W-LAN+Bluetooth Combo Module Data Sheet

NXP 88W8987 Chipset
for 802.11a/b/g/n/ac + Bluetooth 5.1

Design Name: Type1ZM
Tentative P/N : LBEE5QD1ZM-TEMP

This Datasheet is preliminary version, and subject to change without notice.

Revision History

Revision Code	Date	Description	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 1.30mm, 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 Operationg 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

TABLE OF CONTENTS

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

1. Scope

This specification is applied to the IEEE802.11a/b/g/n/ac W-LAN + Bluetooth 5.1 combo module.

2. Key Features
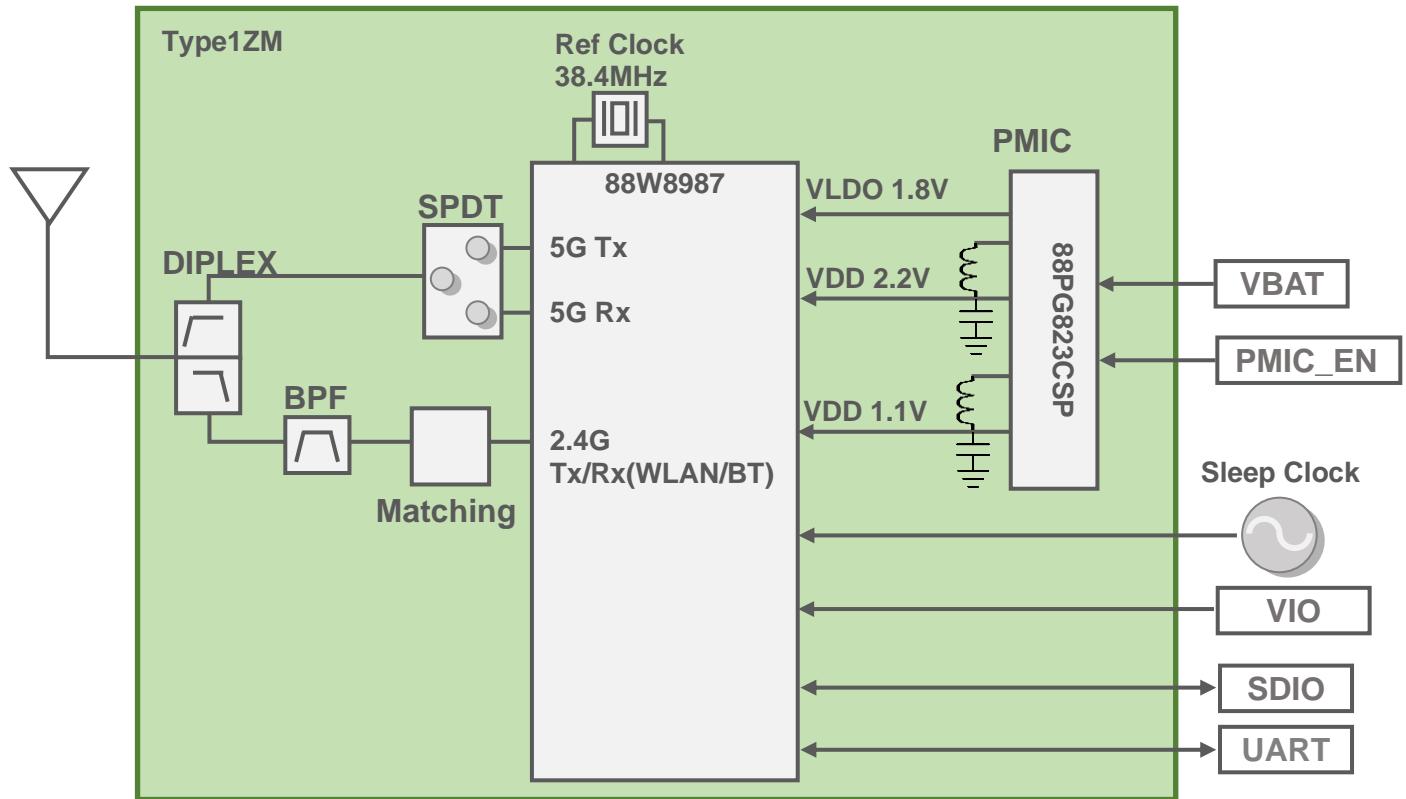
- NXP 88W8987 inside
- Compliant with IEEE802.11a/b/g/n/ac, SISO
- Compliant with Bluetooth specification v5.1
- Supports standard SDIO3.0 interface for WLAN
- UART / SDIO3.0 interfaces support for Bluetooth is Host Controller Interface (HCI)
- Surface mount type 10.2 x 9.3 mm(Typical), H = 1.3 mm(Max.)
- Weight : 318 mg
- MSL : 3
- RoHS compliant

3. Ordering Information

Ordering Part Number	Description
LBEE5QD1ZM-572	MP order
LBEE5QD1ZM-TEMP	In case of sample order
LBEE5QD1ZM-TEMP-D	EVK

"Type1ZM" is design name of this module. Design name may be used in certification test report.

4. Block Diagram

5. Certification Information

5.1. Radio Certification

USA
FCC ID: VPYLB1ZM
Country Code: US
Tx Power limit file： txpower_US.bin

Canada
IC: 772C-LB1ZM
Country Code: CA
Tx Power limit file： txpower_CA.bin

Europe
EN300328/301893, EN300440 conducted test report is prepared.
Country Code: DE
Tx Power limit file： txpower_EU.bin
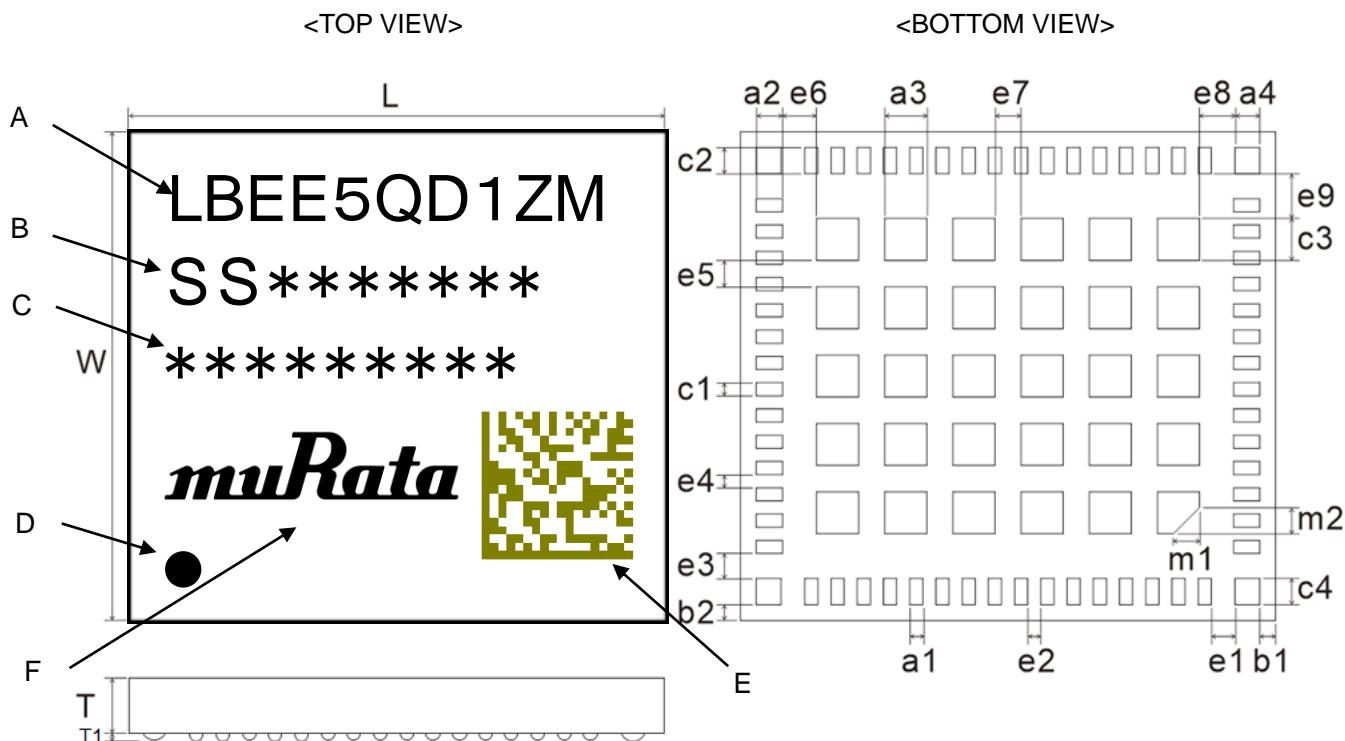
Japan
Japanese type certification is prepared.
Ⓡ 001-P01598
Country Code: JP
Tx Power limit file： txpower_JP.bin

The each country code are 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 Class1 by using "bt_power_config_1.sh".

6. Dimensions, Marking and Terminal Configurations

<TOP VIEW>   <BOTTOM VIEW>
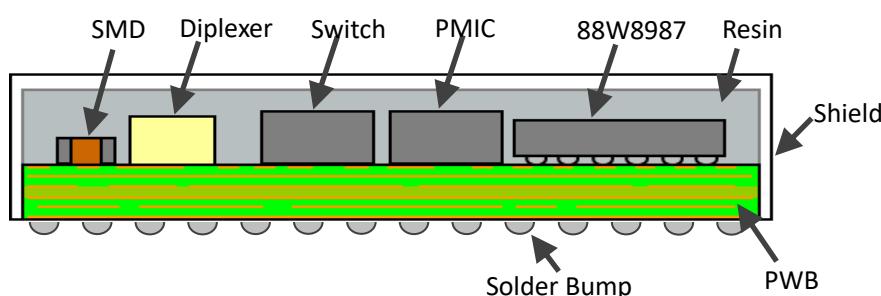
Marking	Meaning
A	Module Type
B	Inspection Number
C	Serial Number
D	Pin 1 Marking
E	2D code
F	Murata Logo

(unit : mm)

Mark	Dimensions	Mark	Dimensions	Mark	Dimensions
L	10.2 +/- 0.2	W	9.3 +/- 0.2	─	─
T	1.30 max.	T1	0.045 typ.	─	─
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.
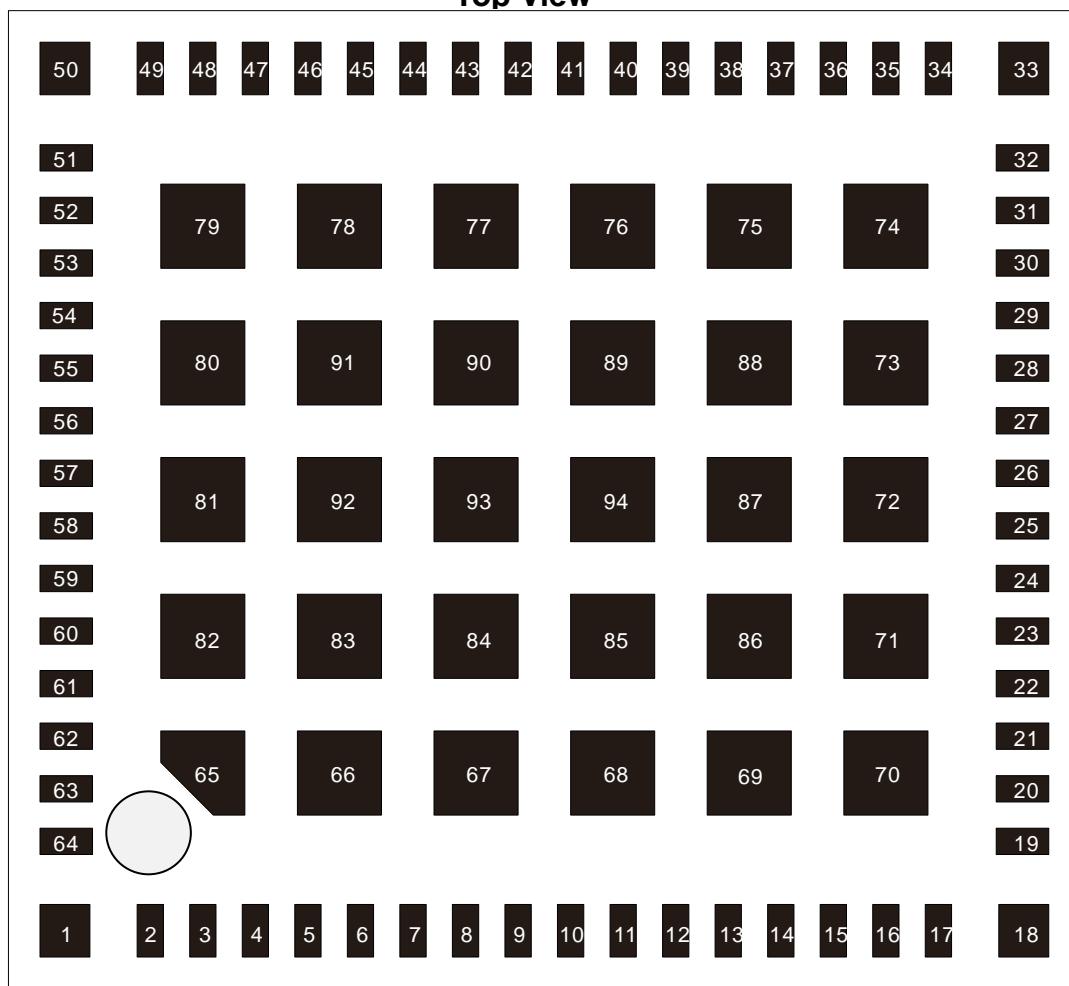
Structure

7. Module Pin Descriptions

7.1. Pin Assignments

Top View

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
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	VDD18	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

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	NC (VDD18)	O	AVDD18(88W8987) VLDO(PMIC)	NC
15	GND	-	-	Ground
16	GND	-	-	Ground
17	GND	-	-	Ground
18	GND	-	-	Ground
19	GND	-	-	Ground
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. *Configurable by software
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. *Configurable by software
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. *Configurable by software
41	GPIO12 (HOST_WAKEUP_BT) *1	I/O	GPIO[12]	Programmable GPIO Pin HOST to BT wakeup. *Configurable by software
42	PMIC_EN	I	EN(PMIC)	Enable Input for All Regulators · Logic high enables regulators and logic low disables regulators · When not in use, connect this pin to GND or connect a 0ohm resistor to GND · **Do not float this pin**
43	GND	-	-	Ground
44	NC	-	-	-
45	GND	-	-	Ground. (PDn)
46	GPIO11 (BT_UART_RTS)	I/O	GPIO[11]	Programmable GPIO Pin *Configurable by software
47	GPIO10 (BT_UART_CTS)	I/O	GPIO[10]	Programmable GPIO Pin *Configurable by software
48	GPIO9 (BT_UART_RXD)	I/O	GPIO[9]	Programmable GPIO Pin *Configurable by software
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 *Configurable by software
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.
*1：NXP recommended GPIO. Check whether NXP software can support this function or not.

7.3. Configuration Pins

CONFIG_HOST[0]	CONFIG_HOST[1]	WLAN	Bluetooth	Remarks
1	1	SDIO	SDIO	Murata Default
0	1	SDIO	UART	-

7.4. Pin States

Pin states information for the tables below 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.

