Datasheet

Type 1ZM Wi-Fi® + Bluetooth® Module

NXP 88W8987 Chipset for 802.11a/b/g/n/ac + Bluetooth 5.1
Datasheet - Rev. R

- Design Name: Type 1ZM
- P/N: LBEE5QD1ZM-572

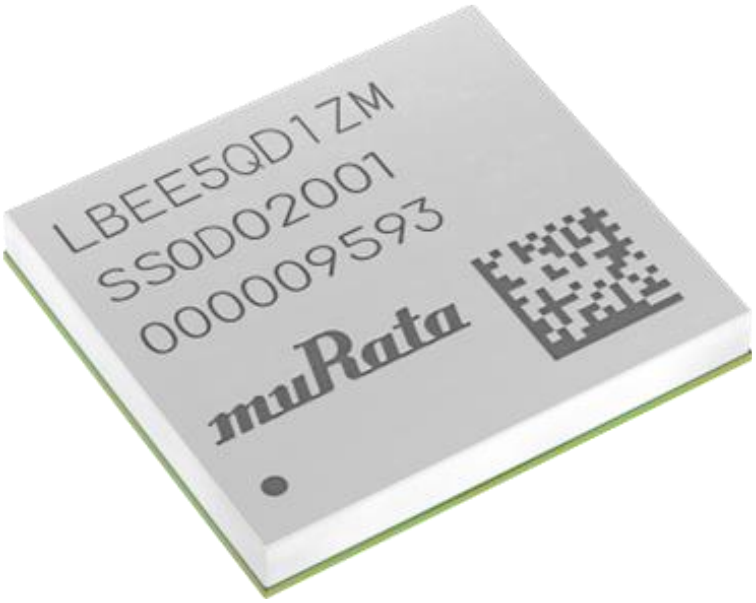


Table of Contents

1 Scope 8
2 Key Features 8
3 Ordering Information 8
4 Block Diagram 9
5 Certification Information 10
5.1 Radio Certification 10
5.2 Bluetooth Qualification 10
6 Dimensions, Marking and Terminal Configurations 11
7 Module Pin Descriptions 13
7.1 Pin Assignments 13
7.2 Pin Descriptions 14
7.3 Configuration Pins 17
7.4 Pin States 17
7.5 SDIO Pin Descriptions 19
8 Absolute Maximum Ratings 19
9 Operating Conditions 20
9.1 Operating Conditions 20
9.2 External Sleep Clock Requirements 20
9.3 PMIC_EN I/O Requirement 21
9.4 Digital I/O Requirements 21
9.5 Package Thermal Conditions 22
10 Power Sequence 22
10.1 Power-On Sequence 22
10.2 Power-Off Sequence 23
11 Interface Timing 24
11.1 SDIO Timing 24
11.1.1 Default Speed Mode 24
11.1.2 High Speed Mode 24
11.1.3 SDR12, SDR25, SDR50 Modes (up to 100 MHz) 25
11.1.4 SDR104 Mode (208 MHz) 26
11.1.5 DDR50 Mode (50 MHz) 27
11.2 High Speed UART Specifications 28
11.3 Bluetooth PCM Timing 28
11.3.1 Master Mode 29
11.3.2 Slave Mode 30

12 DC/RF Characteristics....31
12.1 DC/RF Characteristics for IEEE 802.11b - 2.4 GHz....31
12.1.1 High-Rate Condition for IEEE 802.11b - 2.4 GHz....32
12.1.2 Low-Rate Condition for IEEE 802.11b - 2.4 GHz....33
12.2 DC/RF Characteristics for IEEE 802.11g - 2.4 GHz....34
12.2.1 High-Rate Condition for IEEE 802.11g - 2.4 GHz....34
12.2.2 Low-Rate Condition for IEEE 802.11g - 2.4 GHz....35
12.3 DC/RF Characteristics for IEEE 802.11n - 2.4 GHz....36
12.3.1 High-Rate Condition for IEEE 802.11n - 2.4 GHz....36
12.3.2 Low-Rate Condition for IEEE 802.11n - 2.4 GHz....37
12.4 DC/RF Characteristics for IEEE 802.11a - 5 GHz....38
12.4.1 High-Rate Condition for IEEE 802.11a - 5 GHz....38
12.4.2 Low-Rate Condition for IEEE 802.11a - 5 GHz....39
12.5 DC/RF Characteristics for IEEE 802.11n (HT20) - 5 GHz....40
12.5.1 High-Rate Condition for IEEE 802.11n (HT20) - 5 GHz....40
12.5.2 Low-Rate Condition for IEEE 802.11n (HT20) - 5 GHz....41
12.6 DC/RF Characteristics for IEEE 802.11ac (HT20) - 5 GHz....42
12.6.1 High-Rate Condition for IEEE 802.11ac (VHT20) - 5 GHz....43
12.6.2 Low-Rate Condition for IEEE 802.11ac (VHT20) - 5 GHz....44
12.7 DC/RF Characteristics for IEEE 802.11n (HT40) - 5 GHz....45
12.7.1 High-Rate Condition for IEEE 802.11n (HT40) - 5 GHz....45
12.7.2 Low-Rate Condition for IEEE 802.11n (HT40) - 5 GHz....46
12.8 DC/RF Characteristics for IEEE 802.11ac (VHT40) - 5 GHz....47
12.8.1 High-Rate Condition for IEEE 802.11ac (VHT40) - 5 GHz....47
12.8.2 Low-Rate Condition for IEEE 802.11ac (VHT40) - 5 GHz....48
12.9 DC/RF Characteristics for IEEE 802.11ac (VHT80) - 5 GHz....49
12.9.1 High-Rate Condition for IEEE 802.11ac (VHT80) - 5 GHz....50
12.9.2 Low-Rate Condition for IEEE 802.11ac (VHT80) - 5 GHz....51
12.10 DC/RF Characteristics for Bluetooth....52
12.10.1 Basic Data Rate Condition....52
12.10.2 Enhanced Data Rate Condition....53
12.11 DC/RF Characteristics for Bluetooth Low Energy....54
12.11.1 1 Mbps PHY Condition....54
12.11.2 2 Mbps PHY Condition....55
13 Land Patterns....57
14 General for Radio Regulatory Certification for LBEE5QD1ZM....58
14.1 Application model part number....58

14.2 Label 58
14.3 Package Label 59
14.4 Country of Origin 60
15 Radio Regulatory Certification by Country for LBEE5QD1ZM 60
15.1 Japan 60
15.1.1 Power Levels for Japan 61
15.1.2 Antenna List 63
15.1.3 About Notations 63
15.2 FCC 64
15.2.1 Supply Voltage 64
15.2.2 Power Level for FCC 64
15.2.3 Theory of Operation for FCC 66
15.2.4 Information to Display in User Manual of Host Device 67
15.2.5 Compliance with FCC requirement 15.407(c) 67
15.2.6 Equipment Installation for FCC 68
15.3 ISED 69
15.3.1 Information to Display in Host Device and User Manual 69
15.3.2 Antenna Installation in End Product 70
15.3.3 Equipment Installation for ISED 70
15.3.4 Power Level for ISED 72
15.3.5 Theory of Operation for ISED 74
15.4 Europe 75
15.4.1 Power Level for Europe 75
15.4.2 Theory of Operation for Europe 77
16 Tape and Reel Packing 78
16.1 Dimensions of Tape (Plastic Tape) 78
16.2 Dimensions of Reel 79
16.3 Taping Diagrams 80
16.4 Leader and Tail Tape 81
16.5 Packaging (Humidity Proof Packing) 82
17 Notice 83
17.1 Storage Conditions 83
17.2 Handling Conditions 83
17.3 Standard PCB Design (Land Pattern and Dimensions) 83
17.4 Notice for Chip Placer 84
17.5 Soldering Conditions 84
17.6 Cleaning 84

17.7 Operational Environment Conditions 85
18 Preconditions to Use Our Products 86
Revision History 88

Figures

Figure 1: Block Diagram 9
Figure 2: Dimensions, Marking and Terminal Configurations 11
Figure 3: Structure 12
Figure 4: Pin Assignments - Top View 13
Figure 5: SDIO Pins 19
Figure 6: Package Thermal Conditions 22
Figure 7: Power-On Sequence Graph 22
Figure 8: Power-Off Sequence Graph 23
Figure 9: SDIO Protocol Timing Diagram - Default Speed Mode 24
Figure 10: SDIO Protocol Timing Diagram - High Speed Mode 24
Figure 11: SDIO Protocol Timing Diagram - SDR12, SDR25, SDR50 Mode 25
Figure 12: SDIO Protocol Timing Diagram - SDR104 Mode 26
Figure 13: SDIO CMD Timing Diagram - DDR50 Mode 27
Figure 14: SDIO DATA Timing Diagram - DDR50 Mode 27
Figure 15: High Speed UART Timing Diagram 28
Figure 16: Bluetooth Data Signal - Master Mode 29
Figure 17: Bluetooth PCM_SYNC signal - Master Mode 29
Figure 18: Bluetooth Data Signal - Slave Mode 30
Figure 19: Bluetooth PCM_SYNC signal - Slave Mode 30
Figure 20: Burst Current Definition 31
Figure 21: Land Patterns 57
Figure 22: Radio Regulatory Certification Label 58
Figure 23: Package (Humidity Proof Packing) 59
Figure 24: Package Label Display Example 59
Figure 25: Dimensions of Tape (Unit: mm) 78
Figure 26: Dimension of Reel (Unit: mm) 79
Figure 27: Taping Diagrams 80
Figure 28: Leader and Tail Tape 81
Figure 29: Peeling Off Force 82
Figure 30: Humidity Proof Packaging 82
Figure 31: Reflow soldering standard conditions (Example) 84

Tables

Table 1: Document Conventions 7
Table 2: Ordering Information 8
Table 3: Transmit Power Limit Files 10
Table 4: Markings 11
Table 5: Dimensions 12
Table 6: Terminal Configurations 13
Table 7: Pin Descriptions 14
Table 8: Configuration Pins 17
Table 9: I/O State Table 17
Table 10: SDIO Pin Descriptions 19
Table 11: Absolute Maximum Ratings 19
Table 12: Operating Conditions 20
Table 13: External Sleep Clock Requirements 20
Table 14: PMIC_EN IO Requirements 21
Table 15: Digital I/O Requirements 21
Table 16: Power-On Sequence Parameters 23
Table 17: Power-Off Sequence Parameters 23
Table 18: SDIO Protocol Timing Parameters - Default Speed, High-Speed Modes 25
Table 19: SDIO Protocol Timing Parameters - SDR12, SDR25, SDR50 Modes 25
Table 20: SDIO Protocol Timing Parameters - SDR104 Mode 26
Table 21: SDIO Protocol Timing Parameters - DDR50 Mode 27
Table 22: High Speed UART Timing Parameters 28
Table 23: Symbol Definition for Data Signal & PCM_SYNC Signal - Master Mode 29
Table 24: Symbol Definition for Data Signal & PCM_SYNC Signal - Slave Mode 30
Table 25: DC/RF Characteristics and Files 31
Table 26: Characteristics Values for IEEE 802.11b - 2.4 GHz 31
Table 27: High-Rate Condition for IEEE 802.11b - 2.4 GHz 32
Table 28: Low-Rate Condition for IEEE 802.11b - 2.4 GHz 33
Table 29: Characteristics values for IEEE 802.11g - 2.4 GHz 34
Table 30: High-Rate Condition for IEEE 802.11g - 2.4 GHz 34
Table 31: Low-Rate Condition for IEEE 802.11g - 2.4 GHz 35
Table 32: Characteristics values for IEEE 802.11n - 2.4 GHz 36
Table 33: High-Rate Condition for IEEE 802.11n - 2.4 GHz 36
Table 34: Low-Rate Condition for IEEE 802.11n - 2.4 GHz 37
Table 35: Characteristics Values for IEEE 802.11a - 5 GHz 38
Table 36: High-Rate Condition for IEEE 802.11a - 5 GHz 38
Table 37: Low-Rate Condition for IEEE 802.11a - 5 GHz 39
Table 38: Characteristics Values for IEEE 802.11n (HT20) - 5 GHz 40
Table 39: High-Rate Condition for IEEE 802.11n (HT20) - 5 GHz 40

Table 40: Low-Rate Condition for IEEE 802.11n (HT20) - 5 GHz....41
Table 41: Characteristics Values for IEEE 802.11ac (HT20) - 5 GHz....42
Table 42: High-Rate Condition for IEEE 802.11ac (VHT20) - 5 GHz....43
Table 43: Low-Rate Condition for IEEE 802.11ac (VHT20) - 5 GHz....44
Table 44: Characteristics Values for IEEE 802.11n (HT40) - 5 GHz....45
Table 45: High-Rate Condition for IEEE 802.11n (HT40) - 5 GHz....45
Table 46: Low-Rate Condition for IEEE 802.11n (HT40) - 5 GHz....46
Table 47: Characteristics Values for IEEE 802.11ac (VHT40) - 5 GHz....47
Table 48: High-Rate Condition for IEEE 802.11ac (VHT40) - 5 GHz....47
Table 49: Low-Rate Condition for IEEE 802.11ac (VHT40) - 5 GHz....48
Table 50: Characteristics Values for IEEE 802.11ac (VHT80) - 5 GHz....49
Table 51: High-Rate Condition for IEEE 802.11ac (VHT80) - 5 GHz....50
Table 52: Low-Rate Condition for IEEE 802.11ac (VHT80) - 5 GHz....51
Table 53: Characteristics Values for Bluetooth....52
Table 54: Basic Data Rate Condition....52
Table 55: Enhanced Data Rate Condition....53
Table 56: DC/RF Characteristics for Bluetooth Low Energy....54
Table 57: 1 Mbps PHY Condition....54
Table 58: 2 Mbps PHY Condition....55
Table 59: Japan Power Level 2.4 GHz WLAN Per Antenna Port....61
Table 60: Japan Power Level 2.4 GHz BT/BLE Per Antenna Port....61
Table 61: Japan Power Level 5 GHz WLAN Per Antenna Port (W52)....61
Table 62: Japan Power Level 5 GHz WLAN Per Antenna Port (W53)....62
Table 63: Japan Power Level 5 GHz WLAN Per Antenna Port (W56)....62
Table 64: Antenna Registered Under the Japan Radio Act....63
Table 65: Supply Voltage Values....64
Table 66: FCC Power Level 2.4 GHz WLAN Per Antenna Port....64
Table 67: FCC Power Level 2.4 GHz BT/BLE Per Antenna Port....65
Table 68: FCC Power Level 5 GHz WLAN Per Antenna Port....65
Table 69: FCC Theory of Operation for WLAN....66
Table 70: ISED Power Level 2.4 GHz WLAN Per Antenna Port....72
Table 71: ISED Power Level 2.4 GHz BT/BLE Per Antenna Port....72
Table 72: ISED Power Level 5 GHz WLAN Per Antenna Port....72
Table 73: ISED Theory Operation for WLAN....74
Table 74: Europe Power Level 2.4 GHz WLAN Per Antenna Port....75
Table 75: Europe Power Level 2.4 GHz BT/BLE Per Antenna Port....76
Table 76: Europe Power Level 5 GHz WLAN Per Antenna Port....76
Table 77: Europe Theory of Operation for WLAN....77
Table 78: Taping Specifications....80

About This Guide

Murata's Type 1ZM is a small and high-performance module based on NXP's 88W8987 combo chipset, supporting IEEE 802.11a/b/g/n/ac + Bluetooth 5.1 BR/EDR/LE. This datasheet describes Type 1ZM 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
	Warning Note Indicates very important note. Users are strongly recommended to review.
	Info Note Intended for informational purposes. Users should review.
	Menu Reference Indicates menu navigation instructions. **Example**: Insert➔Tables➔Quick Tables➔Save Selection to Gallery
	External Hyperlink This symbol indicates a hyperlink to an external document or website. **Example**: Embedded Artists AB Click on the text to open the external link.
	Internal Hyperlink This symbol indicates a hyperlink within the document. **Example**: Scope Click on the text to open the link.
`Console input/output or code snippet`	**Console I/O or Code Snippet** This text ***Style*** denotes console input/output or a code snippet.
`# Console I/O comment` `// Code snippet comment`	**Console I/O or Code Snippet Comment** This text ***Style*** denotes a console input/output or code snippet comment. • Console I/O comment (preceded by "#") is for informational purposes only and does not denote actual console input/output. • Code Snippet comment (preceded by "//") may exist in the original code.

1 Scope

This specification is applied to the IEEE 802.11a/b/g/n/ac + Bluetooth 5.1 BR/EDR/LE combo module.

