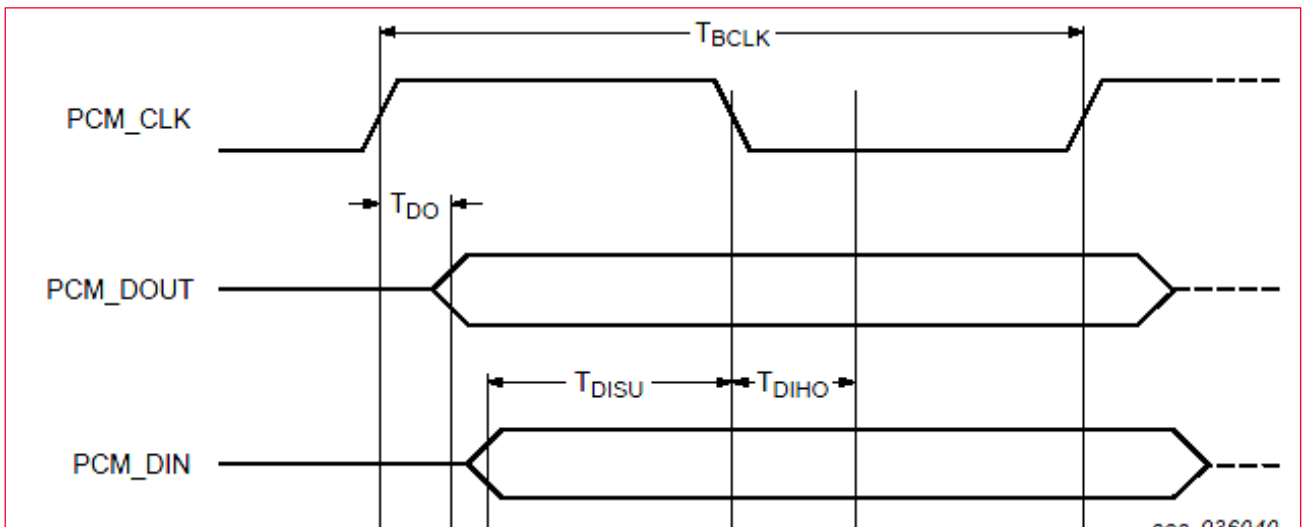


Figure 19: Bluetooth PCM\_Sync Signal - Slave Mode

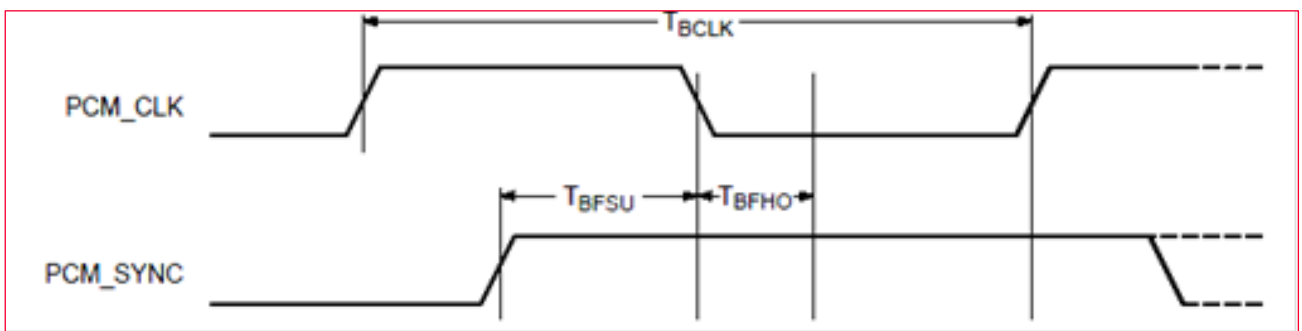


Table 24: Symbol Definition for Data Signal & PCM\_SYNC Signal - Slave Mode

Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
$F_{BCLK}$	Bit clock frequency			2/2.048		MHz
Duty Cycle <sub>BCLK</sub>	Bit clock duty cycle		0.4	0.5	0.6	
$T_{BCLK\ rise/fall}$	PCM_CLK rise/fall time			3		ns
$T_{DO}$	Delay from PCM_CLK rising edge to PCM_DOUT rising edge				30	ns

Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
T <sub>DISU</sub>	Setup time for PCM_DIN before PCM_CLK falling edge		15			ns
T <sub>DIHO</sub>	Hold time for PCM_DIN after PCM_CLK falling edge		10			ns
T <sub>BFSU</sub>	Setup time for PCM_SYNC before PCM_CLK falling edge		15			ns
T <sub>BFHO</sub>	Hold time for PCM_SYNC after PCM_CLK falling edge		10			ns

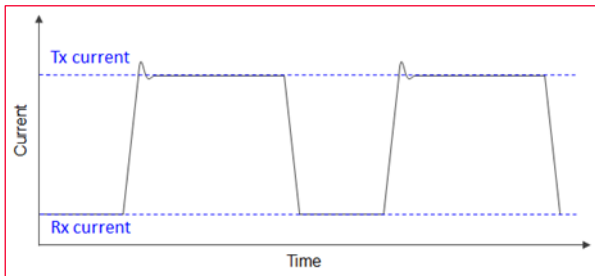
## 12 DC / RF Characteristics

All DC/RF characteristics are defined by following files as shown with file names in **Table 25**. **Figure 20** shows the burst current definition for Type 2XK module.

**Table 25: DC/RF Characteristics and Files**

Characteristics	Filenames
WLAN Tx Power	txpower_US.bin, txpower_CA.bin, txpower_EU.bin, txpower_JP.bin
WLAN Regulatory Limit	db.txt
Energy Detect	ed_mac.bin
Bluetooth Power	bt_power_config_1.sh (Class 1)

**Figure 20: Burst Current Definition**



## 12.1 DC/RF Characteristics for IEEE 802.11b - 2.4 GHz

**Table 26: Characteristics Values for IEEE 802.11b - 2.4 GHz**

Items	Contents
Specification	IEEE 802.11b
Mode	DSSS / CCK
Channel Frequency	2412 to 2472 MHz
Data Rate	1, 2, 5.5, 11 Mbps

### 12.1.1 High-Rate Condition for IEEE 802.11b - 2.4 GHz

**Conditions:** 25 °C, VBAT = 3.3V, VIO = 1.8V, Output power setting = 17 dBm at module pad, 11 Mbps mode

**Table 27: High-Rate Condition for IEEE 802.11b - 2.4 GHz**

Items	Contents			
DC Characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode		400	560	mA
• Rx mode		50	65	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	15.0	17.0	19.0	dBm
Spectrum Mask Margin				
• 1st side lobes	0			dB
• 2nd side lobes	0			dB
Power-on/off ramp			2.0	μs
RF Carrier Suppression	15			dB
Modulation Accuracy			35	%
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 kHz)			-36	dBm
• 47 - 74 MHz (BW = 100 kHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 kHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 kHz)			-54	dBm
• 118 - 174 MHz (BW = 100 kHz)			-36	dBm
• 174 - 230 MHz (BW = 100 kHz)			-54	dBm
• 230 - 470 MHz (BW = 100 kHz)			-36	dBm
• 470 - 862 MHz (BW = 100 kHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 kHz)			-36	dBm
• 1000 - 12750 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	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

## 12.1.2 Low-Rate Condition for IEEE 802.11b - 2.4 GHz

**Conditions:** 25 °C, VBAT = 3.3V, VIO = 1.8V, Output power setting = 17 dBm at module pad, 1 Mbps mode

**Table 28: Low-Rate Condition for IEEE 802.11b - 2.4 GHz**

Items	Contents			
DC Characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode		390	550	mA
• Rx mode		50	65	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	15.0	17.0	19.0	dBm
Spectrum Mask Margin				
• 1st side lobes	0			dB
• 2nd side lobes	0			dB
Power-on/off ramp			2.0	μs
RF Carrier Suppression	15			dB
Modulation Accuracy			35	%
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 kHz)			-36	dBm
• 47 - 74 MHz (BW = 100 kHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 kHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 kHz)			-54	dBm
• 118 - 174 MHz (BW = 100 kHz)			-36	dBm
• 174 - 230 MHz (BW = 100 kHz)			-54	dBm
• 230 - 470 MHz (BW = 100 kHz)			-36	dBm
• 470 - 862 MHz (BW = 100 kHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 kHz)			-36	dBm
• 1000 - 12750 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Minimum Input Level (FER ≤ 8%)			-80	dBm
Maximum Input Level (FER ≤ 8%)	-4			dBm
Adjacent Channel Rejection (FER < 8%)	35			dB



## 12.2 DC/RF Characteristics for IEEE 802.11g - 2.4 GHz

**Table 29: Characteristics Values for IEEE 802.11g - 2.4 GHz**

Items	Contents
Specification	IEEE 802.11g
Mode	OFDM
Channel Frequency	2412 to 2472 MHz
Data Rate	6, 9, 12, 18, 24, 36, 48, 54 Mbps

### 12.2.1 High-Rate Condition for IEEE 802.11g - 2.4 GHz

**Conditions:** 25 °C, VBAT = 3.3V, VIO = 1.8V, Output power setting = 16 dBm at module pad, 54 Mbps mode

**Table 30: High-Rate Condition for IEEE 802.11g - 2.4 GHz**

Items	Contents			
DC Characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode		344	480	mA
• Rx mode		50	65	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	14.0	16.0	18.0	dBm
Spectrum Mask Margin				
• 9 MHz to 11 MHz (0 ~ -20 dBr)	0			dB
• 11 MHz to 20 MHz (-20 ~ -28 dBr)	0			dB
• 20 MHz to 30 MHz (-28 ~ -40 dBr)	0			dB
• 30 MHz to 33 MHz (-40 dBr)	0			dB
Constellation Error (EVM)			-25	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 kHz)			-36	dBm
• 47 - 74 MHz (BW = 100 kHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 kHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 kHz)			-54	dBm
• 118 - 174 MHz (BW = 100 kHz)			-36	dBm
• 174 - 230 MHz (BW = 100 kHz)			-54	dBm
• 230 - 470 MHz (BW = 100 kHz)			-36	dBm
• 470 - 862 MHz (BW = 100 kHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 kHz)			-36	dBm
• 1000 - 12750 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	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

## 12.2.2 Low-Rate Condition for IEEE 802.11g - 2.4 GHz

**Conditions:** 25 °C, VBAT = 3.3V, VIO = 1.8V, Output power setting = 17 dBm at module pad, 6 Mbps mode

**Table 31: Low-Rate Condition for IEEE 802.11g - 2.4 GHz**

Items	Contents			
DC Characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode		376	530	mA
• Rx mode		50	65	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	15.0	17.0	19.0	dBm
Spectrum Mask Margin				
• 9 MHz to 11 MHz (0 ~ -20 dBr)	0			dB
• 11 MHz to 20 MHz (-20 ~ -28 dBr)	0			dB
• 20 MHz to 30 MHz (-28 ~ -40 dBr)	0			dB
• 30 MHz to 33 MHz (-40 dBr)	0			dB
Constellation Error (EVM)			-5	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 kHz)			-36	dBm
• 47 - 74 MHz (BW = 100 kHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 kHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 kHz)			-54	dBm
• 118 - 174 MHz (BW = 100 kHz)			-36	dBm
• 174 - 230 MHz (BW = 100 kHz)			-54	dBm
• 230 - 470 MHz (BW = 100 kHz)			-36	dBm
• 470 - 862 MHz (BW = 100 kHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 kHz)			-36	dBm
• 1000 - 12750 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER < 10%)			-82	dBm
Maximum Input Level (PER < 10%)	-20			dBm
Adjacent Channel Rejection (PER < 10%)	-1			dB

## 12.3 DC/RF Characteristics for IEEE 802.11n (HT20) - 2.4 GHz

**Table 32: Characteristics Values for IEEE 802.11n (HT20) - 2.4 GHz**

Items	Contents
Specification	IEEE 802.11n 20 MHz BW
Mode	OFDM
Channel Frequency	2412 to 2472 MHz
Data Rate	MCS0-MCS7

### 12.3.1 High-Rate Condition for IEEE 802.11n (HT20) - 2.4 GHz

**Conditions:** 25 °C, VBAT = 3.3V, VIO = 1.8V, Output power setting = 15 dBm at module pad, MCS7 mode

**Table 33: High-Rate Condition for IEEE 802.11n (HT20) - 2.4 GHz**

Items	Contents			
DC Characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode		320	450	mA
• Rx mode		50	65	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	13.0	15.0	17.0	dBm
Spectrum Mask Margin				
• 9 MHz to 11 MHz (0 ~ -20 dBr)	0			dB
• 11 MHz to 20 MHz (-20 ~ -28 dBr)	0			dB
• 20 MHz to 30 MHz (-28 ~ -45 dBr)	0			dB
• 30 MHz to 33 MHz (-45 dBr)	0			dB
Constellation Error (EVM) (measured at enhanced mode)			-27	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 kHz)			-36	dBm
• 47 - 74 MHz (BW = 100 kHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 kHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 kHz)			-54	dBm
• 118 - 174 MHz (BW = 100 kHz)			-36	dBm
• 174 - 230 MHz (BW = 100 kHz)			-54	dBm
• 230 - 470 MHz (BW = 100 kHz)			-36	dBm
• 470 - 862 MHz (BW = 100 kHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 kHz)			-36	dBm
• 1000 - 12750 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER ≤ 10%)			-64	dBm
Maximum Input Level (PER < 10%)	-20			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-2			dB