I/O State Table

Pin Name	Supply	No Pad Power State	Reset State	HW State[6]	PD State[7]	PD Prog[8]	Internal PU/PD
GPIO0	VIO	tristate	output	output	drive low	yes	nominal PU
GPIO1	VIO	tristate	input	input	tristate	yes	weak PU
GPIO2	VIO	tristate	input	drive high[3]	tristate	yes	weak PU
GPIO3	VIO	tristate	input	drive high[3]	tristate	yes	weak PU
GPIO4	VIO	tristate	input	input	tristate	yes	nominal PU
GPIO5	VIO	tristate	input	input	tristate	yes	weak PU
GPIO6	VIO	tristate	input	input	tristate	yes	nominal PU
GPIO7	VIO	tristate	input	input	tristate	yes	nominal PU
GPIO8	VIO	tristate	input	Input[4] output[5]	drive low	yes	weak PU
GPIO9	VIO	tristate	input	input	tristate	yes	nominal PU
GPIO10	VIO	tristate	input	input	tristate	yes	nominal PU
GPIO11	VIO	tristate	input	Input[4] output[5]	drive high	yes	weak PU
GPIO12	VIO	tristate	input	Input	tristate	yes	nominal PD
GPIO13	VIO	tristate	input	Input[4] output[5]	drive high	yes	nominal PU
GPIO14	VIO	tristate	input	Input	tristate	yes	nominal PU
GPIO15	VIO	tristate	input	Input	drive high	yes	nominal PU
GPIO16	VIO	tristate	input	Input	tristate	yes	nominal PD
GPIO17	VIO	tristate	input	input	tristate	yes	weak PU
GPIO18	VIO	tristate	output	drive high	tristate	yes	weak PU
GPIO19	VIO	tristate	output	drive high	tristate	yes	weak PU
GPIO20	VIO	tristate	output	drive high[3]	tristate	yes	weak PU
SD_CLK	VIO	tristate	input	input	tristate	no	nominal PU
SD_CMD	VIO	tristate	input	input	tristate	no	nominal PU
SD_D0	VIO	tristate	input	input	tristate	no	nominal PU
SD_D1	VIO	tristate	input	input	tristate	no	nominal PU
SD_D2	VIO	tristate	input	input	tristate	no	nominal PU
SD_D3	VIO	tristate	input	input	tristate	no	nominal PU
CONFIG_HOST[0]	VDD18	tristate	input	input	tristate	no	weak PU
CONFIG_HOST[1]	VDD18	tristate	input	input	tristate	no	weak PU
CONFIG_AUTO_REF_DET	VDD18	tristate	input	input	tristate	no	weak PU

[1]: Not all GPIO pins can be used for Host-to-SoC wakeup signals.

[2]: Maximum input voltage is 0.4V when VIO has no power (or in uncertain situations).

[3]: The signal may toggle while boot code is executing.

[4]: When the device is in SDIO-SDIO mode.

[5]: When the device is in SDIO-UART mode.
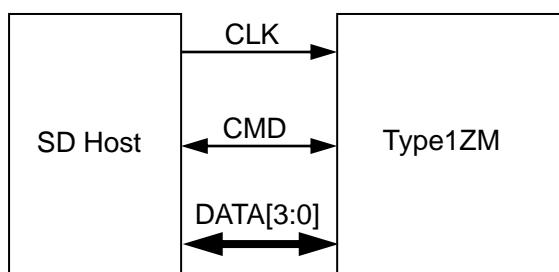
[6]: Hardware default state after reset

[7]: Power-down state
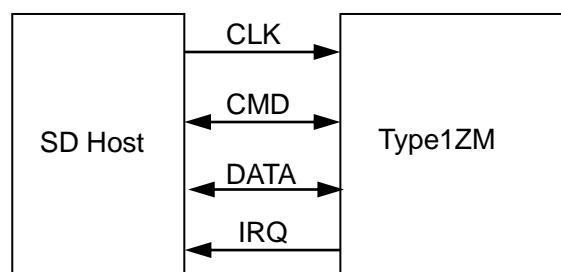
[8]: Power-down state programmable

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

(i) SD 4-bit Mode

(ii) SD 1-bit Mode

8. <u>Absolute Maximum Ratings</u>

Parameter		min.	max.	Unit
Storage Temperature		-40	+85	deg.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. <u>Operating Conditions</u>

9.1. <u>Operating conditions</u>

Parameter		min.	typ.	max.	unit
Operating Temperature		-30	25	+85	deg.C
Supply Voltage	VBAT	2.7	-	5.5	V
	VIO	1.62	1.8	1.92	V
Peak current	VBAT	—	770	950	mA

Note) Operation beyond the recommended operating conditions is neither recommended nor guaranteed.
*Peak current is happen during DPD calibration when the firmware is downloaded.

9.2. <u>External Sleep Clock Requirements</u>

Symbol	Parameter	Min	Typ	Max	Unit
CLK	Clock frequency range/accuracy CMOS input clock signal type $\pm$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 (@ 100kHz)	-	-125	-	dBc/Hz
Jc	Cycle jitter	-	1.5	-	ns(RMS)
SR	Slew rate limit (10-90%)	-	-	100	ns
DC	Duty cycle tolerance	20	-	80	%
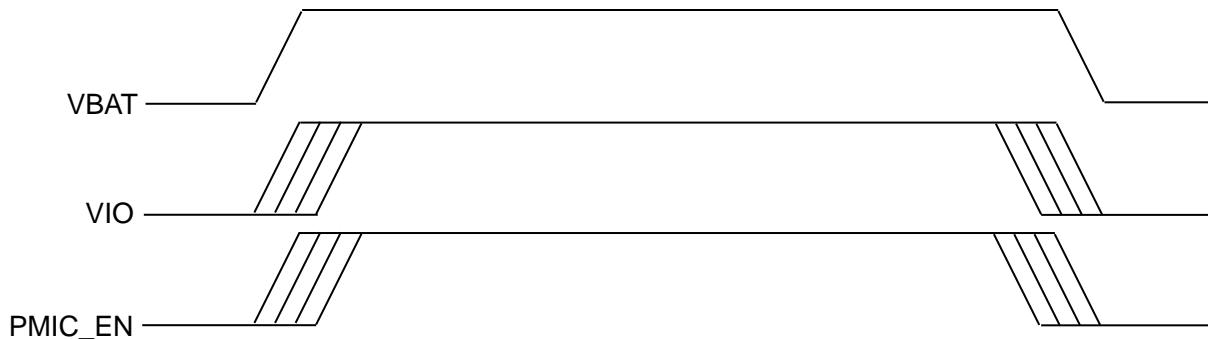
9.3. <u>Digital I/O Requirements</u>

Symbol	Parameter	Condition	Min	Typ	Max	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

10. Power Sequence

10.1. Power Sequence

- VIO must be good (90%) at the same time PMIC_EN ramps up
- Rump-up time of VIO must be <100ms

VBAT

VIO

PMIC_EN
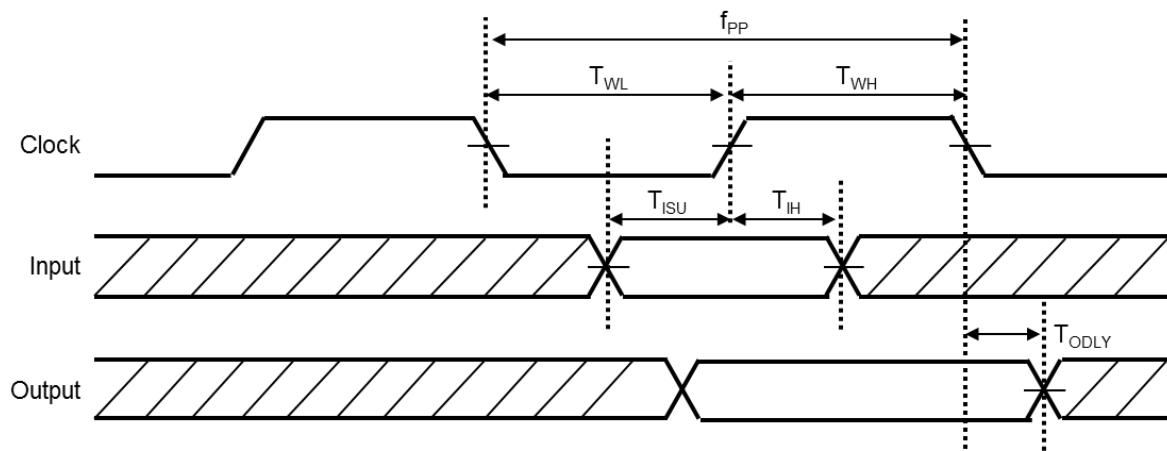
11. Interface Timing

11.1. SDIO Timing
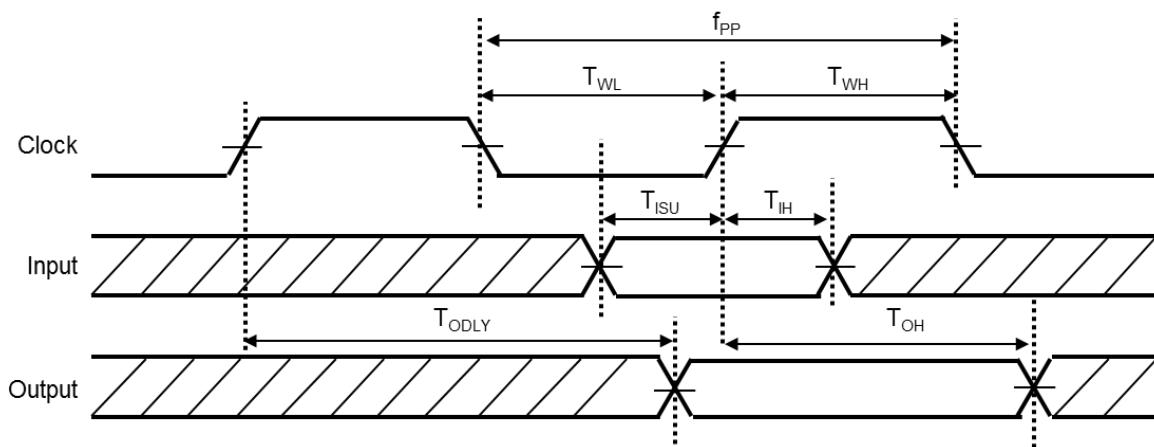
11.1.1. Default Speed Mode

SDIO Protocol Timing Diagram-Default Speed Mode

11.1.2. High Speed Mode
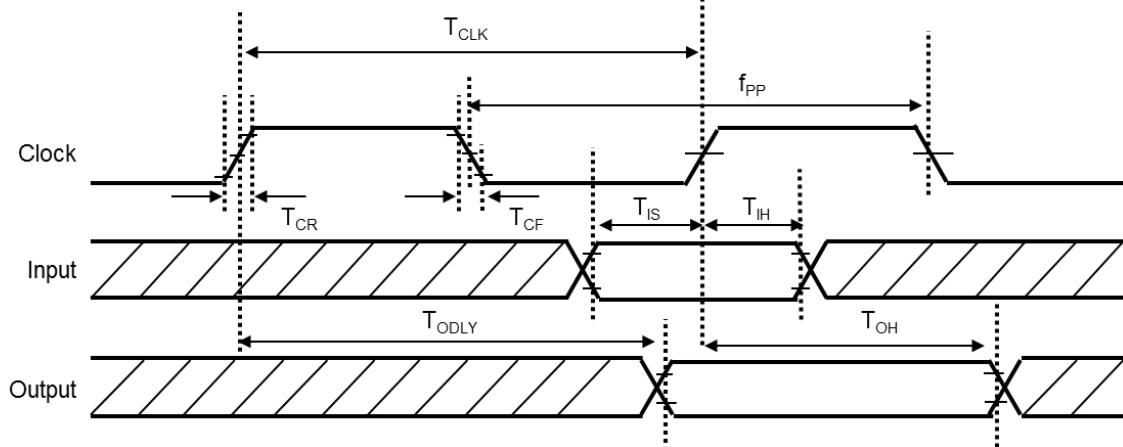
SDIO Protocol Timing Diagram-High Speed Mode

Symbol	Parameter	Condition	Min	Typ	Max	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_{WH}	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_{ODLY}	Output delay time CL≦40pF (1 card)	Normal	-	-	14	ns
		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)
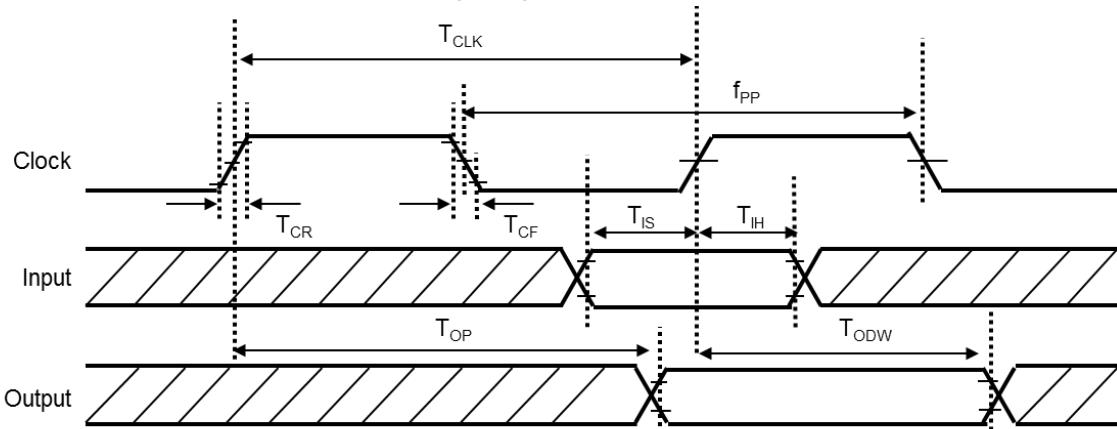
SDIO Protocol Timing Diagram-SDR12,SDR25,SDR50 Mode(up to 100MHz)

Symbol	Parameter	Condition	Min	Typ	Max	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
T_{CR},T_{CF}	Rise time , fall time	SDR12/25/50	-	-	$0.2*T_{CLK}$	ns
T_{ODLY}	Output delay time $T_{CR},T_{CF}< 2ns(max)$ at 100MHz $C_{CARD} = 10pF$	SDR12/25/50	-	-	7.5	ns
T_{OH}	Output hold time	SDR12/25/50	1.5	-	-	ns