2 Key Features

- NXP 88W8987 inside
- Supports IEEE 802.11a/b/g/n/ac specification: Dual band 2.4 GHz and 5 GHz
- SISO with 20 MHz, 40 MHz, and 80 MHz channels
- Up to MCS9 data rates (433 Mbps)
- Supports Bluetooth specification version 5.1
- For supported Bluetooth functions, refer to Bluetooth SIG site
- WLAN interface: SDIO 3.0
- Bluetooth interface: HCI UART, and PCM
- Temperature Range: - 30 °C to 85 °C
- Dimensions: 10.2 x 9.3 x 1.3 mm
- Weight: 318 mg
- MSL: 3
- Surface-mount type
- RoHS compliant
- Total Fit : 57

3 Ordering Information

Table 2: Ordering Information

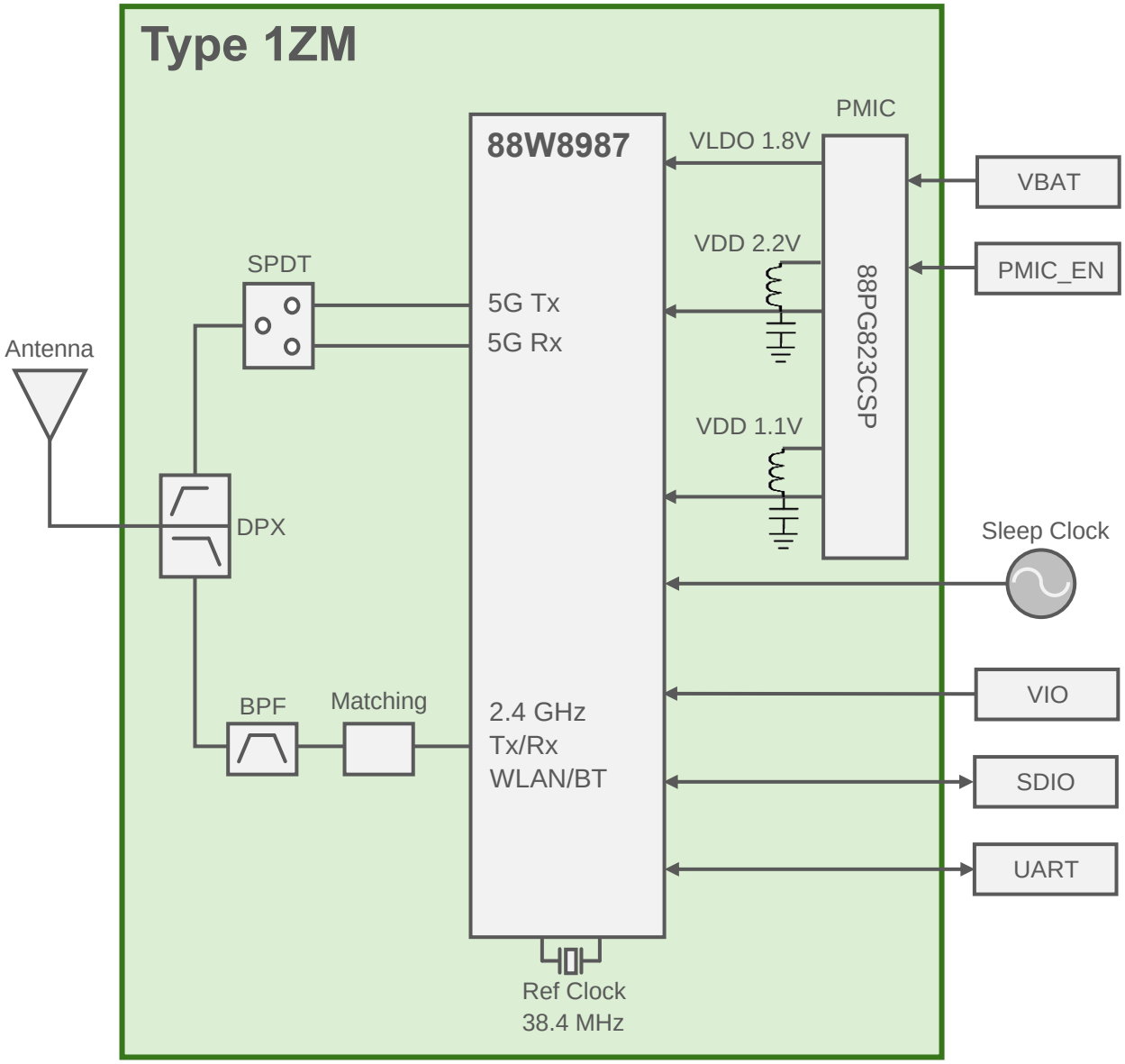
Ordering Part Number	Description
LBEE5QD1ZM-572	Module order
LBEE5QD1ZM-SMP	Sample module order (If module samples are not available through distribution, contact Murata referencing this part number)
EAR00364	Embedded Artists Type 1ZM M.2 EVB (default EVB available through distribution)
LBEE5QD1ZM-EVB	Murata Type 1ZM M.2 EVB (contact Murata as this is special order item)

"Type 1ZM" is design name of this module. Design name may be used in certification test report.

4 Block Diagram

Figure 1 shows the block diagram of Type 1ZM 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” The transmit power files are hosted at Murata GitHub for Linux and FreeRTOS. **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	
			Linux	FreeRTOS
USA (FCC)	VPYLB1ZM	US	txpower_US.bin	wlan_txpwrlimit_cfg_murata_1ZM_US.h
Canada (IC)	772C-LB1ZM	CA	txpower_CA.bin	wlan_txpwrlimit_cfg_murata_1ZM_CA.h
Europe	EN300328/301893, EN300440 conducted test report is prepared.	DE	txpower_EU.bin	wlan_txpwrlimit_cfg_murata_1ZM_EU.h
Japan	Japanese type certification is prepared. Ⓡ 001-P01598	JP	txpower_JP.bin	wlan_txpwrlimit_cfg_murata_1ZM_JP.h

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

5.2 Bluetooth Qualification

- QDID: 142383
- 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, Marking and Terminal Configurations

This section provides information about dimensions, markings, and terminal configuration for Type 1ZM.

Figure 2: Dimensions, Marking and Terminal Configurations

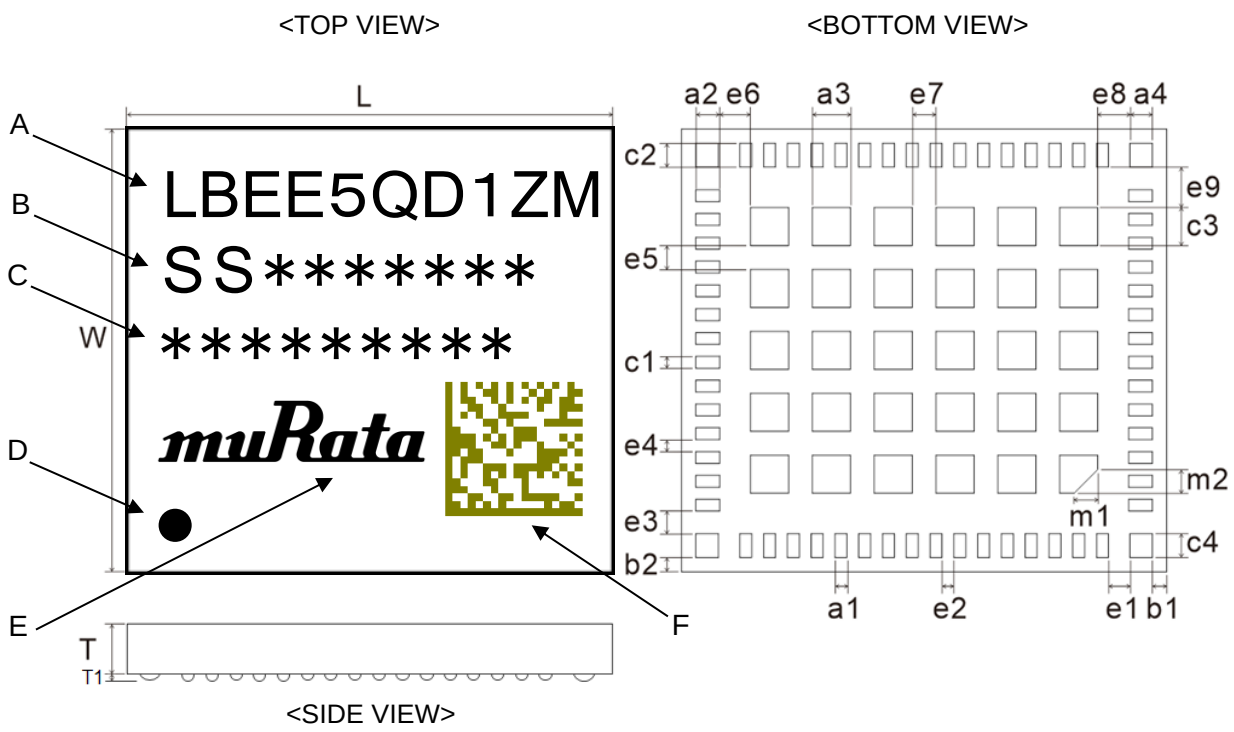


Table 4: Markings

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

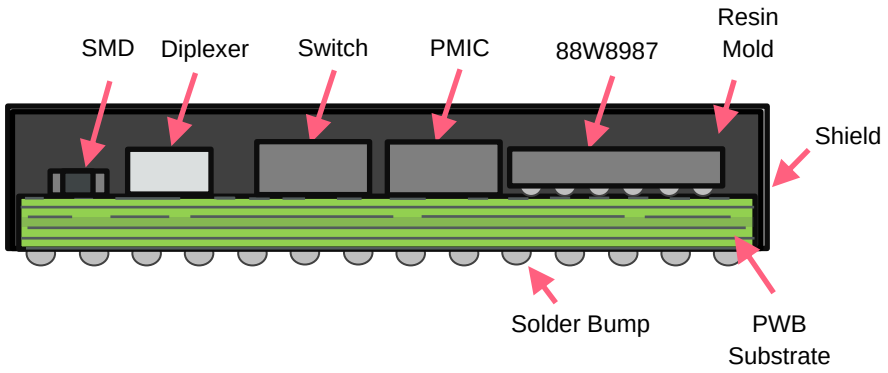
Table 5: Dimensions

Mark	Dimensions (mm)	Mark	Dimensions (mm)	Mark	Dimensions (mm)
L	10.2 +/- 0.2	W	9.3 +/- 0.2		
T	1.30 maximum	T1	0.045 typical		
a1	0.25 +/- 0.1	a2	0.5 +/- 0.1	a3	0.8 +/- 0.1
a4	0.475 +/- 0.1	b1	0.3 +/- 0.2	b2	0.3 +/- 0.2
c1	0.25 +/- 0.1	c2	0.5 +/- 0.1	c3	0.8 +/- 0.1
c4	0.5 +/- 0.1	e1	0.45 +/- 0.1	e2	0.25 +/- 0.1
e3	0.475 +/- 0.1	e4	0.25 +/- 0.1	e5	0.5 +/- 0.1
e6	0.65 +/- 0.1	e7	0.5 +/- 0.1	e8	0.65 +/- 0.1
e9	0.85 +/- 0.1	m1	0.5 +/- 0.1	m2	0.5 +/- 0.1

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

Figure 3 shows the structure for 1ZM module.

Figure 3: Structure



7 Module Pin Descriptions

This section has the pin descriptions of Type 1ZM and pin assignments layout descriptions.

7.1 Pin Assignments

Type 1ZM pin-assignment (top view) is presented in **Figure 4**.

Figure 4: Pin Assignments - Top View

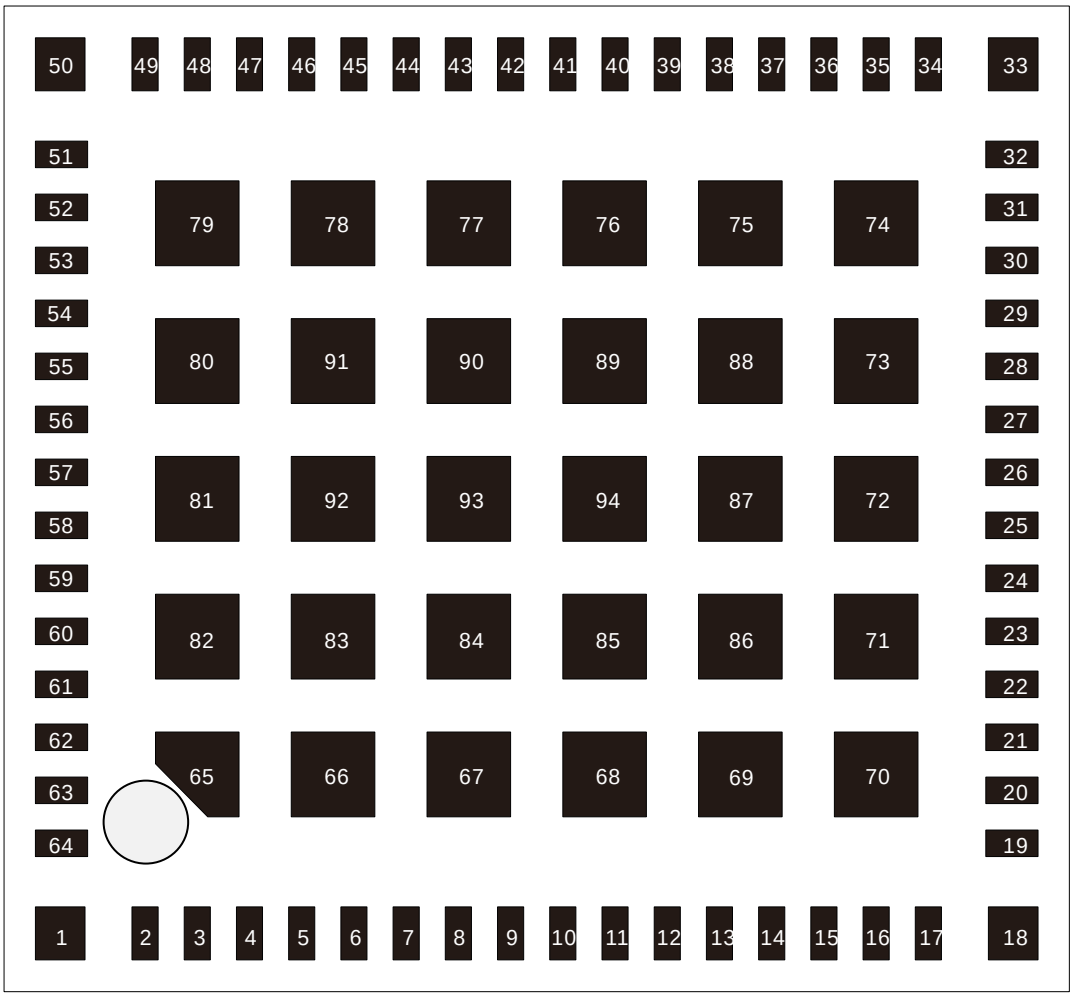


Table 6 illustrates the terminal configurations.

Table 6: Terminal Configurations

No	Pin name	No	Pin name	No	Pin name	No	Pin name
1	GND	18	GND	35	VBAT	52	GND
2	GND	19	GND	36	GND	53	SD_DAT2
3	GPIO19	20	RF	37	GND	54	SD_DAT3
4	GPIO18	21	GND	38	GPIO15	55	SD_DAT1
5	GPIO17	22	GND	39	GPIO14	56	SD_DAT0
6	GPIO16	23	CONFIG_AUTO_REF_DET	40	GPIO13	57	SD_CMD
7	GPIO7	24	GND	41	GPIO12	58	GND

No	Pin name	No	Pin name	No	Pin name	No	Pin name
8	GPIO0	25	GND	42	PMIC_EN	59	SD_CLK
9	GPIO6	26	GND	43	GND	60	GND
10	GPIO5	27	GPIO1	44	NC(PDn)	61	SLP_CLK_IN
11	GPIO4	28	GPIO2	45	GND	62	GND
12	CONFIG_HOST[0]	29	GPIO3	46	GPIO11	63	VIO
13	CONFIG_HOST[1]	30	GPIO20	47	GPIO10	64	GND
14	AVDD18	31	GND	48	GPIO9	65 ~ 94	GND
15	GND	32	GND	49	GPIO8		
16	GND	33	GND	50	GND		
17	GND	34	VBAT	51	GND		

7.2 Pin Descriptions

Table 7 lists the pin descriptions of Type 1ZM.

Table 7: Pin Descriptions

No.	Pin name	Type	Connection to IC pin name	Description
1	GND			Ground
2	GND			Ground
3	NC (GPIO19)	I/O	GPIO[19](88W8987) DVS1(PMIC)	NC
4	NC (GPIO18)	I/O	GPIO[18](88W8987) DVS0(PMIC)	NC
5	GPIO17	I/O	GPIO[17]	Programmable GPIO Pin
6	GPIO16	I/O	GPIO[16]	Programmable GPIO Pin
7	GPIO7 (BT_PCM_SYNC)	I/O	GPIO[7]	Programmable GPIO Pin
8	GPIO0	I/O	GPIO[0]	Programmable GPIO Pin
9	GPIO6 (BT_PCM_CLK)	I/O	GPIO[6]	Programmable GPIO Pin
10	GPIO5 (BT_PCM_DOUT)	I/O	GPIO[5]	Programmable GPIO Pin
11	GPIO4 (BT_PCM_DIN)	I/O	GPIO[4]	Programmable GPIO Pin
12	CONFIG_HOST[0]	I	CONFIG_HOST[0]	Firmware Boot Options
13	CONFIG_HOST[1]	I	CONFIG_HOST[1]	
14	AVDD18	O	AVDD18(88W8987) VLDO(PMIC)	LDO Output. Use for CONFIG_HOST pull-up.
15	GND			Ground
16	GND			Ground
17	GND			Ground
18	GND			Ground
19	GND			Ground

No.	Pin name	Type	Connection to IC pin name	Description
20	RF	I/O		WLAN/Bluetooth Antenna
21	GND			Ground
22	GND			Ground
23	CONFIG_AUTO_REF_DET	I	CONFIG_AUTO_REF_DET	Reference Clock Frequency Detection Select 0 = reference clock frequency detection by CONFIG_XOSC_SEL/GPIO8 1 = reference clock frequency detection using external sleep clock (Default/internal PU) (valid only when external sleep clock is used)
24	GND			Ground
25	GND			Ground
26	GND			Ground
27	GPIO1 (WLAN_WAKEUP_HOST)[1]	I/O	GPIO[1]	Programmable GPIO Pin WLAN to HOST wakeup.[2]
28	GPIO2	I/O	GPIO[2]	Programmable GPIO Pin
29	GPIO3	I/O	GPIO[3]	Programmable GPIO Pin
30	GPIO20 (BT_WAKEUP_HOST)[1]	I/O	GPIO[20]	Programmable GPIO Pin BT to HOST wakeup.[2]
31	GND			Ground
32	GND			Ground
33	GND			Ground
34	VBAT	I	PVIN(PMIC)	Power supply
35	VBAT	I	PVIN(PMIC)	Power supply
36	GND			Ground
37	GND			Ground
38	GPIO15	I/O	GPIO[15]	Programmable GPIO Pin. (JTAG_TMS)
39	GPIO14	I/O	GPIO[14]	Programmable GPIO Pin. (JTAG_TCK)
No.	Pin name	Type	Connection to IC Pin name	Description
40	GPIO13 (HOST_WAKEUP_WLAN)[1]	I/O	GPIO[13]	Programmable GPIO Pin HOST to WLAN wakeup.[2]
41	GPIO12 (HOST_WAKEUP_BT)[1]	I/O	GPIO[12]	Programmable GPIO Pin HOST to BT wakeup.[2]
42	PMIC_EN	I	EN(PMIC)	Enable build-in PMIC. Logic high enables internal regulators and internal hardware reset is de-asserted. Please input more than 1.2V for Logic High. Logic low disables regulators and internal hardware reset is asserted. Please input less than 0.4V for Logic low. **Do not float this pin**
43	GND			Ground

[1] NXP recommended GPIO. Check whether NXP software can support this function or not.
[2] Configurable by Software.

No.	Pin name	Type	Connection to IC pin name	Description
44	NC			
45	GND			Ground. (PDn)
46	GPIO11 (BT_UART_RTS)	I/O	GPIO[11]	Programmable GPIO Pin[2]
47	GPIO10 (BT_UART_CTS)	I/O	GPIO[10]	Programmable GPIO Pin[2]
48	GPIO9 (BT_UART_RXD)	I/O	GPIO[9]	Programmable GPIO Pin[2]
49	GPIO8 (BT_UART_TXD)	I/O	GPIO[8]	Reference Clock Frequency Select Low when CONFIG_AUTO_REF_DET = 0 NC when CONFIG_AUTO_REF_DET = 1[2]
50	GND			Ground
51	GND			Ground
52	GND			Ground
53	SD_DAT2	I/O	SD_DAT[2]	SDIO Data line Bit[2]
54	SD_DAT3	I/O	SD_DAT[3]	SDIO Data line Bit[3]
55	SD_DAT1	I/O	SD_DAT[1]	SDIO Data line Bit[1]
56	SD_DAT0	I/O	SD_DAT[0]	SDIO Data line Bit[0]
57	SD_CMD	I/O	SD_CMD	SDIO Command/response
58	GND			Ground
59	SD_CLK	I	SD_CLK	SDIO Clock input
60	GND			Ground
61	SLP_CLK_IN	I	SLP_CLK_IN	Sleep Clock input
62	GND			Ground
63	VIO	I	VIO VIO_RF VIO_SD	Power supply
64	GND			Ground
65~94	GND			Ground

() of “pin name” is BSP configuration of NXP iMX8.