## 12.3.2 Low-Rate Condition for IEEE 802.11n (HT20) - 2.4 GHz

**Conditions:** 25 °C, VBAT = 3.3V, VIO = 1.8V, Output power setting = 16 dBm at module pad, MCS0 mode

**Table 34: Low-Rate Condition for IEEE 802.11n (HT20) - 2.4 GHz**

Items	Contents			
DC Characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode		351	490	mA
• Rx mode		50	65	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	14.0	16.0	18.0	dBm
Spectrum Mask Margin				
• 9 MHz to 11 MHz (0 ~ -20 dBr)	0			dB
• 11 MHz to 20 MHz (-20 ~ -28 dBr)	0			dB
• 20 MHz to 30 MHz (-28 ~ -45 dBr)	0			dB
• 30 MHz to 33 MHz (-45 dBr)	0			dB
4. Constellation Error (EVM) (measured at enhanced mode)			-5	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 kHz)			-36	dBm
• 47 - 74 MHz (BW = 100 kHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 kHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 kHz)			-54	dBm
• 118 - 174 MHz (BW = 100 kHz)			-36	dBm
• 174 - 230 MHz (BW = 100 kHz)			-54	dBm
• 230 - 470 MHz (BW = 100 kHz)			-36	dBm
• 470 - 862 MHz (BW = 100 kHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 kHz)			-36	dBm
• 1000 - 12750 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER ≤ 10%)			-82	dBm
Maximum Input Level (PER < 10%)	-20			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-2			dB

## 12.4 DC/RF Characteristics for IEEE 802.11a - 5 GHz

**Table 35: Characteristics Values for IEEE 802.11a - 5 GHz**

Items	Contents
Specification	IEEE 802.11a
Mode	OFDM
Channel Frequency	5180 to 5240 MHz, 5260 to 5320 MHz, 5500 to 5720 MHz, 5745 to 5825 MHz
Data Rate	6, 9, 12, 18, 24, 36, 48, 54 Mbps

## 12.4.1 High-Rate Condition for IEEE 802.11a - 5 GHz

**Conditions:** 25 °C, VBAT = 3.3V, VIO = 1.8V, Output power setting = 16 dBm at module pad, 54 Mbps mode

**Table 36: High-Rate Condition for IEEE 802.11a - 5 GHz**

Items	Contents			
DC Characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode		394	550	mA
• Rx mode		62	80	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	14.0	16.0	18.0	dBm
Spectrum Mask Margin				
• 9 MHz to 11 MHz (0 ~ -20 dBr)	0			dB
• 11 MHz to 20 MHz (-20 ~ -28 dBr)	0			dB
• 20 MHz to 30 MHz (-28 ~ -45 dBr)	0			dB
• 30 MHz to 33 MHz (-45 dBr)	0			dB
Constellation Error (EVM) (measured at enhanced mode)			-25	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 kHz)			-36	dBm
• 47 - 74 MHz (BW = 100 kHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 kHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 kHz)			-54	dBm
• 118 - 174 MHz (BW = 100 kHz)			-36	dBm
• 174 - 230 MHz (BW = 100 kHz)			-54	dBm
• 230 - 470 MHz (BW = 100 kHz)			-36	dBm
• 470 - 862 MHz (BW = 100 kHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 kHz)			-36	dBm
• 1000 - 5150 MHz (BW = 1 MHz)			-30	dBm
• 5350 - 5470 MHz (BW = 1 MHz)			-30	dBm
• 5725 - 26000 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	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

## 12.4.2 Low-Rate Condition for IEEE 802.11a - 5 GHz

**Conditions:** 25 °C, VBAT = 3.3V, VIO = 1.8V, Output power setting = 16 dBm at module pad, 6 Mbps mode

**Table 37: Low-Rate Condition for IEEE 802.11a - 5 GHz**

Items	Contents			
DC Characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode		394	550	mA
• Rx mode		62	80	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	14.0	16.0	18.0	dBm
Spectrum Mask Margin				
• 9 MHz to 11 MHz (0 ~ -20 dBr)	0			dB
• 11 MHz to 20 MHz (-20 ~ -28 dBr)	0			dB
• 20 MHz to 30 MHz (-28 ~ -45 dBr)	0			dB
• 30 MHz to 33 MHz (-45 dBr)	0			dB
Constellation Error (EVM) (measured at enhanced mode)			-5	dB
Frequency Tolerance	-20		-20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 kHz)			-36	dBm
• 47 - 74 MHz (BW = 100 kHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 kHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 kHz)			-54	dBm
• 118 - 174 MHz (BW = 100 kHz)			-36	dBm
• 174 - 230 MHz (BW = 100 kHz)			-54	dBm
• 230 - 470 MHz (BW = 100 kHz)			-36	dBm
• 470 - 862 MHz (BW = 100 kHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 kHz)			-36	dBm
• 1000 - 5150 MHz (BW = 1 MHz)			-30	dBm
• 5350 - 5470 MHz (BW = 1 MHz)			-30	dBm
• 5725 - 26000 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER ≤ 10%)			-82	dBm
Maximum Input Level (PER < 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-1			dB

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

**Table 38: Characteristics Values for IEEE 802.11n (HT20) - 5 GHz**

Items	Contents
Specification	IEEE 802.11n
Mode	OFDM
Channel Frequency	5180 to 5240 MHz, 5260 to 5320 MHz, 5500 to 5720 MHz, 5745 to 5825 MHz
Data Rate	MCS0-MCS7

### 12.5.1 High-Rate Condition for IEEE 802.11n (HT20) - 5 GHz

**Conditions:** 25 °C, VBAT = 3.3V, VIO = 1.8V, Output power setting = 15 dBm at module pad, MCS7 mode

**Table 39: High-Rate Condition for IEEE 802.11n (HT20) - 5 GHz**

Items	Contents			
DC Characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode		373	520	mA
• Rx mode		62	80	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	13.0	15.0	17.0	dBm
Spectrum Mask Margin				
• 9 MHz to 11 MHz (0 ~ -20 dBr)	0			dB
• 11 MHz to 20 MHz (-20 ~ -28 dBr)	0			dB
• 20 MHz to 30 MHz (-28 ~ -45 dBr)	0			dB
• 30 MHz to 33 MHz (-45 dBr)	0			dB
Constellation Error (EVM) (measured at enhanced mode)			-27	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 kHz)			-36	dBm
• 47 - 74 MHz (BW = 100 kHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 kHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 kHz)			-54	dBm
• 118 - 174 MHz (BW = 100 kHz)			-36	dBm
• 174 - 230 MHz (BW = 100 kHz)			-54	dBm
• 230 - 470 MHz (BW = 100 kHz)			-36	dBm
• 470 - 862 MHz (BW = 100 kHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 kHz)			-36	dBm
• 1000 - 5150 MHz (BW = 1 MHz)			-30	dBm
• 5350 - 5470 MHz (BW = 1 MHz)			-30	dBm
• 5725 - 26000 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER ≤ 10%)			-64	dBm

Items	Contents			
Maximum Input Level (PER < 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-2			dB

## 12.5.2 Low-Rate Condition for IEEE 802.11n (HT20) - 5 GHz

**Conditions:** 25 °C, VBAT = 3.3V, VIO = 1.8V, Output power setting = 15 dBm at module pad, MCS0 mode

**Table 40: Low-Rate Condition for IEEE 802.11n (HT20) - 5 GHz**

Items	Contents			
<b>DC Characteristics</b>	<b>Minimum</b>	<b>Typical</b>	<b>Maximum</b>	<b>Unit</b>
DC Current				
• Tx mode		373	520	mA
• Rx mode		62	80	mA
<b>Tx Characteristics</b>	<b>Minimum</b>	<b>Typical</b>	<b>Maximum</b>	<b>Unit</b>
Output Power	13.0	15.0	17.0	dBm
Spectrum Mask Margin				
• 9 MHz to 11 MHz (0 ~ -20 dBr)	0			dB
• 11 MHz to 20 MHz (-20 ~ -28 dBr)	0			dB
• 20 MHz to 30 MHz (-28 ~ -45 dBr)	0			dB
• 30 MHz to 33 MHz (-45 dBr)	0			dB
Constellation Error (EVM) (measured at enhanced mode)			-5	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 kHz)			-36	dBm
• 47 - 74 MHz (BW = 100 kHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 kHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 kHz)			-54	dBm
• 118 - 174 MHz (BW = 100 kHz)			-36	dBm
• 174 - 230 MHz (BW = 100 kHz)			-54	dBm
• 230 - 470 MHz (BW = 100 kHz)			-36	dBm
• 470 - 862 MHz (BW = 100 kHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 kHz)			-36	dBm
• 1000 - 5150 MHz (BW = 1 MHz)			-30	dBm
• 5350 - 5470 MHz (BW = 1 MHz)			-30	dBm
• 5725 - 26000 MHz (BW = 1 MHz)			-30	dBm
<b>Rx Characteristics</b>	<b>Minimum</b>	<b>Typical</b>	<b>Maximum</b>	<b>Unit</b>
Minimum Input Level (PER ≤ 10%)			-82	dBm
Maximum Input Level (PER < 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-2			dB



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

**Table 41: Characteristics Values for IEEE 802.11n (HT40) - 5 GHz**

Items	Contents
Specification	IEEE 802.11n
Mode	OFDM
Channel Frequency	5190 to 5795 MHz
Data Rate	MCS0-MCS7

### 12.6.1 High-Rate Condition for IEEE 802.11n (HT40) - 5 GHz

**Conditions:** 25 °C, VBAT = 3.3V, VIO = 1.8V, Output power setting = 14 dBm at module pad, MCS7 mode

**Table 42: High-Rate Condition for IEEE 802.11n (HT40) - 5 GHz**

Items	Contents			
DC Characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode		352	490	mA
• Rx mode		69	90	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	12.0	14.0	16.0	dBm
Spectrum Mask Margin				
• 19 MHz to 21 MHz (0 ~ -20 dBr)	0			dB
• 21 MHz to 40 MHz (-20 ~ -28 dBr)	0			dB
• 40 MHz to 60 MHz (-28 ~ -45 dBr)	0			dB
• 60 MHz to 80 MHz (-45 dBr)	0			dB
Constellation Error (EVM) (measured at enhanced mode)			-27	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 kHz)			-36	dBm
• 47 - 74 MHz (BW = 100 kHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 kHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 kHz)			-54	dBm
• 118 - 174 MHz (BW = 100 kHz)			-36	dBm
• 174 - 230 MHz (BW = 100 kHz)			-54	dBm
• 230 - 470 MHz (BW = 100 kHz)			-36	dBm
• 470 - 862 MHz (BW = 100 kHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 kHz)			-36	dBm
• 1000 - 5150 MHz (BW = 1 MHz)			-30	dBm
• 5350 - 5470 MHz (BW = 1 MHz)			-30	dBm
• 5725 - 26000 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	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

## 12.6.2 Low-Rate Condition for IEEE 802.11n (HT40) - 5 GHz

**Conditions:** 25 °C, VBAT = 3.3V, VIO = 1.8V, Output power setting = 14 dBm at module pad, MCS0 mode.

**Table 43: Low-Rate Condition for IEEE 802.11n (HT40) - 5 GHz**

Items	Contents			
	Minimum	Typical	Maximum	Unit
<b>DC Characteristics</b>				
DC Current				
• Tx mode		352	490	mA
• Rx mode		69	90	mA
<b>Tx Characteristics</b>				
	<b>Minimum</b>	<b>Typical</b>	<b>Maximum</b>	<b>Unit</b>
Output Power	12.0	14.0	16.0	dBm
<b>Spectrum Mask Margin</b>				
• 19 MHz to 21 MHz (0 ~ -20 dBr)	0			dB
• 21 MHz to 40 MHz (-20 ~ -28 dBr)	0			dB
• 40 MHz to 60 MHz (-28 ~ -45 dBr)	0			dB
• 60 MHz to 80 MHz (-45 dBr)	0			dB
Constellation Error (EVM) (measured at enhanced mode)			-5	dB
Frequency Tolerance	-20		20	ppm
<b>Spurious Emissions</b>				
• 30 - 47 MHz (BW = 100 kHz)			-36	dBm
• 47 - 74 MHz (BW = 100 kHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 kHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 kHz)			-54	dBm
• 118 - 174 MHz (BW = 100 kHz)			-36	dBm
• 174 - 230 MHz (BW = 100 kHz)			-54	dBm
• 230 - 470 MHz (BW = 100 kHz)			-36	dBm
• 470 - 862 MHz (BW = 100 kHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 kHz)			-36	dBm
• 1000 - 5150 MHz (BW = 1 MHz)			-30	dBm
• 5350 - 5470 MHz (BW = 1 MHz)			-30	dBm
• 5725 - 26000 MHz (BW = 1 MHz)			-30	dBm
<b>Rx Characteristics</b>				
	<b>Minimum</b>	<b>Typical</b>	<b>Maximum</b>	<b>Unit</b>
Minimum Input Level (PER ≤ 10%)			-79	dBm
Maximum Input Level (PER ≤ 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-2			dB