11.1.4. SDR104 Mode(208MHz)
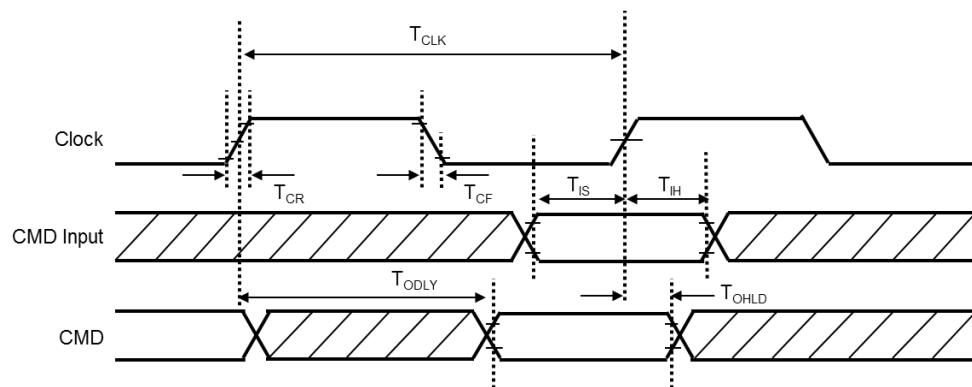
SDIO Protocol Timing Diagram-SDR104 Mode (208MHz)
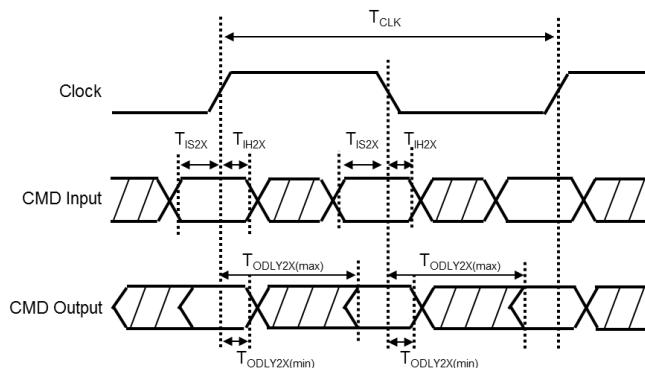
Symbol	Parameter	Condition	Min	Typ	Max	Unit
f_{PP}	Clock frequency	SDR104	0	-	208	MHz
T_{IS}	Input setup time	SDR104	1.4	-	-	ns
T_{IH}	Input hold time	SDR104	0.8	-	-	ns
T_{CLK}	Clock time	SDR104	4.8	-	-	ns
T_{CR},T_{CF}	Rise time , fall time $T_{CR},T_{CF}< 0.96ns(max)$ at 208MHz $C_{CARD} = 10pF$	SDR104	-	-	$0.2*T_{CLK}$	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(50MHz)

SDIO CMD Timing Diagram-DDR50 Mode (50MHz)
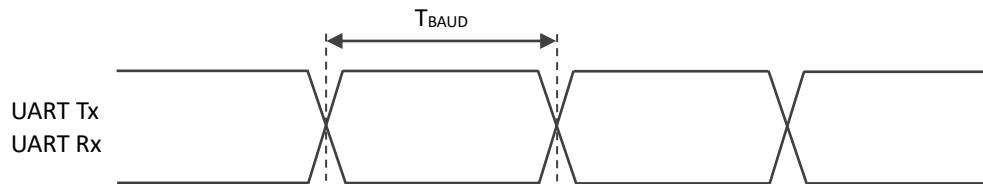
SDIO DATA Timing Diagram-DDR50 Mode (50MHz)

Symbol	Parameter	Condition	Min	Typ	Max	Unit
Clock						
T_{CLK}	Clock time 50MHz (max) between rising edge	DDR50	20	-	-	ns
T_{CR}, T_{CF}	Rise time , fall time $T_{CR}, T_{CF} < 4.00ns$(max) at 50MHz $C_{CARD} = 10pF$	DDR50	-	-	$0.2*T_{CLK}$	ns
Clock Duty	-	DDR50	45	-	55	%
CMD Input (referenced to clock rising edge)						
T_{IS}	Input setup time $C_{CARD} \leqq 10pF$(1 card)	DDR50	6	-	-	ns
T_{IH}	Input hold time $C_{CARD} \leqq 10pF$(1 card)	DDR50	0.8	-	-	ns
CMD Input (referenced to clock rising edge)						
T_{ODLY}	Output delay time during data transfer mode $C_L \leqq 30pF$(1 card)	DDR50	-	-	13.7	ns
T_{OHLD}	Output hold time $C_L \geqq 15pF$(1 card)	DDR50	1.5	-	-	ns
DAT[3:0] Input (referenced to clock rising and falling edges)						
T_{IS2X}	Input setup time $C_{CARD} \leqq 10pF$(1 card)	DDR50	3	-	-	ns
T_{IH2X}	Input hold time $C_{CARD} \leqq 10pF$(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 $C_L \leqq 25pF$(1 card)	DDR50	-	-	7	ns
$T_{ODLY2X(min)}$	Output hold time $C_L \geqq 15pF$(1 card)	DDR50	1.5	-	-	ns

11.2. High-speed UART specifications
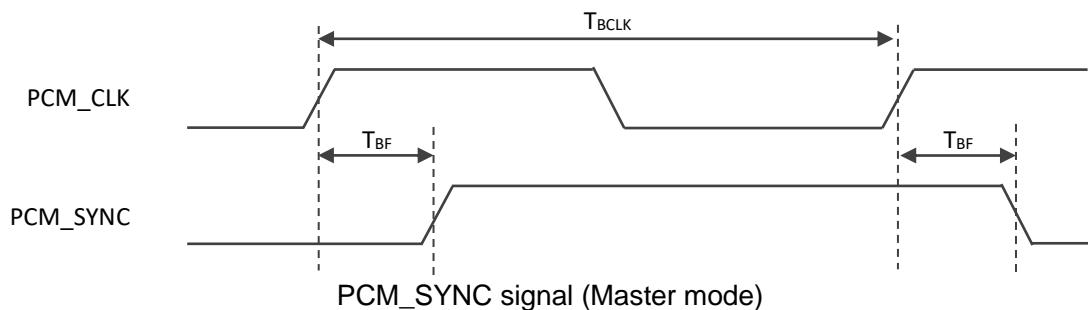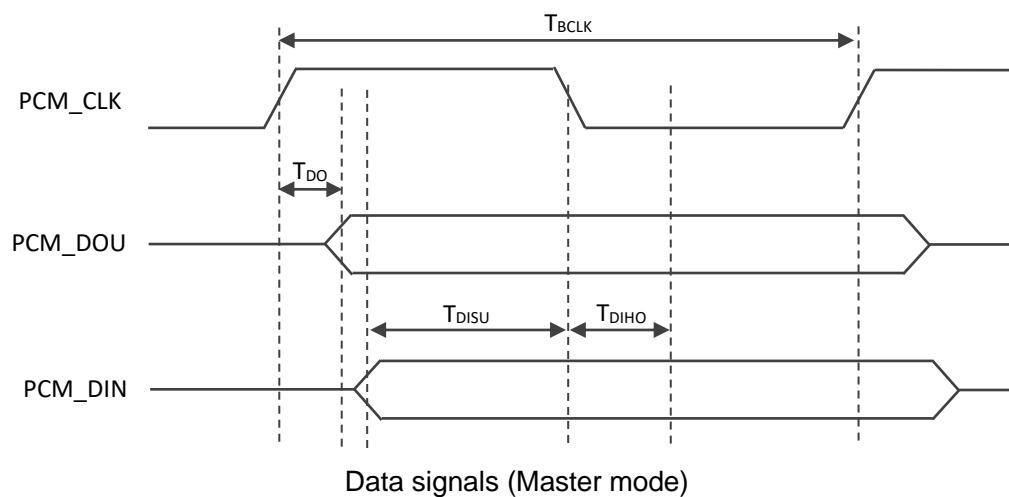
Symbol	Parameter	Condition	Min	Typ	Max	Unit
T_{BAUD}	Baud rate	38.4MHz	250	-	-	ns

* The acceptable deviation from the UART Rx target baud rate is ±3%.
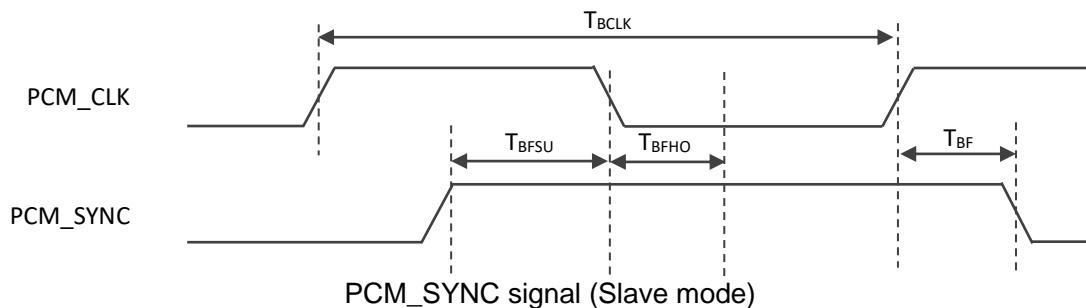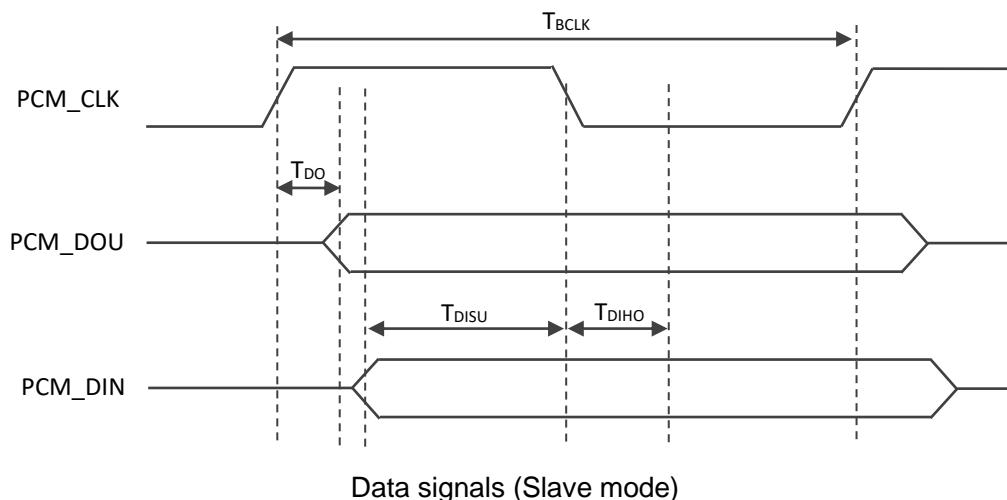
11.3. Bluetooth PCM Timing

11.3.1. Master mode

Data signals (Master mode)

PCM_SYNC signal (Master mode)

Symbol	Parameter	Condition	Min.	Typ.	Max.	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
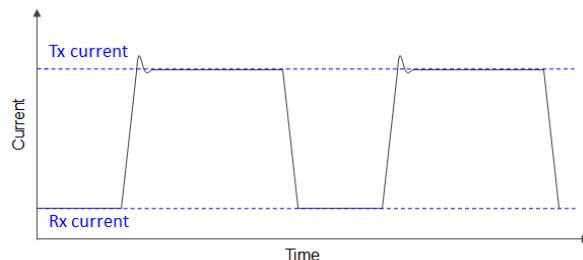
Data signals (Slave mode)

PCM_SYNC signal (Slave mode)

Symbol	Parameter	Condition	Min.	Typ.	Max.	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 file.

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 (Class1)

・Burst current definition

12.1. DC/RF Characteristics for IEEE802.11b - 2.4GHz

Specification	IEEE802.11b
Mode	DSSS / CCK
Channel Frequency	2412 - 2472MHz
Data rate	1, 2, 5.5, 11Mbps

12.1.1. High Rate Condition for IEEE802.11b – 2.4GHz

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

Items	Contents			
- DC Characteristics -	Min.	Typ.	Max.	Unit
1. DC current				
1) Tx mode	-	384	535	mA
2) Rx mode	-	64	76	mA
- Tx Characteristics -	Min.	Typ.	Max.	Unit
2. Output Power	15.0	17.0	19.0	dBm
3. Spectrum Mask Margin				
1) 1st side lobes	0	-	-	dB
2) 2nd side lobes	0	-	-	dB
4. Power-on/off ramp	-	-	2.0	Usec
5. RF Carrier Suppression	15	-	-	dB
6. Modulation Accuracy	-	-	35	%
7. Frequency tolerance	-20		20	ppm
8. Spurious Emissions				
1) 30-47MHz (BW=100kHz)	-	-	-36	dBm
2) 47-74MHz (BW=100kHz)	-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)	-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)	-	-	-54	dBm
5) 118-174MHz (BW=100kHz)	-	-	-36	dBm
6) 174-230MHz (BW=100kHz)	-	-	-54	dBm
7) 230-470MHz (BW=100kHz)	-	-	-36	dBm
8) 470-862MHz (BW=100kHz)	-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)	-	-	-36	dBm
10) 1000-12750MHz (BW=1MHz)	-	-	-30	dBm
- Rx Characteristics -	Min.	Typ.	Max.	Unit
9. Minimum Input Level (FER≤ 8%)	-	-	-76	dBm
10. Maximum Input Level (FER ≤ 8%)	-10	-	-	dBm
11. Adjacent Channel Rejection (FER< 8%)	35	-	-	dB

12.1.2. Low Rate Condition for IEEE802.11b – 2.4GHz

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

Items	Contents			
- DC Characteristics -	Min.	Typ.	Max.	Unit
1. DC current				
1) Tx mode	-	370	516	mA
2) Rx mode	-	64	76	mA
- Tx Characteristics -	Min.	Typ.	Max.	Unit
2. Output Power	15.0	17.0	19.0	dBm
3. Spectrum Mask Margin				
1) 1st side lobes	0	-	-	dB
2) 2nd side lobes	0	-	-	dB
4. Power-on/off ramp	-	-	2.0	Usec
5. RF Carrier Suppression	15	-	-	dB
6. Modulation Accuracy	-	-	35	%
7. Frequency tolerance	-20		20	ppm
8. Spurious Emissions				
1) 30-47MHz (BW=100kHz)	-	-	-36	dBm
2) 47-74MHz (BW=100kHz)	-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)	-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)	-	-	-54	dBm
5) 118-174MHz (BW=100kHz)	-	-	-36	dBm
6) 174-230MHz (BW=100kHz)	-	-	-54	dBm
7) 230-470MHz (BW=100kHz)	-	-	-36	dBm
8) 470-862MHz (BW=100kHz)	-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)	-	-	-36	dBm
10) 1000-12750MHz (BW=1MHz)	-	-	-30	dBm
- Rx Characteristics -	Min.	Typ.	Max.	Unit
9. Minimum Input Level (FER$\leq$ 8%)	-	-	-80	dBm
10. Maximum Input Level (FER $\leq$ 8%)	-4	-	-	dBm
11. Adjacent Channel Rejection (FER< 8%)	35	-	-	dB

12.2. DC/RF Characteristics for IEEE802.11g - 2.4GHz

Specification	IEEE802.11g
Mode	OFDM
Channel Frequency	2412 - 2472MHz
Data rate	6, 9, 12, 18, 24, 36, 48, 54Mbps

12.2.1. High Rate Condition for IEEE802.11g – 2.4GHz

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

Items	Contents			
- DC Characteristics -	Min.	Typ.	Max.	Unit
1. DC current				
1) Tx mode	-	336	458	mA
2) Rx mode	-	64	76	mA
- Tx Characteristics -	Min.	Typ.	Max.	Unit
2. Output Power	15.0	16.0	18.0	dBm
3. Spectrum Mask Margin				
1) 9MHz to 11MHz (0~ -20dBr)	0	-	-	dB
2) 11MHz to 20MHz (-20~ -28dBr)	0	-	-	dB
3) 20MHz to 30MHz (-28~ -40dBr)	0	-	-	dB
4) 30MHz to 33MHz (-40dBr)	0	-	-	dB
4. Constellation Error(EVM)	-	-	-25	dB
5. Frequency tolerance	-20		20	ppm
6. Spurious Emissions				
1) 30-47MHz (BW=100kHz)	-	-	-36	dBm
2) 47-74MHz (BW=100kHz)	-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)	-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)	-	-	-54	dBm
5) 118-174MHz (BW=100kHz)	-	-	-36	dBm
6) 174-230MHz (BW=100kHz)	-	-	-54	dBm
7) 230-470MHz (BW=100kHz)	-	-	-36	dBm
8) 470-862MHz (BW=100kHz)	-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)	-	-	-36	dBm
10) 1000-12750MHz (BW=1MHz)	-	-	-30	dBm
- Rx Characteristics -	Min.	Typ.	Max.	Unit
7. Minimum Input Level (PER < 10%)	-	-	-65	dBm
8. Maximum Input Level (PER < 10%)	-20	-	-	dBm
9. Adjacent Channel Rejection (PER< 10%)	-1	-	-	dB