7.3 Configuration Pins

The pin configurations of Type 1ZM module is shown in **Table 8**.

Table 8: Configuration Pins

CONFIG_HOST[0]	CONFIG_HOST[1]	WLAN	Bluetooth	Remarks
1	1	SDIO	SDIO	May not be supported in software. Contact Murata.
0	1	SDIO	UART	Murata Default

AVDD18 output can be used to pull-up CONFIG_HOST pins.

7.4 Pin States

Pin state information for the **Table 9** 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 9: I/O State Table

Pin Name	Supply	No Pad Power State	Reset State	HW State[3]	PD State[4]	PD Prog[5]	Internal PU/PD	Int'l Pull Value[Ω][6]
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	drive high[7]	tristate	yes	weak PU	800K
GPIO3	VIO	tristate	input	drive high[7]	tristate	yes	weak PU	800K
GPIO4	VIO	tristate	input	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

[3] Hardware default state after reset
[4] Power-down state
[5] Power-down state programmable
[6] Calculate appropriate external pull values with internal pull value
[7] The signal may toggle while boot code is executing

Pin Name	Supply	No Pad Power State	Reset State	HW State[3]	PD State[4]	PD Prog[5]	Internal PU/PD	Int'l Pull Value[Ω][6]
GPIO8	VIO	tristate	input	Input[8] output[9]	drive low	yes	weak PU	800K
GPIO9	VIO	tristate	input	input	tristate	yes	nominal PU	90K
GPIO10	VIO	tristate	input	input	tristate	yes	nominal PU	90K
GPIO11	VIO	tristate	input	input[8] output[9]	drive high	yes	weak PU	800K
GPIO12	VIO	tristate	input	input	tristate	yes	nominal PD	90K
GPIO13	VIO	tristate	input	input[8] output[9]	drive high	yes	nominal PU	90K
GPIO14	VIO	tristate	input	input	tristate	yes	nominal PU	90K
GPIO15	VIO	tristate	input	input	drive high	yes	nominal PU	90K
GPIO16	VIO	tristate	input	input	tristate	yes	nominal PD	90K
GPIO17	VIO	tristate	input	input	tristate	yes	weak PU	800K
GPIO18	VIO	tristate	output	drive high	tristate	yes	weak PU	800K
GPIO19	VIO	tristate	output	drive high	tristate	yes	weak PU	800K
GPIO20	VIO	tristate	output	drive high[7]	tristate	yes	weak PU	800K
SD_CLK	VIO	tristate	input	input	tristate	no	nominal PU	90K
SD_CMD	VIO	tristate	input	input	tristate	no	nominal PU	90K
SD_D0	VIO	tristate	input	input	tristate	no	nominal PU	90K
SD_D1	VIO	tristate	input	input	tristate	no	nominal PU	90K
SD_D2	VIO	tristate	input	input	tristate	no	nominal PU	90K
SD_D3	VIO	tristate	input	input	tristate	no	nominal PU	90K
CONFIG_HOST[0]	AVDD18	tristate	input	input	tristate	no	weak PU	800K
CONFIG_HOST[1]	AVDD18	tristate	input	input	tristate	no	weak PU	800K
CONFIG_AUTO_REF_DET	AVDD18	tristate	input	input	tristate	no	weak PU	800K
SLP_CLK_IN	VIO	tristate	Input[10]	input	tristate	no	nominal PU	90K

- Not all GPIO pins can be used for Host-to-SoC wakeup signals.
- Maximum input voltage is 0.4V when VIO has no power (or in uncertain situations).

[8] When the device is in SDIO-SDIO mode
[9] When the device is in SDIO-UART mode
[10] Input mode after reset

7.5 SDIO Pin Descriptions

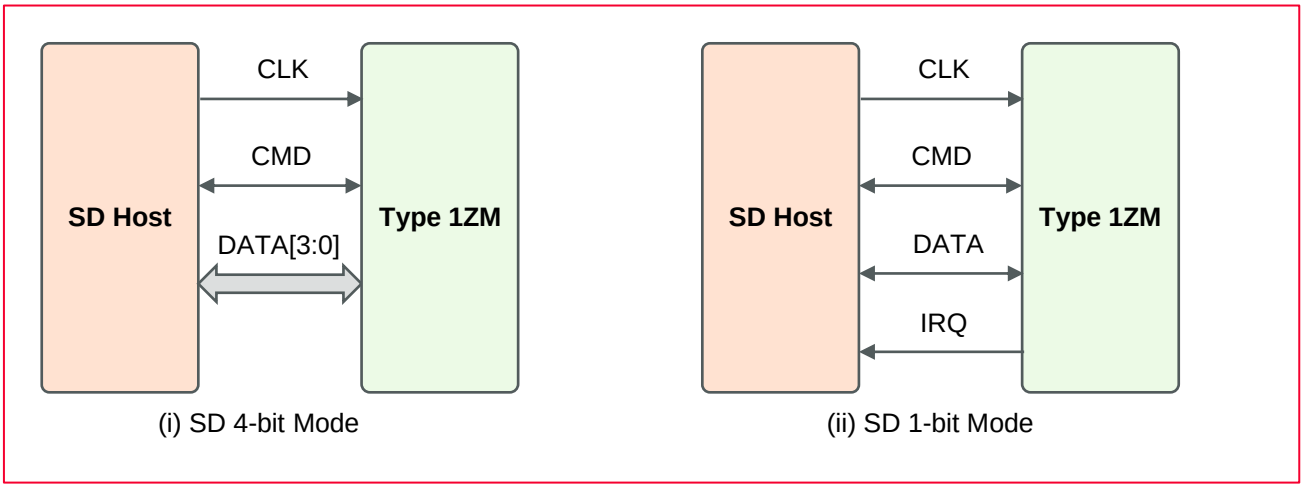
The SDIO pin descriptions of Type 1ZM module is shown in **Table 10**.

Table 10: SDIO Pin Descriptions

No.	Pin Name	(i) SD 4-bit Mode		(ii) SD 1-bit Mode	
59	SDIO_CLK	CLK	Clock	CLK	Clock
56	SDIO_D0	DATA0	Data line 0	DATA	Data line
55	SDIO_D1	DATA1	Data line 1 /Interrupt	IRQ	Interrupt
53	SDIO_D2	DATA2	Data line 2	NC	Not used
54	SDIO_D3	DATA3	Data line 3	NC	Not used
57	SDIO_CMD	CMD	Command line	CMD	Command line

Figure 5 shows the SDIO pin diagram for Type 1ZM module.

Figure 5: SDIO Pins



8 Absolute Maximum Ratings

Table 11 shows the absolute maximum ratings of Type 1ZM.

Table 11: Absolute Maximum Ratings

Parameter		Minimum	Maximum	Unit
Storage Temperature		-40	+85	°C
Supply Voltage	VBAT	-0.3	6.0	V
	VIO	-0.3	2.2	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 12**.

Table 12: Operating Conditions

Parameter		Minimum	Typical	Maximum	Unit
Operating Temperature		-30	25	+85	°C
Supply Voltage	VBAT	2.7		5.5	V
	VIO	1.62	1.8	1.92	V
IO Current	VIO		0.1	0.5	mA
Peak Current	VBAT		770	950	mA

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

9.2 External Sleep Clock Requirements

Table 13 shows the external sleep clock requirements of Type 1ZM.

Table 13: External Sleep Clock Requirements

Symbol	Parameter	Minimum	Typical	Maximum	Unit
CLK	Clock frequency range/accuracy CMOS input clock signal type ±250 ppm (initial, aging, temperature)		32.768		kHz
V_{IH}	Input levels, where VIO=1.8V	0.7 * VIO		VIO + 0.4	V
V_{IL}		-0.4		0.3 * VIO	V
PN	Phase Noise Requirement (@ 100 kHz)		-125		dBc/Hz
J_C	Cycle jitter		1.5		ns (RMS)
SR	Slew rate limit (10-90%)			100	ns
DC	Duty cycle tolerance	20		80	%

Voltage input level = 1.8V

9.3 PMIC_EN I/O Requirement

Table 14: PMIC_EN IO Requirements shows the PMIC_EN I/O requirements of Type1ZM.

Table 14: PMIC_EN IO Requirements

Symbol	Parameter	Minimum	Maximum	Unit
$V_{PMIC_EN_IH}$	Input high voltage	1.2		V
$V_{PMIC_EN_IL}$	Input low voltage		0.4	V

9.4 Digital I/O Requirements

Table 15 shows the digital I/O requirements of Type 1ZM.

Table 15: Digital I/O Requirements

Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
V_{IH}	Input high voltage		0.7 * VIO		VIO + 0.4	V
V_{IL}	Input low voltage		-0.4		0.3 * VIO	V
V_{HYS}	Input hysteresis		100			mV
V_{OH}	Output high voltage		VIO - 0.4			V
V_{OL}	Output low voltage				0.4	V

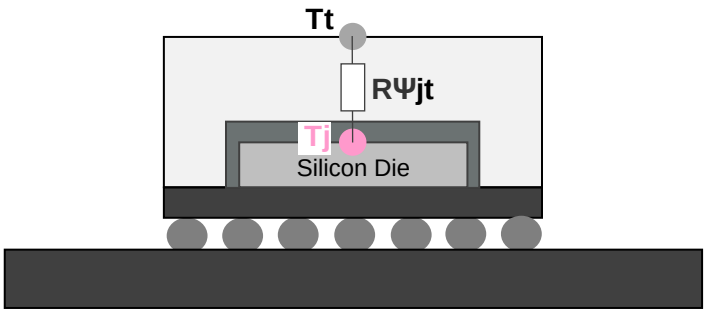
9.5 Package Thermal Conditions

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

- RΨjt: 2.76 °C/W
- RΨjt = (Tj - Tt)/P

Tj: Junction temperature (℃), Tt: Top temperature (℃), 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).
- Ramp-up time of VIO must be < 100 ms.

Figure 7: Power-On Sequence Graph

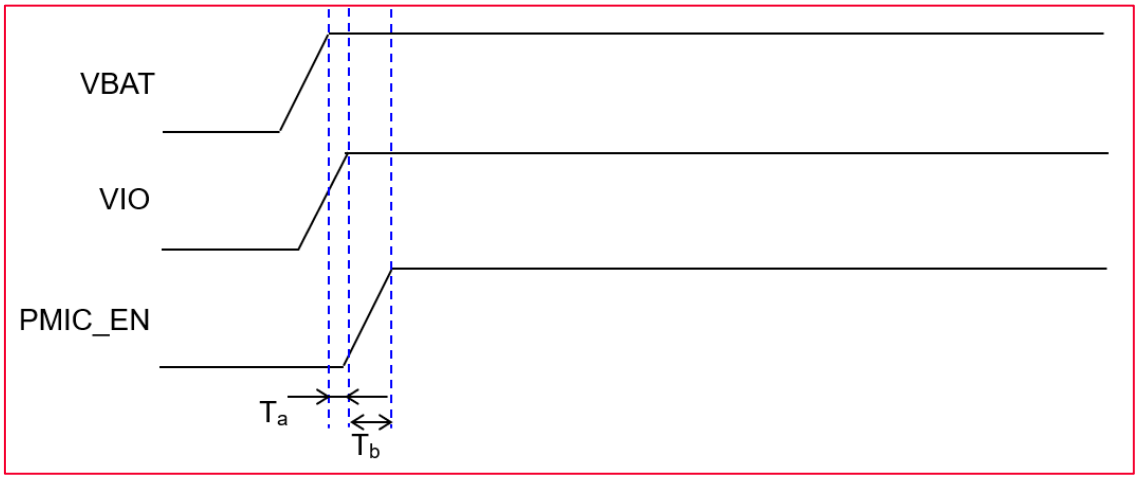


Table 16: Power-On Sequence Parameters

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

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

Figure 8: Power-Off Sequence Graph

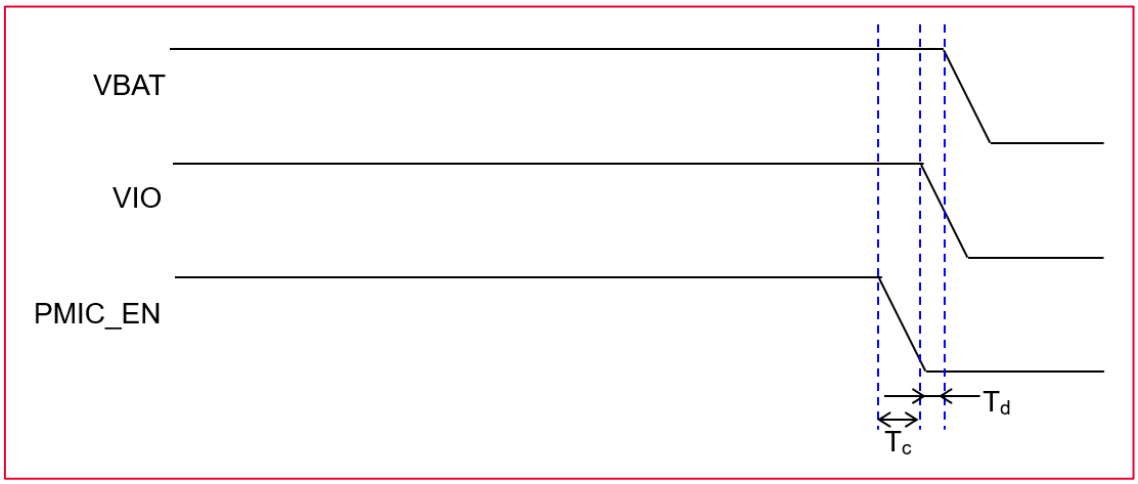


Table 17: Power-Off Sequence Parameters

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

11 Interface Timing

This section describes the interface timings; SDIO and UART timings and their speed modes, related parameters, and graphs.

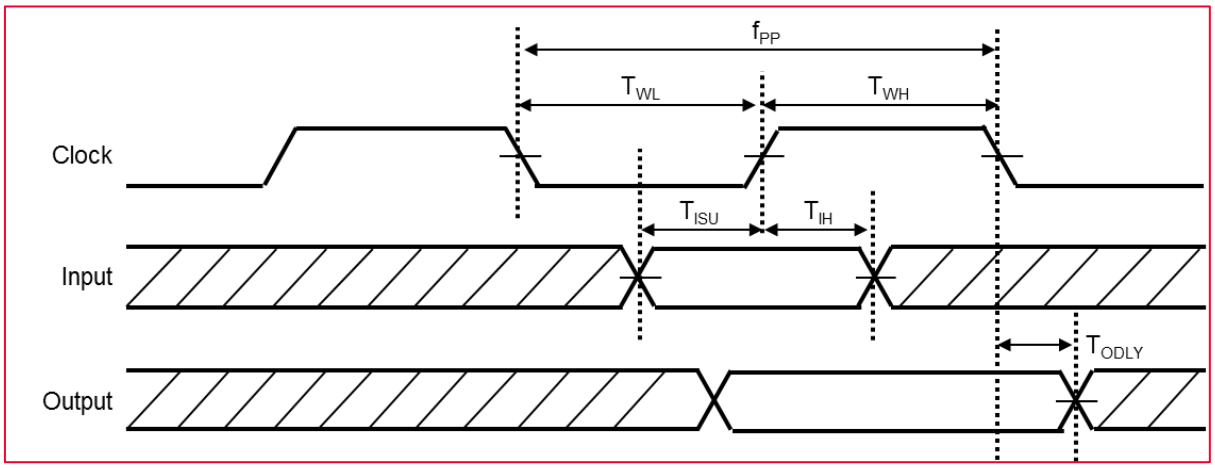
11.1 SDIO Timing

This section describes the SDIO timing for different modes.

11.1.1 Default Speed Mode

The default speed mode is shown in **Figure 9**.

Figure 9: SDIO Protocol Timing Diagram - Default Speed Mode



11.1.2 High Speed Mode

The high-speed mode is shown in **Figure 10**.

Figure 10: SDIO Protocol Timing Diagram - High Speed Mode

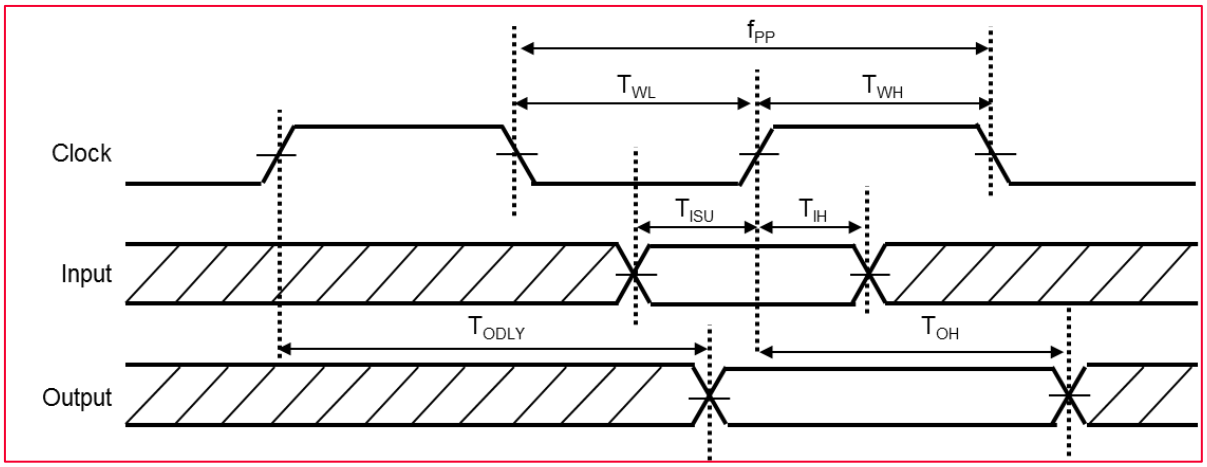


Table 18: SDIO Protocol Timing Parameters - Default Speed, High-Speed Modes

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
		High-speed	7			ns
T_{HW}	Clock high time	Normal	10			ns
		High-speed	7			ns
T_{ISU}	Input setup time	Normal	5			ns
		High-speed	6			ns
T_{IH}	Input hold time	Normal	5			ns
		High-speed	2			ns
T_{OLDY}	Output delay time	Normal			14	ns
	CL ≤ 40 pF (1 card)	High-speed			14	ns
T_{OH}	Output hold time	High-speed	2.5			ns

11.1.3 SDR12, SDR25, SDR50 Modes (up to 100 MHz)

The SDIO protocol timing diagram for SDR12, SDR25, SDR50 modes are shown in **Figure 11**.