## 12.7 DC/RF Characteristics for Bluetooth

**Table 44: Characteristics Values for Bluetooth**

Items	Contents
Bluetooth specification (power class)	Version 5.2 (Class 1)
Channel Frequency (spacing)	2402 to 2480 MHz (1 MHz)
Number of RF Channel	79

### 12.7.1 Basic Data Rate Condition

**Conditions:** 25 °C, VBAT = 3.3V, VIO = 1.8V (Test method: Bluetooth Core Spec Vol.3 Part D)

**Table 45: Basic Data Rate Condition**

Items	Contents			
<b>Current Consumption</b>	<b>Minimum</b>	<b>Typical</b>	<b>Maximum</b>	<b>Unit</b>
• Tx mode DH5		84	110	mA
• Rx mode DH5		65	90	mA
<b>Tx Characteristics</b>	<b>Minimum</b>	<b>Typical</b>	<b>Maximum</b>	<b>Unit</b>
Output Power@DH5	0	3.0	6.3	dBm
Frequency Range	2400		2483.5	MHz
20 dB bandwidth			1	MHz
Adjacent Channel Power <sup>8</sup>				
• [M-N] = 2			-20	dBm
• [M-N] ≥ 3			-40	dBm
Modulation characteristics				
• Modulation $\Delta f_{1\text{avg}}$	140	151	175	kHz
• Modulation $\Delta f_{2\text{max}}$	115			kHz
• Modulation $\Delta f_{2\text{avg}} / \Delta f_{1\text{avg}}$	0.8	1		
Carrier Frequency Drift				
• 1slot	-25		25	kHz
• 3slot / 5slot	-40		40	kHz
• Maximum Drift Rate			20	kHz/50 $\mu$ s
<b>Rx Characteristics</b>	<b>Minimum</b>	<b>Typical</b>	<b>Maximum</b>	<b>Unit</b>
BDR Sensitivity (BER ≤ 0.1%)		-93	-70	dBm
Maximum Input Level (BER ≤ 0.1%)	-20			dBm

<sup>8</sup> Up to three spurious responses within Bluetooth limits are allowed.

## 12.7.2 Enhanced Data Rate Condition

**Conditions:** 25 °C, VBAT = 3.3V, VIO = 1.8V (Test method: Bluetooth Core Spec Vol.3 Part D)

**Table 46: Enhanced Data Rate Condition**

Items	Contents			
Current Consumption	Minimum	Typical	Maximum	Unit
• Tx mode 2DH5		81	110	mA
• Rx mode 2DH5		65	90	mA
• Tx mode 3DH5		81	110	mA
• Rx mode 3DH5		65	90	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power@2DH5/3DH5	-3.0	0	3.3	dBm
Frequency Range	2400		2483.5	MHz
20 dB bandwidth			1	MHz
Adjacent Channel Power <sup>9</sup>				
• [M-N] = 2			-20	dBm
• [M-N] ≥ 3			-40	dBm
EDR Relative Power	-4		1	dB
EDR Carrier Frequency Stability and Modulation Accuracy				
• $\omega_i$	-75		75	kHz
• $\omega_i + \omega_o$	-75		75	kHz
• $\omega_o$	-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				
• 30 - 47 MHz (BW = 100 kHz)			-36	dBm
• 47 - 74 MHz (BW = 100 kHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 kHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 kHz)			-54	dBm
• 118 - 174 MHz (BW = 100 kHz)			-36	dBm
• 174 - 230 MHz (BW = 100 kHz)			-54	dBm
• 230 - 470 MHz (BW = 100 kHz)			-36	dBm
• 470 - 862 MHz (BW = 100 kHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 kHz)			-36	dBm
• 1000 - 12750 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
EDR Sensitivity (BER ≤ 0.007%@8DPSK)		-87	-70	dBm
Maximum Input Level (BER ≤ 0.1%)	-20			dBm

<sup>9</sup> Up to three spurious responses within Bluetooth limits are allowed.

## 12.8 DC/RF Characteristics for Bluetooth Low Energy

**Table 47: Characteristics Values for BLE**

Items	Contents
Bluetooth specification (power class)	Version 5.2 (Class 1.5)
Channel Frequency (spacing)	2402 to 2480 MHz (2 MHz)
Number of RF Channel	40

### 12.8.1 1 Mbps PHY Condition

**Conditions:** 25 °C, VBAT = 3.3V, VIO = 1.8V (Test method: Bluetooth Core Spec Vol.6 Part F)

**Table 48: 1 Mbps PHY Condition**

Items	Contents			
Current Consumption	Minimum	Typical	Maximum	Unit
• Tx mode		80	110	mA
• Rx mode		73	95	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Center Frequency	2402		2480	MHz
Channel Spacing		2		MHz
Number of RF channel		40		
Output Power	0	3.0	6.3	dBm
In-band emission				
• $f_{TX} \pm 2$ MHz			-20	dBm
• $f_{TX} \pm [3+n]$ MHz; n = 0,1,2...			-30	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			
Stable Modulation Characteristics				
• $\Delta f_{1\text{avg}}$	247.5		252.5	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 ( $f_n$ ); n = 0,1,2,3...k	-150		150	kHz
• Frequency drift ( $ f_0 - f_n $ ); n = 2,3,4...k			50	kHz
• Drift rate				
• $ f_1 - f_0 $			23	kHz
• $ f_n - f_{n-5} $ ; n = 6,7, 8...k			20	kHz
Spurious Emissions				
• 30 - 47 MHz (BW = 100 kHz)			-36	dBm
• 47 - 74 MHz (BW = 100 kHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 kHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 kHz)			-54	dBm
• 118 - 174 MHz (BW = 100 kHz)			-36	dBm
• 174 - 230 MHz (BW = 100 kHz)			-54	dBm

Items	Contents			
Current Consumption	Minimum	Typical	Maximum	Unit
• 230 - 470 MHz (BW = 100 kHz)			-36	dBm
• 470 - 862 MHz (BW = 100 kHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 kHz)			-36	dBm
• 1000 - 12750 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Receiver Sensitivity (PER < 30.8%)		-101	-70	dBm
Maximum input signal level (PER < 30.8%)	-10			dBm
PER Report Integrity (-30 dBm input)	50		65.4	%

## 12.8.2 2 Mbps PHY Condition

**Conditions:** 25 °C, VBAT = 3.3V, VIO = 1.8V (Test method: Bluetooth Core Spec Vol.6 Part F)

**Table 49: 2 Mbps PHY Condition**

Items	Contents			
Current Consumption	Minimum	Typical	Maximum	Unit
• Tx mode		76	100	mA
• Rx mode		73	95	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Center Frequency	2402		2480	MHz
Channel Spacing		2		MHz
Number of RF channel		40		
Output Power	0	3.0	6.3	dBm
In-band emission				
• $f_{TX} \pm 4$ MHz			-20	dBm
• $f_{TX} \pm 5$ MHz			-20	dBm
• $f_{TX} \pm [6+n]$ MHz; n = 0,1,2...			-30	dBm
Modulation Characteristics				
• $\Delta f_{1avg}$	450		550	kHz
• $\Delta f_{2max}$ (at 99.9%)	370			kHz
• $\Delta f_{2avg} / \Delta f_{1avg}$	0.8			-
Stable Modulation Characteristics				
• $\Delta f_{1avg}$	495		505	kHz
• $\Delta f_{2max}$ (at 99.9%)	370			kHz
• $\Delta f_{2avg} / \Delta f_{1avg}$	0.8			
Carrier frequency offset and drift				
• Frequency offset ( $f_n$ ); n = 0,1,2,3...k	-150		150	kHz
• Frequency drift ( $ f_0 - f_n $ ); n = 2,3,4...k			50	kHz
• Drift rate				
• $ f_1 - f_0 $			23	kHz
• $ f_n - f_{n-5} $ ; n = 6,7, 8...k			20	kHz
Spurious Emissions				
• 30 - 47 MHz (BW = 100 kHz)			-36	dBm
• 47 - 74 MHz (BW = 100 kHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 kHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 kHz)			-54	dBm
• 118 - 174 MHz (BW = 100 kHz)			-36	dBm

Items	Contents			
	Minimum	Typical	Maximum	Unit
<b>Current Consumption</b>				
• 174 - 230 MHz (BW = 100 kHz)			-54	dBm
• 230 - 470 MHz (BW = 100 kHz)			-36	dBm
• 470 - 862 MHz (BW = 100 kHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 kHz)			-36	dBm
• 1000 - 12750 MHz (BW = 1 MHz)			-30	dBm
<b>Rx Characteristics</b>	<b>Minimum</b>	<b>Typical</b>	<b>Maximum</b>	<b>Unit</b>
Receiver Sensitivity (PER < 30.8%)		-99	-70	dBm
Maximum Input Signal Level (PER < 30.8%)	-10			dBm
PER Report Integrity (-30 dBm input)	50		65.4	%





# 14 General Radio Regulatory Certification for LBEE5CJ1XK and LBEE5CJ2XK

This section contains the following topics:

- Application model part number
- Label
- Package Label
- Country of Origin

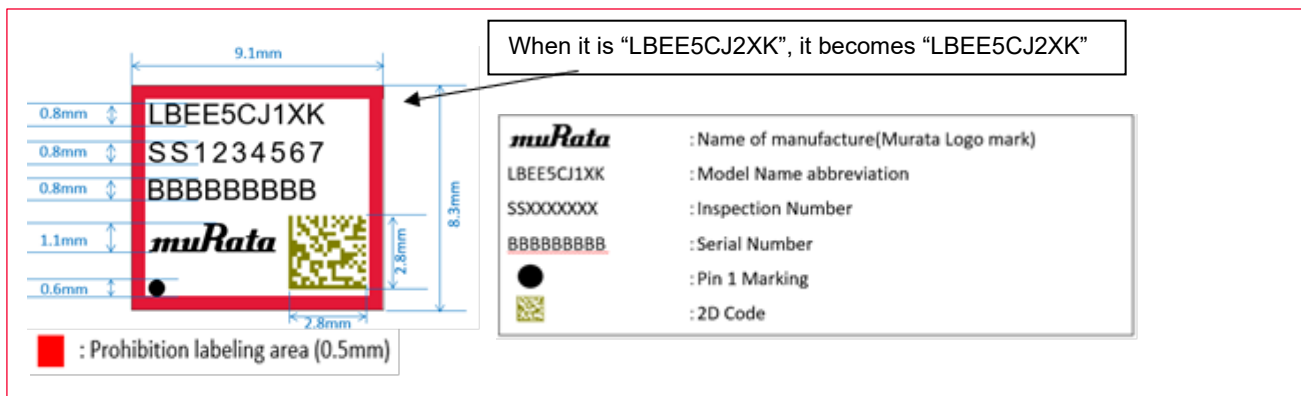
## 14.1 Application Model Part Number

Basically, we apply for “LBEE5CJ1XK” and “LBEE5CJ2XK” in each country.

## 14.2 Label

Figure 22 shows the certification label of Type 2XK module.