12.2.2. Low Rate Condition for IEEE802.11g – 2.4GHz

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

Items	Contents			
- DC Characteristics -	Min.	Typ.	Max.	Unit
1. DC current				
1) Tx mode	-	366	504	mA
2) Rx mode	-	64	76	mA
- Tx Characteristics -	Min.	Typ.	Max.	Unit
2. Output Power	15.0	17.0	19.0	dBm
3. Spectrum Mask Margin				
1) 9MHz to 11MHz (0~ -20dBr)	0	-	-	dB
2) 11MHz to 20MHz (-20~ -28dBr)	0	-	-	dB
3) 20MHz to 30MHz (-28~ -40dBr)	0	-	-	dB
4) 30MHz to 33MHz (-40dBr)	0	-	-	dB
4. Constellation Error(EVM)	-	-	-5	dB
5. Frequency tolerance	-20		20	ppm
6. Spurious Emissions				
1) 30-47MHz (BW=100kHz)	-	-	-36	dBm
2) 47-74MHz (BW=100kHz)	-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)	-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)	-	-	-54	dBm
5) 118-174MHz (BW=100kHz)	-	-	-36	dBm
6) 174-230MHz (BW=100kHz)	-	-	-54	dBm
7) 230-470MHz (BW=100kHz)	-	-	-36	dBm
8) 470-862MHz (BW=100kHz)	-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)	-	-	-36	dBm
10) 1000-12750MHz (BW=1MHz)	-	-	-30	dBm
- Rx Characteristics -	Min.	Typ.	Max.	Unit
7. Minimum Input Level (PER < 10%)	-	-	-82	dBm
8. Maximum Input Level (PER < 10%)	-20	-	-	dBm
9. Adjacent Channel Rejection (PER< 10%)	-1	-	-	dB

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

Specification	IEEE802.11n
Mode	OFDM
Channel Frequency	2412 - 2472MHz
Data rate	MCS0-MCS7

12.3.1. High Rate Condition for IEEE802.11n – 2.4GHz

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

Items	Contents			
- DC Characteristics -	Min.	Typ.	Max.	Unit
1. DC current				
1) Tx mode	-	316	426	mA
2) Rx mode	-	64	76	mA
- Tx Characteristics -	Min.	Typ.	Max.	Unit
2. Output Power	13.0	15.0	17.0	dBm
3. Spectrum Mask Margin				
1) 9MHz to 11MHz (0~ -20dBr)	0	-	-	dB
2) 11MHz to 20MHz (-20~ -28dBr)	0	-	-	dB
3) 20MHz to 30MHz (-28~ -45dBr)	0	-	-	dB
4) 30MHz to 33MHz (-45dBr)	0	-	-	dB
4. Constellation Error (EVM) (measured at enhanced mode)	-	-	-27	dB
5. Frequency tolerance	-20		20	ppm
6. Spurious Emissions				
1) 30-47MHz (BW=100kHz)	-	-	-36	dBm
2) 47-74MHz (BW=100kHz)	-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)	-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)	-	-	-54	dBm
5) 118-174MHz (BW=100kHz)	-	-	-36	dBm
6) 174-230MHz (BW=100kHz)	-	-	-54	dBm
7) 230-470MHz (BW=100kHz)	-	-	-36	dBm
8) 470-862MHz (BW=100kHz)	-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)	-	-	-36	dBm
10) 1000-12750MHz (BW=1MHz)	-	-	-30	dBm
- Rx Characteristics -	Min.	Typ.	Max.	Unit
7. Minimum Input Level (PER ≤ 10%)	-	-	-64	dBm
8. Maximum Input Level (PER < 10%)	-20	-	-	dBm
9. Adjacent Channel Rejection (PER≤ 10%)	-2	-	-	dB

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12.3.2. Low Rate Condition for IEEE802.11n – 2.4GHz

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

Items	Contents			
- DC Characteristics -	Min.	Typ.	Max.	Unit
1. DC current				
1) Tx mode	-	342	466	mA
2) Rx mode	-	64	76	mA
- Tx Characteristics -	Min.	Typ.	Max.	Unit
2. Output Power	14.0	16.0	18.0	dBm
3. Spectrum Mask Margin				
1) 9MHz to 11MHz (0~ -20dBr)	0	-	-	dB
2) 11MHz to 20MHz (-20~ -28dBr)	0	-	-	dB
3) 20MHz to 30MHz (-28~ -45dBr)	0	-	-	dB
4) 30MHz to 33MHz (-45dBr)	0	-	-	dB
4. Constellation Error (EVM) (measured at enhanced mode)	-	-	-5	dB
5. Frequency tolerance	-20		20	ppm
6. Spurious Emissions				
1) 30-47MHz (BW=100kHz)	-	-	-36	dBm
2) 47-74MHz (BW=100kHz)	-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)	-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)	-	-	-54	dBm
5) 118-174MHz (BW=100kHz)	-	-	-36	dBm
6) 174-230MHz (BW=100kHz)	-	-	-54	dBm
7) 230-470MHz (BW=100kHz)	-	-	-36	dBm
8) 470-862MHz (BW=100kHz)	-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)	-	-	-36	dBm
10) 1000-12750MHz (BW=1MHz)	-	-	-30	dBm
- Rx Characteristics -	Min.	Typ.	Max.	Unit
7. Minimum Input Level (PER $\leq$ 10%)	-	-	-82	dBm
8. Maximum Input Level (PER < 10%)	-20	-	-	dBm
9. Adjacent Channel Rejection (PER$\leq$ 10%)	-2	-	-	dB

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

Specification	IEEE802.11a
Mode	OFDM
Channel Frequency	5180 to 5240MHz, 5260 to 5320MHz, 5500 to 5720MHz, 5745 to 5825MHz
Data rate	6, 9, 12, 18, 24, 36, 48, 54Mbps

12.4.1. High Rate Condition for IEEE802.11a – 5GHz

Conditions : 25deg.C, VBAT=3.3V, VIO=1.8V, Output power setting=15dBm at module pad, 54Mbps mode

Items	Contents			
- DC Characteristics -	min.	Typ.	Max.	Unit
1. DC current				
1) Tx mode	-	408	626	mA
2) Rx mode	-	79	90	mA
- Tx Characteristics -	min.	Typ.	Max.	Unit
2. Output Power	13.0	15.0	17.0	dBm
3. Spectrum Mask Margin				
1) 9MHz to 11MHz (0~ -20dBr)	0	-	-	dB
2) 11MHz to 20MHz (-20~ -28dBr)	0	-	-	dB
3) 20MHz to 30MHz (-28~ -45dBr)	0	-	-	dB
4) 30MHz to 33MHz (-45dBr)	0	-	-	dB
4. Constellation Error (EVM) (measured at enhanced mode)	-	-	-25	dB
5. Frequency tolerance	-20		20	ppm
6. Spurious Emissions				
1) 30-47MHz (BW=100kHz)	-	-	-36	dBm
2) 47-74MHz (BW=100kHz)	-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)	-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)	-	-	-54	dBm
5) 118-174MHz (BW=100kHz)	-	-	-36	dBm
6) 174-230MHz (BW=100kHz)	-	-	-54	dBm
7) 230-470MHz (BW=100kHz)	-	-	-36	dBm
8) 470-862MHz (BW=100kHz)	-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)	-	-	-36	dBm
10) 1000-5150MHz (BW=1MHz)	-	-	-30	dBm
11) 5350-5470MHz (BW=1MHz)	-	-	-30	dBm
12) 5725-26000MHz (BW=1MHz)	-	-	-30	dBm
- Rx Characteristics -	Min.	Typ.	Max.	Unit
7. Minimum Input Level (PER ≤ 10%)	-	-	-65	dBm
8. Maximum Input Level (PER < 10%)	-30	-	-	dBm
9. Adjacent Channel Rejection (PER≤ 10%)	-1	-	-	dB

12.4.2. Low Rate Condition for IEEE802.11a – 5GHz

Conditions : 25deg.C, VBAT=3.3V, VIO=1.8V, Output power setting=15dBm at module pad, 6Mbps mode

Items	Contents			
- DC Characteristics -	min.	Typ.	Max.	Unit
1. DC current				
1) Tx mode	-	408	626	mA
2) Rx mode	-	79	90	mA
- Tx Characteristics -	min.	Typ.	Max.	Unit
2. Output Power	13.0	15.0	17.0	dBm
3. Spectrum Mask Margin				
1) 9MHz to 11MHz (0~ -20dBr)	0	-	-	dB
2) 11MHz to 20MHz (-20~ -28dBr)	0	-	-	dB
3) 20MHz to 30MHz (-28~ -45dBr)	0	-	-	dB
4) 30MHz to 33MHz (-45dBr)	0	-	-	dB
4. Constellation Error (EVM) (measured at enhanced mode)	-	-	-5	dB
5. Frequency tolerance	-20		20	ppm
6. Spurious Emissions				
1) 30-47MHz (BW=100kHz)	-	-	-36	dBm
2) 47-74MHz (BW=100kHz)	-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)	-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)	-	-	-54	dBm
5) 118-174MHz (BW=100kHz)	-	-	-36	dBm
6) 174-230MHz (BW=100kHz)	-	-	-54	dBm
7) 230-470MHz (BW=100kHz)	-	-	-36	dBm
8) 470-862MHz (BW=100kHz)	-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)	-	-	-36	dBm
10) 1000-5150MHz (BW=1MHz)	-	-	-30	dBm
11) 5350-5470MHz (BW=1MHz)	-	-	-30	dBm
12) 5725-26000MHz (BW=1MHz)	-	-	-30	dBm
- Rx Characteristics -	Min.	Typ.	Max.	Unit
7. Minimum Input Level (PER ≤ 10%)	-	-	-82	dBm
8. Maximum Input Level (PER < 10%)	-30	-	-	dBm
9. Adjacent Channel Rejection (PER≤ 10%)	-1	-	-	dB

12.5. DC/RF Characteristics for IEEE802.11n(HT20) - 5GHz

Specification	IEEE802.11n
Mode	OFDM
Channel Frequency	5180 to 5240MHz, 5260 to 5320MHz, 5500 to 5720MHz, 5745 to 5825MHz
Data rate	MCS0-MCS7

12.5.1. High Rate Condition for IEEE802.11n(HT20) – 5GHz

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

Items	Contents			
- DC Characteristics -	min.	Typ.	Max.	Unit
1. DC current				
1) Tx mode	-	386	586	mA
2) Rx mode	-	79	90	mA
- Tx Characteristics -	min.	Typ.	Max.	Unit
2. Output Power	12.0	14.0	16.0	dBm
3. Spectrum Mask Margin				
1) 9MHz to 11MHz (0~ -20dBr)	0	-	-	dB
2) 11MHz to 20MHz (-20~ -28dBr)	0	-	-	dB
3) 20MHz to 30MHz (-28~ -45dBr)	0	-	-	dB
4) 30MHz to 33MHz (-45dBr)	0	-	-	dB
4. Constellation Error (EVM) (measured at enhanced mode)	-	-	-27	dB
5. Frequency tolerance	-20		20	ppm
6. Spurious Emissions				
1) 30-47MHz (BW=100kHz)	-	-	-36	dBm
2) 47-74MHz (BW=100kHz)	-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)	-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)	-	-	-54	dBm
5) 118-174MHz (BW=100kHz)	-	-	-36	dBm
6) 174-230MHz (BW=100kHz)	-	-	-54	dBm
7) 230-470MHz (BW=100kHz)	-	-	-36	dBm
8) 470-862MHz (BW=100kHz)	-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)	-	-	-36	dBm
10) 1000-5150MHz (BW=1MHz)	-	-	-30	dBm
11) 5350-5470MHz (BW=1MHz)	-	-	-30	dBm
12) 5725-26000MHz (BW=1MHz)	-	-	-30	dBm
- Rx Characteristics -	Min.	Typ.	Max.	Unit
7. Minimum Input Level (PER ≤ 10%)	-	-	-64	dBm
8. Maximum Input Level (PER < 10%)	-30	-	-	dBm
9. Adjacent Channel Rejection (PER≤ 10%)	-2	-	-	dB

12.5.2. Low Rate Condition for IEEE802.11n(HT20) – 5GHz

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

Items	Contents			
- DC Characteristics -	min.	Typ.	Max.	Unit
1. DC current				
1) Tx mode	-	386	586	mA
2) Rx mode	-	79	90	mA
- Tx Characteristics -	min.	Typ.	Max.	Unit
2. Output Power	12.0	14.0	16.0	dBm
3. Spectrum Mask Margin				
1) 9MHz to 11MHz (0~ -20dBr)	0	-	-	dB
2) 11MHz to 20MHz (-20~ -28dBr)	0	-	-	dB
3) 20MHz to 30MHz (-28~ -45dBr)	0	-	-	dB
4) 30MHz to 33MHz (-45dBr)	0	-	-	dB
4. Constellation Error (EVM) (measured at enhanced mode)	-	-	-5	dB
5. Frequency tolerance	-20		20	ppm
6. Spurious Emissions				
1) 30-47MHz (BW=100kHz)	-	-	-36	dBm
2) 47-74MHz (BW=100kHz)	-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)	-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)	-	-	-54	dBm
5) 118-174MHz (BW=100kHz)	-	-	-36	dBm
6) 174-230MHz (BW=100kHz)	-	-	-54	dBm
7) 230-470MHz (BW=100kHz)	-	-	-36	dBm
8) 470-862MHz (BW=100kHz)	-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)	-	-	-36	dBm
10) 1000-5150MHz (BW=1MHz)	-	-	-30	dBm
11) 5350-5470MHz (BW=1MHz)	-	-	-30	dBm
12) 5725-26000MHz (BW=1MHz)	-	-	-30	dBm
- Rx Characteristics -	Min.	Typ.	Max.	Unit
7. Minimum Input Level (PER ≤ 10%)	-	-	-82	dBm
8. Maximum Input Level (PER < 10%)	-30	-	-	dBm
9. Adjacent Channel Rejection (PER≤ 10%)	-2	-	-	dB

12.6. DC/RF Characteristics for IEEE802.11ac(HT20) - 5GHz

Specification	IEEE802.11ac
Mode	OFDM
Channel Frequency	5180 to 5240MHz, 5260 to 5320MHz, 5500 to 5720MHz, 5745 to 5825MHz
Data rate	MCS0-MCS8