Figure 11: SDIO Protocol Timing Diagram - SDR12, SDR25, SDR50 Mode

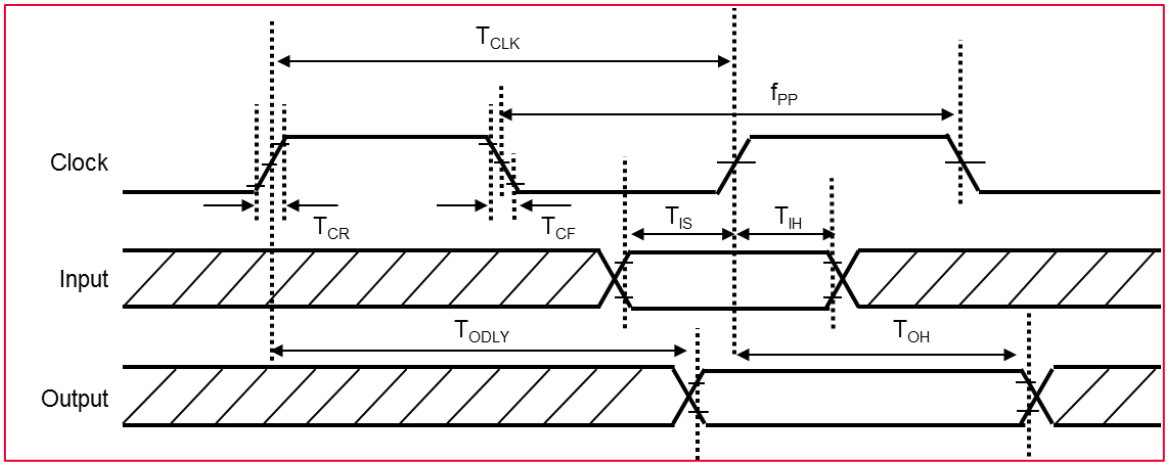


Table 19: SDIO Protocol Timing Parameters - SDR12, SDR25, SDR50 Modes

Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
f_{PP}	Clock frequency	SDR12/25/50	25		100	MHz
T_{IS}	Input Setup time	SDR12/25/50	3			ns
T_{IH}	Input hold time	SDR12/25/50	0.8			ns
T_{CLK}	Clock time	SDR12/25/50	10		40	ns

Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
T_{CR}, T_{CF}	Rise time, fall time	SDR12/25/50			0.2*T_{CLK}	ns
T_{ODLY}	Output delay time T_{CR}, T_{CF} < 2 ns (maximum) at 100 MHz C_{CARD} = 10 pF	SDR12/25/50			7.5	ns
T_{OH}	Output hold time	SDR12/25/50	1.5			ns

11.1.4 SDR104 Mode (208 MHz)

Figure 12 shows the SDIO protocol timing diagram SDR104 Mode (208 MHz).

Figure 12: SDIO Protocol Timing Diagram - SDR104 Mode

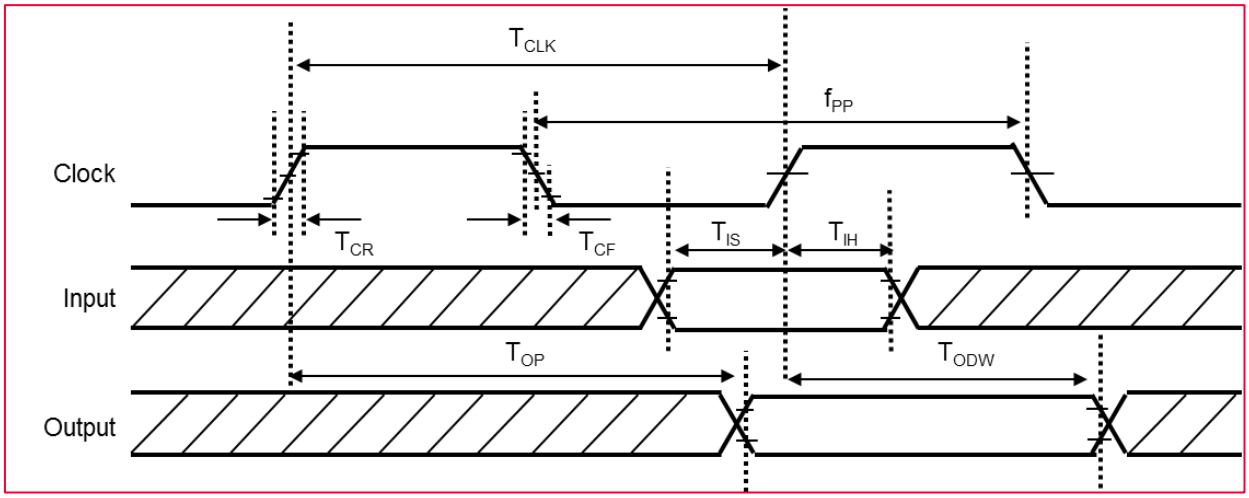


Table 20: SDIO Protocol Timing Parameters - SDR104 Mode

Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
f_{PP}	Clock frequency	SDR104	0		208	MHz
T_{IS}	Input Setup time	SDR104	1.4			ns
T_{IH}	Input hold time	SDR104	0.8			ns
T_{CLK}	Clock time	SDR104	4.8			ns
T_{CR}, T_{CF}	Rise time, fall time T_{CR}, T_{CF}<0.96 ns(maximum) at 208 MHz C_{CARD} = 10 pF	SDR104			0.2*T_{CLK}	ns
T_{OP}	Card output phase	SDR104	0		10	ns
T_{ODW}	Output timing of variable data window	SDR104	2.88			ns

11.1.5 DDR50 Mode (50 MHz)

Figure 13 shows the SDIO CMD timing diagram and **Figure 14** shows the SDIO DATA timing diagram for DDR50 Mode (50 MHz).

Figure 13: SDIO CMD Timing Diagram - DDR50 Mode

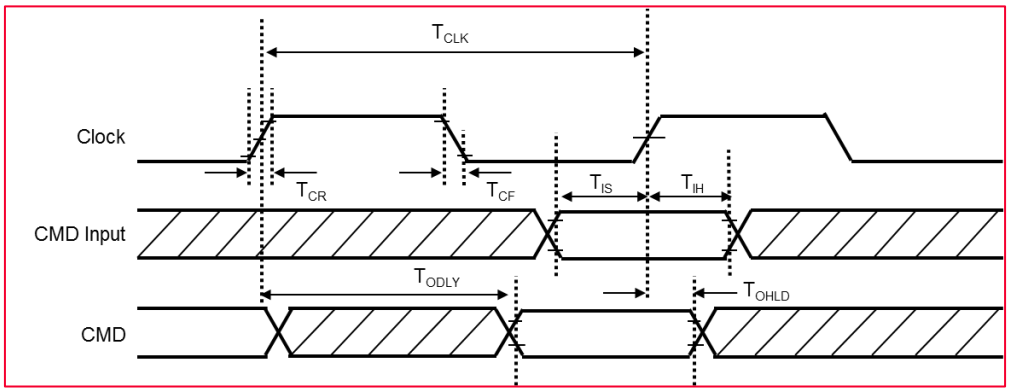


Figure 14: SDIO DATA Timing Diagram - DDR50 Mode

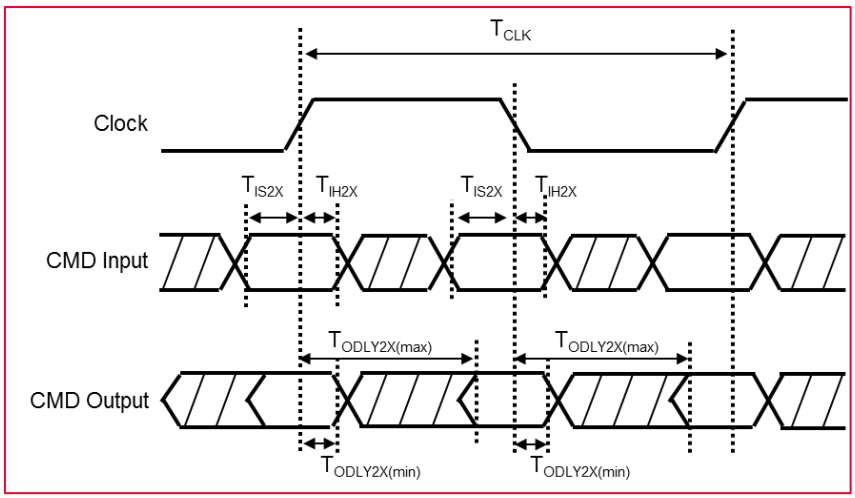


Table 21: SDIO Protocol Timing Parameters - DDR50 Mode

Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
Clock						
T_{CLK}	Clock time 50 MHz (maximum) between rising edge	DDR50	20			MHz
T_{CR}, T_{CF}	Rise time, fall time T_{CR}, T_{CF} < 4.00 ns (maximum) at 50 MHz C_{CARD} = 10 pF	DDR50			0.2 * T_{CLK}	ns
Clock Duty	-	DDR50	45		55	%
CMD input (referenced to clock rising edge)						
T_{IS}	Input Setup time	DDR50	6			ns
T_{IH}	Input hold time	DDR50	0.8			ns

Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
CMD Output (referenced to clock rising edge)						
T_{ODLY}	Output delay time during data transfer mode $C_L \leq 30$ F(1 card)	DDR50			13.7	ns
T_{OHLD}	Output hold time $C_L \geq 15$ F(1 card)	DDR50	1.5			ns
DAT[3:0] Input (referenced to clock rising and falling edges)						
T_{IS2x}	Input setup time $C_{CARD} \leq 10$ pF (1 card)	DDR50	3			ns
T_{IH2x}	Input hold time $C_{CARD} \leq 10$ pF (1 card)	DDR50	0.8			ns
DAT[3:0] Output (referenced to clock rising and falling edges)						
$T_{ODLY2x\ (max)}$	Output delay time during data transfer mode $C_L \leq 25$ pF (1 card)	DDR50			7.0	ns
$T_{ODLY2x\ (min)}$	Output hold time $C_L \geq 15$ pF (1 card)	DDR50	1.5			ns

11.2 High Speed UART Specifications

The default baud rate is 115200 bps. Baud rate is configurable by the host stack.

Figure 15: High Speed UART Timing Diagram

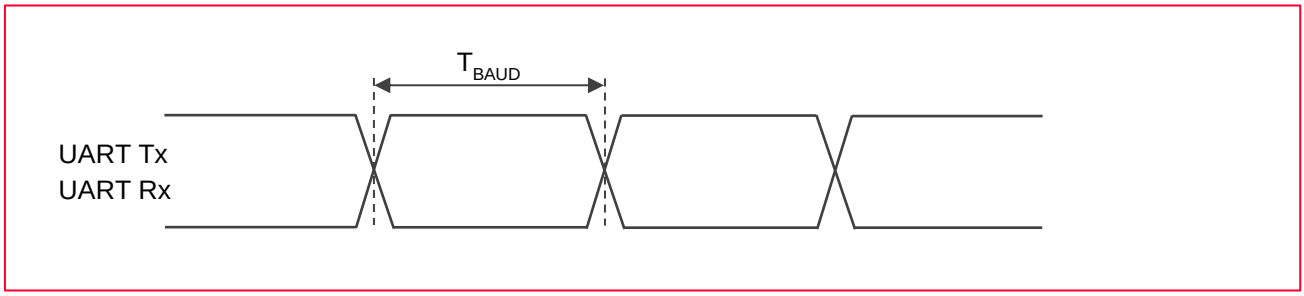


Table 22: High Speed UART Timing Parameters

Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
T_{BAUD}	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 PCM timings: PCM_Sync signal - Master mode, PCM_Sync signal - Slave mode along with their data signals and parameters.

11.3.1 Master Mode

Figure 16 and **Figure 17** shows the timing diagram of master mode for data and PCM_SYNC signals.

Figure 16: Bluetooth Data Signal - Master Mode

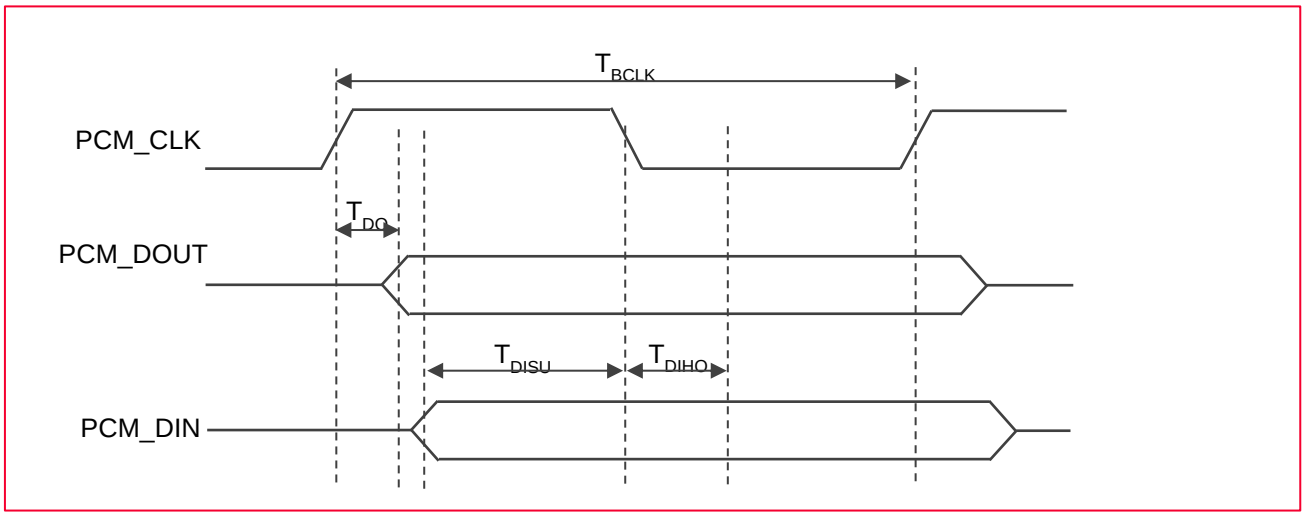


Figure 17: Bluetooth PCM_SYNC signal - Master Mode

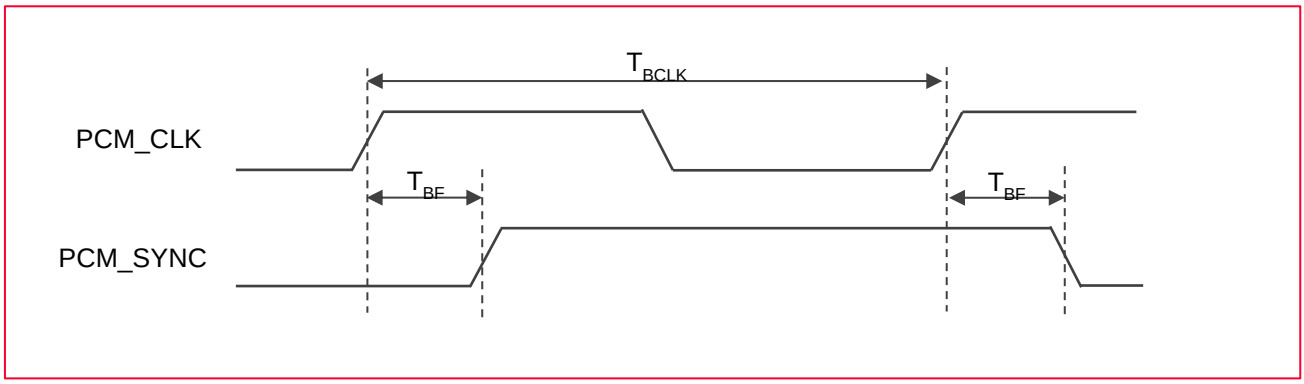


Table 23 lists information about the data and PCM_SYNC signals in master mode.

Table 23: Symbol Definition for Data Signal & PCM_SYNC Signal - Master Mode

Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
T_{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
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

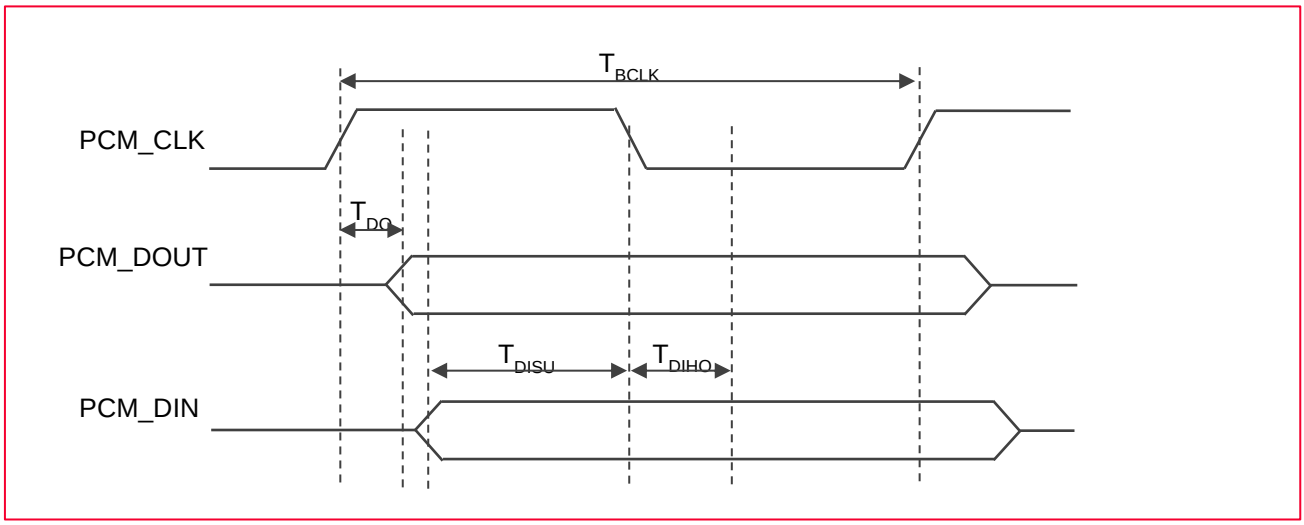


Figure 19: Bluetooth PCM_SYNC signal - Slave Mode

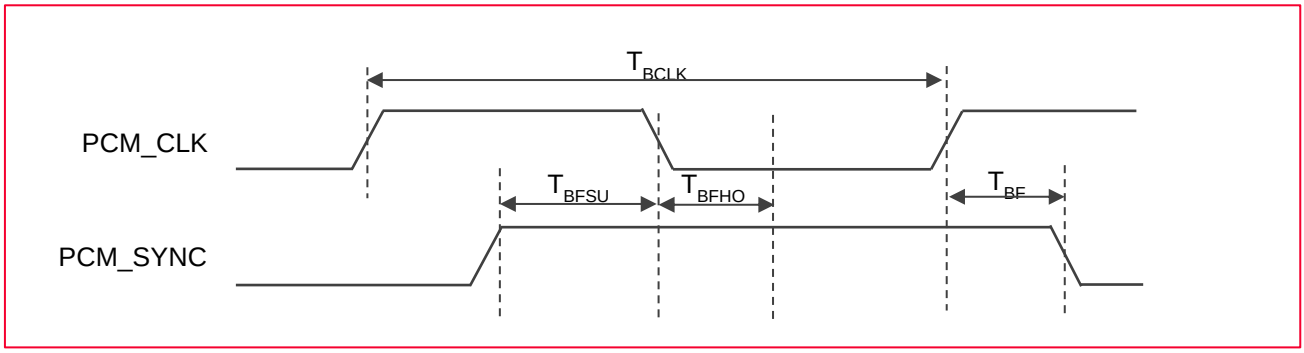


Table 24: Symbol Definition for Data Signal & PCM_SYNC Signal - Slave Mode

Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
T_{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				30	ns
T_{DISU}	Setup time for PCM_DIN before PCM_CLK falling edge		15			ns
T_{DIHO}	Hold time for PCM_DIN after PCM_CLK falling edge		10			ns
T_{BFSU}	Setup time for PCM_SYNC before PCM_CLK falling edge		15			ns
T_{BFHO}	Hold time for PCM_SYNC after PCM_CLK falling edge		10			ns