Figure 22: Radio Regulatory Certification Label

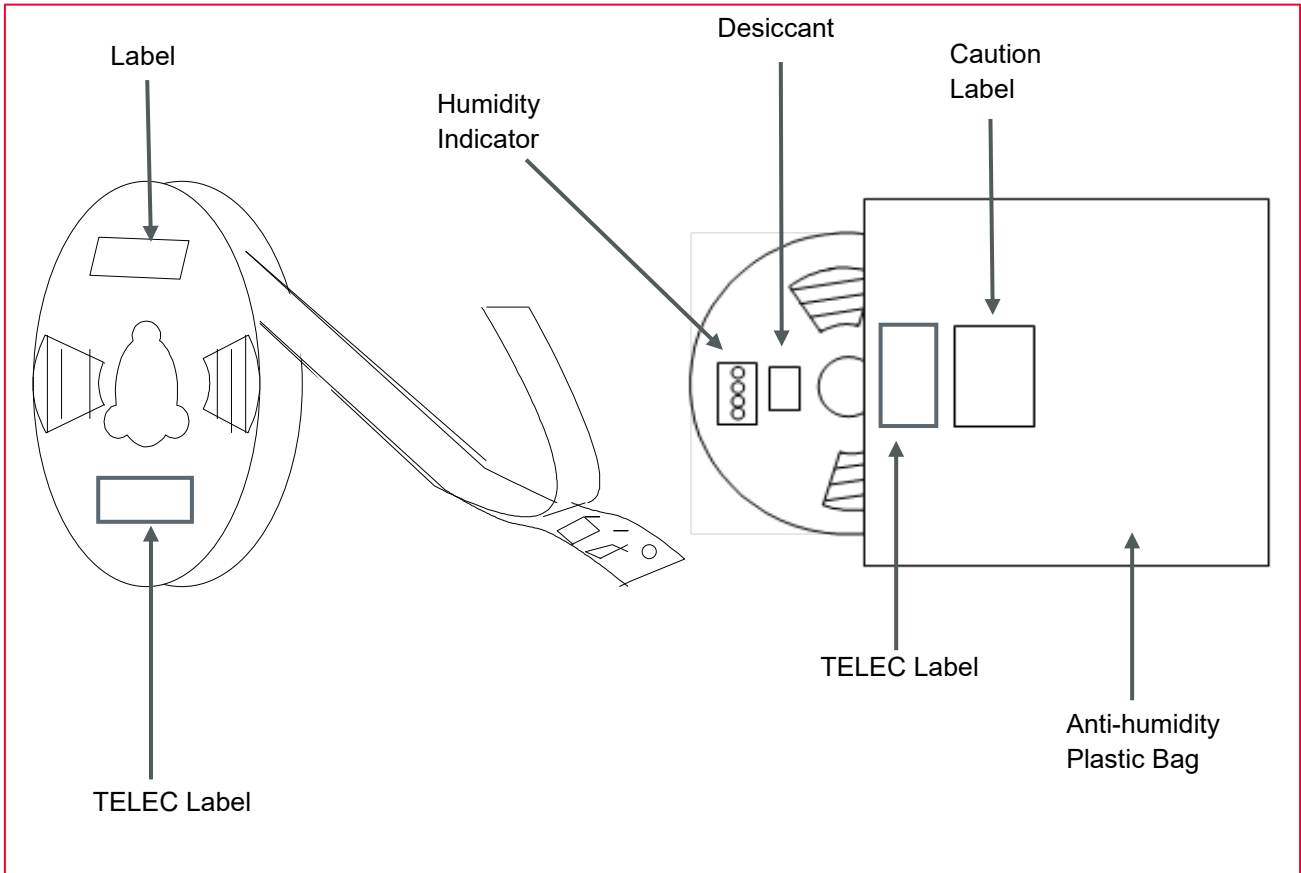


Since there is no space to describe the notational requirements of each country, we are applying for the notational requirements to be posted in the manual or package.

### 14.3 Package Label

**Figure 23** shows the package label information (Humidity Proof Packing).

**Figure 23: Package Label (Humidity Proof Packing)**



The package label may be attached on one side only.

Package label display example is shown in **Figure 24**.

**Figure 24: Package Label Display Example**





The above pictures are examples. It may be attached to only one of them.

## 14.4 Country of Origin

### China

SHENZHEN MURATA TECHNOLOGY CO., LTD.

Some countries have applied for two countries, China, and Japan, in preparation for future factory changes, but the production site in the delivery specifications is the above-mentioned factory in China.

## 15 Radio Regulatory Certification by Country for LBEE5CJ1XK and LBEE5CJ2XK

This section includes regulatory certification information all the following countries:

- Japan
- FCC
- ISED
- Europe



Precautions when using report number:  
E2/2021/30010 ~ E2/2021/30015 (RF Conducted test result only) for final product DoC.

## 15.1 Japan

- Manufacturer: Murata Manufacturing Co., Ltd.
- Model or Product Name: LBEE5CJ1XK or LBEE5CJ2XK
- This module has received "CERTIFICATION for TYPE CERTIFICATION" under the Japanese Radio Act.

### Japanese Version

#### 電波法の要求に基づく警告

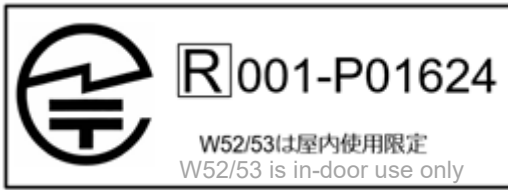
警告) 5 GHz の周波数帯においては、5.2 GHz/5.3 GHz/5.6 GHz 帯(W52/W53/W56)の3種類の帯域を使用することができます。5.2 GHz/5.3 GHz 帯無線 LAN(W52/W53)の屋外使用は5.2 GHz 帯高出力データ通信システムの基地局又は陸上移動中継局と通信する場合を除き電波法で禁止されています。

### English Version

Warning based on the requirements of Japanese Radio Act

(Warning) In the 5 GHz frequency band, you can use 3 bands: 5.2 GHz/5.3 GHz/5.6 GHz (W52/W53/W56).

Outdoor use of 5.2 GHz/5.3 GHz band wireless LANs(W52/W53) is prohibited by the Radio Act except when communicating with 5.2 GHz band high-power data communication system base stations or land mobile relay stations.



### 15.1.1 Power Level for Japan

**Table 50** and **Table 51** shows the per antenna port power table for 2.4 GHz for WLAN and Bluetooth. **Table 52** shows the per antenna port power table for 5 GHz WLAN.

**Table 50: Japan Power Level 2.4 GHz WLAN Per Antenna Port**

Mode	Rate	Channel	Maximum Tune Up Tolerance [dBm]
IEEE 802.11b	All Rates	1 ~ 13	16.0 ± 2.0
IEEE 802.11g	6 Mbps, 9 Mbps, 12 Mbps, 18 Mbps	1 ~ 13	17.0 ± 2.0
	24 Mbps, 36 Mbps, 48 Mbps, 54 Mbps	1 ~ 13	16.0 ± 2.0
IEEE 802.11n (HT20)	MCS0, MCS1, MCS2	1 ~ 13	16.0 ± 2.0
	MCS3, MCS4, MCS5, MCS6, MCS7	1 ~ 13	15.0 ± 2.0

**Table 51: Japan Power Level 2.4 GHz BT/BLE Per Antenna Port**

Mode	Maximum Tune Up Tolerance [dBm]	
	Shared BT Antenna (PIN No.45)	Dedicated BT Antenna (PIN No.47)
BR	3.0 ± 3.0	3.3 ± 3.0
EDR	0.0 ± 3.0	0.3 ± 3.0
LE	3.0 ± 3.0	3.3 ± 3.0
LE 2 Mbps	3.0 ± 3.0	3.3 ± 3.0
LE (Long Range) 125 kbps	3.0 ± 3.0	3.3 ± 3.0
LE (Long Range) 500 kbps	3.0 ± 3.0	3.3 ± 3.0

**Table 52: Japan Power Level 5 GHz WLAN Per Antenna Port**

Mode	Rate	Band	Channel	Maximum Tune Up Tolerance [dBm]
IEEE 802.11a	All Rates	W52/W53	36 ~ 64	14.0 ± 2.0
	All Rates	W56	100 ~ 144	15.0 ± 2.0
IEEE 802.11n (HT20)	All Rates	W52/W53	36 ~ 64	14.0 ± 2.0
	All Rates	W56	100 ~ 144	14.0 ± 2.0
IEEE 802.11n (HT40)	All Rates	W52/W53	38 ~ 62	14.0 ± 2.0
	All Rates	W56	102 ~ 142	14.0 ± 2.0

## 15.1.2 Theory of Operation for Japan

**Table 53** and **Table 54** show the theory of operation for WLAN and Bluetooth.

**Table 53: Japan Theory of Operation for WLAN**

Frequency of Operation			Scan	Ad-hoc Mode
2.4 GHz	11b/g/n (HT20)	2412 - 2462 MHz	Active	Yes
W52	11a/n (HT20)	5180 - 5240 MHz	Active	Yes
	11n (HT40)	5190 - 5230 MHz	Active	Yes
W53	11a/n (HT20)	5260 - 5320 MHz	Passive	No
	11n (HT40)	5270 - 5310 MHz	Passive	No
W56	11a/n (HT20)	5500 - 5720 MHz	Passive	No
	11n (HT40)	5510 - 5710 MHz	Passive	No



DFS MASTER function not available.  
DFS client function available.  
There is a TPC function.

**Table 54: Japan Theory of Operation for Bluetooth**

Frequency of Operation			Scan	Ad-hoc Mode
BT	BR	2402 ~ 2480 MHz	N/A	N/A
	EDR	2402 ~ 2480 MHz	N/A	N/A
LE	LE	2402 ~ 2480 MHz	N/A	N/A
	LE 2 Mbps	2402 ~ 2480 MHz	N/A	N/A
	LE (Long Range) 125 kbps	2402 ~ 2480 MHz	N/A	N/A
	LE (Long Range) 500 kbps	2402 ~ 2480 MHz	N/A	N/A



Without simultaneous transmission in the same frequency band.  
TPC supported.  
Setting value is typical WLAN deviation is  $\pm 2$  dB, BT/BLE deviation is  $\pm 3$  dB.

## 15.1.3 Antenna List

The antennas are registered under the Japan Radio Act. These are shown in the tables below.

- Antenna 1

<b>Antenna name</b>	LBEE5CJ1XK-Antenna
<b>Antenna vendor</b>	muRata
<b>Antenna type</b>	Monopole antenna
<b>Antenna gain</b>	+3.6dBi@2400 MHz
	+4.6dBi@5500 MHz
<b>Frequency</b>	2400 - 2484 MHz
	5150 - 5850 MHz

- Antenna 2

<b>Antenna name</b>	146153
<b>Antenna vendor</b>	Molex
<b>Antenna type</b>	Dipole antenna
<b>Antenna gain</b>	+3.2dBi@2.4 GHz
	+4.25dBi@5 GHz
<b>Frequency</b>	2400 - 2500 MHz
	5150 - 5850 MHz

- Antenna 3

<b>Antenna name</b>	146187
<b>Antenna vendor</b>	Molex
<b>Antenna type</b>	Dipole antenna
<b>Antenna gain</b>	+3.4dBi@2.4 GHz
	+4.75dBi@5 GHz
<b>Frequency</b>	2400 - 2500 MHz
	5150 - 5850 MHz

- Antenna 4

<b>Antenna name</b>	206994
<b>Antenna vendor</b>	Molex
<b>Antenna type</b>	Monopole antenna
<b>Antenna gain</b>	+3.6dBi@2.4 GHz
	+3.6dBi@5 GHz
<b>Frequency</b>	2400 - 2500 MHz
	5150 - 5850 MHz



## 15.1.4 About Notations

It is recommended that the indication of (1) or (2) below is described on the product incorporating this module in Japanese. If there is any problem with the indication of (1) or (2) on the product, we recommend indicating (1) or (2) in the user manual or on the package of the product incorporating this module, or electronic display on the product. In the case of the electronic display, it is necessary to describe "using the electronic display" + "how to reach to below indication" in the user manual of the product.

- Recommended Indication 1

<b>Japanese Version</b> 本製品は、電波法に基づく工事設計認証(認証番号:001-P01624)を受けた特定無線設備を内蔵しています。
<b>English Version</b> This product incorporates specified radio equipment that has received CERTIFICATION for TYPE CERTIFICATION (certification number: 001-P01624) based on the Japan Radio Act.

- Recommended Indication 2

<b>Japanese Version</b>  R001-P01624 5.2 GHz/5.3 GHz 帯無線 LAN (W52/W53) の屋外使用は 5.2 GHz 帯高出力データ通信システムの基地局又は陸上移動中継局と通信する場合を除き電波法で禁止されています。
<b>English Version</b>  R001-P01624 Outdoor use of 5.2 GHz/5.3 GHz band wireless LANs (W52/W53) is prohibited by the Radio Act except when communicating with 5.2 GHz band high-power data communication system base stations or land mobile relay stations.

### 15.1.5 Model Number Change

This module had been certified with model number LBEE5CJ1XK, but model number has been changed from “LBEE5CJ1XK” or “LBEE5CJ2XK” with approval of Ministry of Internal Affairs and Communication (MIC). **Table 55** shows the detailed information about notification to MIC.