12.6.1. High Rate Condition for IEEE802.11ac(VHT20) – 5GHz

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

Items	Contents			
- DC Characteristics -	min.	Typ.	Max.	Unit
1. DC current				
1) Tx mode	-	385	584	mA
2) Rx mode	-	79	90	mA
- Tx Characteristics -	min.	Typ.	Max.	Unit
2. Output Power	12.0	14.0	16.0	dBm
3. Spectrum Mask Margin				
1) 9MHz to 11MHz (0~ -20dBr)	0	-	-	dB
2) 11MHz to 20MHz (-20~ -28dBr)	0	-	-	dB
3) 20MHz to 30MHz (-28~ -45dBr)	0	-	-	dB
4) 30MHz to 33MHz (-45dBr)	0	-	-	dB
4. Constellation Error (EVM) (measured at enhanced mode)	-	-	-30	dB
5. Frequency tolerance	-20		20	ppm
6. Spurious Emissions				
1) 30-47MHz (BW=100kHz)	-	-	-36	dBm
2) 47-74MHz (BW=100kHz)	-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)	-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)	-	-	-54	dBm
5) 118-174MHz (BW=100kHz)	-	-	-36	dBm
6) 174-230MHz (BW=100kHz)	-	-	-54	dBm
7) 230-470MHz (BW=100kHz)	-	-	-36	dBm
8) 470-862MHz (BW=100kHz)	-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)	-	-	-36	dBm
10) 1000-5150MHz (BW=1MHz)	-	-	-30	dBm
11) 5350-5470MHz (BW=1MHz)	-	-	-30	dBm
12) 5725-26000MHz (BW=1MHz)	-	-	-30	dBm
- Rx Characteristics -	Min.	Typ.	Max.	Unit
7. Minimum Input Level (PER ≤ 10%)	-	-	-59	dBm
8. Maximum Input Level (PER < 10%)	-30	-	-	dBm
9. Adjacent Channel Rejection (PER≤ 10%)	-7	-	-	dB

12.6.2. Low Rate Condition for IEEE802.11ac(VHT20) – 5GHz

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

Items	Contents			
- DC Characteristics -	min.	Typ.	Max.	Unit
1. DC current				
1) Tx mode	-	385	584	mA
2) Rx mode	-	79	90	mA
- Tx Characteristics -	min.	Typ.	Max.	Unit
2. Output Power	12.0	14.0	16.0	dBm
3. Spectrum Mask Margin				
1) 9MHz to 11MHz (0~ -20dBr)	0	-	-	dB
2) 11MHz to 20MHz (-20~ -28dBr)	0	-	-	dB
3) 20MHz to 30MHz (-28~ -45dBr)	0	-	-	dB
4) 30MHz to 33MHz (-45dBr)	0	-	-	dB
4. Constellation Error (EVM) (measured at enhanced mode)	-	-	-5	dB
5. Frequency tolerance	-20		20	ppm
6. Spurious Emissions				
1) 30-47MHz (BW=100kHz)	-	-	-36	dBm
2) 47-74MHz (BW=100kHz)	-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)	-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)	-	-	-54	dBm
5) 118-174MHz (BW=100kHz)	-	-	-36	dBm
6) 174-230MHz (BW=100kHz)	-	-	-54	dBm
7) 230-470MHz (BW=100kHz)	-	-	-36	dBm
8) 470-862MHz (BW=100kHz)	-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)	-	-	-36	dBm
10) 1000-5150MHz (BW=1MHz)	-	-	-30	dBm
11) 5350-5470MHz (BW=1MHz)	-	-	-30	dBm
12) 5725-26000MHz (BW=1MHz)	-	-	-30	dBm
- Rx Characteristics -	Min.	Typ.	Max.	Unit
7. Minimum Input Level (PER ≤ 10%)	-	-	-82	dBm
8. Maximum Input Level (PER < 10%)	-30	-	-	dBm
9. Adjacent Channel Rejection (PER≤ 10%)	-7	-	-	dB

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

Specification	IEEE802.11n
Mode	OFDM
Frequency	5190 to 5795MHz
Data rate	MCS0-MCS7

12.7.1. High Rate Condition for IEEE802.11n(HT40) – 5GHz

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

Items	Contents			
- DC Characteristics -	min.	Typ.	Max.	Unit
1. DC current				
1) Tx mode	-	387	583	mA
2) Rx mode	-	91	103	mA
- Tx Characteristics -	min.	Typ.	Max.	Unit
2. Output Power	12.0	14.0	16.0	dBm
3. Spectrum Mask Margin				
1) 19MHz to 21MHz (0~ -20dBr)	0	-	-	dB
2) 21MHz to 40MHz (-20~ -28dBr)	0	-	-	dB
3) 40MHz to 60MHz (-28~ -45dBr)	0	-	-	dB
4) 60MHz to 80MHz (-45dBr)	0	-	-	dB
4. Constellation Error (EVM) (measured at enhanced mode)	-	-	-27	dB
5. Frequency tolerance	-20		20	ppm
6. Spurious Emissions				
1) 30-47MHz (BW=100kHz)	-	-	-36	dBm
2) 47-74MHz (BW=100kHz)	-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)	-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)	-	-	-54	dBm
5) 118-174MHz (BW=100kHz)	-	-	-36	dBm
6) 174-230MHz (BW=100kHz)	-	-	-54	dBm
7) 230-470MHz (BW=100kHz)	-	-	-36	dBm
8) 470-862MHz (BW=100kHz)	-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)	-	-	-36	dBm
10) 1000-5150MHz (BW=1MHz)	-	-	-30	dBm
11) 5350-5470MHz (BW=1MHz)	-	-	-30	dBm
12) 5725-26000MHz (BW=1MHz)	-	-	-30	dBm
- Rx Characteristics -	Min.	Typ.	Max.	Unit
7. Minimum Input Level (PER $\leq$ 10%)	-	-	-61	dBm
8. Maximum Input Level (PER $\leq$ 10%)	-30	-	-	dBm
9. Adjacent Channel Rejection (PER $\leq$ 10%)	-2	-	-	dB

12.7.2. Low Rate Condition for IEEE802.11n(HT40) – 5GHz

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

Items	Contents			
- DC Characteristics -	min.	Typ.	Max.	Unit
1. DC current				
1) Tx mode	-	387	583	mA
2) Rx mode	-	91	103	mA
- Tx Characteristics -	min.	Typ.	Max.	Unit
2. Output Power	12.0	14.0	16.0	dBm
3. Spectrum Mask Margin				
1) 19MHz to 21MHz (0~ -20dBr)	0	-	-	dB
2) 21MHz to 40MHz (-20~ -28dBr)	0	-	-	dB
3) 40MHz to 60MHz (-28~ -45dBr)	0	-	-	dB
4) 60MHz to 80MHz (-45dBr)	0	-	-	dB
4. Constellation Error (EVM) (measured at enhanced mode)	-	-	-5	dB
5. Frequency tolerance	-20		20	ppm
6. Spurious Emissions				
1) 30-47MHz (BW=100kHz)	-	-	-36	dBm
2) 47-74MHz (BW=100kHz)	-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)	-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)	-	-	-54	dBm
5) 118-174MHz (BW=100kHz)	-	-	-36	dBm
6) 174-230MHz (BW=100kHz)	-	-	-54	dBm
7) 230-470MHz (BW=100kHz)	-	-	-36	dBm
8) 470-862MHz (BW=100kHz)	-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)	-	-	-36	dBm
10) 1000-5150MHz (BW=1MHz)	-	-	-30	dBm
11) 5350-5470MHz (BW=1MHz)	-	-	-30	dBm
12) 5725-26000MHz (BW=1MHz)	-	-	-30	dBm
- Rx Characteristics -	Min.	Typ.	Max.	Unit
7. Minimum Input Level (PER $\leq$ 10%)	-	-	-79	dBm
8. Maximum Input Level (PER $\leq$ 10%)	-30	-	-	dBm
9. Adjacent Channel Rejection (PER $\leq$ 10%)	-2	-	-	dB

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

Specification	IEEE802.11ac
Mode	OFDM
Frequency	5190 to 5795MHz
Data rate	MCS0-MCS9

12.8.1. High Rate Condition for IEEE802.11ac(VHT40) – 5GHz

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

Items	Contents			
- DC Characteristics -	min.	Typ.	Max.	Unit
1. DC current				
1) Tx mode	-	357	528	mA
2) Rx mode	-	91	103	mA
- Tx Characteristics -	min.	Typ.	Max.	Unit
2. Output Power	11.0	13.0	15.0	dBm
3. Spectrum Mask Margin				
1) 19MHz to 21MHz (0~ -20dBr)	0	-	-	dB
2) 21MHz to 40MHz (-20~ -28dBr)	0	-	-	dB
3) 40MHz to 60MHz (-28~ -45dBr)	0	-	-	dB
4) 60MHz to 80MHz (-45dBr)	0	-	-	dB
4. Constellation Error (EVM) (measured at enhanced mode)	-	-	-32	dB
5. Frequency tolerance	-20		20	ppm
6. Spurious Emissions				
1) 30-47MHz (BW=100kHz)	-	-	-36	dBm
2) 47-74MHz (BW=100kHz)	-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)	-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)	-	-	-54	dBm
5) 118-174MHz (BW=100kHz)	-	-	-36	dBm
6) 174-230MHz (BW=100kHz)	-	-	-54	dBm
7) 230-470MHz (BW=100kHz)	-	-	-36	dBm
8) 470-862MHz (BW=100kHz)	-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)	-	-	-36	dBm
10) 1000-5150MHz (BW=1MHz)	-	-	-30	dBm
11) 5350-5470MHz (BW=1MHz)	-	-	-30	dBm
12) 5725-26000MHz (BW=1MHz)	-	-	-30	dBm
- Rx Characteristics -	Min.	Typ.	Max.	Unit
7. Minimum Input Level (PER $\leq$ 10%)	-	-	-54	dBm
8. Maximum Input Level (PER $\leq$ 10%)	-30	-	-	dBm
9. Adjacent Channel Rejection (PER $\leq$ 10%)	-9	-	-	dB

12.8.2. Low Rate Condition for IEEE802.11ac(VHT40) – 5GHz

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

Items	Contents			
- DC Characteristics -	min.	Typ.	Max.	Unit
1. DC current				
1) Tx mode	-	388	585	mA
2) Rx mode	-	91	103	mA
- Tx Characteristics -	min.	Typ.	Max.	Unit
2. Output Power	12.0	14.0	16.0	dBm
3. Spectrum Mask Margin				
1) 19MHz to 21MHz (0~ -20dBr)	0	-	-	dB
2) 21MHz to 40MHz (-20~ -28dBr)	0	-	-	dB
3) 40MHz to 60MHz (-28~ -45dBr)	0	-	-	dB
4) 60MHz to 80MHz (-45dBr)	0	-	-	dB
4. Constellation Error (EVM) (measured at enhanced mode)	-	-	-5	dB
5. Frequency tolerance	-20		20	ppm
6. Spurious Emissions				
1) 30-47MHz (BW=100kHz)	-	-	-36	dBm
2) 47-74MHz (BW=100kHz)	-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)	-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)	-	-	-54	dBm
5) 118-174MHz (BW=100kHz)	-	-	-36	dBm
6) 174-230MHz (BW=100kHz)	-	-	-54	dBm
7) 230-470MHz (BW=100kHz)	-	-	-36	dBm
8) 470-862MHz (BW=100kHz)	-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)	-	-	-36	dBm
10) 1000-5150MHz (BW=1MHz)	-	-	-30	dBm
11) 5350-5470MHz (BW=1MHz)	-	-	-30	dBm
12) 5725-26000MHz (BW=1MHz)	-	-	-30	dBm
- Rx Characteristics -	Min.	Typ.	Max.	Unit
7. Minimum Input Level (PER $\leq$ 10%)	-	-	-79	dBm
8. Maximum Input Level (PER $\leq$ 10%)	-30	-	-	dBm
9. Adjacent Channel Rejection (PER $\leq$ 10%)	-9	-	-	dB

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

Specification	IEEE802.11ac
Mode	OFDM
Channel Frequency	5210 - 5775MHz
Data rate	MCS0-MCS9

12.9.1. High Rate Condition for IEEE802.11ac(VHT80) – 5GHz

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

Items	Contents			
- DC Characteristics -	min.	Typ.	Max.	Unit
1. DC current				
1) Tx mode	-	376	558	mA
2) Rx mode	-	102	114	mA
- Tx Characteristics -	min.	Typ.	Max.	Unit
2. Output Power	11.0	13.0	15.0	dBm
3. Spectrum Mask Margin				
1) 39MHz to 41MHz (0~ -20dBr)	0	-	-	dB
2) 41MHz to 80MHz (-20~ -28dBr)	0	-	-	dB
3) 80MHz to 120MHz (-28~ -40dBr)	0	-	-	dB
4) 120MHz to 140MHz (-40dBr)	0	-	-	dB
4. Constellation Error (EVM) (measured at enhanced mode)	-	-	-32	dB
5. Frequency tolerance	-20		20	ppm
6. Spurious Emissions				
1) 30-47MHz (BW=100kHz)	-	-	-36	dBm
2) 47-74MHz (BW=100kHz)	-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)	-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)	-	-	-54	dBm
5) 118-174MHz (BW=100kHz)	-	-	-36	dBm
6) 174-230MHz (BW=100kHz)	-	-	-54	dBm
7) 230-470MHz (BW=100kHz)	-	-	-36	dBm
8) 470-862MHz (BW=100kHz)	-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)	-	-	-36	dBm
10) 1000-5150MHz (BW=1MHz)	-	-	-30	dBm
11) 5350-5470MHz (BW=1MHz)	-	-	-30	dBm
12) 5725-26000MHz (BW=1MHz)	-	-	-30	dBm
- Rx Characteristics -	Min.	Typ.	Max.	Unit
6. Minimum Input Level (PER $\leq$ 10%)	-	-	-51	dBm
7. Maximum Input Level (PER $\leq$ 10%)	-30	-	-	dBm
8. Adjacent Channel Rejection (PER $\leq$ 10%)	-9	-	-	dB

12.9.2. Low Rate Condition for IEEE802.11ac(VHT80) – 5GHz

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

Items	Contents			
- DC Characteristics -	min.	Typ.	Max.	Unit
1. DC current				
1) Tx mode	-	406	611	mA
2) Rx mode	-	102	114	mA
- Tx Characteristics -	min.	Typ.	Max.	Unit
2. Output Power	12.0	14.0	16.0	dBm
3. Spectrum Mask Margin				
1) 39MHz to 41MHz (0~ -20dBr)	0	-	-	dB
2) 41MHz to 80MHz (-20~ -28dBr)	0	-	-	dB
3) 80MHz to 120MHz (-28~ -40dBr)	0	-	-	dB
4) 120MHz to 140MHz (-40dBr)	0	-	-	dB
4. Constellation Error (EVM) (measured at enhanced mode)	-	-	-5	dB
5. Frequency tolerance	-20		20	ppm
6. Spurious Emissions				
1) 30-47MHz (BW=100kHz)	-	-	-36	dBm
2) 47-74MHz (BW=100kHz)	-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)	-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)	-	-	-54	dBm
5) 118-174MHz (BW=100kHz)	-	-	-36	dBm
6) 174-230MHz (BW=100kHz)	-	-	-54	dBm
7) 230-470MHz (BW=100kHz)	-	-	-36	dBm
8) 470-862MHz (BW=100kHz)	-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)	-	-	-36	dBm
10) 1000-5150MHz (BW=1MHz)	-	-	-30	dBm
11) 5350-5470MHz (BW=1MHz)	-	-	-30	dBm
12) 5725-26000MHz (BW=1MHz)	-	-	-30	dBm
- Rx Characteristics -	Min.	Typ.	Max.	Unit
6. Minimum Input Level (PER ≤ 10%)	-	-	-76	dBm
7. Maximum Input Level (PER ≤ 10%)	-30	-	-	dBm
8. Adjacent Channel Rejection (PER ≤ 10%)	-9	-	-	dB

12.10. DC/RF Characteristics for Bluetooth

Items	Contents
Bluetooth specification (power class)	Version 5.1 (Class1)
Channel frequency (spacing)	2402 to 2480 MHz (1MHz)
Number of RF Channel	79