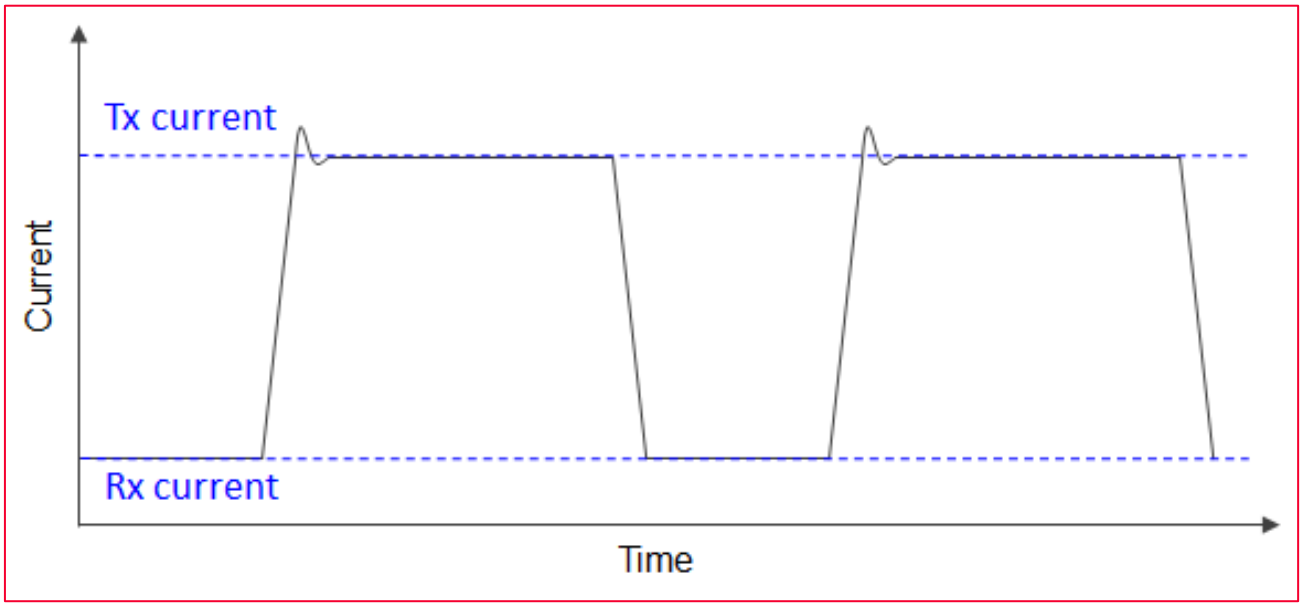
12 DC/RF Characteristics

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 1ZM module.

Table 25: DC/RF Characteristics and Files

Characteristic	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		384	535	mA
• Rx mode		64	76	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		370	516	mA
• Rx mode		64	76	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		336	458	mA
• Rx mode		64	76	mA
Tx Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
Output Power	15.0	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		366	504	mA
• Rx mode		64	76	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 - 2.4 GHz

Table 32: Characteristics values for IEEE 802.11n - 2.4 GHz

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

12.3.1 High-Rate Condition for IEEE 802.11n - 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 - 2.4 GHz

Items	Contents			
DC Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
DC current				
• Tx mode		316	426	mA
• Rx mode		64	76	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 - 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 - 2.4 GHz

Items	Contents			
DC Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
DC current				
• Tx mode		342	466	mA
• Rx mode		64	76	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 - 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 = 15 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		408	626	mA
• Rx mode		79	90	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)			-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

Items	Contents			
• 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 = 15 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		408	626	mA
• Rx mode		79	90	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)			-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

Items	Contents			
• 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 = 14 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		386	586	mA
• Rx mode		79	90	mA
Tx Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
Output Power	12.0	14.0	16.0	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

Items	Contents			
• 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
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 = 14 dBm at module pad, MCS0 mode

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

Items	Contents			
DC Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
DC current				
• Tx mode		386	586	mA
• Rx mode		79	90	mA
Tx Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
Output Power	12.0	14.0	16.0	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

Items	Contents			
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%)	-2			dB

12.6 DC/RF Characteristics for IEEE 802.11ac (HT20) - 5 GHz

Table 41: Characteristics Values for IEEE 802.11ac (HT20) - 5 GHz

Items	Contents
Specification	IEEE 802.11ac
Mode	OFDM
Channel Frequency	5180 to 5240 MHz, 5260 to 5320 MHz, 5500 to 5720 MHz, 5745 to 5825 MHz
Data rate	MCS0 - MCS8

12.6.1 High-Rate Condition for IEEE 802.11ac (VHT20) - 5 GHz

Conditions: 25 °C, VBAT = 3.3V, VIO = 1.8V, Output power setting = 14 dBm at module pad, MCS8 mode

Table 42: High-Rate Condition for IEEE 802.11ac (VHT20) - 5 GHz

Items	Contents			
DC Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
DC current				
• Tx mode		385	584	mA
• Rx mode		79	90	mA
Tx Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
Output Power	12.0	14.0	16.0	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)			-30	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%)			-59	dBm
Maximum Input Level (PER < 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-7			dB

12.6.2 Low-Rate Condition for IEEE 802.11ac (VHT20) - 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 802.11ac (VHT20) - 5 GHz

Items	Contents			
DC Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
DC current				
• Tx mode		385	584	mA
• Rx mode		79	90	mA
Tx Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
Output Power	12.0	14.0	16.0	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%)	-7			dB

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

Table 44: 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

12.7.1 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 45: High-Rate Condition for IEEE 802.11n (HT40) - 5 GHz

Items	Contents			
DC Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
DC current				
• Tx mode		387	583	mA
• Rx mode		91	103	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

Items	Contents			
• 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

12.7.2 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 46: Low-Rate Condition for IEEE 802.11n (HT40) - 5 GHz

Items	Contents			
DC Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
DC current				
• Tx mode		387	583	mA
• Rx mode		91	103	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)			-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

Items	Contents			
• 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%)			-79	dBm
Maximum Input Level (PER ≤ 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-2			dB

12.8 DC/RF Characteristics for IEEE 802.11ac (VHT40) - 5 GHz

Table 47: Characteristics Values for IEEE 802.11ac (VHT40) - 5 GHz

Items	Contents
Specification	IEEE 802.11ac
Mode	OFDM
Channel Frequency	5190 to 5795 MHz
Data rate	MCS0 - MCS9

12.8.1 High-Rate Condition for IEEE 802.11ac (VHT40) - 5 GHz

Conditions: 25 °C, VBAT = 3.3V, VIO = 1.8V, Output power setting = 13 dBm at module pad, MCS9 mode

Table 48: High-Rate Condition for IEEE 802.11ac (VHT40) - 5 GHz

Items	Contents			
DC Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
DC current				
• Tx mode		357	528	mA
• Rx mode		91	103	mA
Tx Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
Output Power	11.0	13.0	15.0	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)			-32	dB

Items	Contents			
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%)			-54	dBm
Maximum Input Level (PER ≤ 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 0%)	-9			dB

12.8.2 Low-Rate Condition for IEEE 802.11ac (VHT40) - 5 GHz

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

Table 49: Low-Rate Condition for IEEE 802.11ac (VHT40) - 5 GHz

Items	Contents			
DC Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
DC current				
• Tx mode		388	585	mA
• Rx mode		91	103	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)			-5	dB

Items	Contents			
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%)			-79	dBm
Maximum Input Level (PER ≤ 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-9			dB

12.9 DC/RF Characteristics for IEEE 802.11ac (VHT80) - 5 GHz

Table 50: Characteristics Values for IEEE 802.11ac (VHT80) - 5 GHz

Items	Contents
Specification	IEEE 802.11ac
Mode	OFDM
Channel Frequency	5210 to 5775 MHz
Data rate	MCS0 - MCS9

12.9.1 High-Rate Condition for IEEE 802.11ac (VHT80) - 5 GHz

Conditions: 25 °C, VBAT = 3.3V, VIO = 1.8V, Output power setting = 13 dBm at module pad, MCS9 mode

Table 51: High-Rate Condition for IEEE 802.11ac (VHT80) - 5 GHz

Items	Contents			
DC Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
DC current				
• Tx mode		376	558	mA
• Rx mode		102	114	mA
Tx Characteristics -	**Minimum**	**Typical**	**Maximum**	**Unit**
Output Power	11.0	13.0	15.0	dBm
Spectrum Mask Margin				
• 39 MHz to 41 MHz (0 ~ -20 dBr)	0			dB
• 41 MHz to 80 MHz (-20 ~ -28 dBr)	0			dB
• 80 MHz to 120 MHz (-28 ~ -40 dBr)	0			dB
• 120 MHz to 140 MHz (-40 dBr)	0			dB
Constellation Error (EVM) (Measured at enhanced mode)			-32	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%)			-51	dBm
Maximum Input Level (PER ≤ 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-9			dB

12.9.2 Low-Rate Condition for IEEE 802.11ac (VHT80) - 5 GHz

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

Table 52: Low-Rate Condition for IEEE 802.11ac (VHT80) - 5 GHz

Items	Contents			
DC Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
DC current				
• Tx mode		406	611	mA
• Rx mode		102	114	mA
Tx Characteristics -	**Minimum**	**Typical**	**Maximum**	**Unit**
Output Power	12.0	14.0	16.0	dBm
Spectrum Mask Margin				
• 39 MHz to 41 MHz (0 ~ -20 dBr)	0			dB
• 41 MHz to 80 MHz (-20 ~ -28 dBr)	0			dB
• 80 MHz to 120 MHz (-28 ~ -40 dBr)	0			dB
• 120 MHz to 140 MHz (-40 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%)			-76	dBm
Maximum Input Level (PER ≤ 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-9			dB

12.10 DC/RF Characteristics for Bluetooth

Table 53: Characteristics Values for Bluetooth

Items	Contents
Bluetooth specification (power class)	Version 5.1 (Class 1)
Channel frequency (spacing)	2402 - 2480 MHz (1 MHz)
Number of RF Channel	79

12.10.1 Basic Data Rate Condition

Conditions: 25 °C, VBAT = 3.3V, VIO = 1.8V

Table 54: Basic Data Rate Condition

Items	Contents			
Current Consumption	**Minimum**	**Typical**	**Maximum**	**Unit**
• Tx mode DH5		91	115	mA
• Rx mode DH5		61	73	mA
Tx Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
Output Power@DH5	0	3.0	6.0	dBm
Frequency range	2400		2483.5	MHz
20 dB bandwidth			1	MHz
Adjacent Channel Power [11]				
• [M-N] = 2			-20	dBm
• [M-N] ≥ 3			-40	dBm
Modulation characteristics				
• Modulation $\Delta f1_{avg}$	140	151	175	kHz
• Modulation $\Delta f2_{max}$	115			kHz
• Modulation $\Delta f2_{avg}$ / $\Delta f1_{avg}$	0.8	1		
Carrier Frequency Drift				
• 1slot	-25		25	kHz
• 3slot / 5slot	-40		40	kHz
• Maximum drift rate			20	kHz/50 µs
Rx Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
BR Sensitivity (BER ≤ 0.1%)		-96	-70	dBm
Maximum Input Level (BER ≤ 0.1%)	-20			dBm

[11] Up to three spurious responses within Bluetooth limits are allowed.

12.10.2 Enhanced Data Rate Condition

Conditions: 25 °C, VBAT = 3.3V, VIO = 1.8V

Table 55: Enhanced Data Rate Condition

Items	Contents			
Current Consumption	**Minimum**	**Typical**	**Maximum**	**Unit**
• Tx mode 2DH5		87	107	mA
• Rx mode 2DH5		61	73	mA
• Tx mode 3DH5		87	107	mA
• Rx mode 3DH5		61	73	mA
Tx Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
Output Power@2DH5/3DH5	-3.0	0	3.0	dBm
Frequency range	2400		2483.5	MHz
20 dB bandwidth			1	MHz
Adjacent Channel Power[12]				
• [M-N] = 2			-20	dBm
• [M-N] ≥ 3			-40	dBm
EDR Relative Power	-4		1	dB
EDR Carrier Frequency Stability and Modulation Accuracy				
• ωi	-75		75	kHz
• ωi+ωo	-75		75	kHz
• ωo	-10		10	kHz
• RMS DEVM (DQPSK)			20	%
• Peak DEVM (QPSK)			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		-88	-70	dBm
Maximum Input Level (BER ≤ 0.1%)	-20			dBm

[12] Up to three spurious responses within Bluetooth limits are allowed.

12.11 DC/RF Characteristics for Bluetooth Low Energy

Table 56: DC/RF Characteristics for Bluetooth Low Energy

Items	Contents
Bluetooth specification (power class)	Version 5.1 (Class 1.5)
Channel frequency (spacing)	2402 to 2480 MHz (2 MHz)
Number of RF Channel	40

12.11.1 1 Mbps PHY Condition

Conditions: 25 °C, VBAT = 3.3V, VIO = 1.8V

Table 57: 1 Mbps PHY Condition

Items	Contents			
Current Consumption	**Minimum**	**Typical**	**Maximum**	**Unit**
• Tx mode		90	110	mA
• Rx mode		60	69	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	6	dBm
In-band emission				
• f_{TX}+/-2 MHz			-20	dBm
• f_{TX}+/-[3+n] MHz; n=0,1,2…			-30	dBm
Modulation Characteristics				
• $\Delta f1_{avg}$	225		275	kHz
• $\Delta f2_{max}$ (at 99.9%)	185			kHz
• $\Delta f2_{avg}$ / $\Delta f1_{avg}$	0.8			
Stable Modulation Characteristics				
• $\Delta f1_{avg}$	247.5		252.5	kHz
• $\Delta f2_{max}$ (at 99.9%)	185			kHz
• $\Delta f2_{avg}$ / $\Delta f1_{avg}$	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

Items	Contents			
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**
Receiver sensitivity (PER < 30.8%)		-97	-70	dBm
Maximum input signal level (PER < 30.8%)	-10			dBm
PER Report Integrity (-30 dBm input)	50		65.4	%

12.11.2 2 Mbps PHY Condition

Conditions: 25 °C, VBAT = 3.3V, VIO = 1.8V

Table 58: 2 Mbps PHY Condition

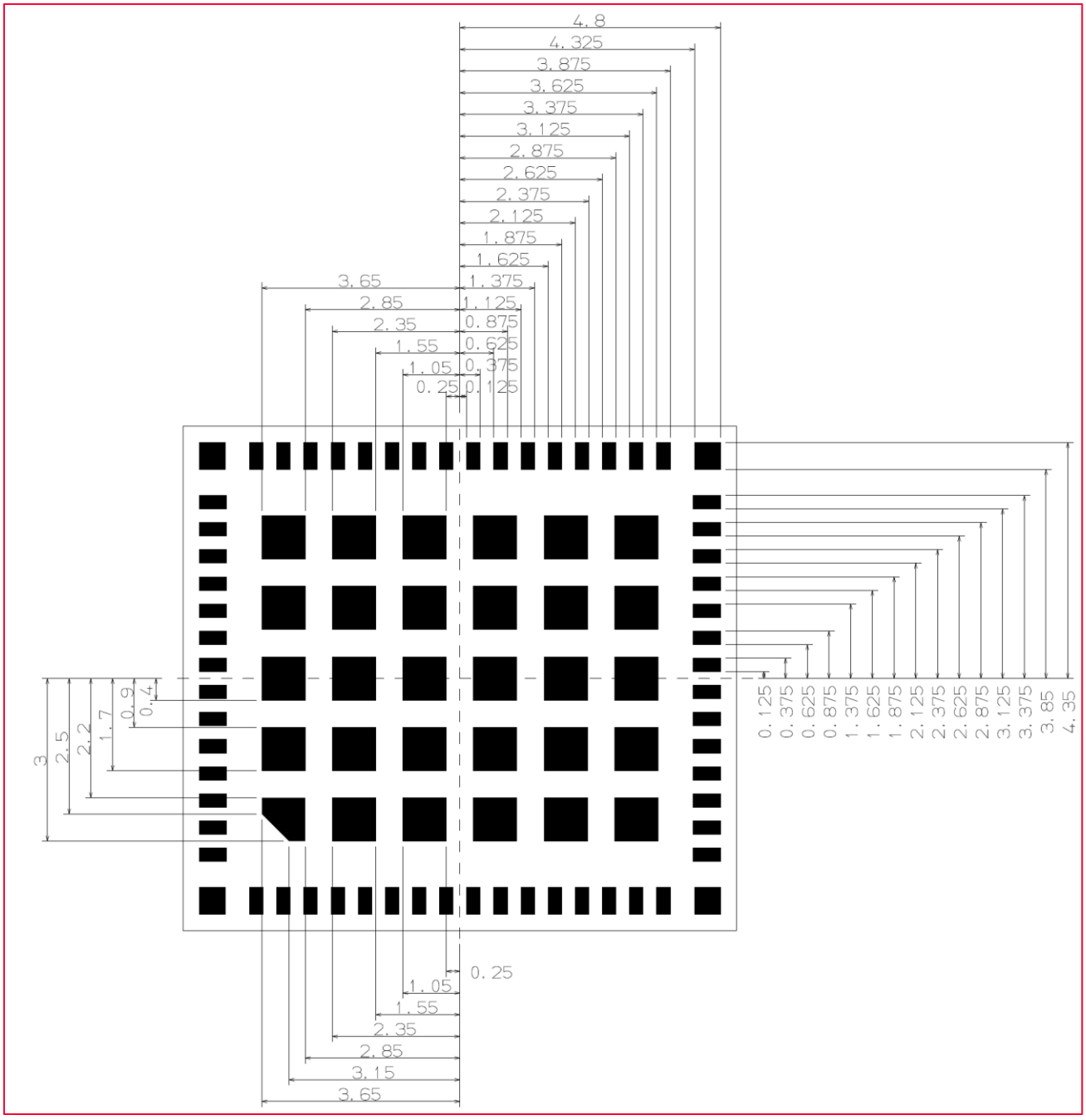
Items	Contents			
Current Consumption	**Minimum**	**Typical**	**Maximum**	**Unit**
• Tx mode		88	112	mA
• Rx mode		60	69	mA
Tx Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
Center Frequency	2402		2480	MHz
Channel Spacing		2		MHz
Number of RF channel		40		-
Output power	0	3	6	dBm
In-band emission				
• f_{TX}+/-4 MHz			-20	dBm
• f_{TX}+/-5 MHz			-20	dBm
• f_{TX}+/-[6+n] MHz; n=0,1,2…			-30	dBm
Modulation Characteristics				
• $\Delta f1_{avg}$	450		550	kHz
• $\Delta f2_{max}$ (at 99.9%)	370			kHz
• $\Delta f2_{avg}$ / $\Delta f1_{avg}$	0.8			

Items	Contents			
Stable Modulation Characteristics				
• $\Delta f1_{avg}$	495		505	kHz
• $\Delta f2_{max}$ (at 99.9%)	370			kHz
• $\Delta f2_{avg}$ / $\Delta f1_{avg}$	0.8			
Carrier frequency offset and drift				
• Frequency offset (fn); n=0,1,2,3…k	-150		150	kHz
• Frequency drift ($\|f_0-f_n\|$); n=2,3,4…k			50	kHz
• Drift rate				
• |f1-f0|			23	kHz
• |fn-fn-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
• 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%)		-97	-70	dBm
Maximum input signal level (PER < 30.8%)	-10			dBm
PER Report Integrity (-30 dBm input)	50		65.4	%

13 Land Patterns

Figure 21 shows the land patterns.