**Table 55: Detail of Notification to MIC**

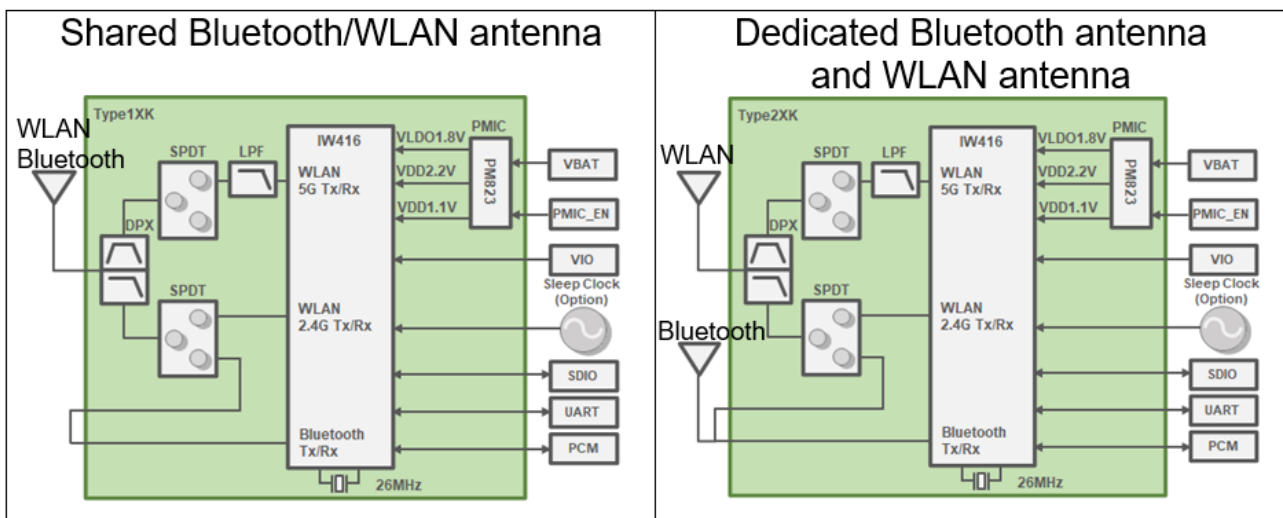
Change	Model Number or Product Name	Changer Date	Reason for Change
Before change	LBEE5CJ1XK	August 19, 2021	This module has already been certified with the model or name LBEE5CJ1XK and certification number 001-P01624.
After change	LBEE5CJ1XK or LBEE5CJ2XK		

This is an authentication that allows both "configuration of WLAN / BT common antenna settings" and "configuration of BT dedicated antenna settings" as shown in **Figure 25**.

However, because management becomes complicated, we newly installed a module with the same design except for the model’s name as LBEE5CJ2XK and added and changed the product name to determine the configuration of the default antenna setting for each.

- **LBEE5CJ1XK:** Default configuration is shared Bluetooth/WLAN antenna
- **LBEE5CJ2XK:** Default configuration is dedicated Bluetooth antenna and WLAN antenna.

**Figure 25: Shared Bluetooth/WLAN Antenna and Dedicated Bluetooth/WLAN Antenna**







## 15.2 FCC

### FCC ID: VPYLB1XK

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

	<ol style="list-style-type: none"> <li>1. This module should be installed in the host device according to the interface specification (installation procedure).</li> <li>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.</li> </ol>
---	--

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

	<ol style="list-style-type: none"> <li>1. This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.</li> <li>2. FCC CAUTION Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.</li> <li>3. This transmitter must not be co-located or operated in conjunction with any other antenna or transmitter.</li> <li>4. This device complies with below part 15 of the FCC Rules. <ul style="list-style-type: none"> <li>• Part 15 Subpart C</li> <li>• Part 15 Subpart E</li> </ul> </li> <li>5. Since there is no space which indicates FCC ID on this module, FCC ID is indicated in a manual. If the FCC ID is not visible when the module is installed inside another device, then the module is installed must also display a label referring to the enclosed module.</li> </ol>
---	--

**Table 56** shows the antenna list for Type 2XK module.

**Table 56: Antenna List**


Part number	Vendor	Peak Gain[dBi]		Type	Connector
		2.4 GHz	5 GHz		
146153	Molex	3.2	4.25	Dipole	u.FL
146187	Molex	3.4	4.75	Dipole	u.FL
LBEE5CJ1XK-Antenna	Murata	3.6	4.6	Monopole	


### 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: VPYLB1XK or Contains FCC ID: VPYLB1XK

	<p>This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:</p> <ul style="list-style-type: none"> <li>• This device may not cause harmful interference.</li> <li>• This device must accept any interference received, including interference that may cause undesired operation.</li> </ul>
---	---

	<p>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.</p>
---	--

### 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.



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.



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 discontinue transmission in case of either absence of information to transmit or operational failure.



Frequency Tolerance:  $\pm 20$  ppm

## 15.2.4 Product Dimensions

Figure 26 shows the product dimension of Type 2XK module.

Figure 26: Product Dimension

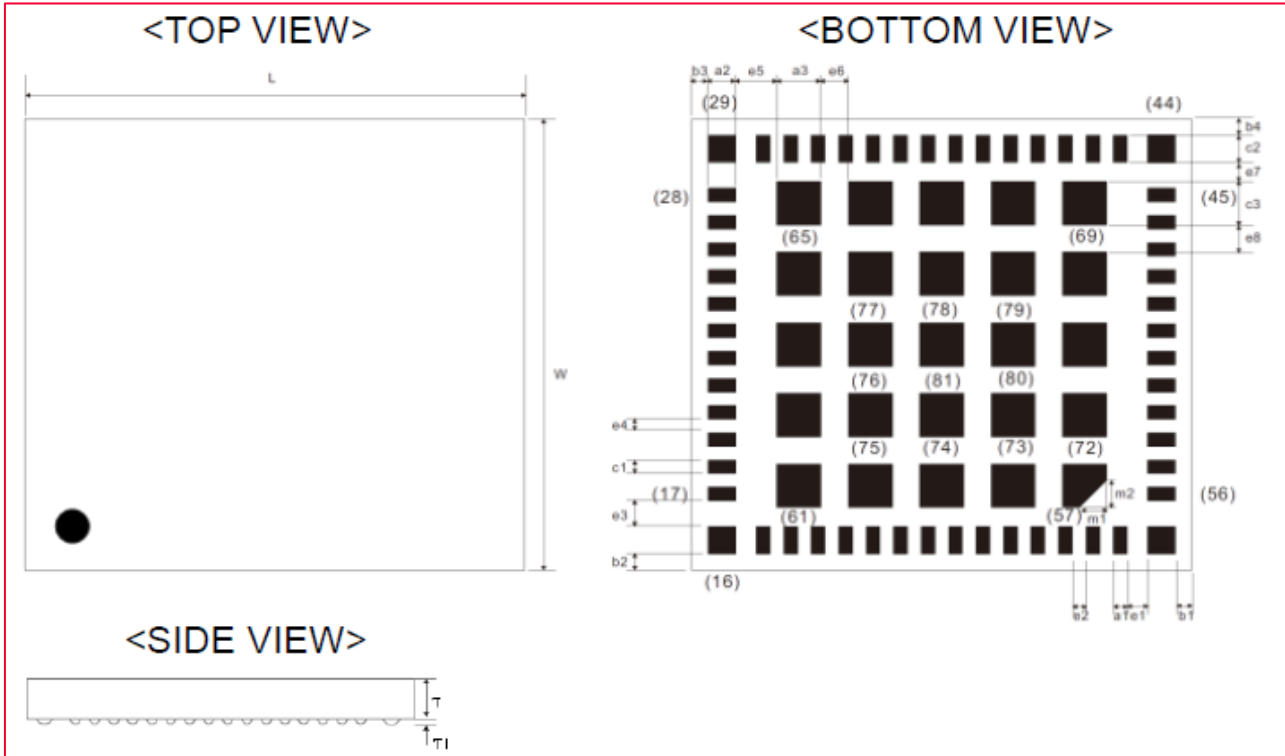


Table 57 shows the product dimensions. The dimension's unit are in mm.

Table 57: Dimensions

Mark	Dimensions	Mark	Dimensions	Mark	Dimensions	Mark	Dimensions
L	9.1 ± 0.2	W	8.3 ± 0.2	T	1.3 maximum	a1	0.25 ± 0.1
a2	0.5 ± 0.1	a3	0.8 ± 0.2	b1	0.3 ± 0.2	b2	0.3 ± 0.2
b3	0.3 ± 0.2	b4	0.3 ± 0.2	c1	0.25 ± 0.1	c2	0.5 ± 0.1
c3	0.8 ± 0.1	e1	0.38 ± 0.1	e2	0.25 ± 0.1	e3	0.48 ± 0.1
e4	0.25 ± 0.1	e5	0.75 ± 0.1	e6	0.5 ± 0.1	e7	0.35 ± 0.1
e8	0.5 ± 0.1	m1	0.5 ± 0.2	m2	0.5 ± 0.2	T1	0.045 typical



T dimension does not include height of solder bumps.

## 15.2.5 Supply Voltage

**Table 58** shows the supply voltage information.

**Table 58: Supply Voltage**

PIN Name	Minimum	Typical	Maximum	Unit
VBAT	2.7	3.3	5.5	V
VIO	1.62	1.8 or 3.3	3.47	V



VIO does not affect RF characteristics.

## 15.2.6 Temperature

**Table 59** shows the temperature information for 2XK module.

**Table 59: Temperature**

Operational Temperature	Minimum	Typical	Maximum	Unit
	-40	25	85	°C

## 15.2.7 Power Level for FCC

**Table 60** and **Table 61** shows the per antenna port power table for 2.4 GHz for WLAN and Bluetooth. **Table 62** shows the per antenna port power table for 5 GHz WLAN.

**Table 60: FCC Power Level 2.4 GHz WLAN Per Antenna Port**

Mode	Rate	Channel	Maximum Tune Up Tolerance [dBm]
IEEE 802.11b	All Rates	1 ~ 11	17.0 ± 2.0
IEEE 802.11g	All Rates	1 ~ 3, 9 ~ 11	14.0 ± 2.0
	6 Mbps, 9 Mbps, 12 Mbps, 18 Mbps	4 ~ 8	17.0 ± 2.0
	24 Mbps, 36 Mbps, 48 Mbps, 54 Mbps	4 ~ 8	16.0 ± 2.0
IEEE 802.11n (HT20)	All Rate	1 ~ 3, 9 ~ 11	13.0 ± 2.0
	MCS0, MCS1, MCS2	4 ~ 8	16.0 ± 2.0
	MCS3, MCS 4, MCS 5, MCS 6, MCS7	4 ~ 8	15.0 ± 2.0

**Table 61: FCC Power Level 2.4 GHz BT/BLE Per Antenna Port**

Mode	Maximum Tune Up Tolerance [dBm]	
	Shared BT Antenna (PIN No.45)	Dedicated BT Antenna (PIN No.47)
BR	3.0 ± 3.0	3.3 ± 3.0
EDR	0.0 ± 3.0	0.3 ± 3.0
LE	3.0 ± 3.0	3.3 ± 3.0
LE 2 Mbps	3.0 ± 3.0	3.3 ± 3.0
LE (Long Range) 125 kbps	3.0 ± 3.0	3.3 ± 3.0

Mode	Maximum Tune Up Tolerance [dBm]	
	Shared BT Antenna (PIN No.45)	Dedicated BT Antenna (PIN No.47)
LE (Long Range) 500 kbps	3.0 ± 3.0	3.3 ± 3.0

**Table 62: FCC Power Level 5 GHz Per Antenna Port**

Mode	Rate	Band	Channel	Maximum Tune Up Tolerance [dBm]
IEEE 802.11a	All Rates	W52/W53	36, 64	14.0 ± 2.0
	All Rates	W52/W53	40 ~ 60	16.0 ± 2.0
	All Rates	W56	100, 144	14.0 ± 2.0
	All Rates	W56	104 ~ 140	15.0 ± 2.0
	All Rates	W58	149 ~ 165	15.0 ± 2.0
IEEE 802.11n (HT20)	All Rates	W52/W53	36, 64	13.0 ± 2.0
	All Rates	W52/W53	40 ~ 60	15.0 ± 2.0
	All Rates	W56	100, 144	13.0 ± 2.0
	All Rates	W56	104 ~ 140	14.0 ± 2.0
	All Rates	W58	149 ~ 165	14.0 ± 2.0
IEEE 802.11n (HT40)	All Rates	W52/W53	38, 62	12.0 ± 2.0
	All Rates	W52/W53	46 ~ 54	14.0 ± 2.0
	All Rates	W56	102, 142	12.0 ± 2.0
	All Rates	W56	110 ~ 134	14.0 ± 2.0
	All Rates	W58	151, 159	14.0 ± 2.0

### 15.2.8 Theory of Operation for FCC

**Table 63** shows the theory of operation for WLAN and **Table 64** shows theory of operation for Bluetooth/LE.

**Table 63: FCC Theory of Operation for WLAN**

Frequency of Operation			Scan	Ad-hoc mode
2.4 GHz	11b/g/n (HT20)	2412 - 2462 MHz	Active	Yes
W52	11a/n (HT20)	5180 - 5240 MHz	Active	Yes
	11n (HT40)	5190 - 5230 MHz	Active	Yes
W53	11a/n (HT20)	5260 - 5320 MHz	Passive	No
	11n (HT40)	5270 - 5310 MHz	Passive	No
W56	11a/n (HT20)	5500 - 5720 MHz	Passive	No
	11n (HT40)	5510 - 5710 MHz	Passive	No
W58	11a/n (HT20)	5745 - 5825 MHz	Active	Yes
	11n (HT40)	5755 - 5795 MHz	Active	Yes



DFS MASTER function not available.  
DFS client function available.  
There is a TPC function.