12.10.1. Basic Data Rate Condition
Conditions : 25deg.C, VBAT=3.3V, VIO=1.8V

Items	Contents			
Current Consumption	Min.	Typ.	Max.	Unit
1) Tx mode DH5	-	91	115	mA
2) Rx mode DH5	-	61	73	mA
- Tx Characteristics -	Min.	Typ.	Max.	Unit
Output Power@DH5	0	3.0	6.0	dBm
Frequency range	2400	-	2483.5	MHz
20dB bandwidth	-		1	MHz
Adjacent Channel Power*				
1) [M-N] =2	-	-	-20	dBm
2) [M-N] ≥3	-	-	-40	dBm
Modulation characteristics				
1) Modulation Δf1avg	140	151	175	kHz
2) Modulation Δf2max	115		-	kHz
3) Modulation Δf2avg / Δf1avg	0.8	1	-	
Carrier Frequency Drift				
1) 1slot	-25	-	25	kHz
2) 3slot / 5slot	-40	-	40	kHz
3) Maximum drift rate		-	20	kHz/50us
- Rx Characteristics -	Min.	Typ.	Max.	Unit
BR Sensitivity (BER≤0.1%)	-	-96	-70	dBm
Maximum Input Level (BER≤0.1%)	-20	-	-	dBm

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

12.10.2. Enhanced Data Rate Condition

Conditions : 25deg.C, VBAT=3.3V, VIO=1.8V

Items	Contents			
Current Consumption	Min.	Typ.	Max.	Unit
1) Tx mode 2DH5	-	87	107	mA
2) Rx mode 2DH5	-	61	73	mA
3) Tx mode 3DH5	-	87	107	mA
4) Rx mode 3DH5	-	61	73	mA
- Tx Characteristics -	Min.	Typ.	Max.	Unit
Output Power@2DH5/3DH5	-3.0	0	3.0	dBm
Frequency range	2400	-	2483.5	MHz
20dB bandwidth	-		1	MHz
Adjacent Channel Power*				
1) [M-N] =2	-	-	-20	dBm
2) [M-N] ≥3	-	-	-40	dBm
EDR Relative Power	-4	-	1	dB
EDR Carrier Frequency Stability and Modulation Accuracy				
1) ωi	-75	-	75	kHz
2) ωi+ωo	-75	-	75	kHz
3) ωo	-10	-	10	kHz
4) RMS DEVM (DQPSK)	-	-	20	%
5) Peak DEVM (DQPSK)	-	-	35	%
6) 99% DEVM (DQPSK)	-	-	30	%
7) RMS DEVM (8DPSK)	-	-	13	%
8) Peak DEVM (8DPSK)	-	-	25	%
9) 99% DEVM (8DPSK)	-	-	20	%
Spurious Emissions				
1) 30-47MHz (BW=100kHz)	-	-	-36	dBm
2) 47-74MHz (BW=100kHz)	-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)	-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)	-	-	-54	dBm
5) 118-174MHz (BW=100kHz)	-	-	-36	dBm
6) 174-230MHz (BW=100kHz)	-	-	-54	dBm
7) 230-470MHz (BW=100kHz)	-	-	-36	dBm
8) 470-862MHz (BW=100kHz)	-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)	-	-	-36	dBm
10) 1000-12750MHz (BW=1MHz)	-	-	-30	dBm
- Rx Characteristics -	Min.	Typ.	Max.	Unit
EDR Sensitivity (BER≤0.007%)@8DPSK	-	-88	-70	dBm
Maximum Input Level (BER≤0.1%)	-20	-	-	dBm

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

12.11. DC/RF Characteristics for Bluetooth Low Energy

Items	Contents
Bluetooth specification (power class)	Version 5.1 (Class1.5)
Channel frequency (spacing)	2402 to 2480 MHz (2MHz)
Number of RF Channel	40

12.11.1. 1Mbps PHY Condition

Conditions : 25deg.C, VBAT=3.3V, VIO=1.8V
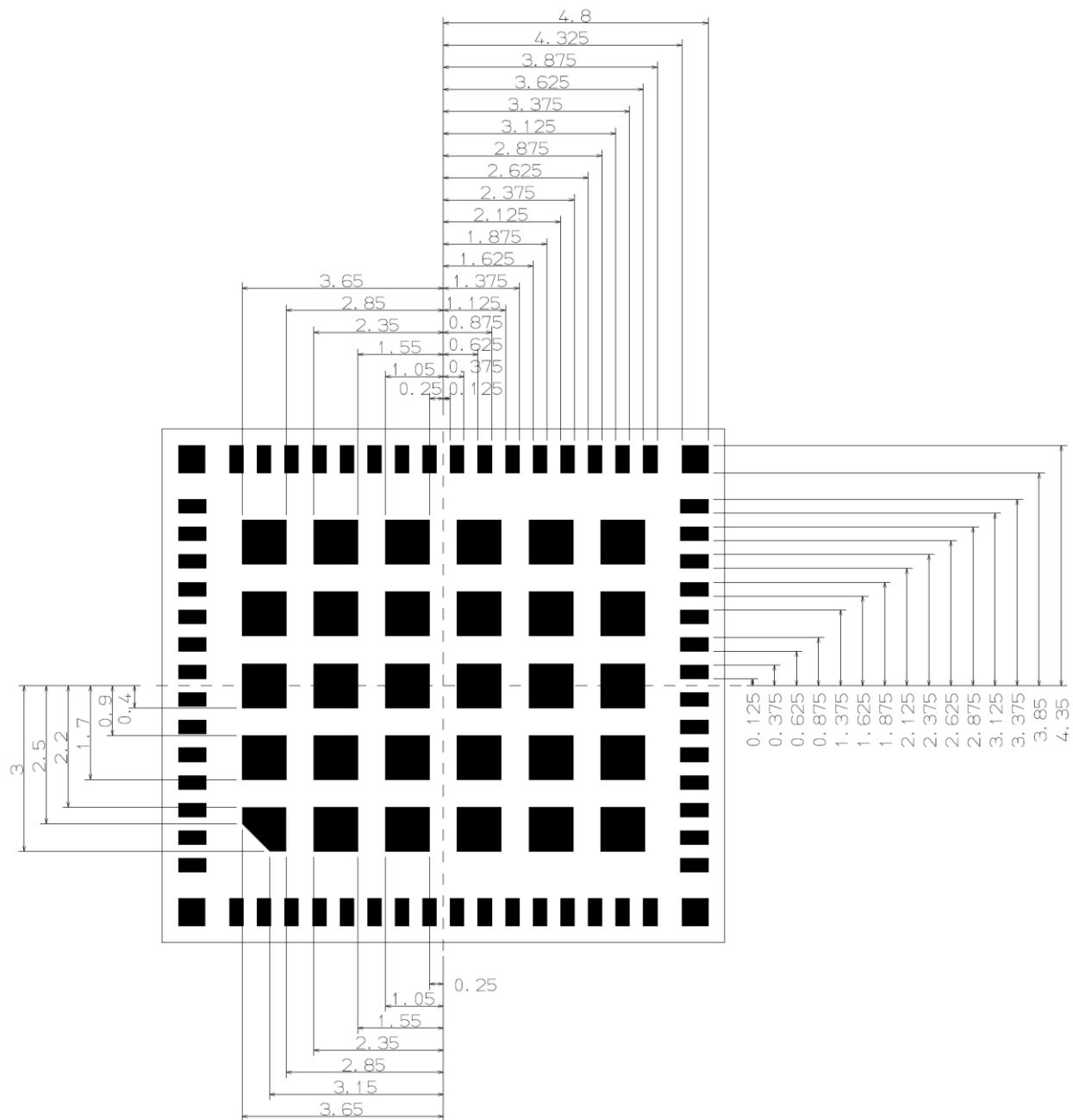
Items	Contents			
Current Consumption	Min.	Typ.	Max.	Unit
1) Tx mode	-	90	110	mA
2) Rx mode	-	60	69	mA
- Tx Characteristics -	Min.	Typ.	Max.	Unit
Center Frequency	2402	-	2480	MHz
Channel Spacing	-	2	-	MHz
Number of RF channel	-	40	-	-
Output power	0	3	6	dBm
In-band emission				
1) f_{TX}+/-2MHz	-	-	-20	dBm
2) f_{TX}+/-[3+n]MHz; n=0,1,2…	-	-	-30	dBm
Modulation Characteristics				
1) $\Delta f1_{avg}$	225	-	275	kHz
2) $\Delta f2_{max}$ (at 99.9%)	185	-	-	kHz
3) $\Delta f2_{avg}$ / $\Delta f1_{avg}$	0.8	-	-	-
Stable Modulation Characteristics				
1) $\Delta f1_{avg}$	247.5	-	252.5	kHz
2) $\Delta f2_{max}$ (at 99.9%)	185	-	-	kHz
3) $\Delta f2_{avg}$ / $\Delta f1_{avg}$	0.8	-	-	-
Carrier frequency offset and drift				
1) Frequency offset (fn); n=0,1,2,3…k	-150	-	150	kHz
2) Frequency drift ($|f_0$-$f_n|$); n=2,3,4…k	-	-	50	kHz
3) Drift rate				
a) $|f_1$-$f_0|$	-	-	23	kHz
b) $|f_n$-$f_{n-5}|$; n=6,7,8,…k	-	-	20	kHz
Spurious Emissions				
1) 30-47MHz (BW=100kHz)	-	-	-36	dBm
2) 47-74MHz (BW=100kHz)	-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)	-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)	-	-	-54	dBm
5) 118-174MHz (BW=100kHz)	-	-	-36	dBm
6) 174-230MHz (BW=100kHz)	-	-	-54	dBm
7) 230-470MHz (BW=100kHz)	-	-	-36	dBm
8) 470-862MHz (BW=100kHz)	-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)	-	-	-36	dBm
10) 1000-12750MHz (BW=1MHz)	-	-	-30	dBm
- Rx Characteristics -	Min.	Typ.	Max.	Unit
Receiver sensitivity (PER < 30.8%)	-	-97	-70	dBm
Maximum input signal level (PER < 30.8%)	-10	-	-	dBm
PER Report Integrity (-30dBm input)	50	-	65.4	%

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12.11.2. 2Mbps PHY Condition

Conditions : 25deg.C, VBAT=3.3V, VIO=1.8V

| Items	Contents			
Current Consumption	Min.	Typ.	Max.	Unit
1) Tx mode	-	88	112	mA
2) Rx mode	-	60	69	mA
- Tx Characteristics -	Min.	Typ.	Max.	Unit
Center Frequency	2402	-	2480	MHz
Channel Spacing	-	2	-	MHz
Number of RF channel	-	40	-	-
Output power	0	3	6	dBm
In-band emission				
1) f_{TX}+/-4MHz	-	-	-20	dBm
2) f_{TX}+/-5MHz	-	-	-20	dBm
2) f_{TX}+/-[6+n]MHz; n=0,1,2…	-	-	-30	dBm
Modulation Characteristics				
1) $\Delta f1_{avg}$	450	-	550	kHz
2) $\Delta f2_{max}$ (at 99.9%)	370	-	-	kHz
3) $\Delta f2_{avg}$ / $\Delta f1_{avg}$	0.8	-	-	-
Stable Modulation Characteristics				
1) $\Delta f1_{avg}$	495	-	505	kHz
2) $\Delta f2_{max}$ (at 99.9%)	370	-	-	kHz
3) $\Delta f2_{avg}$ / $\Delta f1_{avg}$	0.8	-	-	-
Carrier frequency offset and drift				
1) Frequency offset (fn); n=0,1,2,3…k	-150	-	150	kHz
2) Frequency drift ($|f_0-f_n|$); n=2,3,4…k	-	-	50	kHz
3) Drift rate				
a) $|f_1-f_0|$	-	-	23	kHz
b) $|f_n-f_{n-5}|$; n=6,7,8,…k	-	-	20	kHz
Spurious Emissions				
1) 30-47MHz (BW=100kHz)	-	-	-36	dBm
2) 47-74MHz (BW=100kHz)	-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)	-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)	-	-	-54	dBm
5) 118-174MHz (BW=100kHz)	-	-	-36	dBm
6) 174-230MHz (BW=100kHz)	-	-	-54	dBm
7) 230-470MHz (BW=100kHz)	-	-	-36	dBm
8) 470-862MHz (BW=100kHz)	-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)	-	-	-36	dBm
10) 1000-12750MHz (BW=1MHz)	-	-	-30	dBm
- Rx Characteristics -	Min.	Typ.	Max.	Unit
Receiver sensitivity (PER < 30.8%)	-	-97	-70	dBm
Maximum input signal level (PER < 30.8%)	-10	-	-	dBm
PER Report Integrity (-30dBm input)	50	-	65.4	%

13. Land Patterns
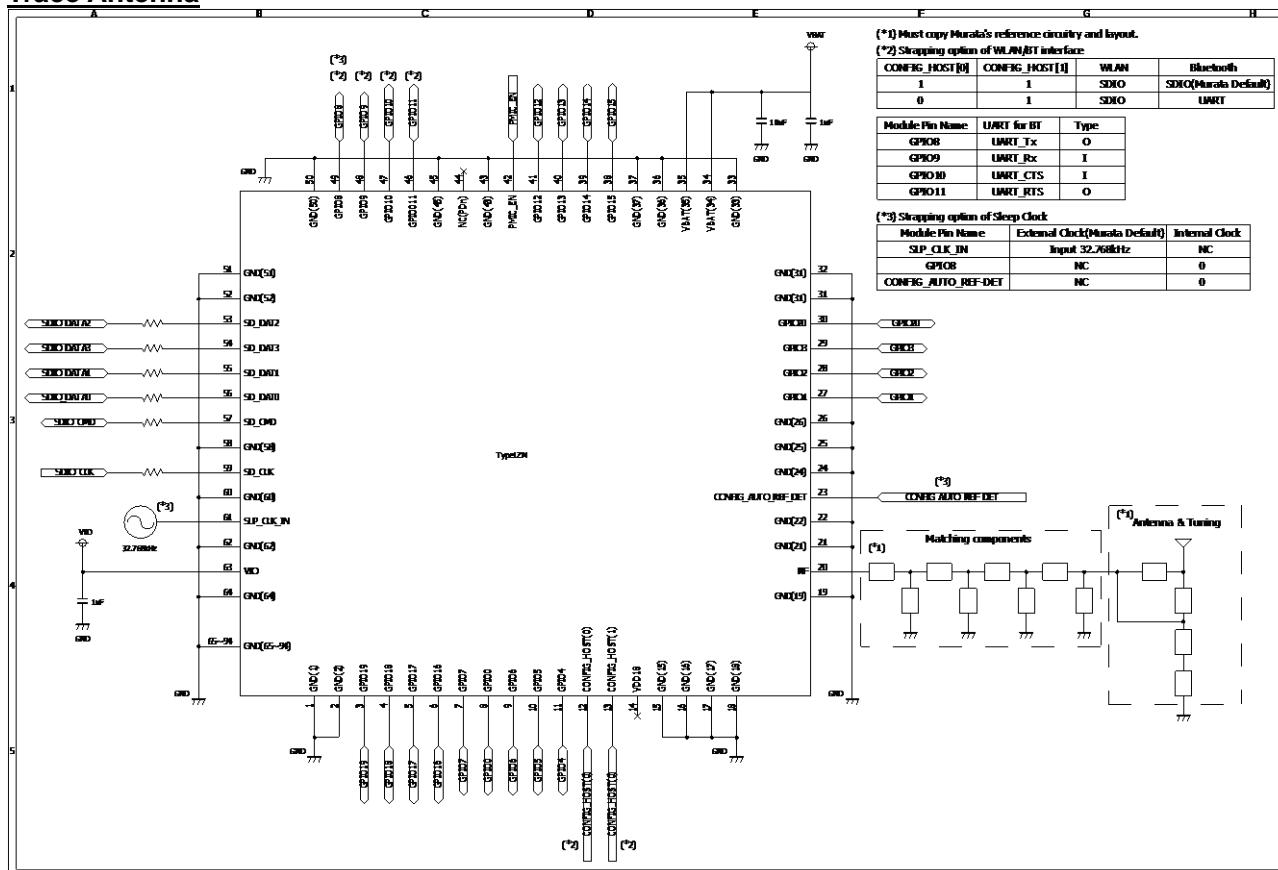
* To avoid the short-circuit between the side shielding and a solder on the module land after the reflow, please locate the module land at 0.2mm away from module outline as above figure.