Figure 21: Land Patterns



To avoid the short-circuit between the side shielding and solder on the module land after the reflow, please place the module land at 0.2 mm away from module outline, as shown in above figure.

14 General for Radio Regulatory Certification for LBEE5QD1ZM

This section contains the following topics:

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

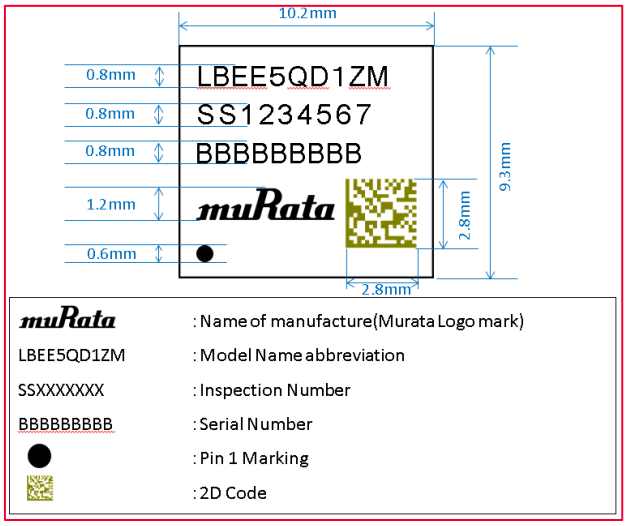
14.1 Application model part number

Basically, we apply for “LBEE5QD1ZM” in each country.

14.2 Label

Figure 22 shows the certification label of Type 1ZM module.

Figure 22: Radio Regulatory Certification Label

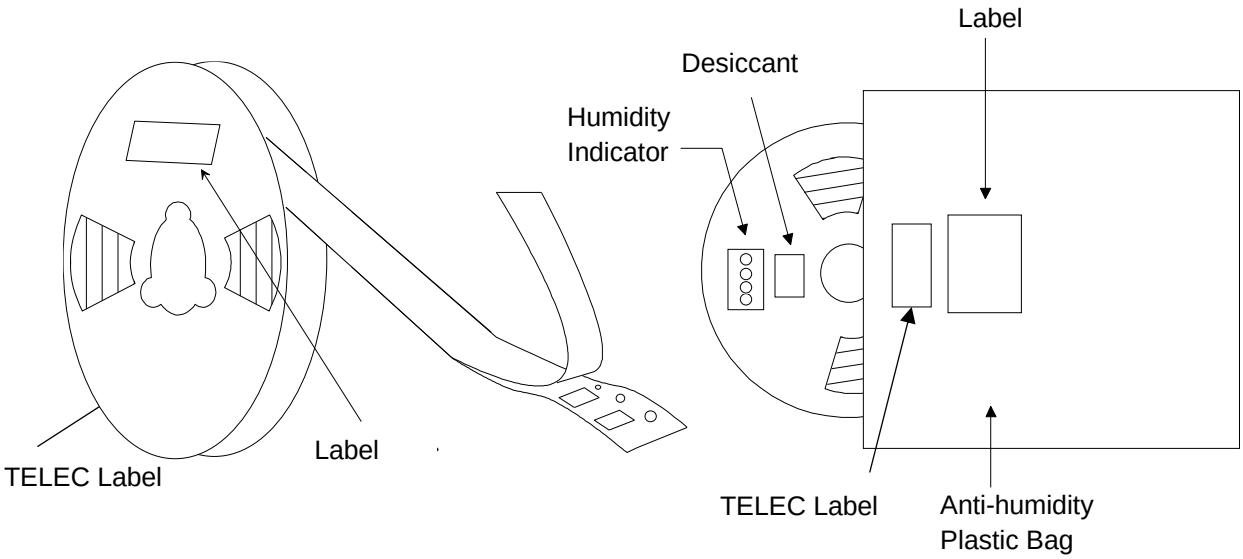


Since there is no space to describe the notational requirements of each country, we are applying for the notational requirements to be posted in the manual or package.

14.3 Package Label

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

Figure 23: Package (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

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 LBEE5QD1ZM

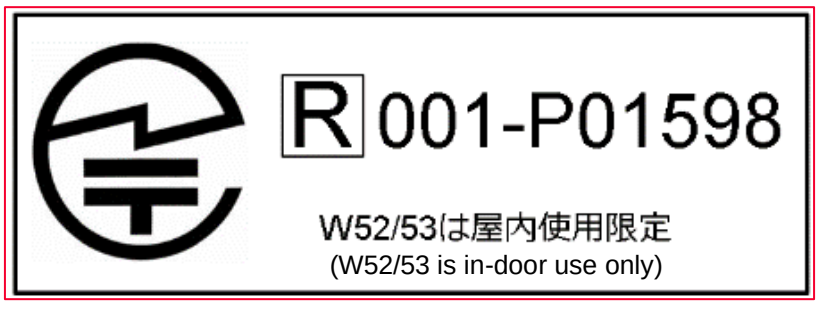
This section includes regulatory certification information all the following countries:

- Japan
- FCC
- ISED
- Europe

15.1 Japan

- Manufacturer: Murata Manufacturing Co., Ltd.
- Model or Product Name: LBEE5QD1ZM
- 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/5.6GHz 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 Levels for Japan

Table 59 and **Table 60** shows the per antenna port power table for 2.4 GHz for WLAN and Bluetooth. **Table 61, Table 62**, and **Table 63** shows the per antenna port power table for 5 GHz WLAN.

Table 59: Japan Power Level 2.4 GHz WLAN Per Antenna Port

Band	Data rate	Minimum (dBm)	Typical (dBm)	Maximum (dBm)
Channels:		**1 ~ 13**		
11b	1 ~ 11 Mbps	14.0	16.0	18.0
11g	6 ~ 18 Mbps	15.0	17.0	19.0
	24 ~ 54 Mbps	14.0	16.0	18.0
11n_HT20	MCS0 ~ 2	14.0	16.0	18.0
	MCS3 ~ 7	13.0	15.0	17.0
11ac_HT20	MCS0 ~ 2	14.0	16.0	18.0
	MCS3 ~ 7	13.0	15.0	17.0
	MCS8	12.0	14.0	16.0

Table 60: Japan Power Level 2.4 GHz BT/BLE Per Antenna Port

Standard	Data rate	Minimum (dBm)	Typical (dBm)	Maximum (dBm)
Band:		**2402 ~ 2480 MHz**		
BT	BR (DH5)	0.0	3.0	6.0
	EDR (2DH5 & 3DH5)	-3.0	0.0	3.0
BLE	1 Mbps	0.0	3.0	6.0
	2 Mbps	0.0	3.0	6.0

Table 61: Japan Power Level 5 GHz WLAN Per Antenna Port (W52)

Band	Data rate	Minimum (dBm)	Typical (dBm)	Maximum (dBm)
Channels:		**36 ~ 48**		
11a	6 ~ 54 Mbps	13.0	15.0	17.0
11n HT20	MCS0 ~ 7	12.0	14.0	16.0
11ac VHT20	MCS0 ~ 8	12.0	14.0	16.0
Channels:		**38 ~ 46**		
11n HT40	MCS0 ~ 7	12.0	14.0	16.0
11ac VHT40	MCS0 ~ 7	12.0	14.0	16.0
	MCS8 ~ 9	11.0	13.0	15.0
Channels:		**42**		
11ac VHT80	MCS0 ~ 2	12.0	14.0	16.0
	MCS3 ~ 9	11.0	13.0	15.0

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Table 62: Japan Power Level 5 GHz WLAN Per Antenna Port (W53)

Band	Data rate	Minimum (dBm)	Typical (dBm)	Maximum (dBm)
Channels:		**52 ~ 64**		
11a	6 ~ 54 Mbps	13.0	15.0	17.0
11n HT20	MCS0 ~ 7	12.0	14.0	16.0
11ac VHT20	MCS0 ~ 8	12.0	14.0	16.0
Channels:		**54 ~ 62**		
11n HT40	MCS0 ~ 7	12.0	14.0	16.0
11ac VHT40	MCS0 ~ 7	12.0	14.0	16.0
	MCS8 ~ 9	11.0	13.0	15.0
Channels:		**58**		
11ac VHT80	MCS0 ~ 2	12.0	14.0	16.0
	MCS3 ~ 9	11.0	13.0	15.0

Table 63: Japan Power Level 5 GHz WLAN Per Antenna Port (W56)

Band	Data rate	Minimum (dBm)	Typical (dBm)	Maximum (dBm)
Channels:		**100 ~ 144**		
11a	6 ~ 54 Mbps	13.0	15.0	17.0
11n HT20	MCS0 ~ 7	12.0	14.0	16.0
11ac VHT20	MCS0 ~ 8	12.0	14.0	16.0
Channels:		**102 ~ 142**		
11n HT40	MCS0 ~ 7	12.0	14.0	16.0
11ac VHT40	MCS0 ~ 7	12.0	14.0	16.0
	MCS8 ~ 9	11.0	13.0	15.0
Channels:		**106 ~ 138**		
11ac VHT80	MCS0 ~ 2	12.0	14.0	16.0
	MCS3 ~ 9	11.0	13.0	15.0

- One antenna port.
- Without simultaneous transmission in the same frequency band.
- TPC supported.
- Setting value is Typical, WLAN deviation is ±2 dB, BT/BLE deviation is ±3 dB.

15.1.2 Antenna List

Table 64 shows list of antennas registered under the Japan Radio Act.

Table 64: Antenna Registered Under the Japan Radio Act

No.	Maker	Support Antenna						
		P/N	Form factor	Type	Gain		Size	Detail
					2.4 GHz	5 GHz		
1	Molex	146153	u.FL/flexible	Dipole	3.2	4.25	35x9x0.1 mm	Flexible//horizontal
2	Molex	146187	u.FL/flexible	Dipole	3.4	4.75	40.95x9x0.7 mm	Rigid//horizontal
3	Molex	206994	u.FL/flexible	Monopole	3.6	3.6	15.4x6.4x0.15 mm	adhesive // flexible //vertical
4	Murata	LBEE5QD1ZM-Antenna	N/A	Monopole	3.6	4.6		Pattern Antenna

15.1.3 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

Japanese Version 本製品は、電波法に基づく工事設計認証（認証番号：001-P01598）を受けた特定無線設備を内蔵しています。
English Version This product incorporates specified radio equipment that has received CERTIFICATION for TYPE CERTIFICATION (certification number: 001-P01598) based on the Japan Radio Act.

- Recommended Indication 2

Japanese Version R001-P01598 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 R001-P01598 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.

15.2 FCC

FCC ID: VPYLB1ZM

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.

This module should be installed in the host device according to the interface specification (installation procedure).

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.
2. This device complies with below part 15 of FCC Rules.
   - Part 15 Subpart C
   - Part 15 Subpart E
3. The modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. The final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.
4. This module designed for mounting inside of the end product by us professionally. Therefore, it complies with the antenna and transmission system requirements of §15.203.
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.

15.2.1 Supply Voltage

Table 65 shows the supply voltage information.

Table 65: Supply Voltage Values

DUT PIN Name	Minimum	Typical	Maximum	Unit
VBAT[13]	2.7	3.3	5.5	V
VIO	1.62	1.8	1.98	V

15.2.2 Power Level for FCC

Table 66 and **Table 67** shows the per antenna port power table for 2.4 GHz for WLAN and Bluetooth. **Table 68** shows the per antenna port power table for 5 GHz WLAN.

Table 66: FCC Power Level 2.4 GHz WLAN Per Antenna Port

Mode	Band	Rate	Channel	Maximum Tune Up Tolerance (dBm)
IEEE 802.11b	2.4 GHz	All Rates	1 ~ 11	17.0 ± 2.0
IEEE 802.11g	2.4 GHz	All Rates	1 ~ 3, 9 ~ 11	14.0 ± 2.0

[13] VBAT: Only this power supply affects the RF characteristics.

Mode	Band	Rate	Channel	Maximum Tune Up Tolerance (dBm)
		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)	2.4 GHz	All Rates	1 ~ 3, 9 ~ 11	13.0 ± 2.0
		MCS0, MCS1, MCS2	4 ~ 8	16.0 ± 2.0
		MCS3, MCS4, MCS5, MCS6, MCS7	4 ~ 8	15.0 ± 2.0
IEEE 802.11ac (VHT20)	2.4 GHz	All Rates	1 ~ 3, 9 ~ 11	13.0 ± 2.0
		VHT_SS1_MCS0, VHT_SS1_MCS1, VHT_SS1_MCS2	4 ~ 8	16.0 ± 2.0
		VHT_SS1_MCS3, VHT_SS1_MCS4, VHT_SS1_MCS5, VHT_SS1_MCS6, VHT_SS1_MCS7	4 ~ 8	15.0 ± 2.0
		VHT_SS1_MCS8	4 ~ 8	14.0 ± 2.0

Table 67: FCC Power Level 2.4 GHz BT/BLE Per Antenna Port

Mode	Maximum Tune Up Tolerance (dBm)
BR	3.0 ± 3.0
EDR	0.0 ± 3.0
LE	3.0 ± 3.0
LE 2 Mbps	3.0 ± 3.0

Table 68: FCC 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
		W52/W53	40 ~ 60	15.0 ± 2.0
		W56	100	14.0 ± 2.0
		W56	104 ~ 144	15.0 ± 2.0
		W58	149 ~ 165	15.0 ± 2.0
IEEE 802.11n (HT20)	All Rates	W52/W53	36, 64	13.0 ± 2.0
		W52/W53	40 ~ 60	14.0 ± 2.0
		W56	100	13.0 ± 2.0
		W56	104 ~ 144	14.0 ± 2.0
		W58	149 ~ 165	14.0 ± 2.0
IEEE 802.11n (HT40)	All Rates	W52/W53	38, 62	12.0 ± 2.0
		W52/W53	46, 54	14.0 ± 2.0
		W56	102	12.0 ± 2.0
		W56	110 ~ 142	14.0 ± 2.0
		W58	151, 159	14.0 ± 2.0
IEEE 802.11ac	All Rates	W52/W53	36, 64	13.0 ± 2.0

Mode	Rate	Band	Channel	Maximum Tune Up Tolerance (dBm)
(VHT20)		W52/W53	40 ~ 60	14.0 ± 2.0
		W56	100	13.0 ± 2.0
		W56	104 ~ 144	14.0 ± 2.0
		W58	149 ~ 165	14.0 ± 2.0
IEEE 802.11ac (VHT40)	All Rates	W52/W53	38, 62	12.0 ± 2.0
	VHT_SS1_MCS0 ~ VHT_SS1_MCS7	W52/W53	46, 54	14.0 ± 2.0
	VHT_SS1_MCS8, VHT_SS1_MCS9	W52/W53	46, 54	13.0 ± 2.0
	All Rates	W56	102	12.0 ± 2.0
	VHT_SS1_MCS0 ~ VHT_SS1_MCS7	W56	110 ~ 142	14.0 ± 2.0
	VHT_SS1_MCS8, VHT_SS1_MCS9	W56	110 ~ 142	13.0 ± 2.0
	VHT_SS1_MCS0 ~ VHT_SS1_MCS7	W58	151, 159	14.0 ± 2.0
	VHT_SS1_MCS8, VHT_SS1_MCS9	W58	151, 159	13.0 ± 2.0
IEEE 802.11ac (VHT80)	All Rates	W52/W53	42, 58	10.0 ± 2.0
	All Rates	W56	106	10.0 ± 2.0
	VHT_SS1_MCS0 ~ VHT_SS1_MCS2 VHT_SS1_MCS3 ~ VHT_SS1_MCS9 VHT_SS1_MCS0 ~ VHT_SS1_MCS2 VHT_SS1_MCS3 ~ VHT_SS1_MCS9	W56	122, 138	14.0 ± 2.0
		W56 W58 W58	122, 138	13.0 ± 2.0
			155	14.0 ± 2.0
			155	13.0 ± 2.0

15.2.3 Theory of Operation for FCC

Table 69 shows the theory of operation power tables for WLAN.

Table 69: FCC Theory of Operation for WLAN

Frequency of Operation			Scan	Ad-hoc mode
2.4 GHz	11b/g/n/ac ((V)HT20)	2412-2462 MHz	Active	Yes
W52	11a/n/ac ((V)HT20)	5180-5240 MHz	Active	Yes
	11n/ac ((V)HT40)	5190-5230 MHz	Active	Yes
	11ac (VHT80)	5210 MHz	Active	Yes
W53	11a/n/ac ((V)HT20)	5260-5320 MHz	Passive	No
	11n/ac ((V)HT40)	5270-5310 MHz	Passive	No
	11ac (VHT80)	5290 MHz	Passive	No
W56	11a/n/ac ((V)HT20)	5500-5720 MHz	Passive	No
	11n/ac ((V)HT40)	5510-5710 MHz	Passive	No
	11ac (VHT80)	5530-5690 MHz	Passive	No
W58	11a/n/ac ((V)HT20)	5745-5825 MHz	Active	Yes
	11n/ac ((V)HT40)	5755-5795 MHz	Active	Yes
	11ac (VHT80)	5775 MHz	Active	Yes

15.2.4 Information to Display in User Manual of Host Device

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

- Contains Transmitter Module FCC ID: VPYLB1ZM or Contains FCC ID: VPYLB1ZM
- **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.

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.

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

15.2.5 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: ±20 ppm

15.2.6 Equipment Installation for FCC

The product can be installed on portable equipment and mobile equipment. The information to be displayed are described in this section.

15.2.6.1 Portable Equipment (FCC)

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

The available scientific evidence does not show that any health problems are associated with using low power wireless devices. There is no proof, however, that these low power wireless devices are absolutely safe. Low power Wireless devices emit low levels of radio frequency energy (RF) in the microwave range while being used. Whereas high levels of RF can produce health effects (by heating tissue), exposure of low-level RF that does not produce heating effects causes no known adverse health effects. Many studies of low-level RF exposures have not found any biological effects. Some studies have suggested that some biological effects might occur, but such findings have not been confirmed by additional research. LBEE5QD1ZM has been tested and found to comply with FCC radiation exposure limits set forth for an uncontrolled environment and meets the FCC radio frequency (RF) Exposure Guidelines.