**Table 64: FCC Theory of Operation for Bluetooth**

Frequency of Operation		Scan	Ad-hoc mode
BT	BR	2402 ~ 2480 MHz	N/A

Frequency of Operation			Scan	Ad-hoc mode
	EDR	2402 ~ 2480 MHz	N/A	N/A
LE	LE	2402 ~ 2480 MHz	N/A	N/A
	LE 2 Mbps	2402 ~ 2480 MHz	N/A	N/A
	LE (Long Range) 125 kbps	2402 ~ 2480 MHz	N/A	N/A
	LE (Long Range) 500 kbps	2402 ~ 2480 MHz	N/A	N/A

### 15.2.9 About LBEE5CJ1XK and LBEE5CJ2XK

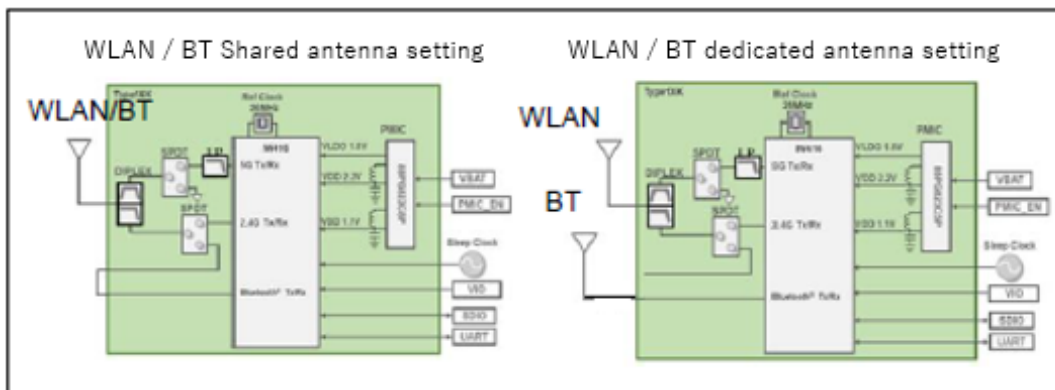
This FCC modular approval with FCC ID: VPYLB1XK has been granted with LBEE5CJ1XK as the original certification model.

This is a certification that allows both “configuration of WLAN/BT shared antenna setting” and “configuration of BT dedicated antenna setting”.

However, due to the complexity of management, a module with the same design except for the model’s name and newly created as “LBEE5CJ2XK”. And we made an addition and change of the product name to decide the configuration of the default antenna setting for each. This is a Class I permissive change.

- LBEE5CJ1XK: default is used with WLAN/BT shared antenna setting
- LBEE5CJ2XK: default is used with WLAN/BT dedicated antenna setting

Figure 27: Antenna Configuration for Type 1XK and Type 2XK Modules



## 15.3 ISED

Product Description: Communication Module

HVIN: LBEE5CJ1XK and LBEE5CJ2XK

PMN: LBEE5CJ1XK

IC Number: 772C-LB1XK

This module is not sold to general end users directly, therefore, there is no user manual of module. For 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.

### 15.3.1 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-LB1XK
- 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.  
 At the time of the channel 52 or 54 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 and channel 52,54)

#### French Version

Pour usage intérieur seulement (5150 - 5250 MHz band and channel 52,54)

#### 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.

#### English Version

This device complies with Industry Canada's applicable license-exempt RSSs. Operation is subject to the following two conditions:

- This device may not cause interference; and
- This device must accept any interference, including interference that may cause undesired operation of the device.

#### French Version

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:

- 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.

**English Version**

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.

**French Version**

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.



If it is difficult to describe these statements on the host product due to the size, please describe them in the User's manual.

### 15.3.2 Antenna Installation in End Product

If the antenna of the end product is removed, please describe the following warning on the manual of the end product which contains this module.

**English Version**

This radio transmitter (772C-LB1XK) 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.

Dipole Antenna	Gain: 3.2 dBi@2.4 GHz/4.25 dBi@5 GHz
Dipole Antenna	Gain: 3.4 dBi@2.4 GHz/4.75 dBi@5 GHz
Monopole Antenna	Gain: 3.6 dBi@2.4 GHz/4.6 dBi@5 GHz

**French Version**

Le présent émetteur radio (772C-LB1XK) 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 tout type figurant sur la liste, sont strictement interdits pour l'exploitation de l'émetteur.

Dipole Antenna	Gain: 3.2 dBi@2.4 GHz/4.25 dBi@5 GHz
Dipole Antenna	Gain: 3.4 dBi@2.4 GHz/4.75 dBi@5 GHz
Monopole Antenna	Gain: 3.6 dBi@2.4 GHz/4.6 dBi@5 GHz

### 15.3.3 Equipment Installation for ISED

There are two types of installation for host device.

#### 15.3.3.1 Portable Equipment

Equipment for which the spaces between human body and antenna are used within 20 cm.



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.



### 15.3.3.2 Mobile Equipment

Equipment used at position in which the spaces between human body and antenna exceeded 20 cm.

#### 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.

### 15.3.4 Power Level for ISED

**Table 65** and **Table 66** shows the per antenna port power table for 2.4 GHz for WLAN and Bluetooth. **Table 67** shows the per antenna port power table for 5 GHz WLAN.

**Table 65: ISED Power Level 2.4 GHz WLAN Per Antenna Port**

Mode	Rate	Channel	Maximum Tune Up Tolerance [dBm]
IEEE 802.11b	All Rates	1 ~ 11	17.0 ± 2.0
IEEE 802.11g	All Rates	1 ~ 3, 9 ~ 11	14.0 ± 2.0
	6 Mbps, 9 Mbps, 12 Mbps, 18 Mbps	4 ~ 8	17.0 ± 2.0
	24 Mbps, 36 Mbps, 48 Mbps, 54 Mbps	4 ~ 8	16.0 ± 2.0
IEEE 802.11n (HT20)	All Rates	1 ~ 3, 9 ~ 11	13.0 ± 2.0
	MCS0, MCS1, MCS2	4 ~ 8	16.0 ± 2.0
	MCS3, MCS 4, MCS 5, MCS 6, MCS7	4 ~ 8	15.0 ± 2.0

**Table 66: ISED Power Level 2.4 GHz BT/BLE Per Antenna Port**

Mode	Maximum Tune Up Tolerance [dBm]	
	Shared BT Antenna (PIN No.45)	Dedicated BT Antenna (PIN No.47)
BR	3.0 ± 3.0	3.3 ± 3.0
EDR	0.0 ± 3.0	0.3 ± 3.0
LE	3.0 ± 3.0	3.3 ± 3.0
LE 2 Mbps	3.0 ± 3.0	3.3 ± 3.0
LE (Long Range) 125 kbps	3.0 ± 3.0	3.3 ± 3.0
LE (Long Range) 500 kbps	3.0 ± 3.0	3.3 ± 3.0

**Table 67: ISED Power Level 5 GHz Per Antenna Port**

Mode	Rate	Band	Channel	Maximum Tune Up Tolerance [dBm]
IEEE 802.11a	All Rates	W52/W53	36 ~ 48	14.0 ± 2.0
	All Rates	W52/W53	52 ~ 60	16.0 ± 2.0
	All Rates	W53	64	14.0 ± 2.0

Mode	Rate	Band	Channel	Maximum Tune Up Tolerance [dBm]
	All Rates	W56	100, 144	14.0 ± 2.0
	All Rates	W56	104 ~ 116, 132 ~ 140	15.0 ± 2.0
	All Rates	W58	149 ~ 165	15.0 ± 2.0
IEEE 802.11n (HT20)	All Rates	W52/W53	36, 64	13.0 ± 2.0
	All Rates	W52	40 ~ 48	14.0 ± 2.0
	All Rates	W53	52 ~ 60	15.0 ± 2.0
	All Rates	W56	100, 144	13.0 ± 2.0
	All Rates	W56	104 ~ 116, 132 ~ 140	14.0 ± 2.0
	All Rates	W58	149 ~ 165	14.0 ± 2.0
	All Rates	W58	149 ~ 165	14.0 ± 2.0
IEEE 802.11n (HT40)	All Rates	W52/W53	38, 62	12.0 ± 2.0
	All Rates	W52/W53	46 ~ 54	14.0 ± 2.0
	All Rates	W56	102, 142	12.0 ± 2.0
	All Rates	W56	110, 134	14.0 ± 2.0
	All Rates	W58	151, 159	14.0 ± 2.0

### 15.3.5 Theory of Operation for ISED

**Table 68** shows the theory of operation for WLAN and **Table 69** shows theory of operation for Bluetooth/LE.

**Table 68: ISED Theory of Operation for WLAN**

Frequency of Operation		Scan	Ad-hoc mode	
2.4 GHz	11b/g/n (HT20)	2412 - 2462 MHz	Active	Yes
W52	11a/n (HT20)	5180 - 5240 MHz	Active	Yes
	11n (HT40)	5190 - 5230 MHz	Active	Yes
W53	11a/n (HT20)	5260 - 5320 MHz	Passive	No
	11n (HT40)	5270 - 5310 MHz	Passive	No
W56	11a/n (HT20)	5500 - 5720 MHz	Passive	No
	11n (HT40)	5510 - 5710 MHz	Passive	No
W58	11a/n (HT20)	5745 - 5825 MHz	Active	Yes
	11n (HT40)	5755 - 5795 MHz	Active	Yes



The frequency band 5600 MHz – 5640 MHz (11a/n 20M band), 5590 MHz-5630 MHz (11n 40M band) is restricted in ISED.  
 DFS MASTER function not available.  
 DFS client function available.  
 There is a TPC function.

**Table 69: ISED Theory of Operation for Bluetooth**

Frequency of Operation		Scan	Ad-hoc mode	
BT	BR	2402 ~ 2480 MHz	N/A	N/A
	EDR	2402 ~ 2480 MHz	N/A	N/A
LE	LE	2402 ~ 2480 MHz	N/A	N/A
	LE 2 Mbps	2402 ~ 2480 MHz	N/A	N/A
	LE (Long Range) 125 kbps	2402 ~ 2480 MHz	N/A	N/A
	LE (Long Range) 500 kbps	2402 ~ 2480 MHz	N/A	N/A

## 15.4 Europe



Precautions when using report number  
E2/2021/30010 ~ E2/2021/30015 (RF Conducted test result only) for final product DoC.

### 15.4.1 Power Level for Europe

**Table 70** and **Table 71** shows the per antenna port power table for 2.4 GHz for WLAN and Bluetooth. **Table 72** shows the per antenna port power table for 5 GHz WLAN.

**Table 70: Europe Power Level 2.4 GHz Per Antenna Port**

Mode	Rate	Channel	Maximum Tune Up Tolerance [dBm]
IEEE 802.11b	All Rates	1 ~ 13	14.0 ± 2.0
IEEE 802.11g	All Rates	1 ~ 13	14.0 ± 2.0
IEEE 802.11n (HT20)	All Rates	1 ~ 13	14.0 ± 2.0

**Table 71: Europe Power Level 2.4 GHz BT/BLE Per Antenna Port**

Mode	Maximum Tune Up Tolerance [dBm]	
	Shared BT Antenna (PIN No. 45)	Dedicated BT Antenna (PIN No. 47)
BR	3.0 ± 3.0	3.3 ± 3.0
EDR	0.0 ± 3.0	0.3 ± 3.0
LE	3.0 ± 3.0	3.3 ± 3.0
LE 2 Mbps	3.0 ± 3.0	3.3 ± 3.0
LE (Long Range) 125 kbps	3.0 ± 3.0	3.3 ± 3.0
LE (Long Range) 500 kbps	3.0 ± 3.0	3.3 ± 3.0

**Table 72: Europe Power Level 5 GHz Per Antenna Port**

Mode	Rate	Band	Channel	Maximum Tune Up Tolerance [dBm]
IEEE 802.11a	All Rates	W52/W53/W56	36 ~ 140	15.0 ± 2.0
	All Rates	W58	149 ~165	7.0 ± 2.0
IEEE 802.11n (HT20)	All Rates	W52/W53/W56	36 ~ 140	14.0 ± 2.0
	All Rates	W58	149 ~165	7.0 ± 2.0
IEEE 802.11n (HT40)	All Rates	W52/W53/W56	38 ~ 134	14.0 ± 2.0
	All Rates	W58	151, 159	7.0 ± 2.0

## 15.4.2 Theory of Operation for Europe

**Table 73** shows the theory of operation for WLAN and **Table 74** shows theory of operation for Bluetooth/LE.

**Table 73: Europe Theory Operation for WLAN**

Frequency of Operation			Scan	Ad-hoc mode
2.4 GHz	11b/g/n (HT20)	2412 - 2472 MHz	Active	Yes
W52	11a/n (HT20)	5180 - 5240 MHz	Active	Yes
	11n (HT40)	5190 - 5230 MHz	Active	Yes
W53	11a/n (HT20)	5260 - 5320 MHz	Passive	No
	11n (HT40)	5270 - 5310 MHz	Passive	No
W56	11a/n (HT20)	5500 - 5700 MHz	Passive	No
	11n (HT40)	5510 - 5670 MHz	Passive	No
W58	11a/n (HT20)	5745 - 5825 MHz	Active	Yes
	11n (HT40)	5755 - 5795 MHz	Active	Yes



DFS MASTER function not available.  
DFS client function available.  
There is a TPC function.