14. Reference Circuit

U.FL/MHF Connector

(*1) Must copy Murata's reference circuitry and layout.
(*2) Strapping option of WLAN/BT interface

CONFIG_HOST[0]	CONFIG_HOST[1]	WLAN	Bluetooth
1	1	SDIO	SDIO(Murata Default)
0	1	SDIO	UART

Module Pin Name	UART for BT	Type
GPIO8	UART_Tx	O
GPIO9	UART_Rx	I
GPIO10	UART_CTS	I
GPIO11	UART_RTS	O

(*3) Strapping option of Sleep Clock

Module Pin Name	External Clock(Murata Default)	Internal Clock
SLP_CLK_IN	Input 32.768kHz	NC
GPIO8	NC	0
CONFIG_AUTO_REF_DET	NC	0

Trace Antenna

15. Tape and Reel Packing

(1) Dimensions of Tape (Plastic tape)
   *1. Cumulative tolerance of max. 40.0 ± 0.15 every 10 pitches
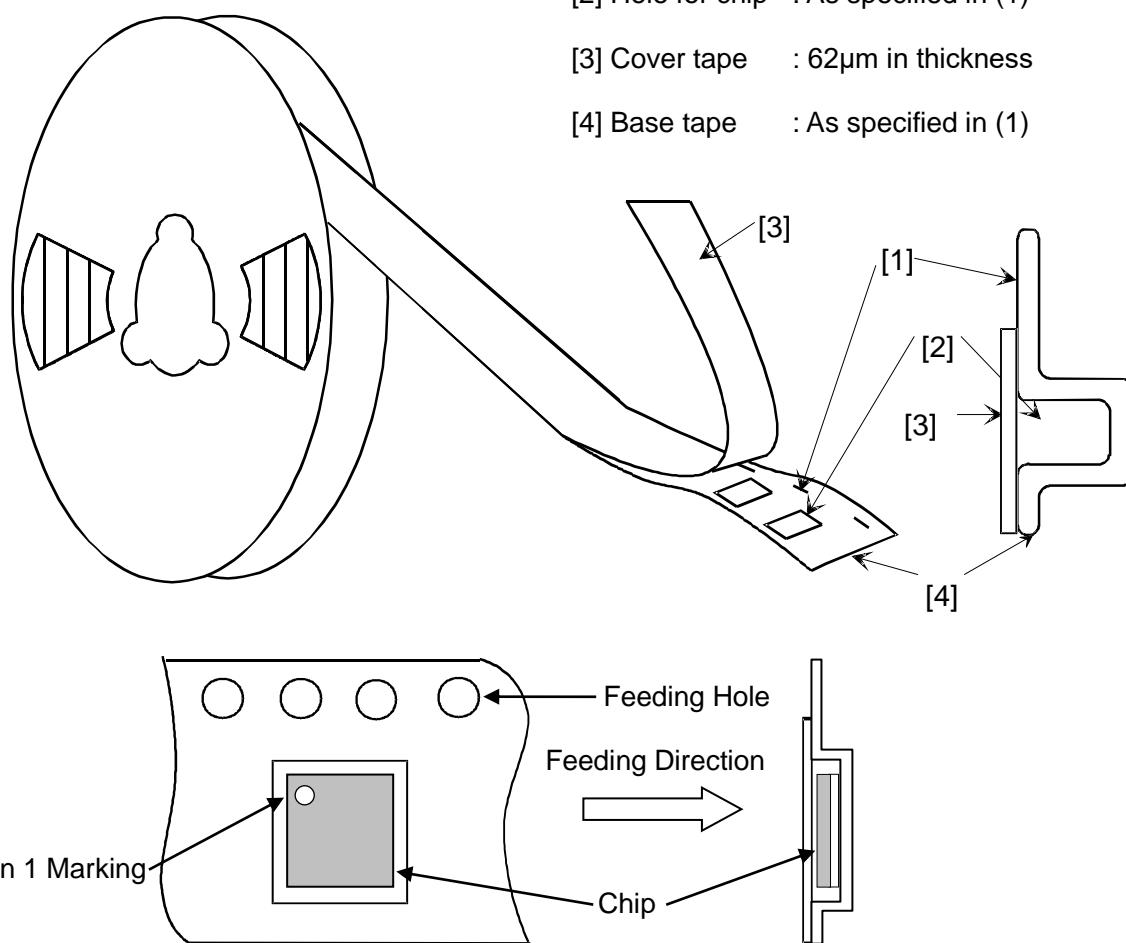
(Unit : mm)

(2) Dimensions of Reel
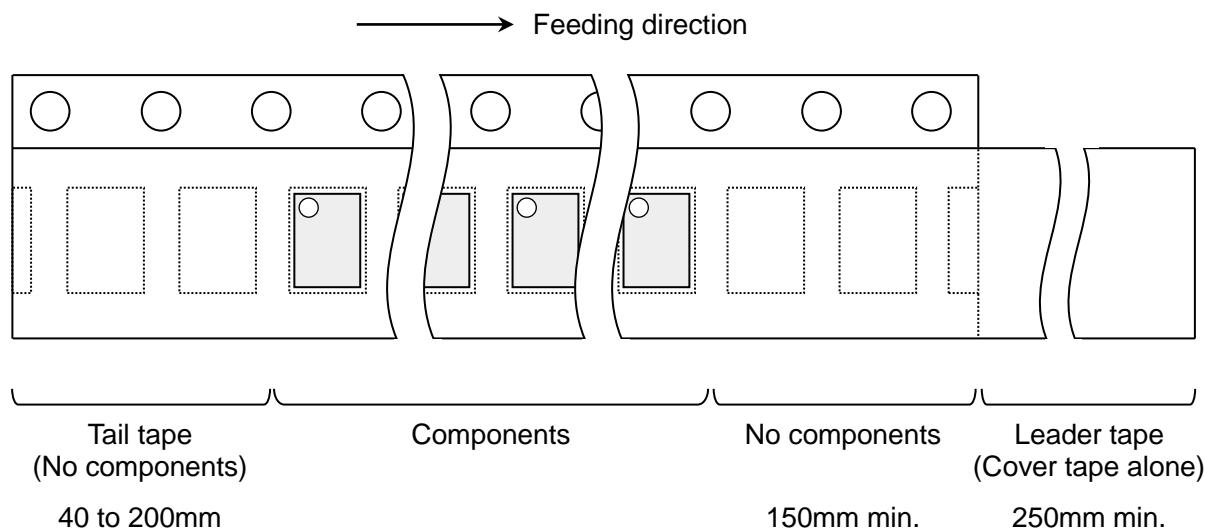
(unit : mm)

(3) Taping Diagrams

[1] Feeding Hole : As specified in (1)

[2] Hole for chip : As specified in (1)

[3] Cover tape   : 62μm in thickness

[4] Base tape   : As specified in (1)

[3]

[1]

[2]

[3]

[4]

Feeding Hole

Feeding Direction

Pin 1 Marking

Chip

(4) Leader and Tail tape

Feeding direction

Tail tape (No components)	Components	No components	Leader tape (Cover tape alone)
40 to 200mm		150mm min.	250mm min.

(5) The tape for chips are wound clockwise, the feeding holes to the right side as the tape is pulled toward the user.

(6) The cover tape and base tape are not adhered at no components area for 250mm min.

(7) Tear off strength against pulling of cover tape : 5N min.
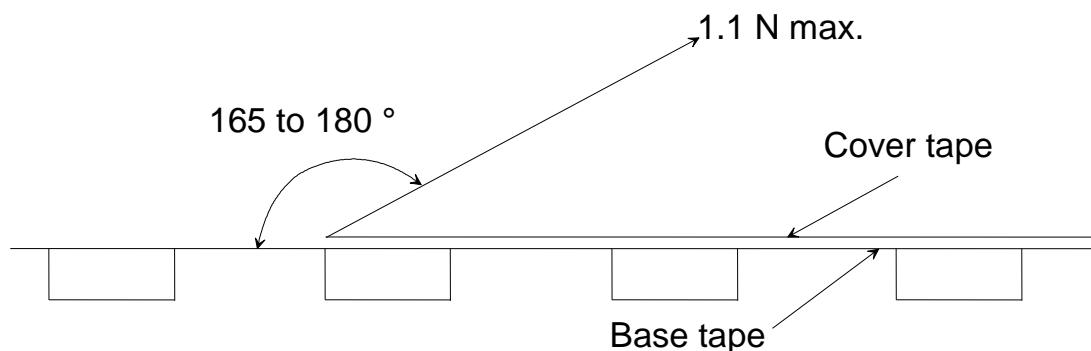
(8) Packaging unit : 1000pcs./ reel

(9) material : Base tape : Plastic
                    Real   : Plastic
                    Cover tape, cavity tape and reel are made the anti-static processing.
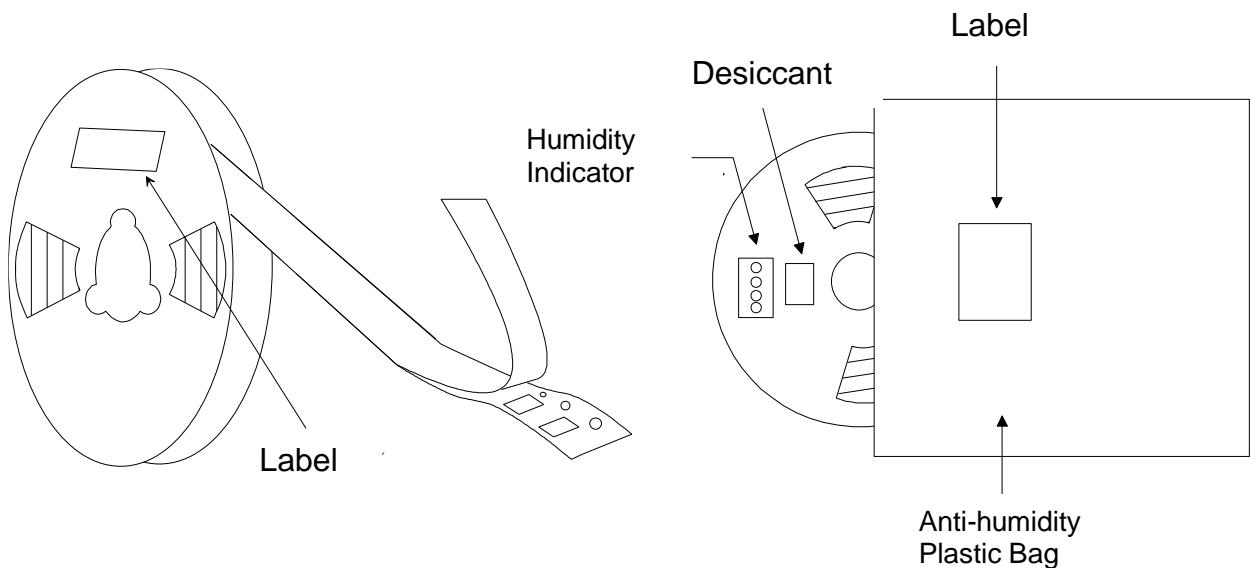
(10) Peeling of force : 1.1N max. in the direction of peeling as shown below.

1.1 N max.

165 to 180 °

Cover tape

Base tape

(11) Packaging (Humidity proof Packing)

Label

Desiccant

Humidity
Indicator

Label

Anti-humidity
Plastic Bag

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

16. Notice

16.1. Storage Conditions:

Please use this product within 6month after receipt.
- The product shall be stored without opening the packing under the ambient temperature from 5 to 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 6months after reception, it needs to be confirmed the solderbility before used.
- The product shall be stored in non corrosive gas (Cl2, NH3, SO2, Nox, 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) are not heat-resistant.

16.2. Handling Conditions:

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

Handle with care if products may have cracks or damages on their terminals, the characteristics of products may change. Do not touch products with bare hands that may result in poor solder ability and destroy by static electrical charge.

16.3. 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.
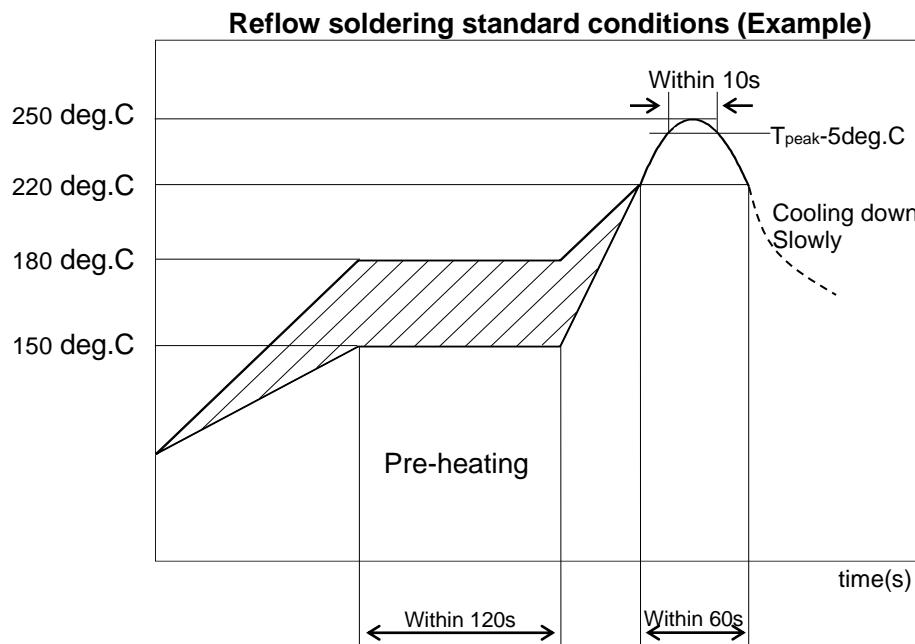
16.4. Notice for Chip Placer:

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.

16.5. Soldering Conditions:

The recommendation conditions of soldering are as in the following figure.
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.

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.

16.6. Cleaning:

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

16.7. 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.

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

17. 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.

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

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

You agree that you will use any and all software or program code (including but not limited to hcd, firmware, nvram, and blob) we may provide or to be embedded into our product ("Software") provided that you use the Software bundled with our product. YOU AGREE THAT THE SOFTWARE SHALL BE PROVIDED TO YOU "AS- IS" BASIS, MURATA MAKES NO REPRESENTATIONS OR WARRANTIES THAT THE SOFTWARE IS ERROR-FREE OR WILL OPERATE WITHOUT INTERRUPTION. AND MORE, MURATA MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED WITH RESPECT TO THE SOFTWARE. MURATA EXPRESSLY DISCLAIM ANY AND ALL WARRANTIES OR CONDITIONS OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE NOR THE WARRANTY OF TITLE OR NON-INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS.