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

15.2.6.2 Mobile Equipment (FCC)

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

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

15.3 ISED

HVIN: LBEE5QD1ZM

PMN: LBEE5QD1ZM

IC Number: 772C-LB1ZM

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.

This module should be installed in the host device according to the interface specification (installation procedure).

15.3.1 Information to Display in 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-LB1ZM

15.3.1.2 Information on User Manual

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

This device complies with Industry Canada's applicable license-exempt RSSs. Operation is subject to the following two conditions: 1. This device may not cause interference; and 2. This device must accept any interference, including interference that may cause undesired operation of the device.
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 : 1. l'appareil ne doit pas produire de brouillage; 2. l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

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.
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 this statement on the host product due to the size, please describe in the User's manual.

In case of the final product which can be carried around to outdoor, the following indication is necessary to the final product.

- When the AP function is used in W52.
  - At the time of a channel setting of W52, please indicate “for indoor use only”. During connecting, please show the channel number which connects.
  - And please indicate that the end user may find out "for indoor use only channel".
- When the STA function is used in channel 52, 54, 58, at the time of the channel 52 or 54 or 58 setting, please indicate “for indoor use only channel”.
  - During connecting, please show the channel number which connects.
  - And please indicate that the end user may find out "for indoor use only channel".

15.3.2 Antenna Installation in End Product

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

This radio transmitter (IC Number: 772C-LB1ZM) identify the device by certification number or model number if Category II) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device. : 146153 Dual Dipole antenna Gain: +3.2dBi@2.4GHz + 4.25dBi@5GHz : 146187 Dual Dipole antenna Gain: +3.4dBi@2.4GHz + 4.75dBi@5GHz : LBEE5QD1ZM-Antenna monopole antenna Gain: +3.6dBi@2.4GHz + 4.6dBi@5GHz
Le présent émetteur radio (IC Number: 772C-LB1ZM) a été approuvé par Industrie 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, sont strictement interdits pour l'exploitation de l'émetteur. Type d’antenne : 146153 Dual Dipole antenna Gain: +3.2dBi@2.4GHz + 4.25dBi@5GHz : 146187 Dual Dipole antenna Gain: +3.4dBi@2.4GHz + 4.75dBi@5GHz : LBEE5QD1ZM-Antenna monopole antenna Gain: +3.6dBi@2.4GHz + 4.6dBi@5GHz

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

For indoor use only (5150-5250 MHz band and channel 52, 54, 58)
Pour usage intérieur seulement (5150-5250 MHz band and channel 52, 54, 58)

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. When installing it in a portable equipment. Please describe the following warning to the manual.

The available scientific evidence does not show that any health problems are associated with using low power wireless devices. There is no proof, however, that these low power wireless devices are safe. Low power Wireless devices emit low levels of radio frequency energy (RF) in the microwave range while being used. Whereas high levels of RF can produce health effects (by heating tissue), exposure of low-level RF that does not produce heating effects causes no known adverse health effects. Many studies of low-level RF exposures have not found any biological effects. Some studies have suggested that some biological effects might occur, but such findings have not been confirmed by

additional research. LBEE5QD1ZM has been tested and found to comply with IC radiation exposure limits set forth for an uncontrolled environment and meets RSS-102 of the IC radio frequency (RF) Exposure rules.
Les connaissances scientifiques dont nous disposons n'ont mis en évidence aucun problème de santé associé à l'usage des appareils sans fil à faible puissance. Nous ne sommes cependant pas en mesure de prouver que ces appareils sans fil à faible puissance sont entièrement sans danger. Les appareils sans fil à faible puissance émettent une énergie fréquence radioélectrique (RF) très faible dans le spectre des micro-ondes lorsqu'ils sont utilisés. Alors qu'une dose élevée de RF peut avoir des effets sur la santé (en chauffant les tissus), l'exposition à de faibles RF qui ne produisent pas de chaleur n'a pas de mauvais effets connus sur la santé. De nombreuses études ont été menées sur les expositions aux RF faibles et n'ont découvert aucun effet biologique. Certaines études ont suggéré qu'il pouvait y avoir certains effets biologiques, mais ces résultats n'ont pas été confirmés par des recherches supplémentaires. LBEE5QD1ZM a été testé et jugé conforme aux limites d'exposition aux rayonnements IC énoncées pour un environnement non contrôlé et respecte les règles d'exposition aux fréquences radioélectriques (RF) CNR-102 de l'IC.

It is necessary to take a SAR test with your set mounting this module.
Class 4 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. When installing it in a mobile equipment. Please describe the following warning to the manual.

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.
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 70 and **Table 71** show 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: ISED Power Level 2.4 GHz WLAN Per Antenna Port

Mode	Band	Rate	Channel	Maximum Tune Up Tolerance (dBm)
IEEE 802.11b	2.4 GHz	All Rates	1~11	17.0 ± 2.0
IEEE 802.11g	2.4 GHz	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)	2.4 GHz	All Rates	1~3, 9~11	13.0 ± 2.0
		MCS0, MCS1, MCS2	4~8	16.0 ± 2.0
		MCS3, MCS4, MCS5, MCS6, MCS7	4~8	15.0 ± 2.0
IEEE 802.11ac (VHT20)	2.4 GHz	All Rates	1~3, 9~11	13.0 ± 2.0
		VHT_SS1_MCS0, VHT_SS1_MCS1, VHT_SS1_MCS2	4~8	16.0 ± 2.0
		VHT_SS1_MCS3, VHT_SS1_MCS4, VHT_SS1_MCS5, VHT_SS1_MCS6, VHT_SS1_MCS7	4~8	15.0 ± 2.0
		VHT_SS1_MCS8	4~8	14.0 ± 2.0

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

Mode	Maximum Tune Up Tolerance (dBm)
BR	3.0 ± 3.0
EDR	0.0 ± 3.0
LE	3.0 ± 3.0
LE 2 Mbps	3.0 ± 3.0

Table 72: ISED 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
		W52/W53	40~60	15.0 ± 2.0
		W56	100	14.0 ± 2.0
		W56	104~144 (not include 120, 124, 128)	15.0 ± 2.0
		W58	149~165	15.0 ± 2.0
IEEE 802.11n (HT20)	All Rates	W52/W53	36, 64	13.0 ± 2.0
		W52/W53	40~60	14.0 ± 2.0
		W56	100	13.0 ± 2.0

Mode	Rate	Band	Channel	Maximum Tune Up Tolerance (dBm)
		W56	104~144 (not include 120, 124, 128)	14.0 ± 2.0
		W58	149~165	14.0 ± 2.0
IEEE 802.11n (HT40)	All Rates	W52/W53	38, 62	12.0 ± 2.0
		W52/W53	46, 54	14.0 ± 2.0
		W56	102	12.0 ± 2.0
		W56	110~142 (not include 118, 126)	14.0 ± 2.0
		W58	151, 159	14.0 ± 2.0
IEEE 802.11ac (VHT20)	All Rates	W52/W53	36, 64	13.0 ± 2.0
		W52/W53	40~60	14.0 ± 2.0
		W56	100	13.0 ± 2.0
		W56	104~144 (not include 120, 124, 128)	14.0 ± 2.0
		W58	149~165	14.0 ± 2.0
IEEE 802.11ac (VHT40)	All Rates	W52/W53	38, 62	12.0 ± 2.0
	VHT_SS1_MCS0 ~ VHT_SS1_MCS7	W52/W53	46, 54	14.0 ± 2.0
	VHT_SS1_MCS8, VHT_SS1_MCS9	W52/W53	46, 54	13.0 ± 2.0
	All Rates	W56	102	12.0 ± 2.0
	VHT_SS1_MCS0 ~ VHT_SS1_MCS7	W56	110~142 (not include 118, 126)	14.0 ± 2.0
	VHT_SS1_MCS8, VHT_SS1_MCS9	W56	110~142 (not include 118, 126)	13.0 ± 2.0
	VHT_SS1_MCS0 ~ VHT_SS1_MCS7	W58	151, 159	14.0 ± 2.0
	VHT_SS1_MCS8, VHT_SS1_MCS9	W58	151, 159	13.0 ± 2.0
IEEE 802.11ac (VHT80)	All Rates	W52/W53	42, 58	10.0 ± 2.0
	All Rates	W56	106	10.0 ± 2.0
	VHT_SS1_MCS0 ~ VHT_SS1_MCS2	W56	138	14.0 ± 2.0
	VHT_SS1_MCS3 ~ VHT_SS1_MCS9	W56	138	13.0 ± 2.0
	VHT_SS1_MCS0 ~ VHT_SS1_MCS2	W58	155	14.0 ± 2.0
	VHT_SS1_MCS3 ~ VHT_SS1_MCS9	W58	155	13.0 ± 2.0

15.3.5 Theory of Operation for ISED

Table 73 shows the theory of operation power tables for WLAN and Bluetooth.

Table 73: ISED Theory Operation for WLAN

Frequency of Operation			Scan	Ad-hoc mode
2.4 GHz	11b/g/n/ac ((V)HT20)	2412-2462 MHz	Active	Yes
W52	11a/n/ac ((V)HT20)	5180-5240 MHz	Active	Yes
	11n/ac ((V)HT40)	5190-5230 MHz	Active	Yes
	11ac (VHT80)	5210 MHz	Active	Yes
W53	11a/n/ac ((V)HT20)	5260-5320 MHz	Passive	No
	11n/ac ((V)HT40)	5270-5310 MHz	Passive	No
	11ac (VHT80)	5290 MHz	Passive	No
W56	11a/n/ac ((V)HT20)	5500-5720 MHz (*ISED:5600-5650 MHz disable)	Passive	No
	11n/ac ((V)HT40)	5510-5710 MHz (*ISED:5600-5650 MHz disable)	Passive	No
	11ac (VHT80)	5530-5690 MHz (*ISED:5600-5650 MHz disable)	Passive	No
W58	11a/n/ac ((V)HT20)	5745-5825 MHz	Active	Yes
	11n/ac ((V)HT40)	5755-5795 MHz	Active	Yes
	11ac (VHT80)	5775 MHz	Active	Yes

15.4 Europe

Product name: Communication Module

Model: LBEE5QD1ZM

Manufacture: Murata manufacturing Co., Ltd.

When shipping final products with this module to Europe, make a self-declaration that the product complies with European regulations and apply the CE mark.

The following report is issued:

- Radio Equipment Directive (RED) 2014/53/EU Article 3.2
  - Conforms to EN 300 328 v2.2.2:2019 Antenna Terminated Conducted test only
    - Report No: T201215W01-RT1
  - Conforms to EN 301 893 v2.1.1:2017 Antenna Terminated Conducted test only
    - Report No.: T200915W04-RT3
  - Conforms to EN 300 440 v2.1.1:2017 Antenna Terminated Conducted test only
    - Report No.: T200915W04-RT5
- Radio Equipment Directive (RED) 2014/53/EU Article 3.1a
  - Conforms to: EN 62311:2008
    - Report No.: T201215W01-MC

These reports can be leveraged as part of the TCF of the final product.

15.4.1 Power Level for Europe

Table 74 and **Table 75** show the per antenna port power table for 2.4 GHz for WLAN. **Table 76** shows the per antenna port power table for 5 GHz WLAN.

Table 74: Europe Power Level 2.4 GHz WLAN Per Antenna Port

Mode	Data Rate	Output Power in dBm (typical)
		Ch. 1-13
11b	1, 2, 5.5, 11 M	14
11g	6, 9, 12, 18 M	14
	24, 36 M	14
	48, 54 M	14
11n-20	MCS0, 1, 2	14
	MCS3, 4	14
	MCS5, 6, 7	14

Table 75: Europe Power Level 2.4 GHz BT/BLE Per Antenna Port

Mode	Maximum Tune Up Tolerance (dBm)
BR	3 ± 3.0
EDR	0 ± 3.0
LE	3 ± 3.0
LE 2 Mbps	3 ± 3.0

Table 76: Europe Power Level 5 GHz WLAN Per Antenna Port

Mode	Data Rate	Output Power in dBm (typical)		
		Ch. 36-64	**Ch. 100-144**	**Ch. 149-165**
11a	6, 9, 12, 18 M	15	15	7
	24, 36 M	15	15	7
	48, 54 M	15	15	7
11n/ac-20	MCS0, 1, 2	14	14	7
	MCS3, 4	14	14	7
	MCS5, 6, 7	14	14	7
11ac-20	MCS8	14	14	7
Mode	**Data Rate**	**Ch. 38-62**	**Ch. 102-142**	**Ch. 151-159**
11n/ac-40	MCS0, 1, 2	14	14	7
	MCS3, 4	14	14	7
	MCS5, 6, 7	14	14	7
11ac-40	MCS8, 9	13	13	7
Mode	**Data Rate**	**Ch. 42-58**	**Ch. 106-138**	**Ch. 155**
11ac-80	MCS0, 1, 2	14	14	7
	MCS3, 4	13	13	7
	MCS5, 6, 7	13	13	7
	MCS8, 9	13	13	7

15.4.2 Theory of Operation for Europe

Table 77 show the theory of operation power tables for WLAN and Bluetooth.

Table 77: Europe Theory of Operation for WLAN

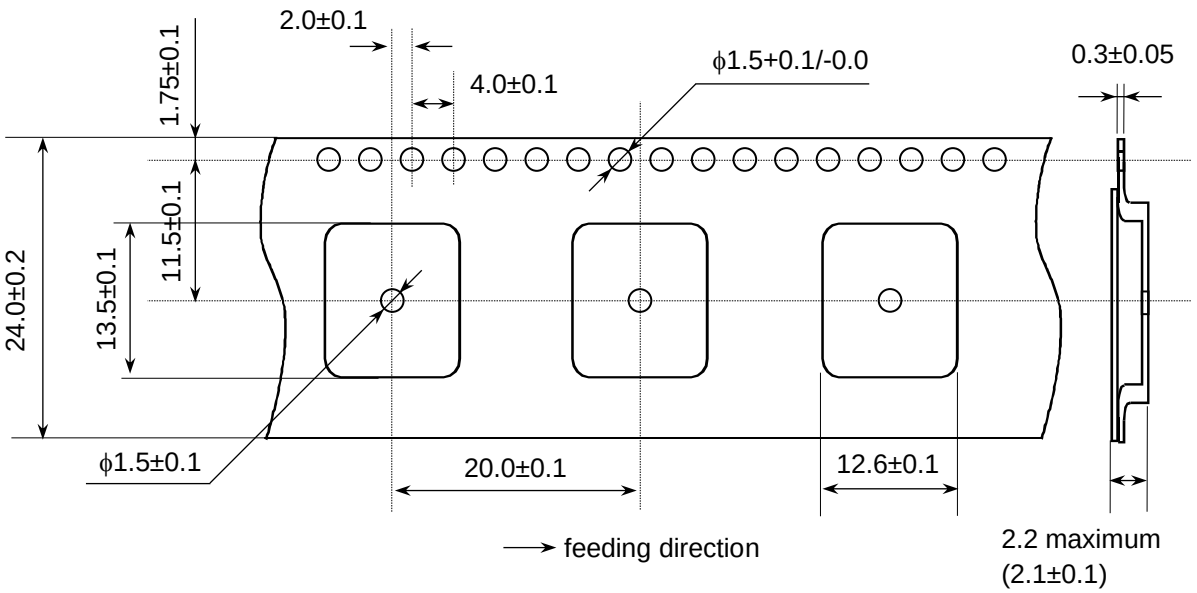
Frequency of Operation			Scan	Ad-hoc mode
2.4 GHz	11b/g/n/ac ((V)HT20)	2412-2472 MHz	Active	Yes
W52	11a/n/ac ((V)HT20)	5180-5240 MHz	Active	Yes
	11n/ac ((V)HT40)	5190-5230 MHz	Active	Yes
	11ac (VHT80)	5210 MHz	Active	Yes
W53	11a/n/ac ((V)HT20)	5260-5320 MHz	Passive	No
	11n/ac ((V)HT40)	5270-5310 MHz	Passive	No
	11ac (VHT80)	5290 MHz	Passive	No
W56	11a/n/ac ((V)HT20)	5500-5700 MHz	Passive	No
	11n/ac ((V)HT40)	5510-5670 MHz	Passive	No
	11ac (VHT80)	5530-5610 MHz	Passive	No
W58	11a/n/ac ((V)HT20)	5745-5845 MHz	Active	Yes
	11n/ac ((V)HT40)	5755-5835 MHz	Active	Yes
	11ac (VHT80)	5775 MHz	Active	Yes

16 Tape and Reel Packing

16.1 Dimensions of Tape (Plastic Tape)

Figure 25 is a graphical representation of the tape dimension (plastic tape)[14].

Figure 25: Dimensions of Tape (Unit: mm)

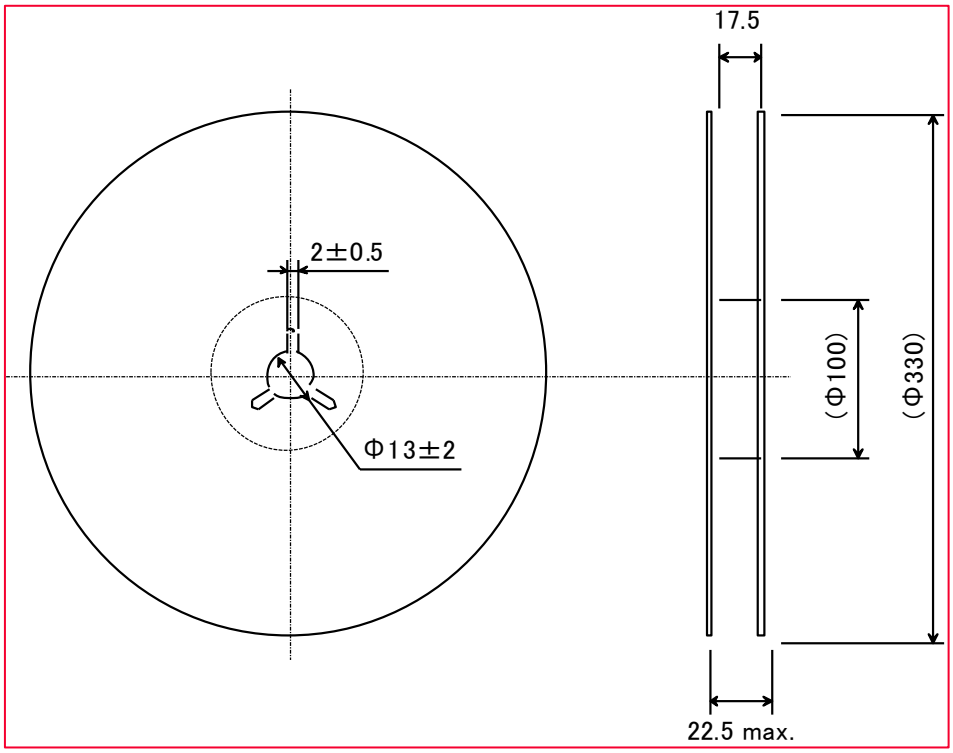


[14] Cumulative tolerance of maximum 40.0 ± 0.15 mm every 10 pitches

16.2 Dimensions of Reel

Figure 26 shows the reel dimensions.