**Table 74: Europe Theory Operation for Bluetooth**

Frequency of Operation			Scan	Ad-hoc mode
BT	BR	2402 ~ 2480 MHz	N/A	N/A
	EDR	2402 ~ 2480 MHz	N/A	N/A
LE	LE	2402 ~ 2480 MHz	N/A	N/A
	LE 2 Mbps	2402 ~ 2480 MHz	N/A	N/A
	LE (Long Range) 125 kbps	2402 ~ 2480 MHz	N/A	N/A
	LE (Long Range) 500 kbps	2402 ~ 2480 MHz	N/A	N/A

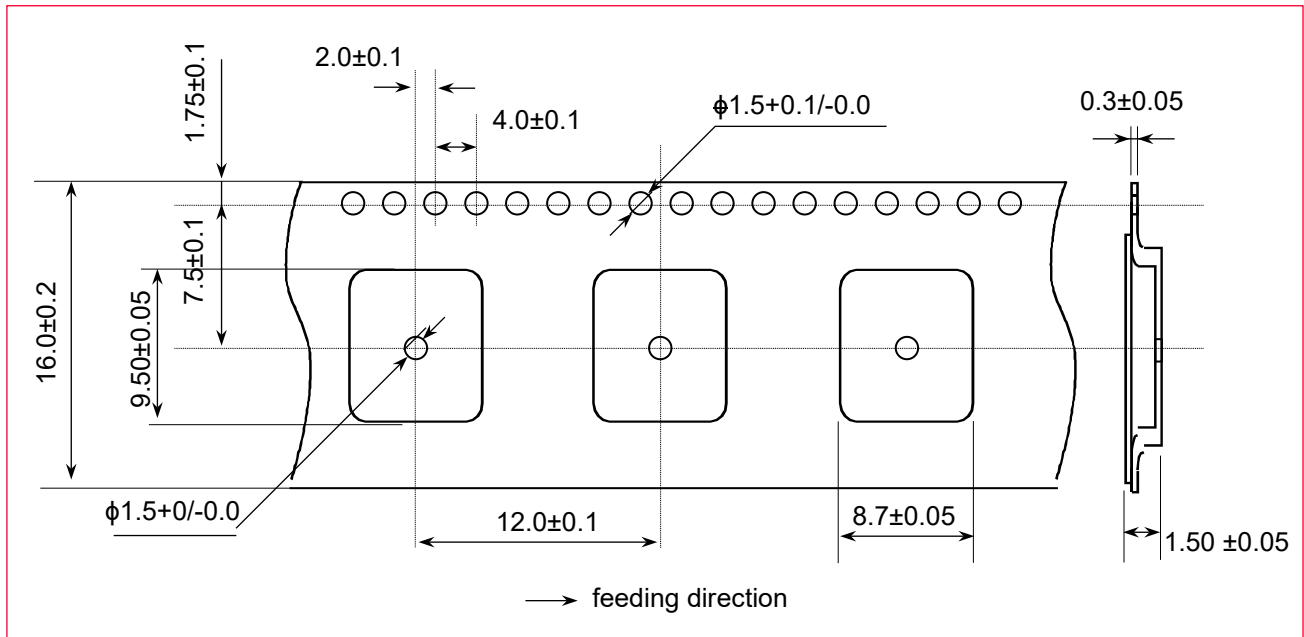
## 16 Tape and Reel Packing

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

### 16.1 Dimensions of Tape (Plastic Tape)

**Figure 28** is a graphical representation of the tape dimension (plastic tape)<sup>10</sup>.

**Figure 28: Dimensions of Tape (Unit: mm)**

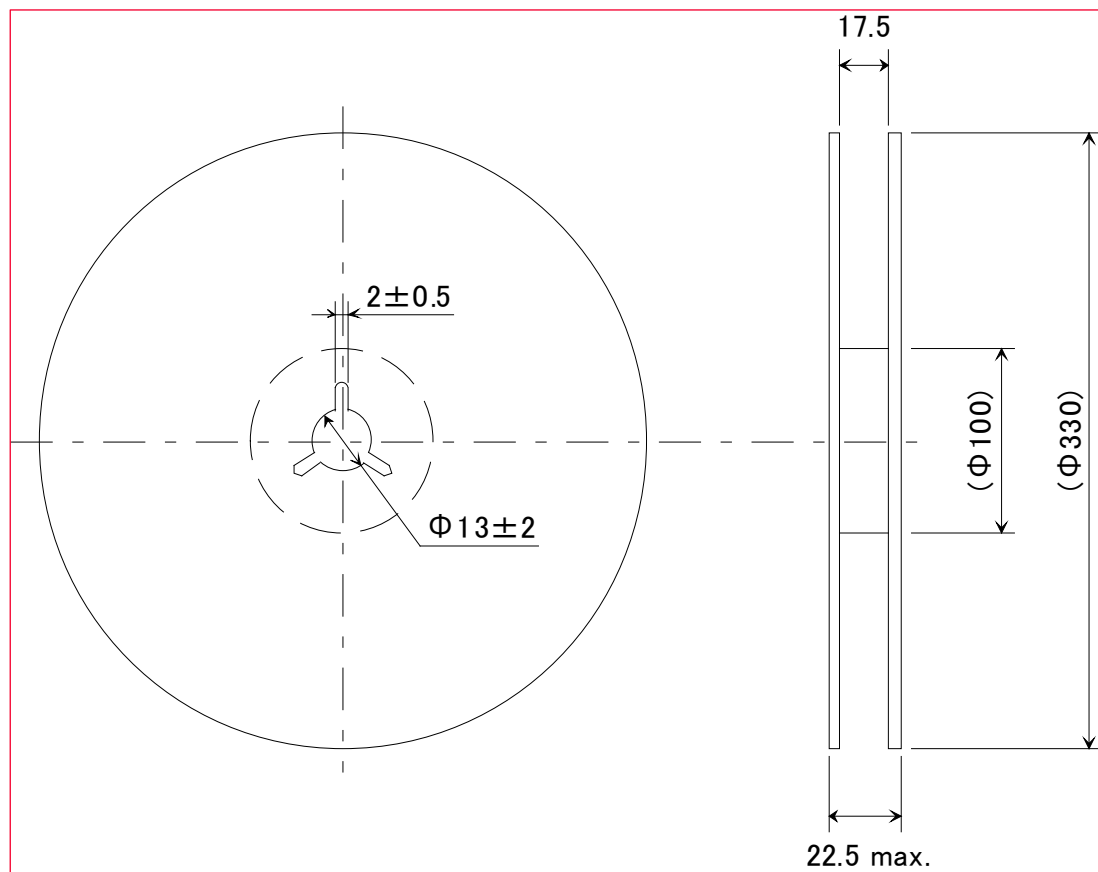


<sup>10</sup> Cumulative tolerance of max 40 +/-0.15 mm for every 10 pitches.

## 16.2 Dimension of Reel

Figure 29 shows the reel dimensions.

Figure 29: Dimensions of Reel (Unit: mm)



### 16.3 Taping Diagrams

Figure 30 and Figure 31 shows the tapings diagrams.

Figure 30: Taping Diagrams

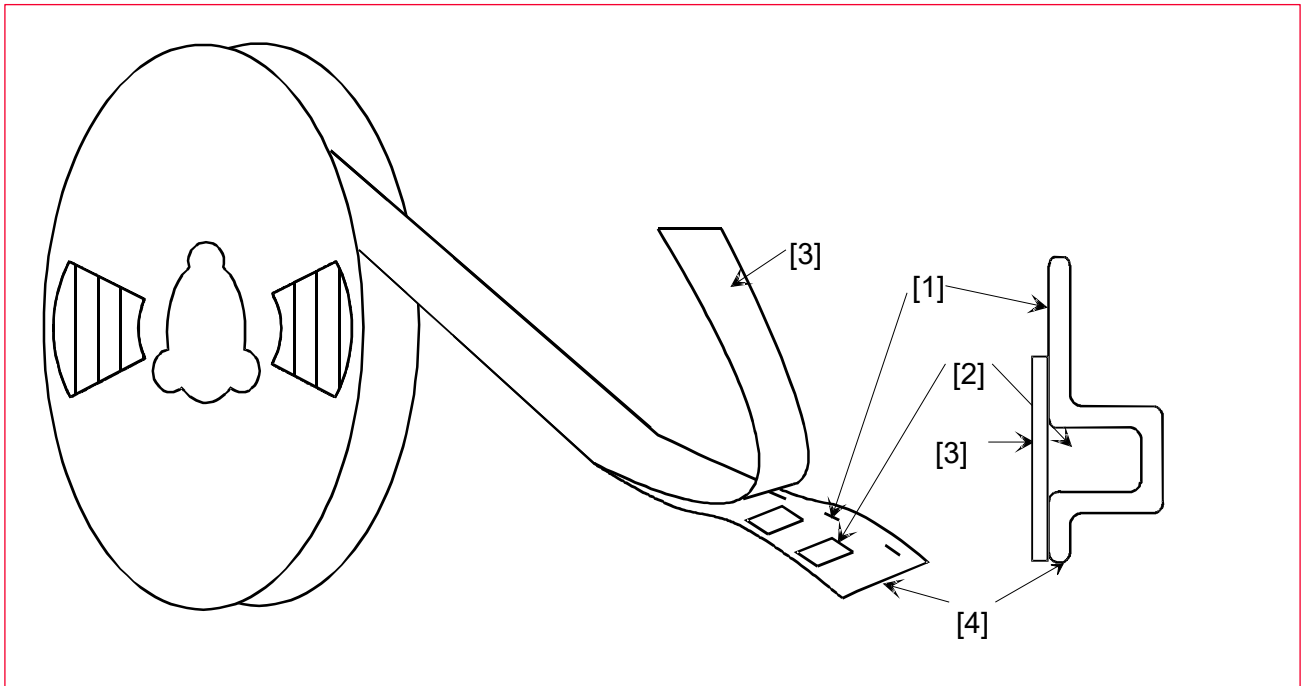
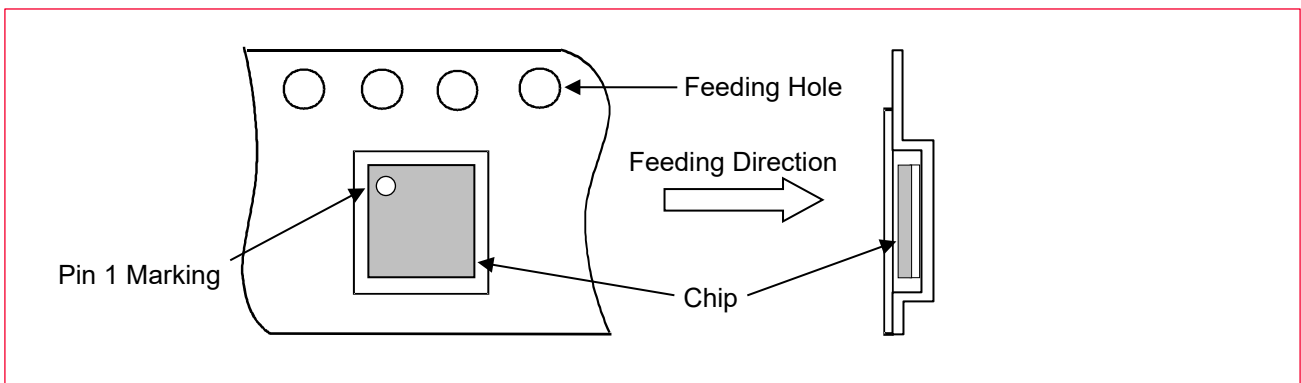


Table 75: Taping Specifications

Mark	Description
1	Feeding Hole. As specified in <a href="#">Dimensions of Tape (Plastic tape)</a> ☞.
2	Hole for chip. As specified in <a href="#">Dimensions of Tape (Plastic tape)</a> ☞.
3	Cover tape. 62 μm in thickness.
4	Base tape. As specified in <a href="#">Dimensions of Tape (Plastic tape)</a> ☞.