You shall indemnify and hold harmless us, our affiliates and our licensor from and against any and all claims, costs, expenses and liabilities (including attorney's fees), which arise in connection with the using the Software.

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

- Aircraft equipment.
- 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.

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

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

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

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

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

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

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

We disclaim any liability for consequential and incidental damages.

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

APPENDIX

User Manual

FCC

Model Name: LBEE5QD1ZM
FCC ID: VPYLB1ZM

Since this module is not sold to general end users directly, 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)

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove
this RF module in the end user's manual of the end product which integrates this module.
The end user manual shall include all required regulatory information/warning as shown in User manual.

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

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

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.
Please describe in the user's manual and also either describe on the device packaging or on a removable label attached to the device.

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

FCC CAUTION
Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This transmitter must not be co-located or operated in conjunction with any other antenna or transmitter.

When installing it in a mobile equipment.

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 20cm or more away from person's body.

When installing it in a portable equipment.

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

Note)
Portable equipment : Equipment for which the spaces between human body and antenna are used within 20cm.
Mobile equipment : Equipment used at position in which the spaces between human body and antenna exceeded 20cm.

The following two sentences can be included in the manual if these cannot be described in application materials such as operation explanation document.

1. The statement to the effect that if either there is no information to send or there is an operational failure, the device will automatically stop transmission.

<Example Sentence>

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.

2. The statement of the frequency stability as follows.

<Example Sentence>

Frequency Tolerance: ±20 ppm

ISED (IC)

Model Name: LBEE5QD1ZM
IC Number:772C-LB1ZM

Since this module is not sold to general end users directly, 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).

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove
this RF module in the end user's manual of the end product which integrates this module.
The end user manual shall include all required regulatory information/warning as shown in User manual.

The following information must be indicated on the host device of this module.
Contains IC: 772C-LB1ZM

In case of the final product which can be carried around to outdoor. The following indication is necessary to the final product.
・When the STA function is used in channel 52, 54, 58
   At the time of the channel 52 or 54 or 58 setting, please indicate "for indoor use only channel".
   During connecting, please show the channel number which connects.
   And please indicate that the end user may find out "for indoor use only channel".

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

for indoor use only(5150-5250MHz band)
Pour usage intérieur seulement (5150-5250MHz band)

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 licence-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.

When installing it in a mobile equipment.

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 20cm 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.

When installing it in a portable equipment.
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.

Note)
Portable equipment : Equipment for which the spaces between human body and antenna are used within 20cm.
Mobile equipment : Equipment used at position in which the spaces between human body and antenna exceeded 20cm.

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.

This radio transmitter (IC Number: 772C-LB1ZM) has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated.
Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Le présent émetteur radio (IC Number: 772C-LB1ZM) a été approuvé par Innovation, Sciences et Développement économique Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal. Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué pour

Japan

Application Model Name: LBEE5QD1ZM
Certification Number: 001-P01598

R 001-P01598

日本では W52/W53 は屋内使用限定
In Japan, W52/W53 is for indoor use only.

特定無線設備の種別 Classification of Specified Radio Equipment	証明規則第 2 条第 1 項第 19 号の無線設備 2.4GHz 帯高度化小電力データ通信システム Radio equipment for Article 2-1-19 of Certification Ordinance
	証明規則第 2 条第 1 項第 19 号の 3 の無線設備 5GHz 帯小電力データ通信システム（Ⅰ） Radio equipment for Article 2-1-19-3 of Certification Ordinance
	証明規則第 2 条第 1 項第 19 号の 3 の 2 の無線設備 5GHz 帯小電力データ通信システム（Ⅱ） Radio equipment for Article 2-1-19-3-2 of Certification Ordinance

This module is a product that has been authorized construction design certification based on the following Certificate of Construction Type.

"(Warning) In the 5 GHz frequency band, three types of 5.2 GHz / 5.3 GHz / 5.6 GHz bands (W52 / W53 / W56) can be used. Outdoor use of the 5.2 GHz / 5.3 GHz band wireless LAN (W52 / W53) is prohibited by the Certificate of Construction Type."

W53 / W56 for STA function only.

● It is recommended to describe the following contents in the end product or user manual.
　・"This product has built-in specified radio equipment which received construction design certification (certification number: 001-P01598) based on the Certificate of Construction."

　・"The W52 / W53 in the 5 GHz band is prohibited from outdoor use under the Japanese Certificate of Construction Type."

Antenna Installation Manual
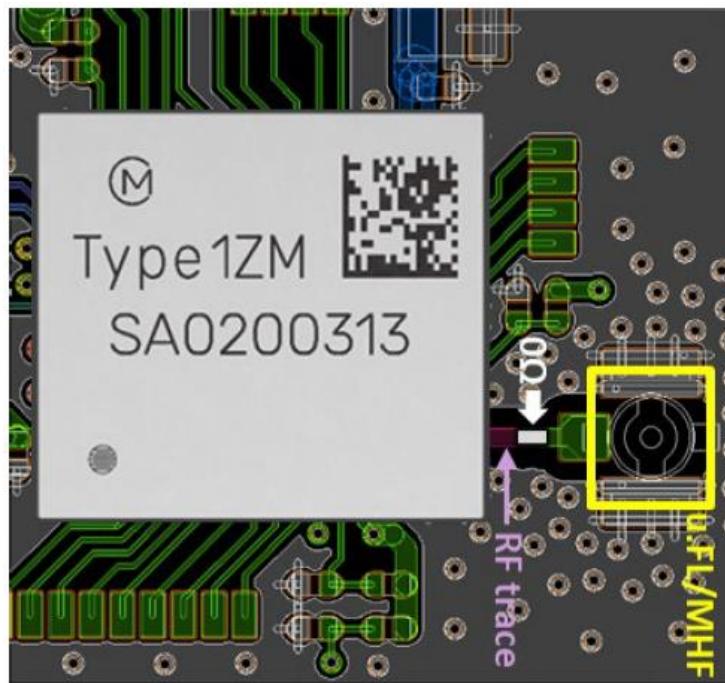
This module is certified with two types of antenna solution by regulatory certification body. To use Murata's regulatory certification, any user must follow below instructions.

PCB Type Di-pole Antenna with the co-axial connector

- Any users must use recommended antennas. However, user can use any equivalent type antenna with less antenna gain than antenna gain of recommended antennas for US and EU under approval of Class I Permissive Change by Murata.
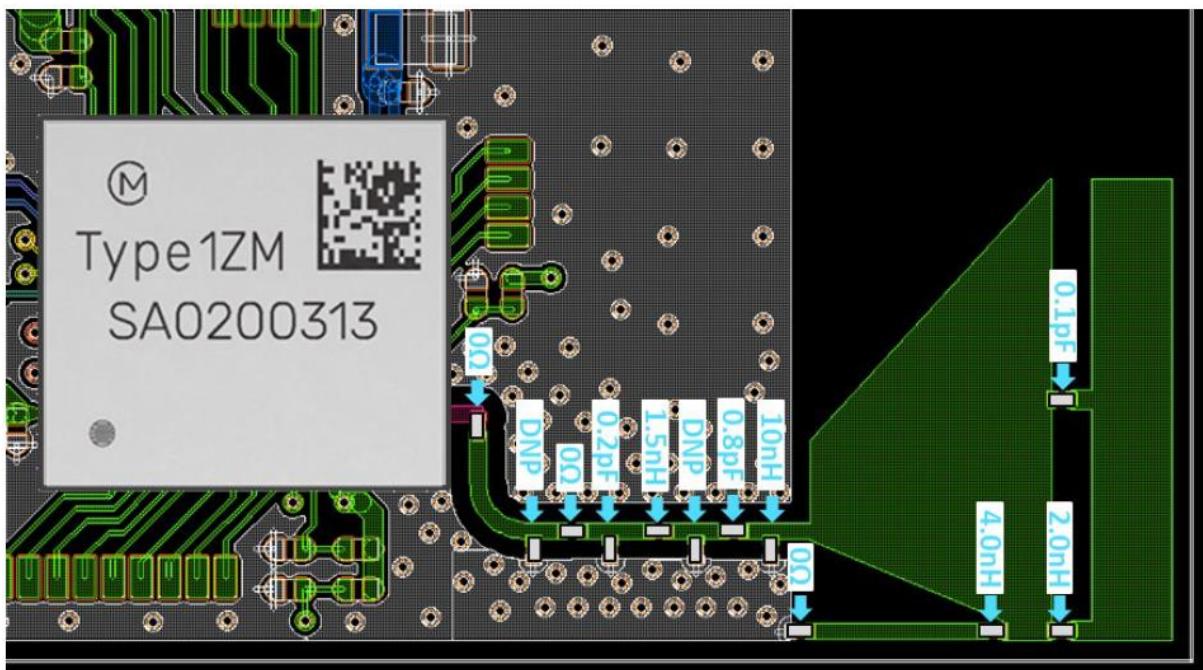
| P/N	Vendor	Form factor	Type	2.4GHz Gain	5GHz Gain	Cable options
146153	Molex	U.FL/PCB	Di-pole	3.2dBi	4.25dBi	050,100,150,200,250 and 300
146187	Molex	U.FL/PCB	Di-pole	3.4dBi	4.75dBi	050,100,150,200,250 and 300

- Any users must copy RF trace to U.FL/MHF connector from the trace layout file provided by Murata; adhering to below guidelines on:
  - Trace width accuracy within +/- 0.25 mm.
  - PCB thickness within 0.6 ~ 1.6 mm range (1.0 mm typ.).
  - Stack height between GND layer and RF trace of 235 um; keeping inaccuracy within +/- 0.5um.
  - Passive component location matching Murata design.
  - Necessary "Keep out" area around U.FL/MHF connector.

Trace Antenna

- Any users must copy antenna design from the antenna layout file provided by Murata.
- Any users must copy RF trace to PCB trace antenna from the trace layout file provided by Murata; adhering to below guidelines on:
  - Trace width accuracy within +/- 0.25 mm.
  - PCB thickness within 0.6 ~ 1.6 mm range (1.0 mm typ.).
  - Stack height between GND layer and RF trace of 235 um; keeping inaccuracy within +/- 0.5 um.
 - Passive component location matching Murata design.
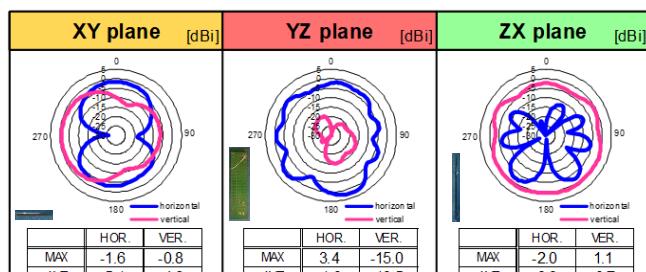

Trace Antenna Performance
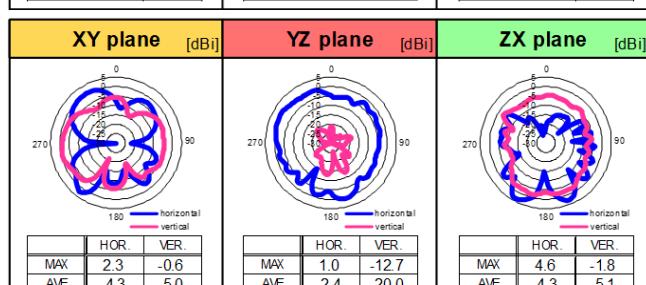
(Gain and Efficiency)

LINEAR POLARIZATION		XY-plane		YZ-plane		ZX-plane		Total Efficiency [dB]
		hor.	ver.	hor.	ver.	hor.	ver.	
2400 MHz	MAX.	-1.6	-0.9	2.6	-16.3	-2.2	1.0	
	AVE.	-4.9	-4.6	-2.0	-20.4	-8.3	-0.9	-1.0
2442 MHz	MAX.	-1.6	-0.8	2.4	-15.0	-2.0	1.1	
	AVE.	-5.1	-4.6	-1.9	-19.5	-8.3	-0.7	-1.0
2484 MHz	MAX.	-1.7	-0.7	2.5	-13.6	-1.7	1.6	
	AVE.	-5.2	-4.5	-1.6	-18.7	-8.2	-0.5	-0.9
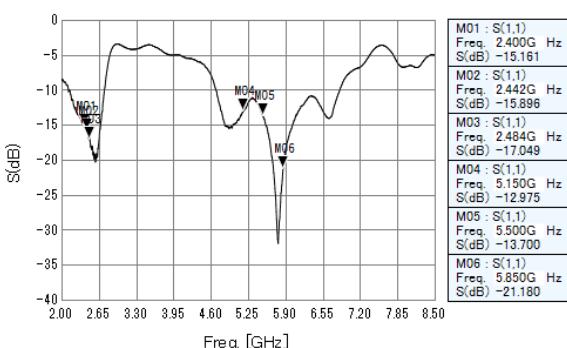
LINEAR POLARIZATION		XY-plane		YZ-plane		ZX-plane		Total Efficiency [dB]
		hor.	ver.	hor.	ver.	hor.	ver.	
5150 MHz	MAX.	2.3	0.1	2.2	-11.4	3.5	-0.2	
	AVE.	-4.1	-4.5	-2.0	-19.2	-3.9	-3.9	-1.3
5500 MHz	MAX.	2.3	-0.6	1.0	-12.7	3.6	-1.8	
	AVE.	-4.3	-5.0	-2.4	-20.0	-4.3	-5.1	-1.6
5850 MHz	MAX.	2.3	-0.7	1.0	-12.9	3.5	-1.6	
	AVE.	-4.1	-5.4	-2.4	-19.8	-4.2	-5.5	-1.5

(Directivity)

XY plane [dBi]	HOR.	VER.
MAX	-1.6	-0.8
AVE	-5.1	-4.6

YZ plane [dBi]	HOR.	VER.
MAX	3.4	-15.0
AVE	-1.9	-19.5

ZX plane [dBi]	HOR.	VER.
MAX	-2.0	1.1
AVE	-8.3	-0.7

XY plane [dBi]	HOR.	VER.
MAX	2.3	-0.6
AVE	-4.3	-5.0

YZ plane [dBi]	HOR.	VER.
MAX	1.0	-12.7
AVE	-2.4	-20.0

ZX plane [dBi]	HOR.	VER.
MAX	4.6	-1.8
AVE	-4.3	-5.1

(Return Loss)

M01 : S(1,1)
Freq. 2.400G Hz
S(dB) -15.161

M02 : S(1,1)
Freq. 2.442G Hz
S(dB) -15.896

M03 : S(1,1)
Freq. 2.484G Hz
S(dB) -17.049

M04 : S(1,1)
Freq. 5.150G Hz
S(dB) -12.975

M05 : S(1,1)
Freq. 5.500G Hz
S(dB) -13.700

M06 : S(1,1)
Freq. 5.850G Hz
S(dB) -21.180

Trace Antenna Installation

● Keep board size and clearance to Metal/GND and Dielectric around the trace antenna for good antenna performance.

Board Size		X ≥ 40 mm Y ≥ 40 mm
Clearance to Metal/GND		A ≥ 20 mm B ≥ 20 mm C ≥ 20 mm D ≥ 20 mm E ≥ 20 mm
Clearance to Dielectric		A ≥ 4 mm B ≥ 4 mm C ≥ 4 mm D ≥ 4 mm E ≥ 4 mm

Configuration Manual

Below files must be applied to satisfy regulatory requirements if user wants to leverage Murata's regulatory certification.

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 (Class1)