Figure 26: Dimension of Reel (Unit: mm)



16.3 Taping Diagrams

Figure 27 shows the taping diagrams.

Figure 27: Taping Diagrams

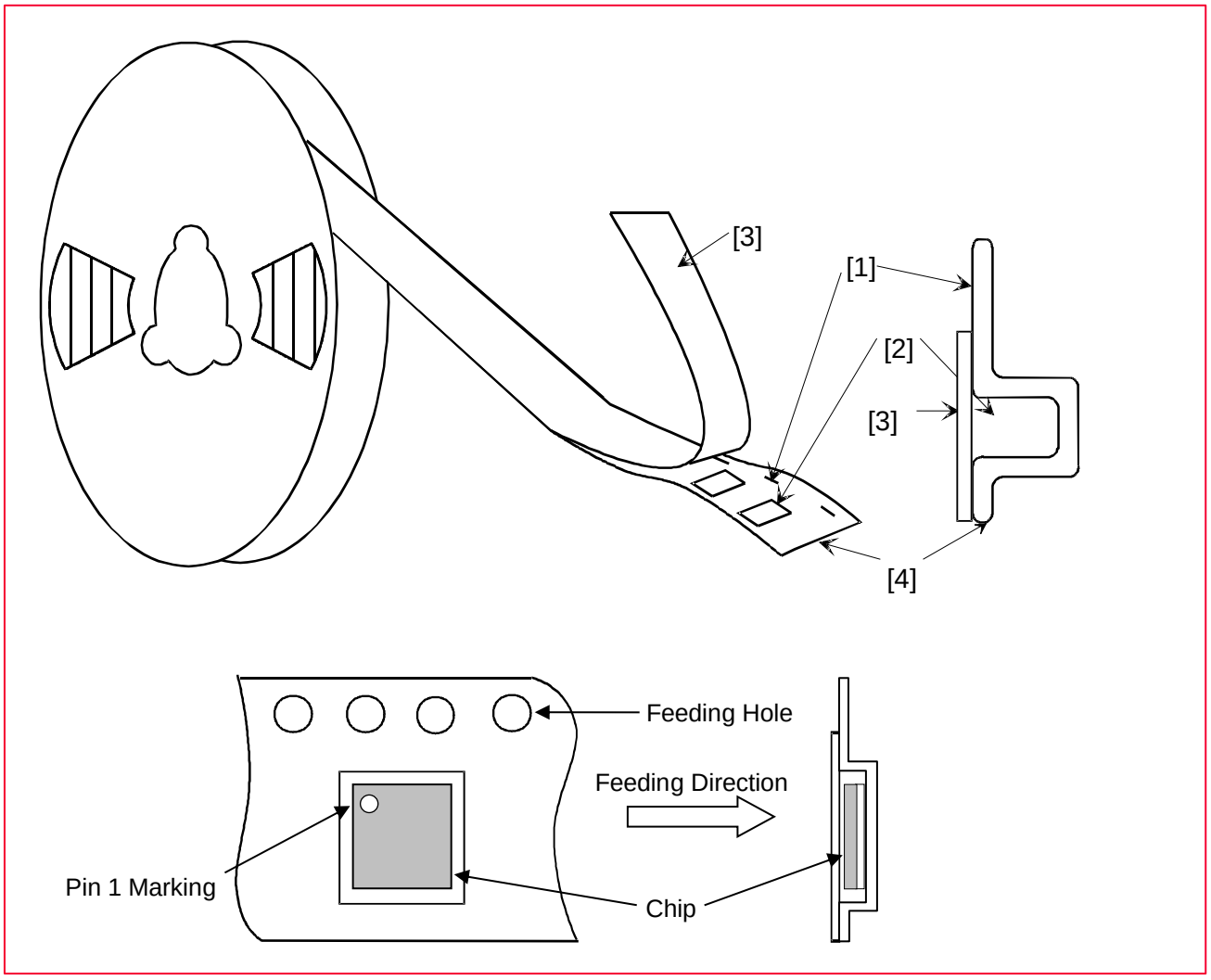


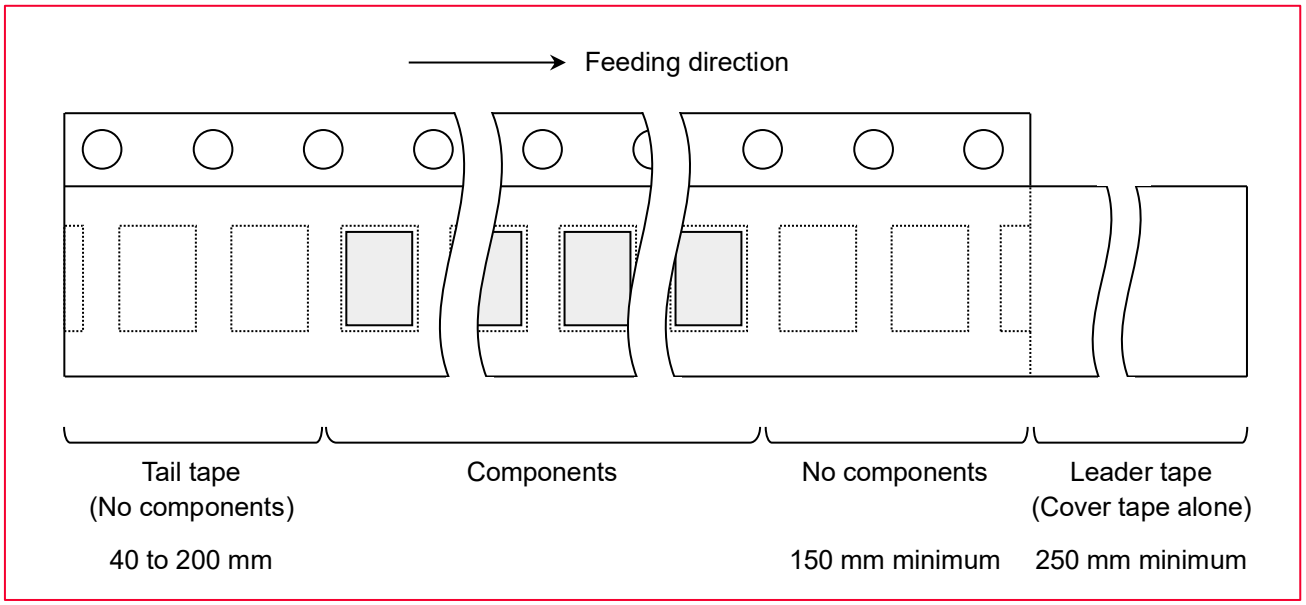
Table 78: Taping Specifications

Mark	Description
1	Feeding Hole. As specified in Dimensions of Tape (Plastic tape).
2	Hole for chip. As specified in Dimensions of Tape (Plastic tape).
3	Cover tape. 62 µm in thickness.
4	Base tape. As specified in Dimensions of Tape (Plastic tape).

16.4 Leader and Tail Tape

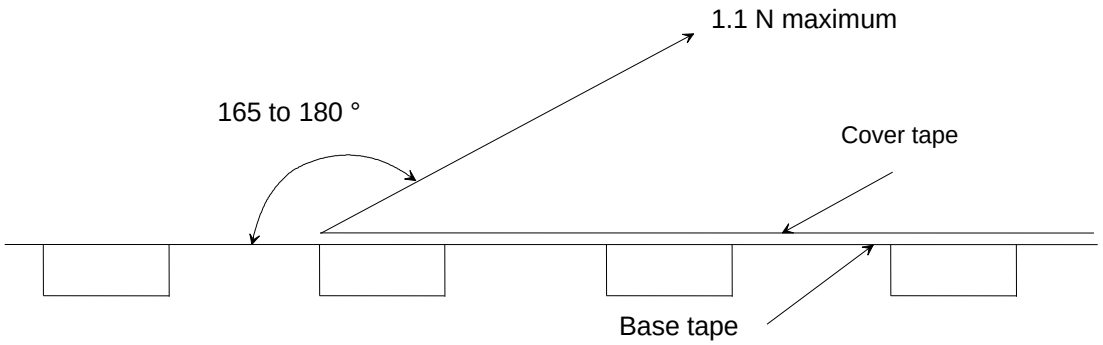
The leader and tail tape are shown in **Figure 28**.

Figure 28: Leader and Tail Tape



1. The tape for chips is wound clockwise, the feeding holes to the right side as the tape is pulled toward the user.
2. The cover tape and base tape are not adhered at no components area for 250 mm minimum.
3. Tear off strength against pulling of cover tape: 5 N minimum.
4. Packaging unit: 1000 pcs. / Reel
5. Material
   - Base tape: Plastic
   - Real: Plastic
   - Cover tape, cavity tape and reel are made the anti-static processing.
6. Peeling off force: 1.1 N maximum in the direction of peeling as shown in **Figure 29.**

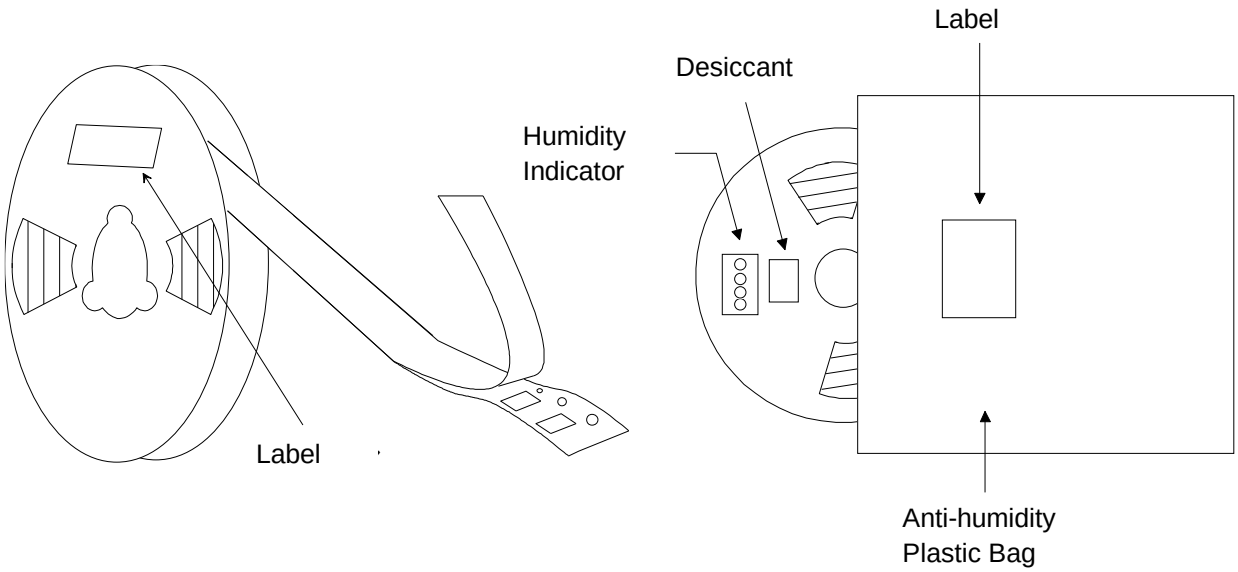
Figure 29: Peeling Off Force



16.5 Packaging (Humidity Proof Packing)

Figure 30 shows the humidity proof packaging.

Figure 30: 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, in particular, may be deformed at the temperature over 40 °C).
  - The product left more than 6 months after reception; it needs to be confirmed the solderability before used.
  - The product shall be stored in noncorrosive gas (Cl_2, NH_3, SO_2, NO_X, etc.).
  - Any excess mechanical shock including, but not limited to, sticking the packing materials by sharp object and dropping the product, shall not be applied in order not to damage the packing materials.
- This product is applicable to MSL3 (Based on 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. If there is any such damage, 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

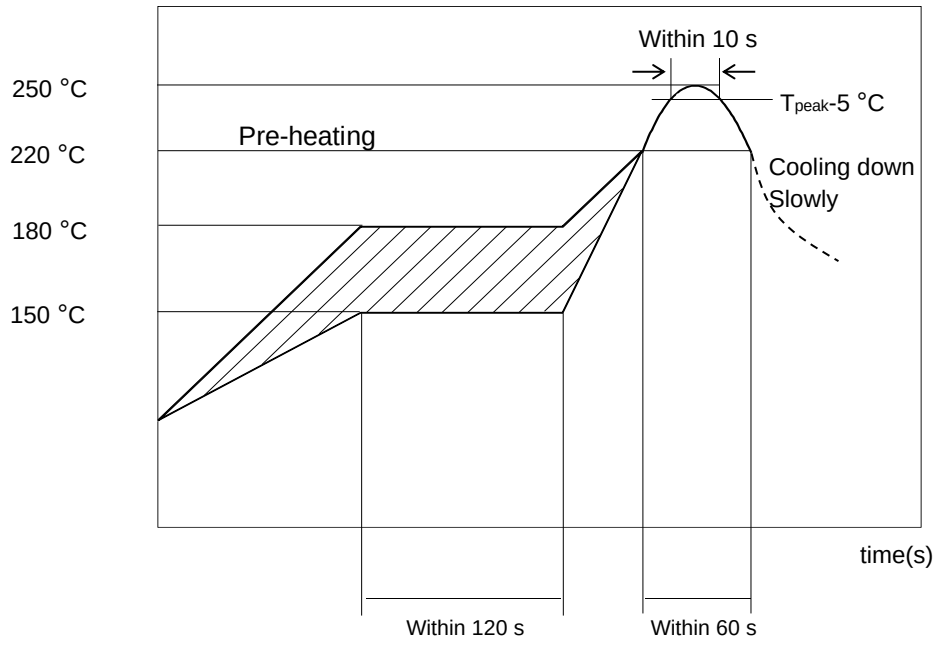
When placing products on the PCB, products may be stressed and broken by uneven forces from a worn-out chucking locating claw or a suction nozzle. To prevent products from damages, be sure to follow the specifications for the maintenance of the chip placer being used. For the positioning of products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

17.5 Soldering Conditions

The recommendation conditions of soldering are shown in **Figure 31**.

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 31: 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_2, NH_3, SO_X, NO_X etc.).
- In an atmosphere containing combustible and volatile gases.
- Dusty place.
- Direct sunlight place.
- Water splashing place.
- Humid place where water condenses.
- Freezing place.

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

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

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

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

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Revision History

Revision Code	Date	Changed Item	Comments
-	2019.10.25	First Issue	
A	2019.12.17	1. Scope 4. DIMENSIONS, MARKING AND TERMINAL CONFIGURATIONS 6.3 POWER ON SEQUENCE 11. LAND PATTERNS 12. REFERENCE CIRCUIT	• Added UART for Bluetooth • Updated • Updated • Updated • Added
B	2020.06.29	4. Added solder bumps 9. DC/RF Characteristics 12. Reference circuit	• Updated height to 1.30 mm and updated the figure of structure. • Correct typo of configuration pins • Added typical Target Power (TBD) • Updated schematic and correct typo
C	2020.08.07	9.10., 9.11. DC/RF Characteristics for Bluetooth / (LE)	• Defined Output power
D	2020.08.24	1. Scope 4. DIMENSIONS, MARKING AND TERMINAL CONFIGURATIONS	• Removed “Default” comment on SDIO of BT/BLE Host interface. • Updated Terminal configuration
E	2020.11.06	Updated to new format 5. CERTIFICATION CONDITIONS 6. DIMENSIONS, MARKING AND TERMINAL CONFIGURATIONS 8. Rating 9.1 Operating conditions 11.3 Bluetooth PCM Timing 14. REFERENCE CIRCUIT Appendix	• Added • Updated marking information. • Updated values. • Added Peak current • Update values. • Corrected typo of signal name “CONFIG_AUTO_REF_DET” • Defined Reference for U.FL/MHF and Reference for Trace Antenna • Added User manual and Antenna Installation Guide
F	2020.12.01	11.1.2 High Speed Mode 11.1.3 SDR12,25,50 Modes 11.2. High-Speed UART Specifications 11.3 Bluetooth PCM Timing 5.1 Radio Certification	• Corrected the diagram • Corrected the diagram • Updated • Updated • MIC Certification number is changed from “001-P01561” to “001-P01598”
G	2021.01.07	9.1 Operating conditions 5.1 Radio Certification 5.3 Bluetooth Qualification 12. DC / RF Characteristics Appendix	• Updated operating temperature from 75 to 85. • Added Tx Power limit file for each region • Added Bluetooth Power class setting file • Updated file names • Added configuration manual
H	2021.03.04	11.2 High-speed UART specifications Appendix - Trace Antenna Installation	• Added default baud rate information. • Added “F” values.
I	2021.04.01	2. Key feature & 5.2 Bluetooth Qualification 7.2 Pin Descriptions 14. Reference circuit	• Added a comment on supported Bluetooth functions • Updated the description of PMIC_EN. • Added values of matching components
J	2021.04.26	7.2 Pin descriptions 7.3 Configuration pins 7.4 Pin States	• Added comment to AVDD18 pin • Added comment on pull-up

Revision Code	Date	Changed Item	Comments
		10. Power Sequence	• Changed DVDD18 to AVDD18. Added Internal pull values • Separated Power ON Sequence and Power OFF Sequence
K	2021.12.14	7.4 Pin States 9.1 Operating Conditions 9.2 External Sleep Clock Requirements 10. Power Sequence	• Added SLP_CLK_IN • Defined IO current and Peak current • Added a comment • Defined timing parameters
L	2022.04.05	4. Block Diagram 11.1.1 Default Speed Mode 11.1.2 High Speed Mode 11.1.3 SDR12, SDR25, SDR50 Modes (up to 100 MHz) 11.1.4 SDR104 Mode (208 MHz) 11.1.5 DDR50 Mode (50 MHz)	• Revise the block diagram • Change the format of table. • Change the format of table. • Change the format of table. • Change the format of table. • Change the format of table.
M	2022.06.09	Appendix	• Translated Japanese to English.
N	2022.07.29	9.4 Package Thermal Conditions	• Added Package Thermal Conditions
O	2022.10.31	2. Key Features 3. Ordering Information 14. Reference Circuit Appendix	• Updated information • Added Embedded Artists' M.2 module information. • Moved section to HW app note. • Moved Appendix information into Sections 14 and 15. • Moved antenna sections to HW app note. • Added power table for Europe region. • Added Europe section from HW app note. Updated to new format
P	2023.01.13	7.4. Pin States 15. Radio Regulatory Certification by Country for LBEE5QD1ZM	• Added comments on termination of open pins. • Update Europe
Q	2023.03.10	7.2 Pin description	• Add comment into Pin 42:PMIC_EN
R	2023.03.24	9.3 PMIC_EN I/O Requirement	• Add sec9.3: PMIC_EN I/O Requirement, and Table14: PMIC_EN I/O Requirements

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