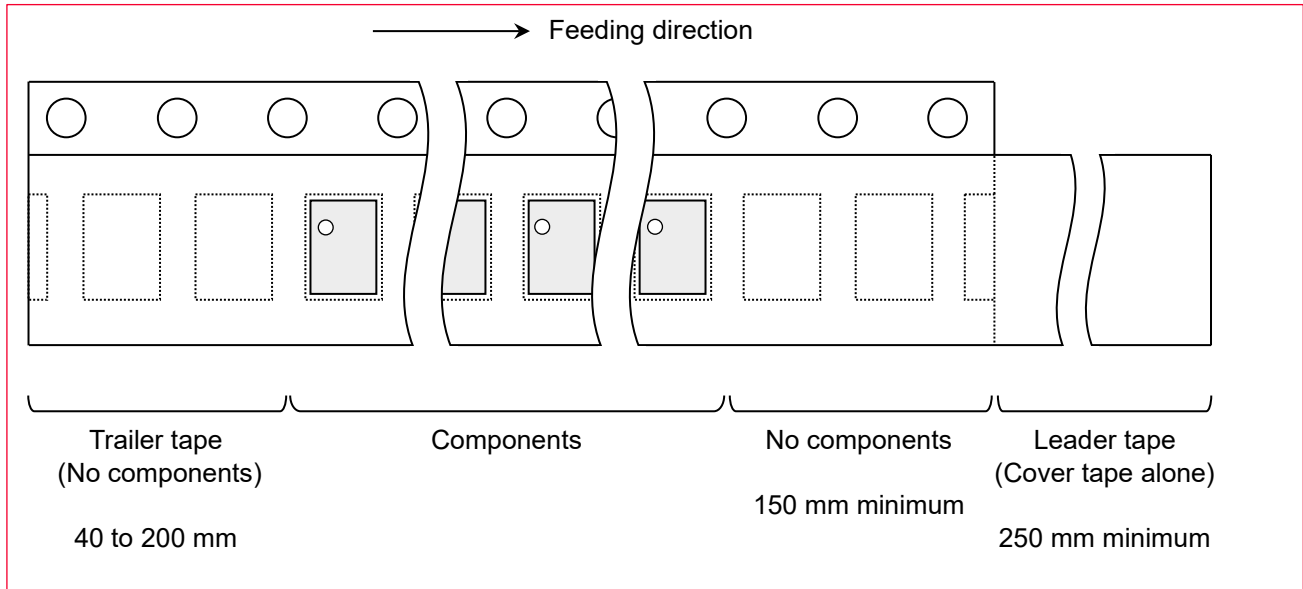
Figure 31: Taping Diagrams (Close Up)



## 16.4 Leader and Tail Tape

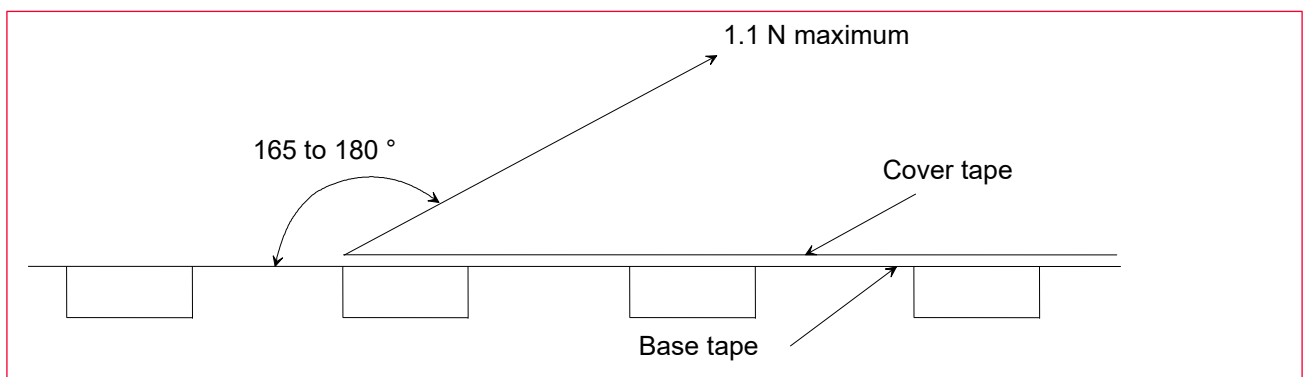
The leader and tail tape are shown in **Figure 32**.

**Figure 32: 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
- Tape 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 33**.

**Figure 33: Peeling Force**

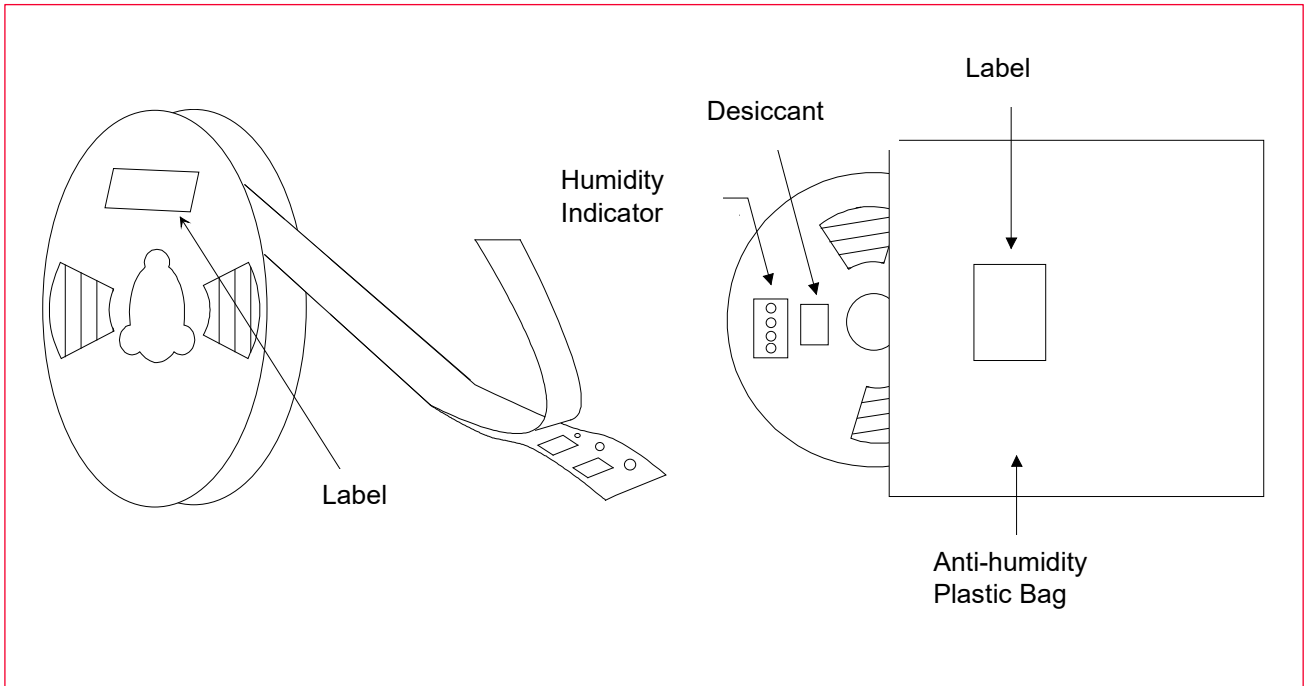




## 16.5 Packaging (Humidity Proof Packing)

Figure 34 shows the humidity proof Packaging.

Figure 34: 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 ~ 70 %RH (Packing materials may be deformed at the temperature over 40 °C).
- The product left more than 6 months after reception; the solderability needs to be confirmed before it is used.
- The product shall be stored in non-corrosive gas (Cl<sub>2</sub>, NH<sub>3</sub>, SO<sub>2</sub>, NO<sub>x</sub>, 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 IPC/JEDEC 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 material (Base Tape, Reel Tape and Cover Tape) is 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

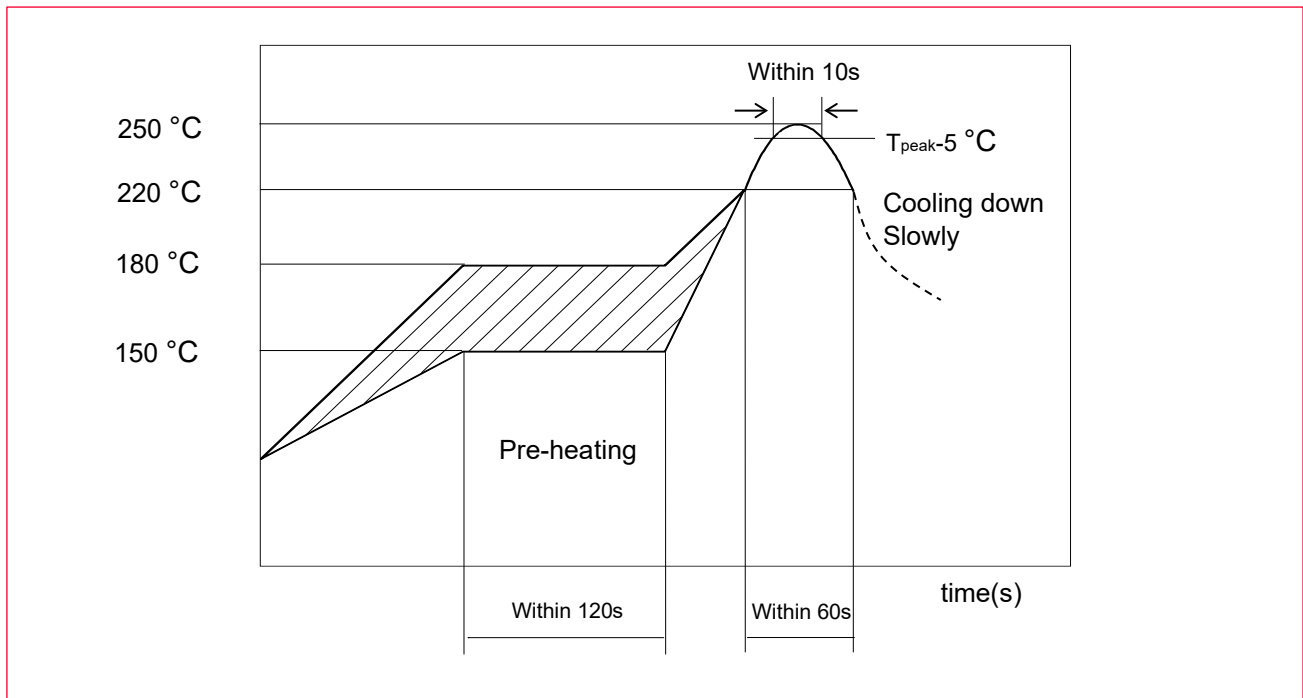
When placing products on the PCB, products may be stressed and broken by uneven forces from a worn-out chucking locating claw or a suction nozzle. To prevent products from damages, be sure to follow the specifications for the maintenance of the chip placer being used. For the positioning of products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

## 17.5 Soldering Conditions

The recommendation conditions of soldering are shown in **Figure 35**.

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 35: 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

This product is moisture sensitive; therefore, 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 (Cl<sub>2</sub>, NH<sub>3</sub>, SO<sub>x</sub>, NO<sub>x</sub> 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.

## 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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## Revision History

Revision Code	Date	Changed Item	Comment
	2021.02.04	First Issue	
A	2022.07.01	9.1 Operating Conditions 9.4. Package Thermal Conditions 7.2 Pin Descriptions 7.3. Configuration Pins  14. Reference Circuit Appendix	<ul style="list-style-type: none"> <li>Defined Ta and Tj.</li> <li>Added</li> <li>Corrected GPIO[0], Deleted JTAG</li> <li>Added Description for configuration pins</li> <li>Corrected typo (P.22 VBAT)</li> <li>Translated Japanese to English</li> <li>Corrected diagram C</li> </ul>
B	2022.09.06	2. Key Features 12. DC/RF Characteristics  12.7 DC/RF Characteristics for Bluetooth 12.8 DC/RF Characteristics for Bluetooth	<ul style="list-style-type: none"> <li>Added fit</li> <li>Corrected Wi-Fi 11a/b/g/n DC current Tx power</li> <li>Added test method</li> <li>Added test method</li> </ul>
C	2022.12.02	10. Power Sequence	<ul style="list-style-type: none"> <li>Added 10.2.2 host power off pin (PMIC_EN) usage</li> </ul>
D	2022.12.06	2. Key Features 6. Dimensions , Markings and Terminal Configuration 7.4 Pin States  14. Reference Circuit Appendix	<ul style="list-style-type: none"> <li>Updated information</li> <li>Added Identification mark</li> <li>Added comments on termination of open pins.</li> <li>Moved section to HW app note.</li> <li>Moved Appendix information into Sections 14 and 15.</li> <li>Moved antenna sections to HW app note.</li> </ul> <p>Updated to new format</p>



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